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REPORT

A RESEARCH REPORT SUBMITTED TO THE SCHOOL OF PUBLIC HEALTH OF THE UNIVERSITY OF THE WITWATERSRAND IN PARTIAL FULFILLMENT OF THE DEGREE OF MASTERS IN MEDICINE IN POPULATION BASED FIELD EPIDEMIOLOGY.

TITLE:

IMMUNIZATION STATUS AND UNDER FIVE SURVIVAL IN RURAL GHANA.

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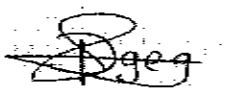
DECLARATION

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



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DATE 22/04/2010

DEDICATION

The work is dedicated to God for his guidance, granting me knowledge and good health to complete this report. This piece is also dedicated with love to my parents Mr and Mrs Nyogea.

ABSTRACT

Introduction

Every year, nearly 10 million children die before their fifth birthday and one half of these deaths occur in Africa. Diseases which are the main causes of mortality in children are diarrhoea, respiratory infections, malaria, malnutrition, congenital conditions, pneumonia, measles, HIV-AIDS and tetanus. The main aim of this study is to investigate the association between immunization status (including hepatitis B and Haemophilus influenza) and survival of children under five in the Kassena-Nankana district of northern Ghana.

Objectives

The objectives of this study were to describe the immunization status in children less than five years, to describe the determinants of immunization status and to investigate the association between immunization status and survival in children aged less than five years.

Methods

The current study used a cohort study design based on the longitudinal data collected by the Navrongo Demographic Surveillance System (NDSS). All children born in 2002 comprised the study population and were followed up until 31st December 2006. A total of 4007 children under-five were included in the study. About 1247 were lost to follow-up due to permanent migration out of the study area. About 184 died before attaining age five. Immunization was categorized into three groups; "no immunization", "partial immunization" and "full immunization" (those who received all the recommended vaccines). We used percentages, logistic regression and Cox proportion hazards methods to address the three objectives.

Results

Immunization coverage rates were high for the first vaccine doses and declined subsequently, suggesting that mothers in rural areas were less likely to ensure that children were fully immunized. Fifty five percent of all children were fully immunized, 21.7% were partly immunized and 23.2% were not immunized at all. Significant determinants of full immunization in multivariate analysis were unmarried mothers [OR=0.49, 95%CI: 0.34-0.69, P-Value<0.001], rural residence [OR=0.56, 95%CI: 0.37-0.93, P-value<0.001], maternal age [20-29: OR=0.69, 95%CI: 0.48-0.98, P-value=0.043. 30-39: OR=0.70, 95%CI: 0.53-1.18, P-value=0.102. 40+: OR=0.64, 95%CI: 0.43-1.15, P-value=0.090] and being a migrant [OR=0.39, 95%CI: 0.32-0.47, P-value<0.001] compared to no vaccination, partial immunization [HR=0.64, 95%CI: 0.36-1.05, P-value=0.077] and full vaccination [HR=0.52, 95%CI: 0.30-0.84, P-value=0.010] were inverse predictors of child mortality, as well as age of the child and household socio-economic status. Mothers maternal age was a risk factor for child mortality.

Conclusion

Factors associated with children's immunization status were maternal age, migration status, marital status and place of residence. Full immunization was shown to be associated with high child survival and variables that tend to influence this significantly were mothers maternal age, child age, marital status and socio-economic status. Partial immunization was non-significantly inversely associated with childhood mortality. This implies that efforts should be intensified to ensure full immunization for infants and children.

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Table of Contents

LIST OF TABLES

LIST OF GRAPHS

LIST OF APPENDICES

LIST OF ACRONYMS AND ABBREVIATIONS

WHO: World Health Organization.

DPT: Diphtheria-Tetanus-Pertussis (DPT) Vaccine

OPV: Oral Polio Vaccine.

UN: United Nations.

EPI: Expanded Programme on Immunization.

MDG: Millennium Development Goals

NDSS: Navrongo Demographic Surveillance System.

BCG: Bacillus Calmette-Guerin.

DSS: Demographic Surveillance System.

INDEPTH NETWORK: International Network of Field Sites with Demographic Evaluation of Populations and their Health.

Hib: Hemophilus Influenza.

Hep B: Hepatitis B.

ORT: Oral Rehydration Therapy.

NHRC: Navrongo Health Research Centre.

GSS: Ghana Statistical Services

CHAPTER ONE

1.0 INTRODUCTION

Every year, nearly 10 million children die before their fifth birthday and one half of these deaths occur in Africa (UNICEF 2008) . In the USA, there has been a 99% decrease in incidence for diseases for which vaccines have been recommended for decades, accompanied by a similar decline in mortality and disease sequelae (Andre et al. 2008).

According to a report by Elguero in 2007, five African countries that are predominately north of the Sahara desert, namely Algeria, Egypt, Libya, Morocco and Tunisia reduced their child mortality rates by at least 45% between 1990 and 2006, putting them on track to meet the Millennium Development Goal child survival target of reducing under-five mortality by two thirds by 2015. In sub-Saharan Africa, however under-five mortality only decreased by 14% between 1990 and 2006 with one in every six children dying before their fifth birthday, thus sub-Saharan Africa remains the most difficult place in the world for a child to survive (Elguero et al. 2006).

Immunization is attaining increasing coverage in the WHO Africa Region, making it attractive for add-on activities that would benefit from raised coverage. Coverage for the third dose of diphtheria/tetanus/pertussis (DTP) vaccine increased from 54% in 2000 to 66% in 2004. Coverage for the third dose of DTP is the commonest way of expressing coverage for a district, province and nation. In 2004, 22 countries in the African Region achieved DTP-3 coverage of at least 80%. An additional six countries achieved DTP coverage between 70% and 79% (Clements, Nshimirimanda, & Gasasira 2008).

In Ghana, the coverage rate for bacillus calmette-guerin (BCG) is 90% and the coverage for the first dose of DPT and Polio are high, coverage declines for subsequent doses of DPT and

polio with only 80% of children receiving the recommended 3 doses of these vaccines. Drop out rates are 12% and 15% for DPT and polio respectively. About 83% of children receive measles vaccine (DHS, 2003). In the Upper East region infant and child mortality have declined in recent years with an even more pronounced mortality decline in the Kassena-Nankana District (Phillip et al, 2005). Although global immunization coverage has increased during the past decade to levels of around 78% for diphtheria–tetanus–pertussis-3 (DPT-3), WHO's African Region has consistently fallen behind, reaching only 69% DTP-3 coverage by 2004 (Arevshatian L et al. 2007). Based on these observations, this study aimed to investigate the association between immunization status and survival of children under five in the Kassena-Nankana district of northern Ghana.

1.1 STATEMENT OF THE PROBLEM

Children under five years are very vulnerable to diseases as their immune system is not strong enough to fight effectively against childhood diseases. Children born in Africa therefore face the worst conditions of surviving the first five years against these childhood diseases. Challenges to improve the survival of children under the age of five years in the midst of effective interventions are distance to health facilities, lack of motivation for staff, parents/guardian ignorance of immunization, lack of political will and lack of sufficient funds to finance the process.

Though vaccinations against these childhood diseases through routine Expanded Programme on Immunization (EPI) are the most effective in ensuring the survival of children under five, lack of methodological approaches to studies on vaccination status and child survival has not resulted in a robust demonstration of the impact of the various vaccines on child survival and the impact of these factors on immunization access.

For example a study done by J Vaugelade et al (2004) in Burkina Faso in 2004 did not take into account oral polio vaccine (OPV) and those who were partially immunized. Similarly a study conducted in Senegal by Elguero et al (2005) did also not include OPV vaccine. These studies therefore failed to demonstrate the influence of the recommended childhood vaccines on childhood survival.

This study aims to add knowledge on the association of partial and full immunization to childhood mortality and through advocacy help improve policies aimed at reducing mortality in children under five and hence fulfil the MDG4 goal.

1.2 LITERATURE REVIEW

1.2.1 Under five mortality

Although child mortality has been decreasing over the past 40 years, the global child mortality rate is still 12 times higher than the rate for industrialized countries (72 per 1,000 live births versus 6 per 1,000 live births, respectively). In many developing countries, it is 25 to 30 times or more as high (UNICEF 2008). On average under five mortality rates (U5MR) fell by 65% between 1960 and 2000 around the world. In some countries like the United Arabs Emirates, the U5MR decreased by 95% (from 223 to 5 per 1000 live birth) (Adentuji J 2000) during this period.

Despite recent improvements in child survival in Ghana, mortality levels are still very high. The estimated infant mortality rate in Ghana is 64 per 1,000 live births while U5MR is 111 per 1,000 live births (DHS 2003). In rural settings where health services are not accessible to a large proportion of the population, the situation is even worse.

In the Kassena-Nankana district, a typical rural Guinea savannah area, infant and under-5 mortality rates for 2003 were 85 and 83 per 1,000 live births, respectively (Binka et al, 2005).

Namibia for instance had infant and under-five mortality rates of 55 and 67 respectively (UNDP 2003) in 2001 and thus considerably lower than that of Kassena-Nankana. In this region infant mortality rate and under five mortality rate have dropped from 81.5/1000 and 155.3/1000 respectively in 1998, to 33/1000 and 79/1000 in 2003 (UNICEF 2004).

1.2.2 Causes of under-five mortality

Globally, diseases which are the main causes of mortality in children are diarrhoea, respiratory infections, malaria (which is endemic in 90 countries half of them in Africa) malnutrition, congenital conditions, pneumonia, measles, HIV-AIDS and tetanus. Others include injury, infectious diseases (such as pertussis, meningitis, tuberculosis diphtheria and hepatitis B), non-communicable diseases (such as digestive, epilepsy and asthma,) and nutritional deficiencies (such as protein-energy malnutrition and lack of vitamin A). The underlying factors are poverty, hunger, easily preventable diseases and illnesses, and other related causes. In spite of the scale of this daily/ongoing catastrophe, it rarely manages to achieve, much less sustain, prime-time, headline coverage (Shah 2009).

In sub-Saharan Africa, HIV-AIDS, malaria, tuberculosis and war are the main causes of deaths. AIDS remains one of the leading causes of death among children under the age of five years in the region (Dorrington R.E, Bradshaw D, & Budlender D 2004). Malaria is hyper endemic in Ghana and remains the major cause of morbidity and mortality among children under five years of age. The disease contributes to 44% of all outpatient visits to health facilities (2004 Annual report NMCP). In the Upper East region of Ghana, an average of 225 children under-five years die each year from malaria in hospitals and most other deaths are malaria related. Other causes are anaemia (mostly malaria-related), diarrhoea, malnutrition and measles (UNICEF 2004).

In Kassena-Nankana childhood mortality remains high, infectious diseases are the predominant cause of deaths in the district; all causes of childhood illness have declined, including malaria, diarrhea diseases, acute respiratory infections, and immunizable diseases (Adjuik M et al. 2006). Despite these achievements, further substantial work is needed to improve child survival.

1.2.3 Immunization status and child survival

Pre-exposure vaccination of infants with several antigens is the cornerstone of successful immunization programmes against a cluster of childhood diseases (Andre et al. 2008). The benefits of vaccination extend beyond prevention of specific diseases in individuals. They enable a rich, multifaceted harvest for societies and nations. Vaccination makes good economic sense, and meets the need to care for the weakest members of societies. Reducing global child mortality by facilitating universal access to safe vaccines of proven efficacy is a moral obligation for the international community as it is a human right for every individual to have the opportunity to live a healthier and fuller life (Andre et al, 2008). Extensive scientific evidence also demonstrates that low-cost vaccines are effective in reducing childhood mortality (Nyarko P, Pence B, & Depbuur C 2001).

Vaccines are the most effective protection against most diseases caused by viruses and related organisms, because few antibiotics work against them. Immunization in early childhood offers protection against childhood diseases (Cooper et al. 2003). The risk of dying for children younger than five is reduced by more than 70 percent among those who are fully immunized compared with those who are not. Partial immunization also prevents mortality (Bawah A et al. 2006).

It has also been said that disease may occur in previously vaccinated individuals. Such breakthroughs are primarily due to vaccine failure. In such cases, the disease is usually milder than in the non-vaccinated (Andre et al. 2008).

Understandably, vaccine safety gets more public attention than vaccination effectiveness, but independent experts and WHO have shown that vaccines are far safer than therapeutic medicines (Andre et al. 2008).

Vaccines also protect against diseases beyond the targeted disease. For example, in Finland, USA and elsewhere, influenza vaccination has been found protective for acute otitis media in children, with a vaccine efficacy of more than 30%. Measles vaccination protects against multiple complications such as dysentery, bacterial pneumonia, keratomalacia and malnutrition. An enterotoxic Escherichia coli vaccine demonstrated protection against diarrhoea due to Salmonella enterica (Andre, Booy R, Bock HL, Clemens J.Datta, & K.John 2008).

The coverage rate for fully immunized children in Ghana has increased from 47% in 1988 to 55% in 1993 to 62% in 1998 and further up to 69% in 2003 (DHS 2003). This has considerably reduced morbidity and mortality caused by vaccine preventable diseases in children. Immunization against the six childhood diseases is one of the effective ways of protecting the children against infection and subsequently death (Debpuur et al. 2005).

Although national coverage rates in Ghana are higher than in other West African countries, with most of the vaccinations exceeding 80 percent coverage, pronounced differences exist within the country by region and district (GSS 2004). These existing differentials in health status and health service utilization are generally seen as unnecessary, needless and unfair (Debpuur, Wontuo, Akazili James, & Nyarko Philomena 2005).

1.2.4 Programmes for under-five child survival in Ghana

Improving childhood vaccination coverage is a key health policy objective in Africa. Two thirds of under-five deaths could be prevented by interventions that are available and affordable in low income countries today (Jones et al. 2003). Ghana has implemented several programmes to improve under-five survival in the country. This include Expanded Programme on Immunization (EPI) which was launched in 1978, Roll back Malaria initiative in 1998, Abuja targets set in 2000, Accelerated Child Survival Development (ACSD) program in 2002 and apart from those, Ghana has also set aside one week in May every year to promote child health and to distribute insecticide treated nets.

The Expanded Program on Immunization (EPI) was launched in Ghana in 1978 and has since 1985 been operational in all 10 regions and all districts in Ghana.

The Accelerated Child Survival development (ACSD) project was initiated by UNICEF in 2002 in Upper East region and later in four districts in the Northern region to scale up delivery of cost effective child-survival interventions. Key components of the strategy were to define a package of cost effective interventions, train community-based volunteers and social support groups, provide logistics and introduce new interventions. The interventions were repacked "EPI plus", "ANC plus" and "IMCI plus" which became later packages for introducing new interventions:

(a) "EPI plus" added vitamin A supplementation, de-worming and defaulter tracing to routine EPI interventions.

(b) "ANC plus" added ITN and intermittent preventive treatment (IPT) to routine antenatal care.

(c) "IMC plus" added home-based care for fevers as well as ITN use.

The one week set aside by the government of Ghana in May each year to promote child health involves providing a package which includes insecticides-treated nets (ITNs) distribution and re-treatment using community-based agents and organizations, immunization, oral rehydration therapy (ORT) administration as well as birth registration.

Monitoring the progress in child survival requires monitoring of immunization status and its impact on mortality. Routinely collected information on immunization in smaller areas will provide trend analysis of immunization status of children and survival and hence will provide a platform for informing policy.

1.2.5 Theoretical framework

Reduction of survival probability of under-five is due to integration of social, biological, economic factors, public health interventions (such as immunization), demographic and environmental forces. Socio-economic determinants operate through more basic proximate determinants that in turn influence the risk of disease and the outcome of disease processes. Specific diseases and nutrient deficiencies may be viewed as biological indicators of the operations of the proximate determinants. One intervention factor is childhood vaccination. Social factors are place of residence, parity, marital status, and migrations status. Demographic factors are maternal age and the age of the child (at the time of death). Mortality in children is the cumulative consequences of multiple processes. Only infrequently is a child death a result of a single isolated disease episode (Henry M & Lincoln C 1984).

Married women are more likely to take their under-five year old children to be immunized due to the combined decision of the two parents and are also more likely to cover costs associated with vaccination. These in turn will increase the survival chances of the child.

Place of residence is expected to influence the uptake of vaccines and prevent deaths as hospitals and health centres are usually in closer proximity to peoples in urban residences than rural residences.

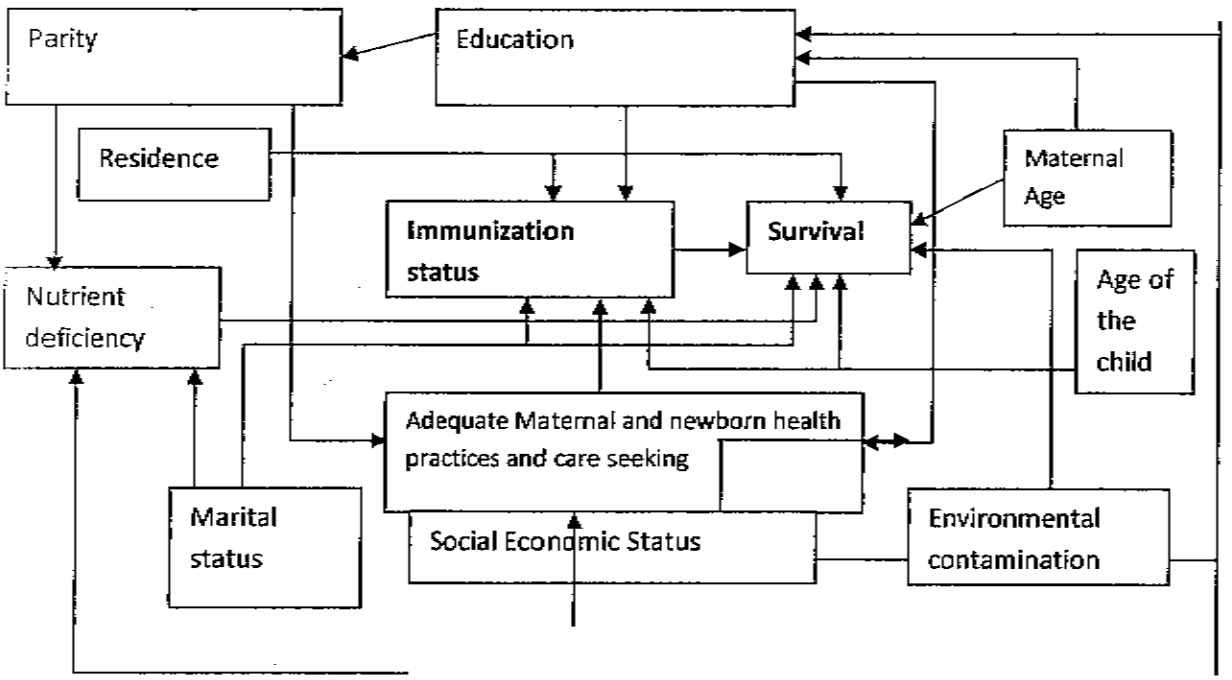
It is expected that as a child grows older, he/she will be fully vaccinated and body immunity against diseases will increase and hence less deaths will be expected.

A mother who has higher education and also adequate maternal and newborn health practices is more likely to take the child to be vaccinated and thus improve the chances of the child survival.

Mothers' Personal illness control can be influenced by both by socio-economic status and education level of the mother and thus lead to immunization of their children.

Birth order can tell how many children in the house the mother is supposed to take care of and if a mother is from a poor family and having many children, it is more likely that the children will have nutrient deficiency and also less likely to take the child to be immunized and their survival will be risked. The number of children the mother has had can affect adequate maternal and new born health practices and care seeking which will influence the mother to take the child to be vaccinated.

Figure 1: Conceptual framework



1.3 VACCINATION SCHEDULE

National EPI Policy of Ghana is that each child should receive one dose of BCG at birth, three doses of DPT-Hemophilus influenza and Hepatitis B (Hib & Hep B) at 6, 10 and 14 weeks, 3 doses of OPV at birth, 6, 10 and 14 weeks, one dose of measles at 9 months. Every

woman of childbearing age between 12-44 years should receive 5 doses of tetanus toxoid. In 2002, Ghana replaced DPT in the scheme with the pentavalent vaccine (DPT-Hib-HeB).

In this study, those who did not receive any vaccine were classified as "no vaccination", those who received partial BCG/OPV/DPT and measles series vaccine were classified as "partial vaccination" and those who received both BCG/OPV/DPT and measles vaccine were classified as "full vaccination".

1.4 RESEARCH GAP

Research from other studies has demonstrated significant reductions in mortality associated with measles immunization programs (Aaby 1995). Hepatitis B (Hep B) and Hemophilus Influenza (Hib) vaccines were introduced in Ghana in 2002 and no study has assessed their effectiveness in the country. This study assesses this new pentavalent intervention together with other vaccines. The study further explores if those children who received several vaccine doses (Partial vaccination) and those who received all vaccines dose had a decreased mortality risk compared to those who did not receive any vaccine

This study furthermore aims also to elucidate whether the association between vaccination status and child survival is biological or due to other factors such as socio-economic status (which is related to parental concern and access to medical care).

1.5 AIM OF THE STUDY

To investigate the association between immunization status and survival of children under five in the Kassena-Nankana district of northern Ghana.

1.6 OBJECTIVES

1. Describe the immunization status in children aged less than 5 years in the

   Kansena-Nankana district of northern Ghana.

2. Describe the determinants of immunization status in children aged less than 5 years in Kassena-Nankana.
3. Investigate the association between immunization and survival in children aged less than five years in Kassena-Nankana.

CHAPTER TWO: METHODOLOGY

2.0 Introduction

This chapter shows the methods and analyses approaches done in this study. It shows the study design, study area, sample size, inclusion and exclusion criteria and data analysis plan.

2.1 Study Design

The current study is a secondary data analysis of longitudinally prospectively cohort data collected within the Navrongo DSS framework.

2.2 Study area

The study was conducted in the Kassena-Nankana district of northern Ghana. The Navrongo Demographic Surveillance System (NDSS) is located in the Kassena-Nankana District of the Upper East region of Ghana. It measures roughly 50 km long and 55 km wide and has an altitude of 200m-400m above sea level. Located in the Guinea Savannah belt, the district's ecology is typically Sahelian (hot and dry), with the vegetation consisting mostly of semi-arid grassland interspersed with short trees. There are two main climatic seasons, the wet and dry seasons. The wet season extends from April to October, with the heaviest rainfall mainly occurring between June and October. The mean annual rainfall is 1365 mm but the highest level is recorded in August.

2.3 The Demographic Surveillance System and data generation for this Study

The NDSS was established in the year 1993 by the Navrongo Health Research Centre to support research studies and to provide a means for testing various health interventions. The NDSS routinely updates vital events (births, deaths, migration, marriages and pregnancies) in all the approximately 14,200 compounds within the study area. All vital demographic events occurring within the district are updated through regular visits to each compound every 90

days. Where a death has occurred, the compound is revisited to obtain information on the circumstances leading to the death. These verbal post-mortems are conducted using different schedules for children and adults.

Trained field supervisors visit each compound where a death has been reported and administer the appropriate verbal autopsy questionnaire to the closest relative of the deceased. Three medical doctors code these questionnaires independently to determine the probable cause of death. Where at least two doctors agree on one diagnosis, it is accepted as the cause of death. When there are some disagreements, the case is coded as undetermined and is set aside for further discussion.

In addition to the vital events there is an annual monitoring of education attainment and vaccination coverage within the population. Information on the vaccination status of children aged two years, as well as the educational attainment of those aged 7 years and above, are updated once every year.

2.4 Study population and sample size

All children born between 01/01/2002 and 31/12/2002 in NDSS were included in the current study.

This study included 4007 children aged under-five years. About 2301 under-five year old children (57.4%) entered the study by birth and 1706 (42.6%) children under-five entered by migrating to the DSS area.

2.4.1 Inclusion and exclusion criteria

All children born in 2002 were included in the study. Children who were born elsewhere and migrated into the study area were also included as long as they had a vaccination card or any written document and were less than 2 years at the time of the survey. To give children time

to be fully vaccinated and time to be evaluated for the vaccines, only children who were aged 12 months or above 12 months of age were included in the current analysis.

2.5 Data collection

All vital demographic events occurring within the district are updated through regular visits to each compound every 90 days. During these 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 birth and death reporting, in particular by capturing neonatal deaths. Data are collected on births, deaths, in- and out-migration, marriages, and pregnancies. Also included in the database is basic demographic information such as sex, dates of events, and relationships of household members. The NDSS data collection includes a socioeconomic module, which lists compound possessions and the materials used in constructing the building.

2.5.1 Collection on vaccination information

Data on vaccination status has been collected annually since 1996 for children less than 2 years of age at the time of interview. The interviewer records dates of vaccination only if the mother has a health card or some other written record of the date and the vaccination given. This means that some of the children classified as not vaccinated may in fact have received vaccinations but lost their health cards by the time of the survey.

Three indicator group variables on immunization status were generated from individual vaccine uptake variables to assess the association between immunization status and child survival. These are:

1) **No vaccination**

For those children who did not get vaccinated at all against (neither BCG/OVP/DPT

series nor measles).

2) Partial vaccination

This group consists of those children who received an incomplete BCG/OPV/DPT series and measles vaccine.

3) Full Vaccination

This variable includes those with complete BCG/OVP/DPT series and those who received measles vaccine.

Children with no information on home visit were neither included in these classifications and were neither part of the analysis.

2.5.2 Measurement of socio-economic status

Socio-economic status was assessed by constructing a house hold 'wealth index' based on household asset ownership as proposed by Filmer and Pritchett (2001). This approach uses the principal component analysis (PCA), which involves a mathematical procedure that transforms a number of correlated variables into a smaller number of uncorrelated variables, thus allows variables that are collinear to be grouped together to form a composite index capable of representing the group of variables itself. This method is based on the formula $A_j=f_1*(a_{j1}-a_1)/(s_1)+\ldots.+f_N*(a_{jN}-a_N)/(s_N)$ where f_1 is the 'scoring factor' for the first asset and a_1 and s_1 are the mean and standard deviation of the first asset variable over all households.

Based on the constructed index, households were classified into wealth quintiles, rated as poorest, poorer, poor, less poor and least poor. The component explained 18.2% of the total variability and the greatest weight was given to ownership of electricity (0.30), fan (0.28) and refrigerator (0.28). Variables like owning land, bed net and cattle had negative scoring factors. The first four Eigen values were 7.3, 3.34, 2.1, and 1.5 and accounted for 18%, 8%,

5% and 3% respectively. Information on SES (wealth index) was available for 3383 households (84% of the sample population).

2.5.3 Data processing

Data processing was done using the Household Registration System (HRS2). Data was extracted; cleaned and edited using Fox Pro software. STATA software version 9 was used for analysis. To transfer data from FoxPro format to Stata format, Stat transfer (version 7) was used. Coding, editing and merging was done using Stata software version 9.

2.5.4 Data analysis

A total of 4503 children born between 01/01/2002 and 31/12/2002 were included in the study. About 2764 children were recruited by birth and 1739 migrated into the study area. About 496 children under-five were less than 12 months of age and hence were excluded from the analysis investigating immunization status and determinants of full immunization. Of the total number, 4007 children were included in the analysis. About 1247 children were lost to follow-up due to permanent migration out of the study area. This left 2460 children of whom 184 died before attaining age five to investigate the association between immunization status and survival in children under age five.

Descriptive analysis of demographic and baseline socio-economic characteristics of children was done by immunization status and vital status. Drop out rates were calculated to find the proportion that took the first vaccine of DPT/Polio but did not go to the third vaccine of DPT/Polio. Immunization levels were reported by use of percentage of study participants completing certain levels of immunizations. For categorical variables, the association between baseline characteristics and immunization status was assessed by use of chi-square statistic. All the tests were at 5% level of significance. To establish factors that determine full immunization status, logistic regression analysis was used. Outcome was coded:

(1) Full immunized children.

(0) None/partial immunized children.

Kaplan-Meier survival functions were used to examine differences in child mortality according to vaccination coverage, socio-economic and demographic factors. The association between vaccination status and mortality was assessed by Cox proportional hazards model with follow-up time in the study as the underlying time variable. Time of follow up was between one year and five years. To control for confounders' statistical modelling (Multivarate) was used.

2.6 Study variables

The study variables used in this study were:

Sex of the child, age of the child (in months), mother's maternal education, socio-economic status, mothers maternal age, marital status of the mother, immunization status, vital status (death/alive), place of birth, number of live births, household size, birth order, migration status and mother's residence.

2.6.1 Outcome variable

The outcome variable in this study was vital status. Vital status was coded "1" for died and "0" for alive.

2.6.2 Confounders

Suspected confounders considered were socio-economic status, mother's age, mothers' level of education, marital status, migration status and sex of the child. Statistical modelling was employed to deal with the confounders. The criterion used to include variables in the multivariate analysis was a manual process (confirmatory approach) based on how the variables improved the final model.

Table 1: Variable list and definitions used in the study.

No	Variable	Definition
1	Immunization status.	None (0), Partial (1), Full (2).
2	Vital status	Dead (1) Alive (0).
3	Mother's age at birth (years).	<20 (1) 20-29 (2) 30-39 (3) 40+ (4).
4	Mother marital status.	Married (1) Not married (2).
5	Education level of the mother.	None (0) Formal (1)
6	Place of birth.	Hospital/Clinic (1) Home/TBA/Others(2).
7	Live births.	One (1) Two (2).
8	Household size.	1-6 (1) 7-12 (2) >13 (3).
9	Migration status	Residents (1) Migrants (2)
10	Sex.	Females (1) Males (2).
11	Birth order.	First (1) 2nd or 3rd (2) 4th of 5th (3) more than 5 (4)
12	Age of the child (months)	Age of child at the time of migrating, Dying or the end of the study. (1 year to 5 years)
13	Residence.	Urban (1) Rural (2).
14	Socio-economic status.	Poorest (1) poorer (2) poor (3) less poor (4) least poor(5)

2.7 Ethics consideration

Ethical clearance was granted by the University of the Witwatersrand Committee for Research on Human Subjects (Medical), Johannesburg, South Africa and by the Institution Review Board (IRB) of the Navrongo DSS. Individuals who participated in the survey signed informed consent letters before participating in the survey. The database did not contain names of persons instead identification numbers for each participant were being used. This ensured confidentiality of people involved in answering the questionnaires.

CHAPTER THREE: RESULTS

3.0 Introduction

In this chapter, results were presented in two parts, the descriptive part in which immunization status and background characteristics of immunization status are presented in graphs and tables and the analytical part which includes logistic and Cox regression results and Kaplan Meier survival curves showing the probability of survival against person time. Person-time contributed by all children was 176300 months. The average person-time was 44 months.

3.1.0 Description of immunization status

3.1.1 Socio-demographic and economic background of respondents

This analysis included 4007 under-five year old children (51% males and 49% females). Of all the children under-five in this study, 92% were staying in the rural areas. Majority of mothers were aged 20-29 years (47%) at the time of birth. About 71% of all births were either at home and/or attended by a traditional birth attendant. Only 29% of the births were health facility-based. Among the children included, 3383 (84%) were assigned a SES index ranging from poorest to least poor. More than 70% of mothers whose children were included in the study had no formal education. More than a third (36%) of the children included in the study were either second or third born. 1703 (42%) of the under-five were fully immunized by age 9 months. 2036 (50.8%) were fully immunized by age 1 year (Appendix 9).

3.1.2 Vaccination coverage of the study population

In the study population, 2208 children (55.1%) were fully immunized, 870 (21.7%) were partly immunized and 929 (23.2%) not immunized at all (Table 2). About 1703 (42%) of the under-five year old were fully immunized by age 9 months and 2036 (50.8%) were fully

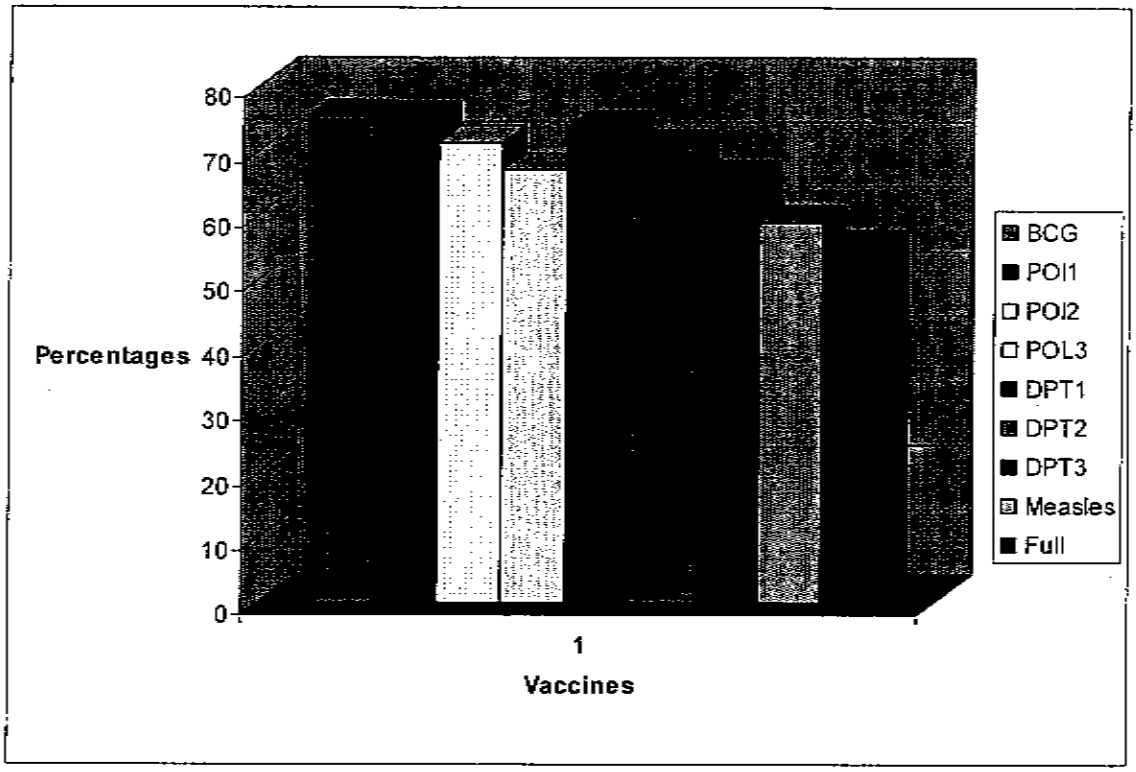
immunized by age 1 year. This means among the fully immunized children, 77% were fully immunized on time.

Table 2: Immunization status coverage categories of under-five year old children in Kassena-Nankana

Vaccination Status	N	%
None	929	23.2
Partial	870	21.7
Full	2208	55.1
Total	4007	100

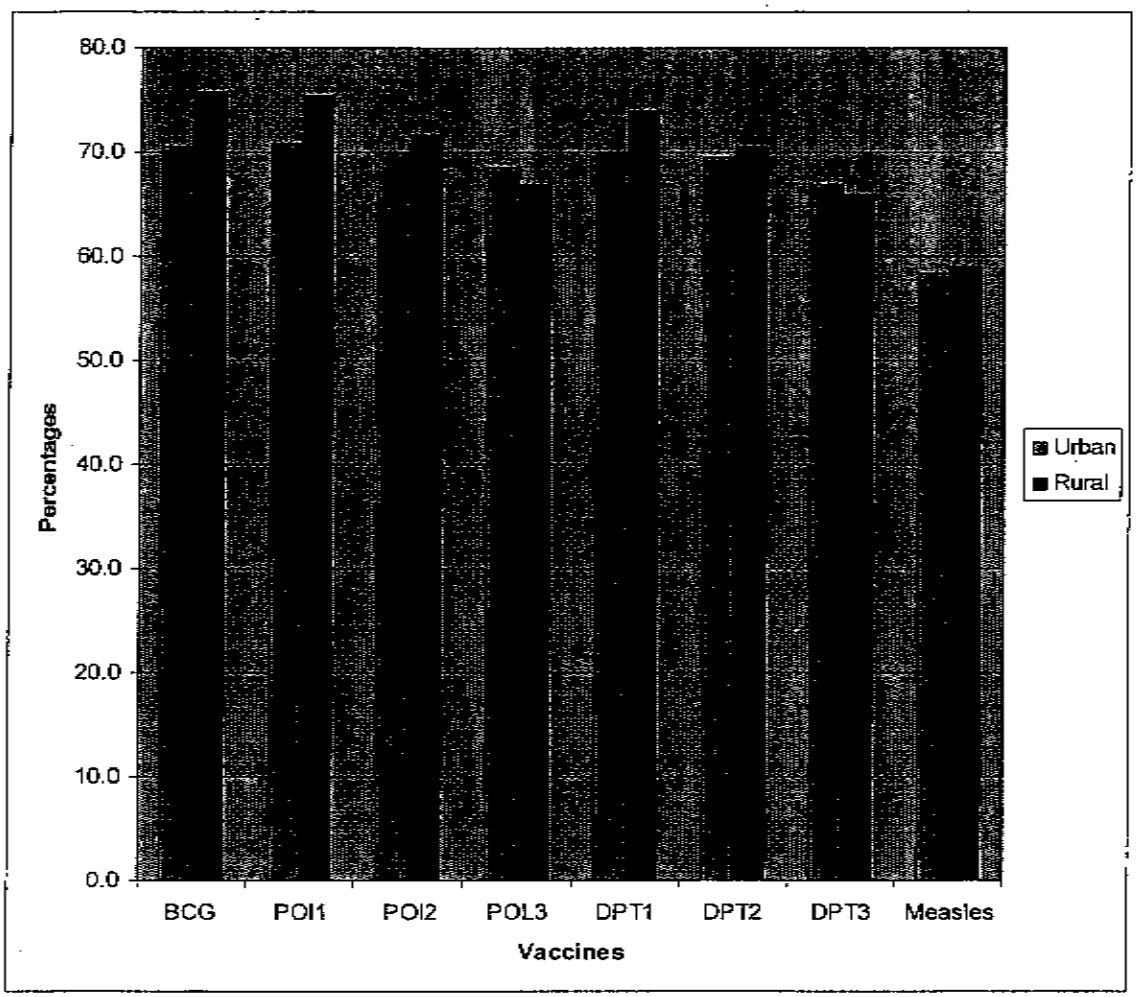
Figure 2 below shows immunization percentages for individual vaccines. Vaccines such as BCG and Polio1 showed the highest coverage of 75.3% and 75.1% respectively. Coverage of above 75% indicates 7 in 10 children received BCG and Polio 1 as the first dose. Completed DPT and Polio vaccination was observed in 66% and 67.1% of the children respectively. Lowest coverage was measles vaccine (59%) at 9 months of age. Dropout rates for DPT and OPV were 10.4% and 10.7% respectively.

Figure 2: Percentage of vaccine specific coverage in Kassena-Nankana district



Among the children who lived in the rural area, 22% and 54.9% were partially and fully immunized respectively compared to 13% and 57.8% of children who lived in the urban areas (Figure 3). Vaccine coverage for various vaccines was consistently high in rural areas. Although the coverage rates in the urban areas were lower, they had the highest or sustained coverage for vaccines given in series (DPT and Polio).

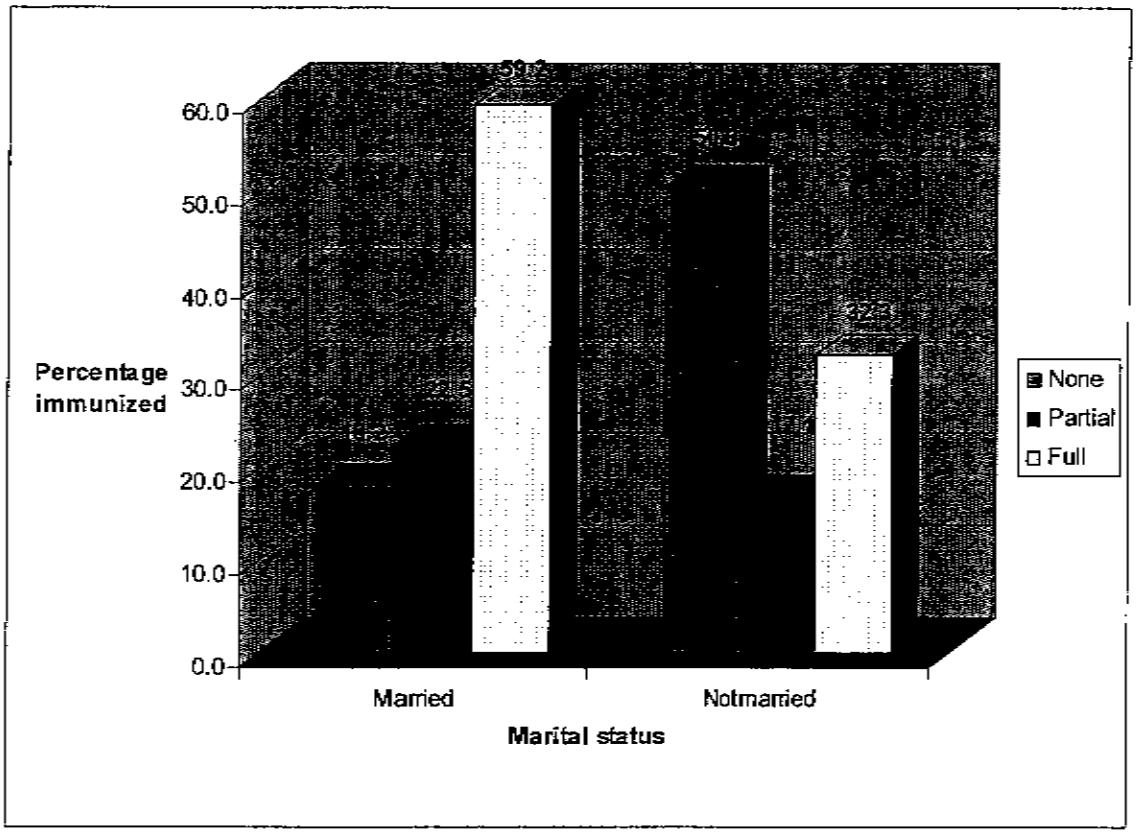
Figure 3: Percentage of vaccine specific coverage by place of residence in Kassena Nankana.



3.2 Characteristics of immunization status

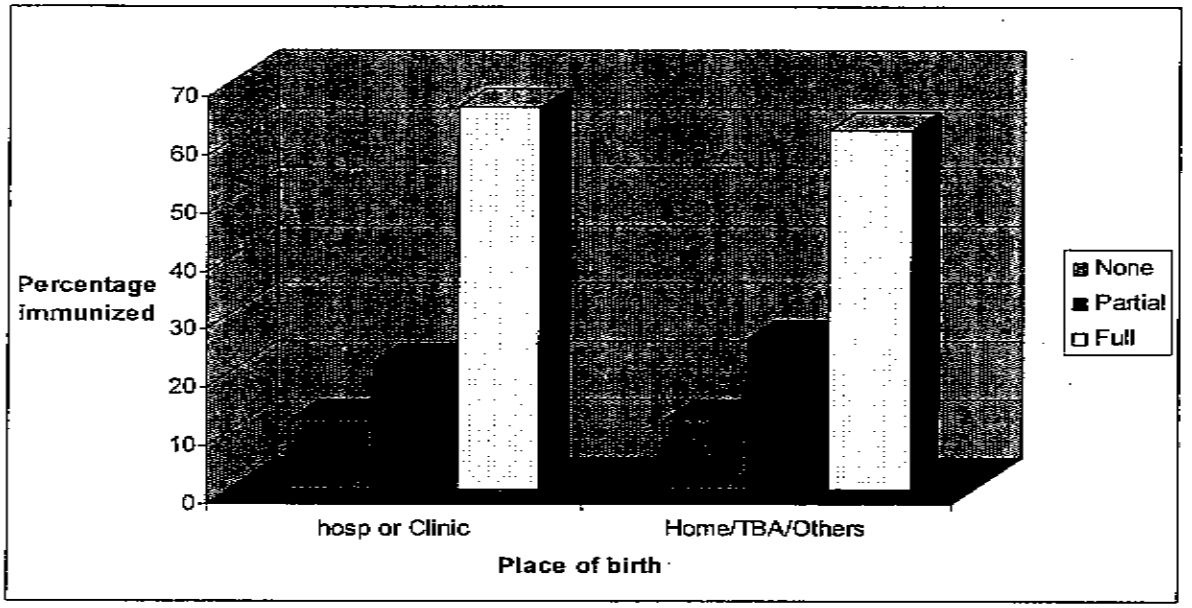
In the current study, 3394 (84%) of the mothers were married. Among the children whose mothers were married, 59% were fully immunized compared to mothers who were not married (32). There were more children of unmarried women who were not immunized at all (n=310, 50.6%) as shown in figure 4.

Figure 4: Percentage distribution of immunization status by marital status in Kassena Nankana



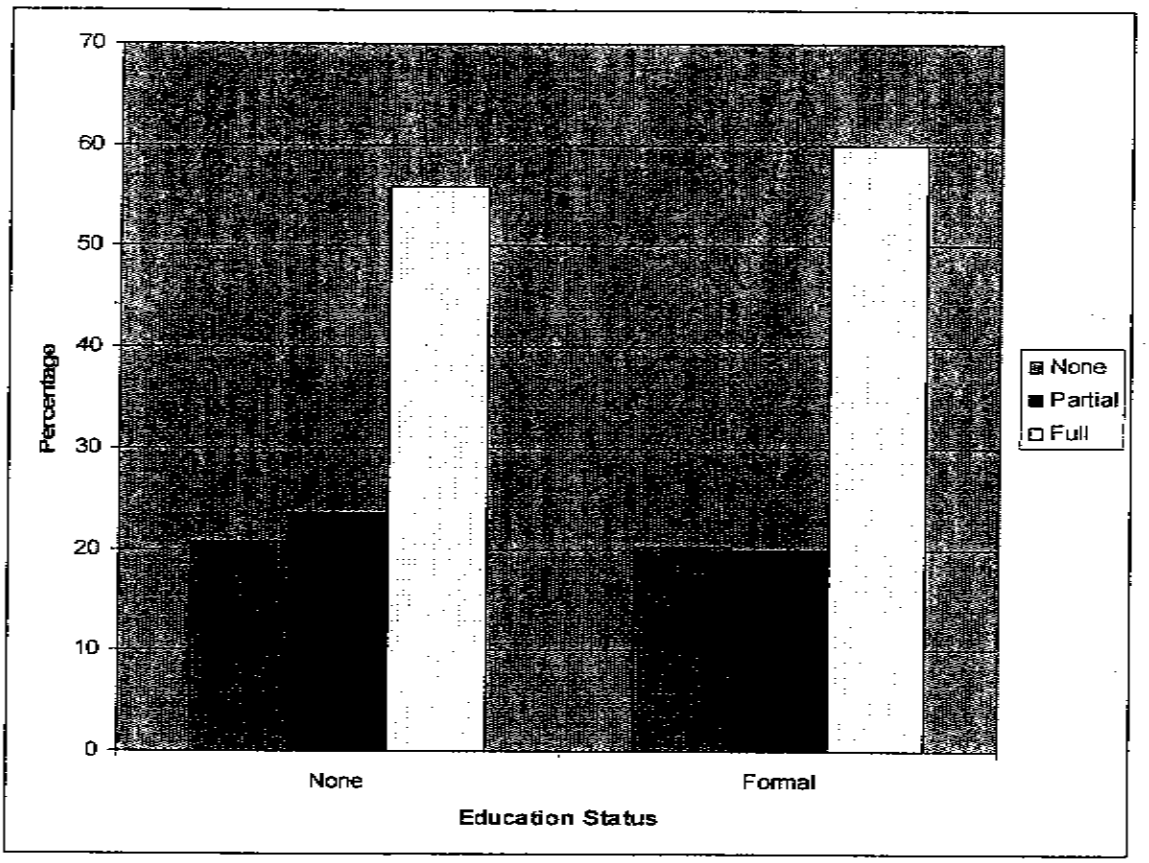
Place of birth of the child and immunization status showed a similar pattern (Figure 5) with a slightly higher proportion of children born in a health facility (66%) being fully immunized than children born some where else (62%). These differences were marginally significant (P-value=0.055).

Figure 5: Percentage distribution of immunization status by place of birth in Kassena Nankana



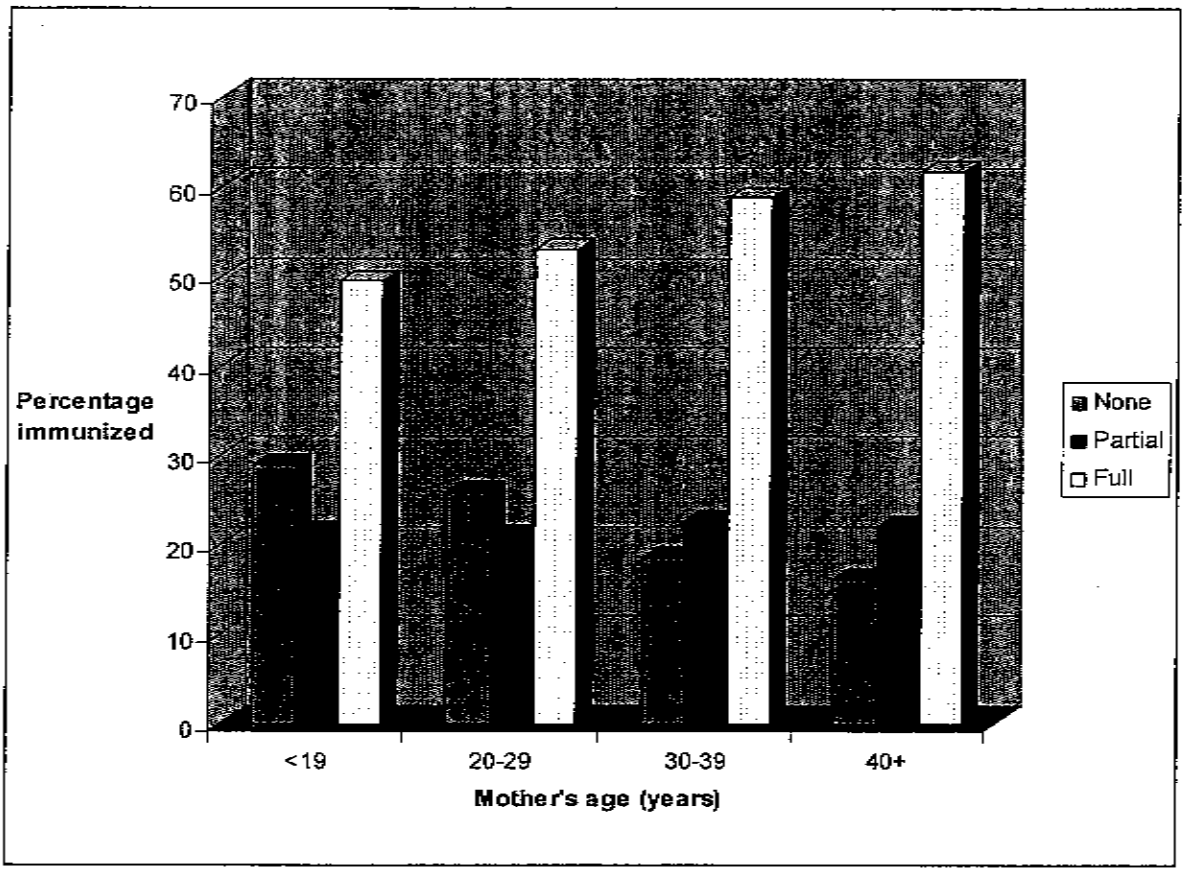
Children of mothers with at least primary education were more of the fully immunized (60%) than those whose mothers had no formal education (56%). The percentage of non-immunized children did not differ considerably according to mother's educational attainment (Figure 6).

Figure 6: Percentage distribution of immunization status by mothers' level of Education in Kassena Nankana



Among children under-five years born to mothers older than 40 years of age, 61.8% were fully vaccinated compared to 49.5% born to mothers younger than 20 years of age (Figure 7). The differences were statistically significant. A higher proportion of children born to mothers younger than 20 years of age (28.9%) was not immunized at all compared to children born to mothers aged 40 years or above (16.1%). A linear trend showed the older the mother the higher the chances of the child being fully immunized (49.5% for 19 years or less, 53% for 20-29 years, 58% for 30-39 years and 61.8% for 40 years or above).

Figure 7: Percentage of immunization status by mother's age in Kassena Nankana



Among the under-five year old children who came from the least poor families, 59.9% were fully vaccinated compared to the under-fives who came from the poorest families (57%). Among children under-five who were 6th born or above, 61.6% of them were fully vaccinated while among the firstborns only 48.8% were fully immunized. About 69% of their under-five year old resident children were fully immunized compared to 35% of migrant children. About 42.6% of migrant children were not immunized at all compared to 8% of resident children (Table 3).

Table 3 Association of immunization status and covariates of under-five year old children in Kassena Nankana(N, %)

Variable	None (%)	Partial (%)	Full (%)	P-values
Sex				
Female	460(23.4)	444(22.5)	1066(54.1)	
Male	469(23)	426(20.9)	1142(56.1	0.376
Marital status				
Married	619(18.2)	765(22.5)	2010(59.2)	<0.001
Not Married	310(50.6)	105(17.1)	198(32.3)	
Place of birth				
Hosp/Clinic	102(12.1)	185 (22)	556 (66)	
Hom/tba/others	256(12.1)	552(26.1)	1308 (61.8)	0.055
Education				
None	533(20.7)	605(23.5)	1439(55.8)	0.032
Formal	216(20.3)	210(19.8)	637(59.9)	
Household size				
1-6	385(22.7)	360(21.3)	949(56)	
7-12	292(20.8)	289(20.5)	826(58.7)	0.640
13+	68(21.9)	65(20.9)	178(57.2)	
Maternal age (yrs)				
<19	156(28.9)	116(21.5)	267(49.5)	
20-29	488(25.9)	398(21.1)	999(53)	
30-39	226(18.6)	275(22.6)	716(58.8)	<0.001
40+	59(16.1)	81(22.1)	226(61.8)	
Live birth				
Singleton	366(11.7)	788(25.1)	1981(62.3)	0.712
Twins	5(8.3)	15(25)	40(66.7)	
Residence				
Urban	90(29.2)	40(13)	178(57.8)	
Rural	839(22.7)	830(22.4)	2030(54.9)	<0.001
SES				
Poorest	131(19.4)	160(23.6)	386(57)	
Poorer	109(16)	171(25.1)	402(58.9)	
Poor	138(20.5)	146(21.7)	388(57.7)	0.002
Less poor	144(21.3)	135(20)	397(58.7)	
Least poor	159(23.5)	112(16.6)	405(59.9)	
Birth Order				
1st	374(31.6)	231(19.5)	577(48.8)	
2nd & 3rd	353(24.5)	310(21.5)	780(54.1)	
4th & 5th	91(17)	114(21.2)	332(61.8)	<0.001
>6	111(13.2)	214(25.4)	519(61.5)	
Migration status				
Resident	185(8)	517 (22.5)	1599 (69.5)	<0.000
Migrant	744(43.6)	353 (20.7)	609 (35.7)	

In logistic regression analysis, marital status, place of residence, mother's age and migration status were found to be significant determinants of full immunization status (Table 4). Under-five years old children whose mothers were not married were 51% less likely to be fully immunized than under-five whose mothers were married. Children whose mothers were migrants were 61% less likely to be fully immunized compared to under-five born by mothers who were residents. Under-five whose mothers were aged 20-29 years at the time of their birth were 31% less likely to be fully vaccinated than under-five whose mothers were aged 14-19 at the time of birth. Under-five whose mothers were dwelling in the rural were 44% more likely to be fully immunized compare to under-five whose mothers were dwelling in urban areas.

Table 4: Logistic regression analysis of determinants of full immunization status in under-five year old children in Kassena Nankana

Factors	Univariate (unadjusted) OR (95% CI) P-value	Multivariate (adjusted) OR (95% CI) P-value
Sex		
Female	1	
Male	1.08 (0.96-1.23) 0.214	
Marital status		
Married	1	1
Not Married	0.32 (0.27-0.39) <0.001	0.49 (0.34-0.69) <0.001
Place of birth		
Hospital/Clinic	1	1
Home/TBA/Others	0.84 (0.71-0.99) 0.035	0.93 (0.74-1.17) 0.536
Education level of mother		
None	1	1
Primary/ Sec +	1.18 (1.02-1.37) 0.024	1 (0.80-1.36) 0.990
Household size		
1-6	1	
7-12	1.11 (0.97-1.29) 0.132	
13+	1.05 (0.82-1.34) 0.692	
Maternal age (years)		
<19	1	1
20-29	0.14 (0.95-1.39) 0.156	0.69 (0.48-0.98) 0.043
30-39	0.45 (0.18-1.79) <0.001	0.70 (0.53-1.18) 0.102
40+	0.64 (0.26-2.15) <0.001	0.64 (0.43-1.15) 0.090
Live-birth		
Singleton	1	
Twins	1.17 (0.68-2.00) 0.580	
Migration status		
Residents	1	1
Migrants	0.21 (0.21-0.27) <0.001	0.39 (0.32-0.47) <0.001
Residence		
Urban	1	1
Rural	0.89 (0.70-1.12) 0.324	0.56 (0.37-.93) 0.024
Social economic status		
Poorest	1	1
Poorer	1.08 (0.87-1.34) 0.472	0.96 (0.73-1.26) 0.750
Poor	1.03 (0.83-1.28) 0.789	1.06 (0.80-1.40) 0.676
Less poor	1.07 (0.86-1.33) 0.524	1.06 (0.799-1.4) 0.681
Least poor	1.13 (0.91-1.40) 0.280	1.10 (0.79-1.53) 0.550
Birth Order		
1st	1	1
2nd & 3rd	1.23 (1.06-1.44) 0.008	0.91 (0.70-1.19) 0.494
4th & 5th	1.70 (1.38-2.10) <0.001	1.00 (0.71-1.42) 0.989
>6	1.67 (1.40-2.00) <0.001	0.92 (0.63-1.33) 0.653

3.3 Immunization status and child survival

The average follow-up time was 44 months and the total person time was 176300.4 months.

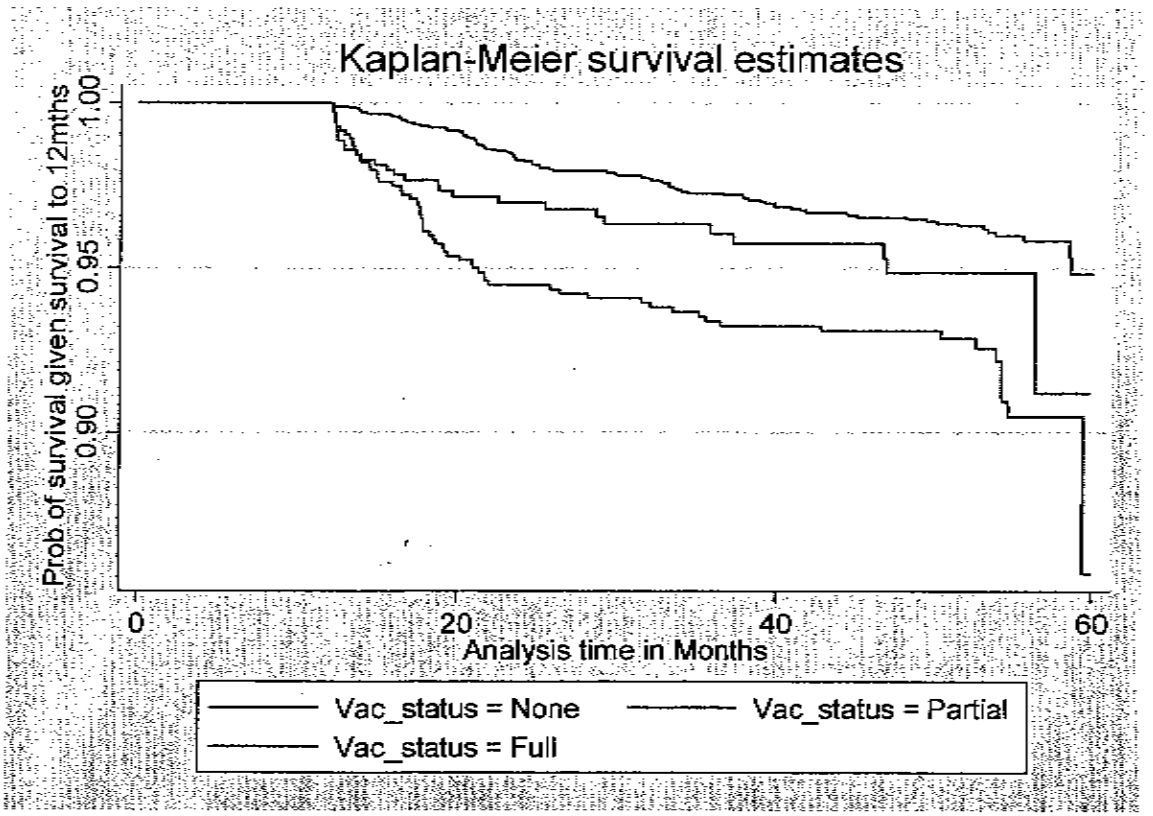
Table 5: Percentage distribution by vital status of under-five year old children in Kassena Nankana

Variable	Alive (%)	Died (%)	P-values
Vaccination status			
None	895 (96.3)	34 (3.7)	
Partial	802 (92.2)	68 (7.8)	<0.001
Full	2126 (96.3)	82 (3.7)	
Sex			
Female	1882 (95.5)	88(4.5)	0.710
Male	1941(95.3)	96(4.7)	
Marital			
Married	3220(94.9)	174(5.1)	<0.001
Not Married	603(98.4)	10(1.6)	
Place of birth			
Hosp/clinic	812 (96.3)	31 (3.7)	0.088
Home/TBA/Others	2007 (94.9)	109 (5.2)	
Education			
None	2454(95.2)	123(4.8)	0.406
Formal	1019(95.9)	34(4.1)	
HH size			
1-6	1656(97.8)	38(2.2)	
7-12	1387(98.6)	20(1.4)	0.224
13+	304(97.8)	7(2.3)	
Maternal age (years)			
<19	513(95.2)	26(4.2)	
20-29	1821(96.6)	64(3.4)	
30-39	1135(93.3)	82(6.7)	<0.001
40+	354(96.7)	12(3.3)	
Live birth			
Singleton	2974(94.9)	161(5.1)	0.550
Twins	56(93.3)	4(6.7)	
Residence			
Urban	299(97.1)	9(2.9)	0.145
Rural	3524(95.3)	175(4.7)	
SES			
Poorest	639(94.4)	38(5.6)	
Poorer	645(94.6)	37(5.4)	
Poor	632(94.1)	40(5.9)	0.008
Less poor	657(97.2)	19(2.8)	
Least poor	655(96.9)	21(3.1)	
Birth Order			
1st	1133(95.9)	49(4.1)	
2nd & 3rd	1384(95.9)	59(4.1)	
4th & 5th	514(95.7)	23(4.3)	0.073
>6	791(93.7)	53(6.3)	

Migration status			
Resident	2153(93.6)	148 (6.4)	<0.000
Migrant	1670(97.9)	36(2.1)	

About 184 of the children died during follow-up. Among the under-five year old children who died, 88 (47.8%) were females and 96 (52.2%) were males. Of mothers whose were not married, 98.4% of their children survived compared 95% of children whose mothers were married. Among the least poor families, 96.9% of their children under-five survived compared to 93.6% of poorest families whose children survived. Among the migrants, 97.9% of their children survived compared to 93.6% of children from the residents. Among the children who were fully immunized, 96% survived compared to 92% of children who were partially immunized.

Figure 8: Kaplan Meier Survival, by immunization status



The Kaplan Meier Survival curve for immunization status shows that, under-five year old children who were fully immunized were surviving better than those who were partially

immunized and those who were not immunized (Figure 8). Under-five year old children whose mothers were not married were surviving better than the under-five whose mothers were married (Appendix 3). Under-five year old children whose mothers had received formal education (primary education or above) were surviving better than under-five whose mothers had not received any formal education (Appendix 2). Children who were born to migrant mothers were surviving better than under-five whose mothers were residents (Appendix 1).

Table 6: Cox proportional hazards regression between univariate and multivariate analysis of factors that determine death in children under five years old, Kassena Nankana

Factors	Univariate(unadjusted) HR (95% CI) P-value	Multivariate (adjusted) HR (95% CI) P-value
Vaccination Status		
None	1	1
Partial	1.3 (0.88-2.02) 0.169	0.64 (0.37-1.06) 0.083
Full	0.57 (0.38-0.85) 0.006	0.52 (0.30-0.87) 0.014
Age of the under-five(mths)	0.68 (0.66-0.70) <0.001	0.64 (0.61-0.67) <0.001
Sex		
Female	1	
Male	1.04 (0.778-1.39) 0.798	
Marital status		
Married	1	1
Not Married	0.48 (0.25-0.91) 0.025	0.36 (0.14-0.92) 0.033
Place of birth		
Hospital/Clinic	1	
Home/TBA/Others	1.14 (0.95-2.11) 0.088	
Education level of mother		
None	1	1
Primary/ Sec +	0.87 (0.61-1.22) 0.414	1.57 (1.05-2.33) 0.028
Household size		
1-6	1	
7-12	0.61 (0.36-1.05) 0.075	
13+	0.97 (0.43-2.17) 0.939	
Maternal age (years)		
<19	1	1
20-29	0.65 (0.41-1.02) 0.061	1.84 (0.94-3.63) 0.076
30-39	1.20 (0.77-1.87) 0.411	3.38 (1.74-6.56) <0.001
40+	0.54 (0.27-1.07) 0.079	2.15 (0.89-5.17) 0.088
Live-birth		
Singleton	1	
Twins	1.20 (0.45-3.28) 0.700	
Migration status		
Residents	1	1
Migrants	0.45 (0.311-0.648) <0.001	0.99 (0.57-1.72) 0.978
Residence		
Urban	1	
Rural	1.50 (0.79-3.02) 0.202	
Social economic status		

Poorest	1	1
Poorer	0.94 (0.60-1.48) 0.793	0.87 (0.54-1.43) 0.592
Poor	1.10 (0.69-1.68) 0.734	0.93 (0.58-1.49) 0.762
Less poor	0.49 (0.29-0.86) 0.013	0.68 (0.38-1.22) 0.194
Least poor	0.55 (0.32-0.94) 0.029	0.23 (0.11-0.47) <0.001
Birth Order		
1st	1	
2nd & 3rd	0.89 (0.61-1.3) 0.565	
4th & 5th	0.85 (0.52-1.4) 0.538	
>6	1.20 (0.82-1.79) 0.322	

3.3.3 Univariate analysis

Under-fives who were partially immunized were 30% (OR=1.3, 95% CI:0.88-2.02, P-value=0.169) more likely to die during the follow-up period than children who were not immunized while under-fives who were fully immunized were 43% more likely to survive than children who were not immunized at all (HR=0.68, 95% CI:0.38-0.85, P-value=0.006).

One month of age during the follow-up period, was associated with a reduction of 32% in the probability of dying (HR=0.68, 95%CI: 0.66-0.77, P-value<0.001).

Under-fives whose mothers were unmarried were 52% less likely to die than those whose mothers were married (HR=0.48, 95%CI: 0.25-0.91, P-value=0.025).

Under-fives whose mothers were migrants were 55% less likely to die than under-five whose mothers were resident. The association was highly significant (P<0.001).

Under-fives from families which were least poor were 45% less likely to die before attaining age five, compared to under five who came from families which were the poorest (HR=0.55, P-value=0.029)

3.3.4 Multivariate Analysis

After adjusting for potential confounders and covariates in the multivariate Cox proportional model, children who were partially immunized were 37% less likely to have died compared to those who were not immunized. Those who were fully immunized were 48% less likely to

have died compared to children who were never immunized. This difference was statistically significant (HR=0.52, 95%CI: 0.30-0.87, P=0.010).

Further factors to be significantly associated with under-five mortality were age of the child, marital status, socio-economic status, education level of the mother and mother's maternal age.

An increase in one month of age led to protection of the child by 36% against under five year mortality (HR=0.64 95%CI: 0.61-0.67, P-value<0.001).

The under-five whose mothers were not married were 64% less likely to have died than the under-five whose mothers were married.

After adjustment, education level was statistically significant in predicting under-five deaths. Under-five whose mothers had primary education or more were 1.57 more likely to die than under-five whose mother had no education at all. These differences were statistically significant.

After adjustment maternal age became significant. Under-five born to mothers whose maternal age was 20-29 years were 1.84 times at increased risk of dying than under-five mothers whose maternal age was 14-19 years. Under five whose mothers maternal age was 30-39 years were 3.38 times at increased risk than under-five whose mother's maternal age was 14-19 years. Under-five whose mothers' maternal age was 40 years or above were 2.15 times at increased risk than under five whose mothers' maternal age was 14-19 years old. Multivariate adjustment resulted in considerable changes in risk estimates for all categories of maternal age as shown in table 6. To investigate potential confounding of the association between maternal age and mortality, the distribution of various characteristics according to mother's maternal age was examined (Appendix 8).

Older mothers were observed to be in the poorest category (27.7%), were married (90.4%), were delivering at home (81.7%), not having formal education (91.1%), having more than six children (75.7%) and most of their children were fully immunized (61.6%).

The under-five who came from poorer families were 13% less likely to have died than the under-five who came from poorest families. The under-five who came from the least poor families were 78% less likely to have died than those who came from poorest families. These differences were statistically significant ($P<0.001$).

CHAPTER FOUR: DISCUSSION, CONCLUSION AND RECOMENDATIONS

4.0 Introduction

In this chapter, results of the major findings are discussed as well as limitations of the study that should be taken into consideration when interpreting and applying the results. Lastly conclusions and recommendations are explained.

The main aim of this study was to investigate the association between immunization status (partial and full) and child survival among children under-five years of age in Kassena-Nankana district of northern Ghana using Navrongo DSS data collected longitudinally from 2002 to 2006. In our analysis, we assessed that in comparison to no vaccination, partial vaccination [HR=0.62, 95%CI: 0.36-1.05 P-value=0.077] and full vaccination [HR=0.5, 95%CI: 0.30-0.84 P-value=0.010] were inverse predictors of child mortality. Further factors to be significantly related to under-five mortality were age of the child and household socio-economic status as well as mother's maternal age.

4.1 Description of immunization status

This study showed that 7 in 10 children in the district received their first doses BCG and Polio vaccines. This is lower compared to the report of Ghana DHS of 2003 where 9 in 10 children received their first BCG dose. In Niger BCG and polio coverage rates were 18.9% and 32.4% (Yumi A et al. 2004). In Nigeria, BCG and OPV vaccine coverage rates were around 50% (Sofo C & Tony P 2003). In Algeria, the coverage rates for BCG and Polio were above 90% (UNICEF 2005). While coverage for BCG and Polio1 was high, coverage declined for subsequent doses. A similar trend was observed in Ghana DHS of 2003. The

dropouts for Polio and DPT were 10.7% and 10.4% respectively. This an improvement from DHS survey of 2003 where the drop out rates for polio and DPT were 15 and 12 respectively.

Vaccine coverage was high in rural areas except for DPT 3 and Polio 3 where the coverage in the urban areas was slightly higher than the one of the rural areas. These differences in vaccine coverage pose a challenge for health professionals. This study showed coverage for full DPT and Polio vaccines to be 66% and 67.1% respectively while in 2003 DHS survey reported 80% of the children received a complete dose for DPT and Polio vaccines. The measles coverage rate in the current study was found to be 59%. For Nigeria a measles vaccination rate of 41% (Sofo C & Tony P 2003) and for Papua New Guinea of 50% was reported. Tanzania, Algeria and Seychelles have attained their target of a measles vaccine coverage of more than 90% (UNICEF 2005).

This study reported full immunization coverage among study children to be 55.1%. Compared to the previously which reported immunization coverage rate in the 2003 DHS (69%). immunization coverage declined and was well below the 2010 immunization coverage target for Ghana (90%). Opportunity cost in terms of money and time incurred by the parents, demand-related factors, such as parents' knowledge about vaccination and immunization and their attitudes towards them, may have influenced vaccination uptake, further factors such as trust (e.g. in health-care providers or 'western' medicine) and culture may be influential. This was noted previously when political and religious leaders in three Nigerian states boycotted a WHO polio vaccination campaign in 2003, claiming that the vaccine caused sterility and AIDS similarly. It may, however, also be that methodological differences between the DHS and the current study have contributed to the differences in vaccination coverage. For the current study only children for whom a immunization card was available could be classified

to be immunized. Furthermore, the study was conducted in one region of Upper East region in Ghana and might thus not be representative for Ghana.

4.2 Determinants of immunization status

Analysis by multivariate logistic regression showed marital status, place of residence, maternal age and migration status to be associated with immunization status. In Bangladesh, it has been found that mothers level of education, the sex of the child, region of residence, economic status and proximity to the immunization centres was significantly positively related to immunization status (Kanta J et al. 1999). In Cameroon, whether a child is immunized was strongly correlated with both mother's level of education and household economic status (Hugh R.Waters et al. 2004).

The reasons behind children under five born to unmarried women to be less likely fully immunized might be women's lack of final decision/acting independently in household decisions including health decisions. This has been experienced in Pakistan. Pakistani women's mobility was shown to be constrained, only 24 percent can seek care at a hospital by themselves (NIPS & LSHTM 1998). They rarely participate in making important household decisions and almost never reach such decisions on their own. For example, only 28 percent of currently women surveyed reported that they made the final decision concerning the treatment of a sick child (NIPS & LSHTM 1998). This is contributed by poverty and lack of resources. In light of women's not being able to act independently on matters regarding their own health, and because of the limited resources available to them as a result of widespread poverty, the quality of and access to health care must be improved for poor women in particular (Mir et al. 2004).

Other reasons might be children being left at grandparents home and there might be no immediate person to take the child to be vaccinated. From the data used by the current study

many of these women are young and thus inexperience and also probably less informed about the vaccination schedules and thus less likely to take their under five children to be immunized.

Under-five who were born to mothers staying in the rural areas were more likely to be fully vaccinated. In Nigeria it is different. It was found that urban children were 3 times more likely to be fully vaccinated than rural children (Sofo C & Tony P 2003). This may be because in Kassena-Nankana, there are more health services available in the rural areas. Furthermore there may also be the impact of Community Health Planning Services Programme in which many nurses were posted into the rural areas to facilitate various health programmes. Assigning nurses to community locations where they provide basic curative and preventive care substantially reduces childhood mortality and accelerates progress towards attainment of the child survival MDG (James F Phillips, Ayaga A Bawah, & Fred N Binka 2006). Other reasons might be that in rural areas, some vaccines like OPV are taken from house to house and people are usually less busy than in towns thus they can have time to take their children to be vaccinated. Lastly this might be attributed by larger numbers of children in the rural areas (84% of the study population live in the rural areas).

From the results, the higher the maternal age of mothers the more likely that children will be fully immunized. Many of these women were married (from the data) and marital status has been found to be associated with full immunization (in this study). This might be caused by lack of experience. Young mothers, particularly those in their teens, tend to be less experienced in childcare (Bussarawan T & James F Phillips 2007).

Under-five who were born to mothers who migrated into the study area were less likely to be fully vaccinated compared to under-five who were born by mothers who were residents. This is expected due to the nature of data collection which is collected once in a year between

October and December and it is contributed by inability to meet people. Example a child under-two years who migrated when he/she was 14 months old and missed in the earlier survey, in the next survey he/she will be will old and won't qualify in the survey and thus vaccination update would not be available.

Maternal education is not associated with full immunization. In Vietnam, maternal education is a prominent covariate of health-seeking behaviour. It reflects mother's knowledge related to childcare (Bussarawan T & James F Phillips 2007). In Kassena-Nankana, most of the mothers did not have any formal education (70%) and thus make it not easy to see the real differences in effects in terms of education. The effects might be brought up by small numbers of the mothers with formal education.

Household socio-economic status was not directly associated with immunization status in Navrongo. There is a tendency of less poor parents to seek professional intervention (Bussarawan T & James F Phillips 2007). In Ghana, immunization is free of charge and many indirect costs have been minimized by improving access to immunization centres.

4.3 Full/Partial Immunization and Child Survival

The Kaplan Meier survival curve indicated that children who receive only part of the EPI package of immunizations didn't benefit substantially from reduced mortality. In fact they had an increased mortality especially after 20 months of follow-up time compared to none-immunized group (Figure 8). This may be due to delayed vaccination up-take or may be the deaths may be due to other reasons apart from the vaccination status.

Also a child might be partially vaccinated but their mothers may be less inclined to use clinical services and hence children die from other causes. It was also observed that among the partially immunized, very few were coming from the least poor families thus economic

ability of the families may have contributed to this. Trend analysis of vaccination was done and was found to be significant (P-value=0.021).

Children with partial and full BCG/POLIO/DPT coverage had 36% and 48% reduced odds of mortality, respectively, relative to unvaccinated children after controlling for age, marital status, mother's maternal age, mother's education, socio-economic status and migration status.

The results of this study are consistent with a study done by Nyarko in the same area (Nyarko P, Pence B, & Depbuur C 2001). Mortality between 9 months and five years is reduced by one third for those who have received BCG, polio, and DPT vaccinations and by two-thirds for those who received the full EPI immunization package (BCG, polio, DPT, and measles).

A study done by Bawah et al in 2006 in the same area showed the risk of dying for children younger than five is reduced by more than 70% among those who are fully immunized, compared to those who are not. Partial immunization also prevents mortality (Bawah et al, 2006). This reduction in hazards is higher than what this study shows. This may be due to large sample that was used with the later study and also by including infants in the study.

4.4 Other Factors Determining Child Mortality

Further factors predicting child mortality were age of the child, mothers' maternal age, mother's level of education and social economic status.

Children who came from the least poor families had a 77% decreased risk compared to children who came from the poorest families. Poverty has also consistently been shown to be associated with childhood mortality. Several studies have shown that the burden of disease is highest among the poorest segments of populations (Wagstaff Adam 2000). Moreover, the poor and less-educated are less likely than those who are better off to comply with a medical

regimen, enhancing their risk of developing antibiotic resistance (Gwatkin et al. 2005). It has been shown that the poor are the most cost sensitive in their demand for medical health care compared the non poor (Sauerborn et al, 1994).

The study showed that the older the mother, the higher the reduced risk to the child. Maternal age and education reflect mother's knowledge related to childcare, which in turn is hypothesized to affect children's incidence of illnesses, type of care selected for sick children, and children's health outcomes (Bussarawan T & James F Phillips 2007). In the univariate model, the Hazard ratio for the 30-39 maternal age group was 1.2 but after controlling for potential confounders it jumped to 3.7, indicating that the association between maternal age and under five survival was confounded by others factors. Further analysis of this age group showed that women aged 30-39 years of age more often had no formal education (81.4%) and were staying in the rural areas (93.4%), were the poorest (93.4%) and more often had six or more children (Appendix 8). These differences remained the same even after controlling for parity

Under-five whose mothers were not married had 64% reduced risk than those under-five whose mothers were married. This was not expected as many under-five whose mother were married, were fully immunized and thus more protection was expected. A study done in 1993 by Katapa using DHS data collected in Tanzania from 1991-1992 revealed that child survival chances were more likely to be improved by having a married mother (Katapa.K.S & Aston NM 1993).

Under-five born by mothers who were not married had probably survived well due to other reasons apart from the vaccines as most of the children who are in this situation are taken care of by their grand parents who make sure their grandchildren get most of the basic requirements. The study also observed that among the unmarried, many of them were in least

poor group (30%), thus higher social economic status may have helped the under-five survive by having enough food and social amenities available in the household as noted by Gadomski "The poor are unable to afford curative care, are unaware of the importance of preventive care, and are at greater risk because of their high levels of malnutrition or living arrangements that lower their resistance to infectious diseases" (Gadomski et al. 2001). The data also showed that compared to married women a higher percentage of the unmarried delivered in the health facility (27% versus 42%).

Under-five year old children whose mothers attended formal education had a higher risk of dying. This is highly unexpected and it may be biased by the numbers as 70% of the under-five had mothers who had never been to school at all. Most of the educated mothers were coming from the least poor families. Among the educated mothers 36% were coming from the least poor families. It is shown clearly in Kaplan Meier (Appendix 2) survival curve that under-five year old whose mothers had formal education had better survival probabilities. This difference may be a result of numbers as since those mothers who attended formal school were few, it was not easy to see the real impact of mother's formal education. Maternal education appeared to be a potential confounder in the association between immunization and under five survival.

Age of the child was expected to be associated with improvement in survival as death rates are usually high in neonatal and then infants and continue to decrease as children become older since the immunity against diseases increases. The neonatal and infants were excluded in this study. So as the more the child departs from age one, the more the better the survival.

4.5 Limitations of the Study

Most under-five year old children in this study were coming from the rural areas so any association with the place of residence might have been attributed to numbers, size of the

sample used in this study is smaller compared to others studies with 4007 children aged under-five years. While we used multivariate methods to control as much as possible for differences in other factors, there are likely to be residual unmeasured differences between the two groups that may be partly responsible for the associations. Survival bias was likely to have occurred as children who migrated had survived until they migrated although by following them for a long time may reduce this effect. Migration status has to be interpreted with caution as probably, its not all of them classified as not immunized were actually not immunized because of the nature of data collection. Possible confounding characteristics include parental preference for the health of their children, the genetically determined hardiness and health status of the child, and parental attitudes towards modern health services and health-seeking behaviour. Most of these confounders are difficult to measure in any setting. This analysis was restricted to children with vaccination card to be classified as who got the specific vaccine. Lost to follow-up bias as some of the children under-five recruited were lost due to follow-up process.

4.6 Application, Importance and contribution

This study is very useful. It shows that partial immunization is not good enough to offer the full benefit from vaccination to avoid under-five deaths, thus this study encourages full immunization. It has highlighted factors that determine immunization status in the Kassena-Nankana district. These are marital status, migration status, mother's maternal age and place of residence. The study has also revealed that many women had no education at all (70%). Previous studies done in Navrongo did not explore as many variables as this study (Parity, migration status, marital status, type of birth) hence this study has investigated several factors linked to under-five survival and if real attempts are made on the basis of this study under-five deaths could be reduced significantly.

4.7 Conclusion

This study aimed to investigate the association between immunization status and child survival in rural Ghana. The study has shown that not all under-five year old children were immunized on time as recommended by EPI Ghana. Coverage rates were high for first vaccine doses and declined for subsequent doses. Mothers staying in rural areas were less likely to take the children back to be vaccinated for vaccines given in series. This may need urgent improvement to EPI policies with regard to conduct of the programme and to make sure that vaccination coverage is high and that vaccines were taken in the time recommended.

Effects of mass campaigns appeared to have worked well among mothers of older maternal age, urban residents and married women. This means campaigns have to be tailored to younger mothers, rural residents and unmarried women to comply strictly with EPI schedule.

Full immunization leads to high child survival (protection of 48%) and variables that tend to influence this significantly were mothers maternal age (Children born to older mothers had higher survival probabilities compare to children born to younger mothers), child age (the older the child the higher the survival probabilities), marital status (children born to unmarried mothers had higher survival probabilities compare to children to married mothers) and socio-economic status (Children born in least poor families had higher survival probabilities compared to children born in least poor families). Partial immunization protects the child from hazards by only 36%. These imply that efforts should be made to make infants have full immunization instead of only partial immunization.

4.8 Recommendations

The study makes the following recommendations:

1. Partial immunization though is less protective, remains high thus mothers of child

bearing age should be educated on the importance of timely and full immunization and the importance of proper health seeking behaviour on frequent basis.

2. Migrant settlement should be a special target for immunization as they are less likely to go for immunization perhaps because they don't know centres which offer vaccination services.

3. Enhancing accessibility of immunization among all people from rural to urban areas to reduce the burden of not being fully vaccinated among rural children under-five. Example vaccination should be carried out from house to house.

4. The study site should improve data collection on immunization status from once in a year to twice or thrice. This may help to capture information on under-five who either migrated just after the survey and may not qualify in the next survey or a resident missed in the first survey and may not qualify in the next survey.

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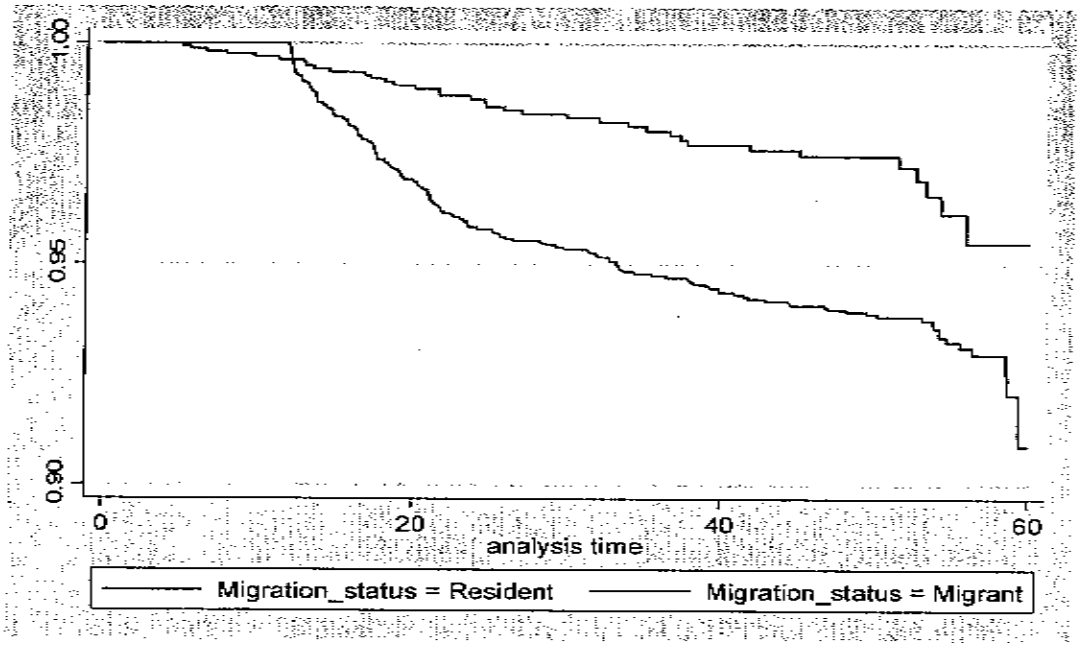
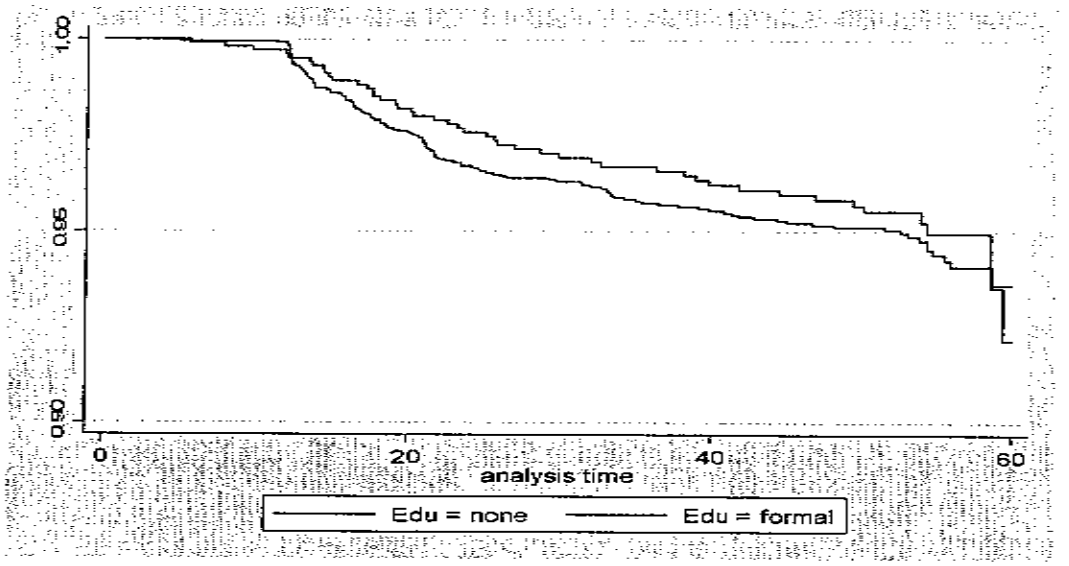
List of appendices

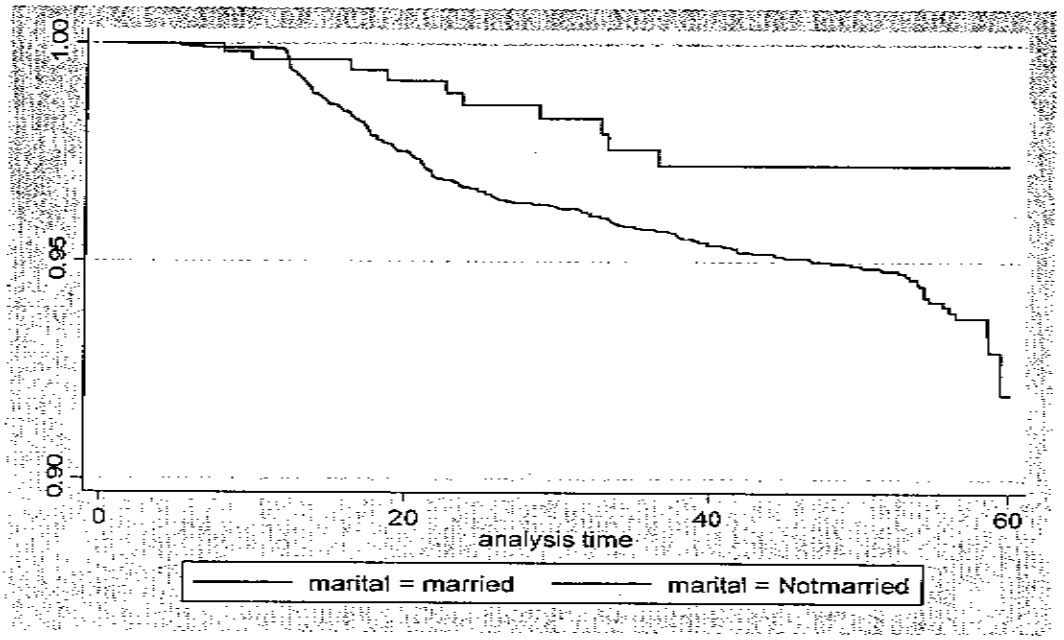
Appendix 1: Kaplan-Meier survival estimates by migration status



Appendix 2: Kaplan-Meier survival estimates by education



Appendix 3: Kaplan-Meier survival estimates by marital status


1.00
0.95
0.90
0
20
40
60
analysis time
marital = married
marital = Notmarried

Appendix 4: Wits Ethical Clearance

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Noyega

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER M081152**
PROJECT	Immunization Status and Child Survival in Navrongo Demographic Surveillance system, rural Ghana from 2000-2004
INVESTIGATORS	Mr DS Noyega
DEPARTMENT	School of Public Health
DATE CONSIDERED	08.11.28
DECISION OF THE COMMITTEE*	Approved unconditionally

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

DATE 08.11.28 **CHAIRPERSON** .....
(Professor P E Cleaton Jones)

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : K K-Grobusch

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 5: NHRC IRB ethics clearance

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

My Ref. : app077
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. Daniel Simon Nyogea
University of Witwatersrand
School of Public Health
7 York Road
Parktown 2193
South Africa

ETHICS APPROVAL ID: NHRCIRB077

Dear Mr. Nyogea,

Approval of a protocol titled "Immunization status and child survival in rural Ghana (200-2004)"

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 6: Change of title letter

Faculty of Health Sciences
Medical School, 7 York Road, Parktown, 2193
Fax: (011) 717-2119
Tel: (011) 717-2745

Reference: Ms Tania Van Leeve
E-mail: tania.vanleeve@wits.ac.za
02 March 2009
Person No: 326551
PAG

Mr DS Nyogea
IHRDC
P O Box 53
IFAKARA
Tanzania, United Republic of

Dear Mr Nyogea

Master of Science in Medicine (Population-Based Field Epidemiology): Approval of Title

We have pleasure in advising that your proposal entitled "*Immunization status and under-five survival in rural Ghana*" has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

Appendix 7: Vaccination coverage by months of age of the child

Source of Information	BCG	DPT 1	DPT 2	DPT 3	POLIO 1	POLIO 2	POLIO 3	Measles	All[1]
Vaccinated at any time before the survey									
Vaccination Card	75.3	73.7	70.5	66	75.1	71.4	67.1	58.9	55.1
Vaccinated by Age 12 months of age	74.8	73.1	69.6	64.4	74.5	70.7	65.6	53.7	50.8

[1] BCG, measles and three doses of each DPT (DPT/Hep-B/HiB) and Polio Vaccine

Appendix 8: Percentage distribution by mother's maternal age categories

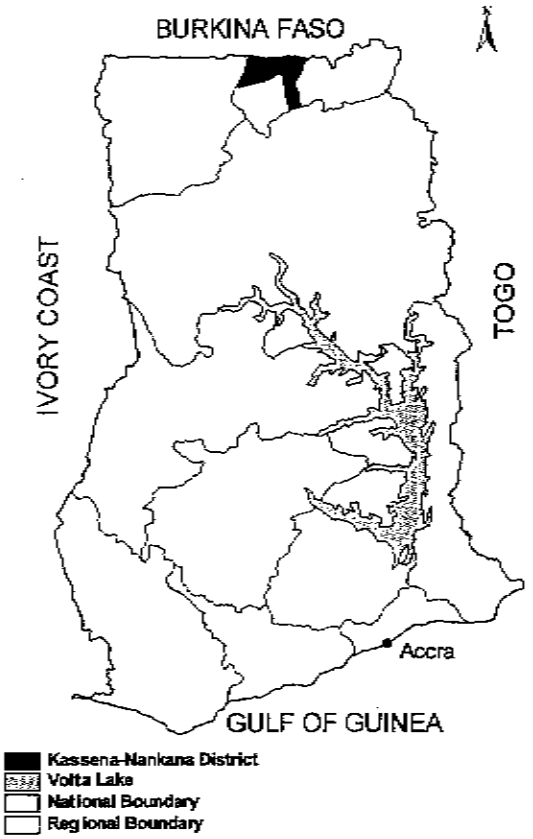
Variable	<19 (N, %)	20-29 (N, %)	30-39 (N, %)	40-49 (N, %)
SES Index				
Poorest	84 (20.3)	263 (17.0)	235 (21.8)	95 (27.7)
Poorer	86 (20.8)	284 (18.3)	228 (21.2)	84 (24.5)
Poor	89 (21.5)	298 (19.2)	223 (20.7)	62 (18.1)
Less Poor	88 (21.6)	328 (21.2)	204 (19.0)	56 (16.3)
Least Poor	67 (16.8)	377 (24.3)	186 (17.3)	46 (13.4)
Marital status				
Married	408 (75.7)	1574 (83.5)	1081 (88.8)	331 (90.4)
Not Married	311 (24.3)	311 (16.5)	136 (11.2)	35 (9.6)
Vital status				
Alive	513 (95.2)	1821 (96.6)	1135 (93.3)	354 (96.7)
Died	26 (4.8)	64 (3.4)	82 (6.7)	12 (3.3)
Place of birth				
Health facility	177 (32.6)	448 (33.4)	222 (23.4)	56 (18.1)
Home	242 (67.4)	894 (66.6)	726 (76.6)	254 (81.9)
Education				
None	248 (54.3)	1081 (63.9)	930 (81.4)	318 (91.1)
Formal	209 (45.7)	610 (36.1)	213 (18.6)	31 (8.9)
Migration status				
Residents	241 (44.7)	968 (51.4)	809 (66.5)	283 (77.3)
Migrants	298 (55.3)	917 (48.7)	408 (33.5)	83 (22.7)
Residents				
Urban	35 (6.5)	187 (9.9)	80 (6.6)	6 (1.6)
Rural	504 (93.5)	1698 (90.1)	1137 (93.4)	360 (98.4)
Birth order				
1st	461 (85.5)	653 (34.7)	64 (5.3)	4 (1.1)
2nd & 3rd	77 (14.3)	1022 (54.3)	316 (26.0)	28 (7.7)
4th & 5th	1 (0.2)	169 (9.0)	310 (25.5)	57 (15.6)
> 6th	0 (0.0)	40 (2.1)	527 (43.3)	277 (75.7)
Vaccination status				
None	156 (28.9)	488 (25.9)	266 (18.6)	59 (16.1)
Partial	116 (21.5)	398 (21.1)	275 (22.6)	81 (22.1)
Full	267 (49.5)	999 (53.0)	716 (58.8)	226 (61.6)

Note: Column percentages

Appendix 9: Background characteristic of the study population

Variable	N	%
Sex		
Male	2037	50.8
Female	1970	49.2
Marital status		
Married	3394	84.7
Not married	613	15.3
Education		
None	2577	70.8
Formal	1063	29.2
Migration status		
Residents	2301	57.4
Migrants	1706	42.6
Vaccination status		
None	929	23.2
Partial	870	21.7
Full	2208	55.1
Place of birth		
Health facility	843	28.5
Home	2116	71.5
Socio-economic status		
Poorest	677	20.01
Poorer	682	20.16
Poor	672	19.86
Less poor	676	19.98
Least Poor	676	19,98
Vital status		
Alive	3823	95.4
Died	184	4.6
Resident		
Urban	308	7.7
Rural	3699	92.3
Birth order		
1st	1182	29.5
2nd & 3rd	1443	36.0
4th & 5th	537	13.4
> 6th	844	21.1
House hold size		
1-6	1694	49.7
7-12	1407	41.2
>13	311	9.1
Live birth		
Singleton	3135	98.1
Twins	60	1.9

Appendix 10: Map of Ghana showing the Kassena-Nankana district



UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

FACULTY OF HEALTH SCIENCES

FACULTY ICT COMMITTEE MEETING

The next meeting will be held on Wednesday 28 April at 12h00 in the PPS Committee Room, Level 4, Wits Medical School. The agenda for the meeting is set out below and the supporting documents are attached.

If you are unable to attend and wish to record your apologies, please e-mail Elize Schreuder at (Elizabeth.schreuder@wits.ac.za).

Support: Elize Schreuder

AGENDA

10.1 WELCOME

10.2 CONFIRMATION OF THE MINUTES OF THE PREVIOUS MEETING (17/02/2010)

TO CONFIRM

10.3 MATTERS ARISING FROM THE MINUTES OF THE PREVIOUS MEETING (17/02/2010)

10.3.1 IT Postgraduate Hub

Completed

10.3.1.1 Statistical Software: STATA

10.3.1.2 Statistica

10.3.1.3 SPSS

10.3.1.4 Ms Schutte to report

10.4 MATTERS FROM THE SENATE HOUSE MEETING

Ms Schutte to report

10.5 MATTERS FROM THE DEANERY

Prof Kramer to report

10.6 MATTERS FROM CNS

Ongoing

10.7 NEW MATTERS

10.7.1 PDA Software

10.7.2 Computer Literacy Assessments

To be revered to the Deanery

10.7.3 University Open Source Software and eLearning Strategy

Dr Allen to report on meeting organised by CHSE

10.7.4 IT Related training, research and associate infrastructure activities in the Faculty Of Health Sciences

Ongoing

10.7.5 IT Connectivity at Chris Hani Baragwanath Hospital

Ongoing

10.7.6 CNS report re PC installation

Completed

10.8 GENERAL

10.8.1 Update on PCs in Faculty

Not discussed

10.8.2 Multi casting vs Uni-casting

Ms Schutte to report

10.8.3 Anti-Plagiarism – Pilot SafeAssign

Ms Schutte to report

/ES
22/04/2010

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Noyega

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER M981152**
PROJECT	Immunization Status and Child Survival in Navrongo Demographic Surveillance system, rural Ghana from 2000-2004
INVESTIGATORS	Mr DS Noyega
DEPARTMENT	School of Public Health
DATE CONSIDERED	08.11.28
DECISION OF THE COMMITTEE*	Approved unconditionally

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

DATE 08.11.28 **CHAIRPERSON** .....
(Professor P E Cleaton Jones)

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : K K-Grobusch

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...