KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

MODELING THE DETERMINANTS OF UNDER-FIVE MORTALITY USING LOGIT REGRESSION

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By

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DECLARATION

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

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DEDICATION

This thesis is dedicated to the Almighty God, my wife Mavis Owusu Tabuaah and my two children; Asiedu Afriyie Boakye-Yiadom and Maame Asuama Boakye-Yiadom.

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ABSTRACT

Child mortality, also known as under-five mortality refers to the death of infants and children under age of five. The objectives of this thesis are to identify the significant determinants of under-five mortality, set up a logit model and use it to predict under-five mortality in the Tano South district of Ghana. The district was divided into four zones and the target populations were identified using the purposive sampling. A total sample size of 200 mothers or caregivers was used, of which 50 were selected randomly from each zone. Binary logit regression was the main statistical tool for the analysis of data. The results revealed that higher parity, in particular grandmultigravidae parity has adverse significant impact on under-five mortality. Among the diseases, both anaemia and malaria showed adverse significant impact on under-five mortality. However, while there are factors that adversely impact on under-five mortality, others such as the use of treated bed net, child vaccine, not exclusive and exclusive breast feeding reduce its likelihood. It is therefore recommended that more education and sensitization on precautionary measures and good health should be given to mothers, especially mothers of grandmultigravidae parity. Additionally, education on the use treated bed-nets in the homes of mothers should be intensified.

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CHAPTER 1

INTRODUCTION

1.0 Introduction

This chapter presents the background of the study, problem statement, objectives, methodology, justification and organization of the thesis.

1.1 Background

Child mortality, also known as under-five mortality refers to the death of infants and children under age of five.The under-five mortality rate is the number of children who die by the age of five, per thousand live births per year. In 2011, the world average was 51 percent, down from 87 percent in 1990.The association between deprivation and poor survival in infancy was already documented with survey data as early as 1824 (villerme, 1830 quoted by Lesaege-Dugied, 1972).The association between socio-economic factors and infant mortality level over time ran parallel with general social and economic development in most industrialized countries during the twentieth century. Furthermore, since the Second World War corroboration of the strong inverse relationship between socio-economic development and mortality rate has been found repeatedly among countries and areas within countries.

Due to adverse effect infant mortality has on the development of the population, the Millennium Development Goal 4 (MDG4) is targeted at reducing global under-five mortality rates by two-thirds between 1990 and 2015 (UNICEF, 2013). In 2012, 6.6 million children under-five died, down from 7.6 million in 2010, 8.1 million in 2009 and 12.4 million in 1990. Between 1990 and 2010, the annual number of deaths in children under-five fell to 57 per 1000 births in 2010 from 88 per 1000 births in 1990.

Deaths among children under age five increasingly are concentrated in sub-Saharan Africa and south Asia with 82 percent of child death occurring in these regions in 2010 compared with 69 percent in1990.

Babies are particularly vulnerable. More than 40 percent of deaths in children under age five occur within the first month of life and more than 70 percent occur in the first year of life.In sub-Saharan Africa one in eight children die before reaching age five. That compares with one in one hundred and forty three in developed countries (UNICEF, 2013).To achieve the MDG4 there is the need to understand the determinant of under-five mortality and implementing appropriate intervention expected from each of the nations of the world.

1.2 Problem statement

The last few decades have witnessed large and sustained decreases in child mortality in most low to middle income countries. Across the world, the number of deaths among children under-five has been on a continuous decline for over a two decade. The number of children under the age five dying globally has dropped remarkably from nearly 12 million in 1990 to an estimated 6.6 million in 2012 (UNICEF, 2013). About 14000 fewer children under-five die each day than was the case 21 years ago. However, despite the millions of lives saved, almost 19000 children under-five still die every day from disease that preventable. Of the 6.6 million under-five deaths in 2012, most were from preventable diseases such as pneumonia, diarrhea or malaria; 44 percent neonatal causes. Unfortunately, under-five deaths are increasingly concentrated in sub-Saharan Africa and Asia despite the marked decline in under-five mortality. Sub –Saharan Africa has achieved only about 30 percent reduction in under-five mortality. One in every nine children in sub-Saharan Africa dies before reaching the age of five. Data from Inter-agency Group Child Mortality Estimation, however, shows under-five mortality rate has decreased from 122 in 1990 to 74 per 1000 live births in 2010, with an annual rate of reduction of about 2.5 which poses a challenge toachieve the MDG target of 41 per 1000 live births by 2015.The situation is even worse in Tano South District as the Annual Report for the under-five mortality for the past five years is on the increase.This has called for an in-depth study of the determinant of under-five mortality in the district in order to find out and suggest strategies to help improve the current situation.

1.3 Objectives

1. To determine factors that are significantly associated with under-five mortality in the Tano South district.
2. To use logistic regression to model under- five mortality in the Tano South district.
3. To predict under- five mortality in the district using the logit model.

1.4 Methodology

The problem of the research was to identify the determinants of under-five mortality and suggest measures in diverse ways to reduce its incidence in Tano South district, in the BrongAhafo region, Ghana. In line with this, we aimed at studying the socio-economic, demographic, biological and environmental factors associated with under-five mortality.

The district was divided into four zones, namely Bechem, Brosankro, Techimantia and Derma and 50 target respondents (mothers) aged 15 years and older from each zone were purposively sampled from child health clinics. Questionnaires were administered to 200 mothers in the district. Multivariate logistic regression was used to determine the likelihood of the independents variables affecting under-five mortality. In this model, under-five mortality was measured on a dichotomous scale (i.e., yes: to indicate a mother has ever observed under-five mortality, and no: if otherwise) and used as response variable. In the coding scheme the categories yes and no were given the codes 1 and 0 respectively. The explanatory variables used were socio-economic, demographic, biological and environmental factors. These were used as dummies with several categories for each. In the coding scheme the categories of each dummy variable were assigned to numeric codes. A 5% level of statistical significance was used throughout the analysis of this thesis. Data analyses were computationally implemented using SPSS software. Information from textbooks, journals, working papers and other related publications were searched from Kwame Nkrumah University of Science and Technology library and the internet.

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1.5 Justification

Below are the benefits of the findings of this thesis:

The results presented in this thesis would help to identify the determinants of under-five mortality in the Tano South district.

Secondly, the thesis would help to find the extent at which these factors impact on under-five mortality. In particular, this would deepen our understanding as to which of the factors are more life threatening than the other.

Finally, this thesis would serve as an analytical basis for further research particularly, in the field of under-five mortality and its correlates.

1.6 Organization of thesis

Chapter 1 is made up of the introduction, which comprises the background of the thesis, problem statement, and objectives of the thesis, methodology and justification. Chapter 2 highlights on literature review of ideas of different authors whose findings have been defined in relation to the topic under study. Chapter 3 presents methodological review in the light of statistical tools that are relevant to the analyses of the various data gathered. The main statistical model covered under this chapter is the multivariate logistic regression model. Chapter 4 deals with data analysis and discussion of results, and Chapter 5 consists of conclusion and recommendations. The thesis report, however, ends with references and appendices in supportive to the researcher's investigation.

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CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter presents a review of related literature in accordance with the study objectives. It presents related literature on the global overview, proximate factors, socio-economic factors and health system factors.

2.1 Overview

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Children are the human resource bank of every nation. However, they are more vulnerable to diseases and other health risks. Under-five mortality therefore erodes the potential economic labour force of a country thus plunges the country into human resource crisis and slows development. The study of the mortality levels, patterns and trends serves three main purposes. First it provides information about the population's state of health, which in turn serves as a measure of living standards in the country. It also gives an indication of the social differences that exist within the society. Lastly, it provides information on the population's future growth potential. A rapid fall in mortality, for example, can result in accelerated growth in the situation of high fertility, unless the declines in mortality are matched by similar declines in fertility. Knowledge about a country's mortality situation is therefore relevant for effective development planning.Mosley and Chen (1984) provided analytical framework for child survival in developing countries. They grouped the proximate determinants into five categories. These are maternal factor (age, parity, birth interval); environmental contamination (air, food/water etc); nutrient deficiency; injury (accidental, intentional) and personal illness control (preventive measures and treatments).

Gandotra et al. (1990) latter categorized the underlying factors behind the immediate causes of child deaths into five broad groups: demographic factors; socio-economic factors; environmental factors; sanitation and hygienic factors and medical factors.

This study adapted Mosley and Chen (1984) conceptual framework to assess the determinants of under-five mortality under the broad factors:socio-economic, demographic, biological and environmental factors.

2.2 Socio-economic Factors

The importance of mothers' education for child survival through pathways other than enhanced socioeconomic status was brought into focus by Caldwell's (1979) seminal paper on Nigeria. This paper argued that education of women played an important role in determining child survival even after control for a number of other factors, including such socioeconomic characteristics of the husband, as his educational level and occupation. Caldwell (1979) suggested several pathways whereby mother's education might enhance child survival. In increasing probable order of importance (according to Caldwell) these were: a shift from 'fatalistic' acceptance of health outcomes towards implementation of simple health knowledge; an increased capability to manipulate the modern world, including interaction with medical personnel; and a shift in the familial power structures, permitting the educated woman to exert greater control over health choices for her children.

According to Hobcraft et al. (1984), factual knowledge concerning the associations between maternal education and child survival at the micro-level expanded considerably as a result of the World Fertility Survey (WFS) program in the 1980s and from a United Nations study which used both survey and census data (Mensch et al., 1985). Both of these major studies showed that increased levels of mother's education were associated with improved chances of child survival in a wide range of developing countries: Hobcraft et al. (1984) covered 28 WFS surveys and Mensch et al. (1985) covered 15 countries; and there was some overlap in coverage. This association usually survived controls for a number of other socioeconomic variables, including the husband's education and occupation. The Hobcraft et al. (1984) study demonstrated that socioeconomic differentials in child survival widened with increasing age of the child and found the greatest consistency in fitted models for mortality between ages one and five, where there were strong suggestions that a model that included terms for both mother's and father's levels of education and the father's occupation had widespread applicability. Mensch et al. (1985) explored a wider range of covariates and found that on average about half of the gross effect of maternal education survived as a net effect after controls. They also found that the association of maternal education and child survival was approximately the same in rural and urban areas, which was seen as consistent with Caldwell's hypothesized pathways, whereas the husband's educational level was associated with greater childsurvival advantage in urban areas. Both studies suggested that the associations between mother's education and child survival were weaker in sub-Saharan Africa than in Asia or particularly Latin America, where socioeconomic differentials were generally larger. Hobcraft et al. (1984) also suggested that the husband's socioeconomic characteristics, especially education, were slightly more strongly associated with improved child survival in the sub-Saharan African countries. Both studies also suggested that there was no threshold level of maternal education that needed to be reached before advantages in child survival began to accrue; even a small amount of education was usually associated with improved chances of child survival, and the gains generally increased with increasing levels of education. There is also overwhelming evidence that the strong and persistent associations of infant and child mortality with birth spacing is barely mediated by maternal education.

Lindenbaum (1990) has stressed the apparent role of greater cleanliness among educated women in explaining differentials in child mortality in Bangladesh. However, Cleland (1990) on the contrary, reviews the very mixed international evidence on reported incidence of diarrhoea episodes by levels of maternal education, including some further studies on Bangladesh; this review suggests that greater cleanliness, if it exists, often fails to be translated into lower frequency of diarrhoea episodes.

A second pathway to receive considerable attention is the role of education in ensuring that the mother utilizes health services for her children. Again, Cleland (1990) concludes that education may have a modest effect on health knowledge and beliefs, but a pronounced effect on the propensity to use modern medical facilities, and adopt modern health practices, because of a closer social identification with the modern world, greater confidence at handling bureaucracies or a more innovative attitude to life among women who have some experience of school.

A third pathway is that maternal education may be associated with greater emphasis on child quality, perhaps ensuring that fewer children are more likely to survive, have greater food and human capital investments and thus end up as higher quality citizens, being healthier, better educated, more affluent, and emotionally better developed. LeVine et al. (1991), in a small study in Mexico, suggest that better educated mothers expect earlier intellectual and emotional development of their children. Moreover, Chavez et al. (1975) suggest that nutrition can play a critical role in making children more active, demanding and independent, thereby gaining more attention from the mother. However, there are also possible indications that educated mothers may become more effective at discriminating against little valued children. Das Gupta (1990) confirmed this assertion by finding that the relative excess mortality of second and later daughters was greater for the children of the more educated mothers.

A final pathway to receive attention is perhaps best referred to as the empowerment of women through education. Cleland (1990) identifies three components to this empowerment, which he terms instrumentality, social identification, and confidence. Instrumentality is the ability to manipulate and feel control over the outside world. Social identification is concerned with engagement with modern institutions and bureaucracies. Greater confidence permits the interaction with such officials and bureaucracies. Caldwell's original concerns with women's education altering power structures within the family should also be considered here. Most evidence for this pathway is indirect and can be summarized thus: educated women make greater use of health services for themselves and their children; hence they are empowered.

Despite a decade of attention to pathways, the evidence is still not clear about which pathways are important where, and even leaves room for doubt as to whether the strong associations of child survival and access to health care with levels of women's education are causal. A study by DaVanzo et al. (1986), strongly suggests that little of the overall change in infant mortality in Malaysia from 1946 to 1975 could be attributed to changes in maternal education at the micro-level, even though a strong cross-sectional relationship was apparent at different points in time. Ewbank et al. (1990) have extended findings on links between child mortality and maternal education to around 1900 in the developed world and suggested that the weaker associations observed were due to the lack of access to facilities and modern medical knowledge which were simply unavailable at that time.

Correspondingly, Boltanski (1969) suggested that the general education level of the mother is more efficient toward adoption of new infant care practices and of more general preventive attitude and enhances the reduction of infant mortality.

Bbaale et al. (2011) used maximum likelihood models to analyze the impact of mother's education on infant and child mortality in Uganda. They used Uganda Demographic Survey Data 2006. The results confirmed that mother's education is fundamental in reducing infant and child mortality. They then suggested that the effort to reduce child mortality need to target measures that aim to educate women. They also commended the government program to extend free education at the secondary level and the need to embrace by all stakeholders to encourage girls to attain education beyond secondary level.

Shamebo et al. (1993) used conditional multiple logistic regression analysis in the Butajira project in Ethiopia to assess the relative importance of parental and environmental characteristics. Under-five mortality was found to be associated with paternal illiteracy and not being in the committee of people's organizations. Parental factors affected the infants relatively more than they did in the children especially in acute respiratory infection (ARI) which was found to one of the major causes of under-five deaths.

Gule (1990) used multivariate analysis to study the determinants of mortality variations at the areal and individuals level in Swaziland. Mothers education and access to major roads were found to be significantly associated with under-five mortality at both areal and individual levels. He also found that the advantages of using tap or tank water are limited if women are uneducated and suggested that educated mother makes better use of existing water facilities.

Bicego (1990) applied a three-step procedure using proportional hazards regression to estimate trends and determinants of childhood mortality in Haiti. He used the data from the 1987 Mortality, Morbidity and Services Utilization Survey (EMMUS) in Haiti.
Maternal education and low mother's age at birth were found to have marked effects on neonatal survivorship but little effect thereafter. Similarly, mother's education was found to be a protective factor at all birth order which in turn has significant effect on under-five mortality by Singh (2013) using multivariate logistic model. Despite the differences in the statistical methodology the results are in agreement to each other.

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Kapungwe (2005) researched into quality of child health care and under-five mortality in two districts in Luapula Province in Zimbabwe. Statistical Package for Service Solutions (SPSS) was used in the study and the findings indicate that most children died before the second year of life with more than 50% dying before their first birth day. The conclusion was that most deaths could have been averted had quality health care been provided in the two districts.

Evidences from studies that used data of censuses Tulasidhar (1993) and demographic surveillance systemsBhuiyat (1991) showed the same mortality differential by maternal education. The only identifiedcounterintuitive result on this association was brought by
Adetunji (1995) who had examined the 1986-1987Ondo State DHS using birth history data from 2635 women aged 15-49. The study showed that infantmortality is higher in those born to mothers with secondary education compared to uneducated mothers. Hesuggested that the lower maternal age at birth and less duration of breastfeeding which were associated withthis group of women could be responsible for this finding.However, a Tanzanian study had shown lack of infant and child mortality differentials by such socioeconomicfactors as maternal education, partner's education, urban/rural residence, and presence of radio in thehousehold.

Also demographic factors such as short birth interval (less than 2 years), teenage pregnancies (less than 20 years) and previous child death were all significantly associated with increased infant and child mortality.

Arriaga et al. (1982) reviewed that mother's employment status is also considered an important factor affecting neonatal, infant and child mortality. The mother's work status determines the amount of time and care a mother can give to her child, and it may determine the amount of resources (income) available to the mother and thus her access to various goods and services. Mother's employment may also have an effect on child's health through lack of time for breastfeeding. However, breastfeeding is found to be one of the most important determinants of child survival (Kiros et al. 2004).

2.3Demographic Factors

Many studies have shown that demographic factors such as small size at birth, short birth interval, mother's age at birth sex of child etc are associated with child mortality.

Madise et al. (2010), studied in Zambia and the results showed that demographic factors such as small size at birth and short birth interval are associated with higher neonatal mortality. They also found that, in the post-neonatal period, urban children from poorer households had the highest mortality.Manda (1998) used data from the 1992 Demographic and Health Survey (DHS) in Malawi to study the relationship between infant and child mortality and birth interval, maternal age at birth and birth order, with and without controlling for other relevant explanatory variables. He also investigated the direct and indirect (through its relationship with birth intervals) effects of breastfeeding on childhood mortality. The study employed proportional hazards models. The results show that birth interval and maternal age effects are largely limited to the period of infancy. As the child increases in age, the influence of social and economic variables on the mortality risk is enhanced and the relationship between bio-demographic variables and mortality risk is strengthened. The study further shows that breastfeeding status does not significantly alter the effects of preceding birth interval length on mortality risk, but does partially diminish the succeeding birth interval effect.

Zeleke (2009) used the South African Demographic and Health Survey data to study the key predictors of mortality among children under the age of five years. Survey logistic regression and cox regression were used for the data analysis. The results of the study show that duration of breastfeeding, marital status and ownership of flush toilet have significant effect on under- five mortality. Pandey et al.(1998) considered child's year of birth, child's sex, mother's age at birth, residence, mother's literacy, religion-caste/tribe membership, mother's exposure to mass media, availability of toilet facility, type of cooking fuel and ownership of goods score as a covariate of infant mortality in their analysis.

Many studies have shown that short birth intervals (less than or equal to 18 months), high parity (6 or more children), low maternal age (less than 20 years) and high maternal age (35 and more years) adversely impact infant and child mortality (Bicego, 1990).

Guilkey et al. (1998) found that controlling for biological mechanisms; the birth order and parity no longer have a direct effect on mortality. According to Pellitier et al. (1993) higher parity, short birth interval and low birth weight are known to be interrelated. The growthand development of young children are affected by their mothers past nutritional histories, and their well-being during pregnancy. Birth weight is affected by maternal nutrition and health. High parity and short birth interval are known to deplete maternal nutrition and influence the child survival through birth weight.

Adjuik et al. (2010) studied the spatial and temporal clusters in under-five mortality in the KassenaNankana district of the Upper East region of Ghana for the period 1997 -2006. In this study a spatial scan statistic was used to test for the clusters of the mortality in both space and time. It was revealed that under-fivemortality has been declined. The conclusion, therefore, was that there is higher than average under-five mortality clustering in the villages in the north east of the district. Correspondingly, Lutambi, et al. (2010), studied spatial-temporal clusters in Ifakara Health and Demographic Surveillance sites (HDSS) in south- eastern Tanzania for a period 1997-2006. Kulldorff's spatial scan test statistic was used for the identification and testing of childhood mortality clusters. There was evidence of spatial clustering in childhood mortality within the Ifakara HDSS which is in agreement with Adjuik et al. (2010) even though there is difference in the study area and population.

Houweling et al. (2005) used ordinary least square regression to estimate the relative effect of determinants of under-five mortality among the poor and the rich. The results showed that higher national incomes were associated with lower under-five mortality. Ethnic fragmentation was significantly more strongly associated with higher under-five mortality among the poor compared with the rich. The findings also revealed that there were on differential in the relative effect of female literacy which disagrees with the findings of mothers' education on under-five mortality in Adetunji (1995).

Nurul et al. (2010) used Kulldorff's space-time scan statistic on HDSS in Matlab, a rural area in Bangladesh in a study of spatio- temporal pattern of under-five mortality and village-level mortality risk. Logistic regression was used to examine if village-level education and economic status explained village-level mortality risk. The results were 3,434 deaths among children under-five years in HDSS area during 1998-2007 with an average year rate of 13 deaths per 1000 under-five child years. The mortality rate showed a declining trend with high concentration in 1998-2002 but not in 2003-2007.They concluded that spatial clustering of childhood mortality observed during 1998-2002 had disappeared in subsequent years with a decline in mortality rates.

2.4 Biological and Environmental Factors

There are a number of different analytical frameworks through which to view the effects of different determinants on childhood mortality. Demographic research by Mosley and Chen (1984) and by Schultz (1984) made the distinction between variables considered to be exogenous or socio-economic (i.e. cultural, social, economic, community, and regional factors) and endogenous or biomedical factors (i.e. breastfeeding patterns, hygiene, sanitary measures, and nutrition). The effects of the exogenous variables are considered indirect because they operate through the endogenous biomedical factors. Likewise, the bio-medical factors are called intermediate variables or proximate determinants because they constitute the middle step between the exogenous variables and child mortality (Jain, 1988; Mosley and Chen, 1984; Schultz, 1984).Conventional methods of classifying causes of death suggest that about seventy percent of deaths of children (aged 0-4 years) worldwide are due to diarrhoea illness, acute respiratory infection, malaria and immunizable diseases.

Pelletier et al. (1995) used developed- epidemiological method to estimatethe percentage of child deaths (aged 6-59 months) which could be attributed to the potentiating effects of malnutrition in infectious disease. The results from 53 developing countries with nationally representative data on child weight-for-age indicate that 56% of child deaths were attributable to malnutrition's potentiating effects, and 83% of these were attributable to mild-to-moderate as opposed to severe malnutrition. For individual countries, malnutrition's total potentiating effects on mortality ranged from 13% to 66%, with at least three-quarters of this arising from mild-to-moderate malnutrition in each case. These results show that malnutrition has a far more powerful impact on child mortality than is generally appreciated, and suggest that strategies involving only the screening and treatment of the severely malnourished will do little to address this impact. The methodology provided in this paper makes it possible to estimate the effects of malnutrition on child mortality in any population for which prevalence data exist.

In WHO (2005) report, malaria threatens the lives and livelihoods of 3.2 billion people worldwide and causes over one million deaths annually. Malaria remains the major cause of morbidity and mortality in sub-Saharan Africa. It is the leading cause of deaths in children aged under-five years (Snow et al. 2004). In Ghana, the disease accounts for 44% of ambulatory care, 13% of all hospital deaths and 22% of mortality among children less than five years of age. UNICEF anticipates that under-five mortality rates could be reduced by about 25-30% if all young children in malaria endemic areas were protected by treated bed nets at night.

Alaii et al. (2003) conducted a large clinical trial in Kenya to confirm the effectiveness of treated bed nets in curbing malaria infection. The results show a significant reduction in clinical malaria and moderate-severe anaemia by 60% in children under-five years.Bbaale (2011) studied the determinants of diarrhoea and acute respiratory infection (ARI) among under-fives in Uganda. A maximum likelihood probit model was used in order to ascertain the probability of occurrence of the diseases. The study revealed that on the average, 32% and 48% of children in the survey suffered from diarrhoea and ARI and the occurrence was concentrated amongst children aged 0-24 months. Mothers' education, especially at postsecondary level reduced the probability of diarrhoea but had no effect on ARI occurrence. It was also found out that, first hour initiation and exclusive breastfeeding reduced the probability occurrence of both diarrhoea and ARI. Other factors associated with occurrence of both diseases in the study include: regional and location differentials, wealth status, type of dwelling, mother's occupation, child age and child nutritional status.

Abdul-Rahman (2011) applied logistic regression model to analyze predictors of malaria mortality among children using impatient morbidity and mortality data for the year 2010 from Tamale Teaching Hospital. The results showed that the logarithm of mortality in children increases linearly with predictors such as referral status, distance, treatment type and length of stay of children administered as malaria patient in 2010 at Tamale Teaching Hospital. It was further found that age, sex and season are not good predictors of malaria mortality. Referral status, distance, treatment type and length of stay were relevant in predicting malaria mortality.

Mesike et al. (2012)studied the environmental determinants of child mortality using principal component analysis as a data reduction technique with varimax rotation to assess the underlying structure for sixty-five measured variables, explaining the covariance relationships amongst the large correlated variables in a more parsimonious way and simultaneous multiple regression for child mortality modeling in Nigeria. For purpose of robustness, a model selection technique procedure was implemented. Estimation from the stepwise regression model shows that household environmental characteristics do have significant impact on mortality.

Apart from classical determinants of child survival, ecological factors can have a strong influence on child survival in rural subsistence societies, particularly by their impact on malnutrition and on reduction of income. Persistence of unfavourable climate conditions may lead to a sharp reduction of food production and children under-five are particularly sensitive to food shortage.Folasade (2000) studied the effect of environmental factors on situation of women and child mortality in two contrasting towns in southwestern Nigeria. He analyzed and determined the relative significance of environmental and maternal factors on child mortality. The results of the study reveal interesting insights into child mortality and maternal factors on one hand and domestic environmental conditions on the other. They give credence to an ecological perspective as a way to understand the complexities behind child survival. Domestic environmental conditions were stronger predictors of child mortality in the more developed study town, Ota, than the more traditional town, Iseyin. However, in both sites maternal factors, in particular age of mother at marriage, age of mother at first childbirth and parity were statistically significant predictors of child mortality. Mother's education was only significant in the more urbanized center, and generally remains inconsistent in its relationship with child mortality. Furthermore, child mortality rates continued to be a function of an environmental factor, namely source of drinking water, and a child care behavior factor, where the child was kept when mother was at work, especially the market environment

Dos Santos et al. (2008) used reliable multi-source data in event-history models to understand how rainfall variations may influence child survival in Burkina Faso which experiences high level of child mortality and high rainfall disparities. The results highlighted the necessity of measuring the rainfall variations with accuracy at fine spatial and temporal resolutions. Child survival in Burkina Faso depends on rainfall conditions but there are specific pattern of rainfall variations and children mortality relationships in each agro-climate region.

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CHAPTER 3

METHODOLOGY

3.0 Introduction

The present chapter describesthe theoretical aspects of logistic regression model which is the main statistical tool employed in the analysis of data in this thesis.

3.1 Purpose of Logistic Regression (Logit Regression)

The crucial limitation of linear regression is that it cannot deal with dependent variables that are dichotomousand categorical. A range of regression techniques have been developed for analyzing data with categorical dependent variables, including logistic regression (logitregession) and discriminant analysis (DA). Logitregression is regularly used rather than discriminant analysis when there are only two categories of the dependent variable.

Since the dependent variable is dichotomous we cannot predict a numerical value for it using logistic regression, so the usual regression least squares deviations criteria for best fit approach of minimizing error around the line of best fit is inappropriate. Instead, logistic regression employs binomial probability theory in which there are only two values to predict: that probability (p) is 1 rather than 0. Logistic regression forms a best fitting equation or function using the maximum likelihood method, which maximizes the probability of classifying the observed data into the appropriate category given the regression coefficients.

3.2 Assumptions of Logistic Regression

- Logistic regression does not assume a linear relationship between the dependent and independent variables.

The dependent variable must be a dichotomy (2 categories).`

- The independent variables need not be interval, nor normally distributed, nor linearly related, nor of equal variance within each group.
- The categories (groups) must be mutually exclusive and exhaustive; a case can only be in one group and every case must be a member of one of the groups.

3.3 Probability distributions

In this section we discuss the probability distributions of generalized linear models (GLMs) in which the outcome variables are measured on a binary scale. The words ‘success’ and ‘failure’ are used as generic terms of the two categories. We define a binary or dichotomous random variable as

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$$Y = \begin{cases} 1 \; if \; the \; outcome \; is \; a \; success \\ 0 \; if \; the \; outcome \; is \; a \; failure \end{cases}$$

With probabilities $\Pr(Z = 1) = \gamma$ and$\Pr(Z = 0) = 1 - \gamma$. If there are n such random variables $Z_1, \dots, Z_n$ which are independent with $\Pr(Z_j = 1) = \gamma_j$, then the joint probability is

$$\prod_{j=1}^{n} \gamma_j^{z_j} (1 - \gamma_j)^{1 - z_j} = exp \left[\sum_{j=1}^{n} z_j log \left(\frac{\gamma_j}{1 - \gamma_j} \right) + \sum_{j=1}^{n} \log(1 - \gamma_j) \right] \qquad (3.1)$$

which is a member of the exponential family. For the case where the $\gamma_j{}'s$ are equal, we define

$$Y = \sum_{j=1}^{n} Z_j$$

So that Y is the number of successes in n ‘trials’. The random variable Y has the distribution $binomial(n, \gamma)$:

$$\Pr(Y = y) = \binom{n}{y} \gamma^y (1 - \gamma)^{n-y} \;, \quad y = 0,1, \dots, n \qquad (3.2)$$

Consider N independent random variables $Y_1, Y_2, \cdots, Y_N$ corresponding to the number of successes in N different groups or strata. If $Y_i \sim binomial(n_i, \gamma_i)$, the log-likelihood function is

$$l(\gamma_1, \cdots, \gamma_N;\ y_1, \cdots, y_N) = \sum_{i=1}^{N} y_i log\left(\frac{\gamma_i}{1-\gamma_i}\right) + n_i log(1-\gamma_i) + log\binom{n_i}{y_i} \quad (3.3)$$

The logistic model is one of the models that accommodates response variable that follows the binomial family. The probability distribution is

$$f(x) = \frac{\beta_2 exp(\beta_1+\beta_2 x)}{[1+exp(\beta_1+\beta_2 x)]^2} \quad (3.4)$$

So integrating $f(x)$, we obtain the logistic function

$$\gamma = \int_{-\infty}^{x} f(x)dx = \frac{exp(\beta_1+\beta_2 x)}{1+exp(\beta_1+\beta_2 x)} \quad (3.5)$$

Writing the logistic regression in terms of odds for success is

$$\frac{\Pr(success)}{\Pr(failure)}$$

$$odds = \frac{\Pr(success)}{1-\Pr(success)} = \frac{\gamma}{1-\gamma} \quad (3.6)$$

This can be obtained as follows

$$\frac{\gamma}{1-\gamma} = \frac{exp(\beta_1+\beta_2 x)}{1+exp(\beta_1+\beta_2 x)} \div \left(1 - \frac{exp(\beta_1+\beta_2 x)}{1+exp(\beta_1+\beta_2 x)}\right)$$

$$= \frac{exp(\beta_1+\beta_2 x)}{1+exp(\beta_1+\beta_2 x)} \div \left(\frac{1\left(1+exp(\beta_1+\beta_2 x)\right) - \left(exp(\beta_1+\beta_2 x)\right)}{1+exp(\beta_1+\beta_2 x)}\right)$$

$$= \left(\frac{exp(\beta_1+\beta_2 x)}{1+exp(\beta_1+\beta_2 x)}\right) \div \left(\frac{1+exp(\beta_1+\beta_2 x) - exp(\beta_1+\beta_2 x)}{1+exp(\beta_1+\beta_2 x)}\right)$$

$$= \frac{exp(\beta_1+\beta_2 x)}{1+exp(\beta_1+\beta_2 x)} \div \left(\frac{1}{1+exp(\beta_1+\beta_2 x)}\right)$$

$$= \frac{exp(\beta_1 + \beta_2 x)}{1 + exp(\beta_1 + \beta_2 x)} \times \frac{1 + exp(\beta_1 + \beta_2 x)}{1}$$

$$= exp(\beta_1 + \beta_2 x)$$

Therefore, $\frac{\gamma}{1-\gamma} = exp(\beta_1 + \beta_2 x)$(3.7)

3.4 The Logit Model

Taking the logarithm of the odds gives the link function

$$log\left(\frac{\gamma}{1-\gamma}\right) = \beta_1 + \beta_2 x \quad (3.8)$$

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The term $\log[(\gamma/1-\gamma)]$ is sometimes called the logit function and it has a natural interpretation as the logarithms of odds. The simple linear logistic model or the logit model $\log[(\gamma/1-\gamma)] = \beta_1 + \beta_2 x$ is a special case of the general logistic regression model

$$logit\ \gamma_i = log\left(\frac{\gamma_i}{1-\gamma_i}\right) = X_i^T \beta \quad (3.9)$$

whereX_i is a vector continuous measurements corresponding to covariates and dummy variables corresponding to factor levels and β is the parameter vector. This model is very widely used for analyzing data involving binary or binomial responses and several explanatory variables.

3.5 Coefficients and Odds Ratios of Logit Model

The odds of an outcome being present among individuals with $x = 1$ is defined as $\gamma(1)/[1-\gamma(1)]$. Similarly, the odds of an outcome present among individuals with $x = 0$ is defined as$\gamma(0)/[1-\gamma(0)]$. The odds ratios denoted ORis defined as the ratio of the odds for $x = 1$ to the odds for $x = 0$ and is given by the equation

$$OR = \frac{\gamma(1)/[1-\gamma(1)]}{\gamma(0)/[1-\gamma(0)]} \quad (3.10)$$

$$OR = \frac{\left(\frac{\exp(\beta_0+\beta_1)}{1+\exp(\beta_0+\beta_1)}\right)/\frac{1}{1+\exp(\beta_0+\beta_1)}}{\frac{\exp(\beta_0)}{1+\exp(\beta_0)}/\frac{1}{1+\exp(\beta_0)}}$$

$$= \frac{\exp(\beta_0 + \beta_1)}{\exp(\beta_0)}$$

$$= \exp[(\beta_0 + \beta_1) - \beta_0]$$

$$= \exp(\beta_1) \quad (3.11)$$

Hence, the odds ratios are the exponential functions of the coefficients in the logit model.

Maximum likelihood estimates of the logitcoefficient β, and consequently of the probabilities $\gamma_i = g(X_i^T\beta)$, are obtained by maximizing the log-likelihood function

$$l(\gamma; y) = \sum_{i=1}^{N} \left[y_i \log \gamma_i + (n_i - y_i)\, log(1-\gamma_i) + log \binom{n_i}{y_i}\right] \quad (3.12)$$

3.6 Maximum Likelihood Estimation Method (MLE)

In practice, the parameter value for the binomial distribution is unknown. Using sample data, we estimate the parameters. The estimation method for the binomial parameter is called maximum likelihood. The idea is to use a value in the parameter space that corresponds to the largest likelihood for the observed data as an estimate of the unknown parameter. Since we are estimating the parameter for binomial function,we solve for the maximum likelihood estimator for the Bernoulli parameter γ,which have a function

$$f(\gamma, x) = \gamma^x (1 - \gamma)^{1-x} \quad (3.13)$$

the likelihood function is given by

$$L(\gamma, x) = \prod_{i=1}^{n} \pi^x (1-\gamma)^{1-x}$$

$$= \gamma^{\sum_{i=1}^{n} x_i} (1-\gamma)^{n-\sum_{i=1}^{n} x_i} \quad (3.14)$$

Solving for the log likelihood function, we have

$$ln(\gamma, x) = ln\left[\gamma^{\sum_{i=1}^{n} x_i}(1-\gamma)^{n-\sum_{i=1}^{n} x_i}\right]$$

$$= \sum_{i=1}^{n} x_i ln\gamma + ln(1-\gamma)^{n-\sum_{i-1}^{n} x_i}$$

$$= \sum_{i=1}^{n} x ln\gamma + \left(n - \sum_{i=1}^{n} x_i\right) ln(1-\gamma)$$

Calculating the score function, the score function is the partial derivative with respect to the log-likelihood function.

$$S(\pi, x) = \frac{\partial}{\partial \pi} l(\gamma, x_i)$$

$$= \frac{\partial}{\partial \gamma}\left[\sum_{i=1}^{n} x_i\, ln\gamma + n - \sum_{i=1}^{n} x_i\, ln(1-\gamma)\right]$$

$$= \left[\frac{x}{\gamma} + \frac{x-n}{1-\gamma}\right] \quad (3.15)$$

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Let $I(\gamma, x)$ be the information function. It is thefunction, that prove that the score function $s(\gamma, x)$ is greater than zero.

$$I(\pi, x) = -\frac{\partial}{\partial \gamma}\left[\frac{x}{\gamma} + \frac{x-n}{1-\gamma}\right]$$

$$= -\left[\frac{-x}{\gamma^2} + \frac{x-n}{(1-\gamma)^2}\right]$$

$$= \frac{x}{\gamma^2} + \frac{n-x}{(1-\gamma)^2} > 0$$

Solving for the maximum likelihood (ML) estimator is given as

$$s(\gamma, x) = 0$$

$$S(\gamma, x) = \frac{\partial}{\partial \pi} l(\gamma, x_i)$$

$$= \frac{\partial}{\partial \gamma}\left[\sum_{i=1}^{n} x_i \, ln\gamma + n - \sum_{i=1}^{n} x_i \, ln(1-\gamma)\right]$$

$$= \left[\frac{x}{\gamma} + \frac{x-n}{1-\gamma}\right]$$

$$\frac{x}{\gamma} + \frac{x-n}{1-\gamma} = 0$$

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$$x(1-\gamma) + \gamma(x-n) = 0$$

$$x - x\gamma + x\gamma - n\gamma = 0$$

$$n\gamma = x$$

$$\hat{\gamma} = \frac{x}{n} \tag{3.16}$$

where$\hat{\gamma}$ is the estimator of the parameter γ.

3.7 The Wald Test

The Wald test provides a test of significancefor the coefficients (i.e. the β's) in the logistic regression. Using the Wald test, we calculate the Wald statistic which is the square of this ratio,

$$W = \left(\frac{\beta_1}{S.E(\beta_1)}\right)^2 \tag{3.17}$$

The standard errors are also computed by SPSS, and their estimation also relies on MLE theory.If the null hypothesis states that β_1 = 0 is true, then this statistic has a chi-square distributionwith "p" degrees of freedom. A p-value less than 0.05 indicate that the coefficient β, is significant at 5% level in predicting the outcome variable. In most cases likelihood ratio test and Wald test lead to the same conclusion. However in some cases the Wald test produces a test statistic that is not significant when the likelihood ratio test indicates that the variable should be kept in the model. This is because the estimated standard errors are too large and this happens when the absolute value of the coefficient becomes large so that the ratio (Wald statistic) becomes too small.

3.8 Likelihood Test Criterion

The likelihood ratio test is performed to see whether the inclusion of an explanatory variable in a model tell us more about the outcome variable than a model that does not include that variable. The likelihood ratio (LR) test is based on likelihood function. The likelihood ratio (LR) test statistic is given by

$$-2\log\left(\frac{L_0}{L_1}\right) = -2[\log(L_0) - log(L_1)] = -2(L_0 - L_1) \tag{3.18}$$

where L_1 = maximized value of the likelihood function for the full model and

Lo =maximized value of the likelihood function for the reduced model.

For each model fit, the calculated the statistic -2*log likelihood (known as -2LL) is called the scaled deviance and it measures the degree of discrepancy between the observation values and the predicted values from the model. The SPSS (Software) gives the value for -2LL in the “Omnibus Tests of model coefficient” table. This value is then compared with the table value from a chi-square distributionwith “p” degrees of freedom. If the value is greater than the table value, the null hypothesis is than rejected. The SPSS provides a p - value. If this p - value is less than 0.05, then we reject the null hypothesis at 5% level of significance and conclude that the inclusion of the explanatory variable is better at predicting the outcome variable than when it is not included.

3.9 Hosmer and Lemeshow Test

The Hosmer and lemeshow goodness of fit statistics $\hat{C}$ is obtained by calculating the Pearson Chi-square from 2×2 contingence table of observed and estimated expected frequency

The formula of $\hat{C}$ is given by

$$\hat{C} = \sum_{k=1}^{g} \frac{(o_k - n_k' \hat{\pi}_k)^2}{n_k' \pi_k (1 - \hat{\pi}_k)} \quad (3.19)$$

Where n_k' is the total number of subjects in the k^{th} group, C_k denote the number of covariate patterns in the k^{th}deciles

$$O_k = \frac{m_j \hat{\pi}_j}{n_k'}$$

is the number of responses among C_k covariate pattern and

$$\hat{\pi}_k = \sum_{j=1}^{C_k} \frac{m_j \hat{\pi}_j}{n_k'} \quad (3.20)$$

is the average estimated probability.

3.10 Variance Explained Measure for Logit Model

The deviance for the observed model, null model and saturated model are useful quantities for exploring the fit of a logistic regression. One slightly controversial application of the deviance is to derive a pseudo-R square measure from it, known as the loglikelihood or Hosmer and LemeshowR square (Hosmer and Lemeshow, 1989). This is done by expressing the deviance of the model as a proportion of deviance for the null model. If the deviance for the modelisD_M, loglikelihood pseudo-*R* square is:

$$R_L^2 = \frac{ln(\ell_M) - \ln(\ell_0)}{\ln(\ell_S) - \ln(\ell_0)} = \frac{D_0 - D_M}{D_0} = 1 - \frac{D_M}{D_0} \quad (3.21)$$

This is termed as pseudo-*R* square measure because there is no agreed equivalent to *R*square in logistic regression (or other generalized linear models). The problem stems mostly from the fact that *R* square can be defined in several ways. One definition is the improvement in fit from adding predictors to a null model (which R_L^2 attempts to tackle). Another definition is in terms of the square of the correlation between predicted and observed values. A further definition is in terms of the proportion of explained variation in the data (e.g., *R* squared can be calculated by subtracting the unexplained variance from one). For a normal generalized linear model with an identity link, these definitions coincide and lead to the same quantity, but theywill not coincide for a generalized linear model. Applying the logic of the explained variance measure leads to the Cox and Snell pseudo-*R* square:

$$R_{CS}^2 = 1 - \left(\frac{\ell_0}{\ell_M}\right)^{2/N} = 1 - e^{-1/2N[ln(\ell_M) - \ln(\ell_0)]} \quad (3.22)$$

For a normal generalized linear model this formula has a maximum of one, but for logistic regression its maximum is .75 or lower. A correction known as the Nagelkerke pseudo-*R* square adjusts it to range between zero and one. The corrected formula is:

$$R_N^2 = \frac{R_{CS}^2}{1 - \ell_0^{2/N}} = \frac{R_{CS}^2}{1 - e^{2/N \ln(\ell_0)}} \quad (3.23)$$

The first two measures are often similar (but rarely identical) in value. The Nagelkerke *R* square measure will typically be substantially larger than the other two by virtue of the correction. On the other hand, all pseudo-*R* square measures produce low *R* square values compared to those associated with good fits in least squares regression. For this reason it is inappropriate to compare *R* square with pseudo-*R* square measures (or to compare different pseudo-*R* square variants). Comparisons between pseudo-*R* square must be restricted to the same measure within the same data set to be at all meaningful.

CHAPTER 4

DATA ANALYSIS AND RESULTS

4.0 Introduction

In this chapter, the methodologies presented in previous chapter are used to analyze primary data collected from 200 mothers in Tano South district in the Brong-Ahafo region, Ghana. It gives brief descriptive analysis of respondents. The main analyses were carried out using multivariate logistic regression model. This model was based on 5% level of statistical significance.

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4.1 Materials and Methods

This investigation was carried out in the Tano South district to study factors associated with under-five mortality in the area. The study was restricted to mothers, caregivers with wards under-five years of age. The statistical tools used in the present study were carefully selected to ascertain quality results and investigate all possible relationship that were directly influencing under-five mortality in the Tano South district.

4.2 Sampling Technique and Sampling Size

The district was divided into four zones and the target populations were identified using the purposive sampling. A total sample size of 200 mothers or caregivers was used, of which 50 was selected randomly from each zone.

4.3 Study variables

The information which was sought from mothers form the study variables. These include socio-economic variables including education of mother/caregiver, education of father, occupation of mother/caregiver, occupation of father, income of mother/caregivers, income of father, marital status of mother, household durables and the average amount spent per day for each household were utilized. Demographic factors of under-five mortality such as age of mother at birth, religion of mother or caregiver, parity, sex of child, age of child at death, number of children alive, number of children under-five dead, breastfeeding among others.

Finally, biological and environmental factors of under-five mortality, such as place delivery, care centre, diseases, type of health care provider, distance from residence to health facility, times taken to the health facility, cost of health care, waiting time before receiving treatment, information about vaccination, frequency of vaccination and respondents status of national health insurance.

4.4 Descriptive Analysis

The descriptive analysis gives details of the characteristics of the sample of mothers in the Tano South district.

Table 4.1 Show the frequency and percentage across different age groups of 200 mothers interviewed at the Tano South district.

Tabble 4.1: Frequency and Percentage of Mothers stratified by Age

Age (years)	**Frequency**	**Percentage**
15-24	45	22.5
25-34	88	44.0
35+	67	33.5
Total	200	100.0

Most of the respondents were aged between 25-34 years from the table. Those in this age category accounted for 44.0% of the entire figure. This was followed by individuals aged 35 years and older (33.5%). The respondents within the age group of 15-24 years were fewer (22.5%).

The table 4.2 shows the summary statistics of demographic factors such parity, birth interval and breastfeeding in relation to under- five mortality in the Tano South district.

Table 4.2: Demographic Factors stratified by Under-five Mortality

		Under-five Mortality	
		Yes	**No**
Parity	Primigravidae	27 (26.5%)	25 (25.5%)
	Multigravidae	66 (64.7%)	58 (59.2%)
	Grandmultigravidae	9 (8.8%)	15 (15.3%)
Birth interval	Less than two years	27 (26.5%)	14 (14.3%)
	At least two years	14 (13.7%)	12 (12.2%)
Breast feeding	None	9 (8.8%)	7 (7.1%)
	Exclusive	25 (24.5%)	30 (30.6%)
	Not-exclusive	52 (51.0%)	39 (39.8%)

From the table, under-five mortality was common among mothers of multigravidae (64.7%). Among those of primigravidae parity 26.5% experienced under-five mortality and fewer among the women of grandmultigravidae parity (8.8%). Women with two or more years birth intervals experienced fewer under-five mortality cases (13.7%) than those with less than two years birth intervals (26.5%). Mothers who did not practice exclusive breastfeeding experienced more cases of under-five mortality (51.0%) than those who practiced exclusive breast feeding (24.5%). However, mothers who did not breastfeed their kids experienced only 8.8% cases of under-five mortality.

The table 4.3 below shows the summary statistics of socio- economic factors such as marital status, mothers' education, mothers' occupation, mothers' income, fathers' education, fathers' occupation, fathers' income in relation to under-five mortality in the district.

Table 4.3: Socio-economic Factors stratified by Under-five Mortality

		Under-five Mortality	
		Yes	**No**
Marital Status	Widowed/ separated	9 (9.2%)	13 (12.7%)
	Married	80 (81.6%)	77 (75.5%)
	Single	9 (9.2%)	12 (11.8%)
Mothers Education	No education	16 (16.3%)	26 (25.5%)
	Basic	54 (55.1%)	37 (36.3%)
	Secondary	17 (17.3%)	27 (26.5%)
	Tertiary	11 (11.2%)	12 (11.8%)
Mothers Income (GH¢)	< 500.00	31 (31.6%)	34 (33.3%)
	500.00-999.00	32 (32.7%)	28 (27.5%)
	1000.00-5999.00	4 (4.1%)	6 (5.9%)
	6000.00 +	12 (12.2%)	15 (14.7%)
Mothers Occupation	Unemployed	10 (10.2%)	13 (12.7%)
	Farmer	36 (36.7%)	33 (32.4%)
	Trading	21 (21.4)	24 (23.5%)

	Artisan	17 (17.3%)	14 (13.7)
	Public\ Civil servant	12 (12.2%)	16 (15.7)
Fathers education	None	44 (44.9%)	37 (36.3%)
	Basic	29 (29.6%)	36 (35.3%)
	Secondary	21 (21.4%)	22 (21.6%)
	Tertiary	4 (4.1%)	7 (6.9%)
Fathers occupation	Unemployed	43 (43.9%)	37 (36.3%)
	Farmer	29 (29.6%)	36 (35.3%)
	Trading	13 (13.3%)	21 (20.6%)
	Artisan	12 (12.2%)	7 (6.9%)
	Public\ Civil servant	1 (1%)	1 (1%)
Fathers Income (GH¢)	< 500.00	31 (31.6%)	34 (33.3%)
	500.00-999.00	4 (4.1%)	15 (14.7%)
	1000.00-5999.00	12 (12.2%)	6 (5.9%)
	6000.00 +	32 (32.7%)	28 (27.5%)

From the table under-five mortality was prevalent among married mothers, constituting (81.6%), mothers who are widowed or separated and those who were single experienced few cases of under-five mortality.

Among women with basic education 55.1% experienced under-five mortality. Also women with no education and those with secondary education experienced 16.3% and 17.3% cases respectively. However, only few cases were observed among women with tertiary education (11.2%). Under-five mortality was 31.6%, 32.7%, 4.1%, and 12.2% in women who earn annually income less than GH¢500, GH¢500-GH¢999, GH¢1000-GH¢5999 and GH¢6000+

respectively. This was also higher among women who are farmers (36.7%), compared to traders (21.4%), artisans (17.3%), public/ civil servant (12.2%) and the unemployed (10.2%). Families headed by fathers with no level of education experienced the highest cases of under-five mortality (44.9%) compared to those with basic (29.6%), secondary (21.4%) and tertiary (4.1%). Furthermore, under-five mortality washigher among fathers who were unemployed (43.9%), compared to farmers (29.6%), traders (13.3%), artisans (12.2%) and public/ civil servant (1.1%).

The table 4.4 shows the summary statistics of biological and environmental factors such as antenatal care visits,child vaccine, health staff, NHIS beneficiary, treated bed net usage, diseases in relation to under-five mortality in the district.

Table 4.4 Biological and environmental factors stratified by Under-five Mortality

		Under-five Mortality	
		Yes	No
Antenatal Care	Yes	9 (8.8%)	71 (69.6%)
	No	10 (10.2%)	7 (6.9%)
Use of child vaccine	Yes	31 (31.6%)	41 (40.2%)
	No	67 (68.4%)	61 (59.8%)
Health Staff	Nurse	34 (33.3)	42 (42.9%)
	Doctor	5 (5.1%)	11 (10.8%)
	Medical Assistant	43 (43.9%)	49 (48.0%)
	Mid Wife	8 (7.8%)	8 (7.8%)
NHIS	Yes	5 (4.9%)	7 (7.1%)
	No	91 (92.9%)	97 (95.1%)

Treated Bed-net use	Yes	20 (20.4%)	56 (54.9%)
	No	78 (79.6%)	46 (45.1%)
Disease	Diarrhoea	8 (8.2%)	7 (6.9%)
	Anaemia	8 (8.2%)	13 (12.7%)
	Malnutrition	10 (9.8%)	10 (9.8%)
	Malaria	71 (72.4%)	65 (63.7%)
	Pneumonia	1 (1.0)	7 (6.9%)

From the table mothers who attended antenatal care have fewer cases of under-five mortality (8.8%), compared to those who did not attend antenatal care (10.2%). Similarly, under-five mortality was fewer among parents who vaccinated their children (31.6%), than does who did not (68.4%). Under-five mortality is higher when health care is delivered by a nurse (33.3%). The respective cases of under-five mortality for children who sleep under treated bed-net and those who do not are 20.4% and 79.6%. Malaria alone accounted for 72.4% of under-five mortality, compared to diarrhoea (8.2%), anaemia (8.2%), malnutrition (9.8%) and pneumonia (1.0%).

4.5 Further Analysis

Hypothesis for Logit Model Coefficients

$\boldsymbol{H_0}$: Information about the socio-economic, demographic, biological and environmental factors do not allow for better prediction of under-five mortality.

$\boldsymbol{H_A}$: Information about the socio-economic, demographic, biological and environmental factors allow for better prediction of under-five mortality.

The table 4.5 shows the results of the omnibus test of the logit model coefficients of the factors associated with under-five mortality.The table also presents the Chi-square values, degrees of freedom (d.f) and corresponding p-values for three tests criterion.

Table 4.5: Omnibus Tests of the Logit Model for Under-five Mortality

	Chi-square	d.f	P-value
Step	77.968	43	0.001
Block	77.968	43	0.001
Model	77.968	43	0.001

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From the table, the Chi-square value and their corresponding p-values are 77.968 and 0.001 for the entire Omnibus test criterion. These results suggest that the entire tests are statistically significant at 5% level, therefore leading to the rejection of the null hypothesis. This brings out the implication that the information about the socio-economic, demographic and biological and environmental factors allow for better prediction of under-five mortality in context of the logit model.

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The table 4.6 presents the results of the logit model for the association of factors with significant categorical effect on under-five mortality. The coefficient estimates, standard errors, odds ratio (OR) and the p-values of all the factors are shown. The odds ratios are the exponential functions of the coefficient estimates which reflect the multiplicative effects of the factors under consideration. Significant factors are mainly identified by the p-values.

Table 4.6: Logit Model for under-five Mortality

Variables	Estimate	Std. Error	Odds Ratio	P-Value
Intercept	2.714	1.183	15.089	0.307
Parity				
Primigravidae	0.000	0.000	1.000	
Multigravidae	0.511	1.017	1.667	0.435
Grandmultigravidae	0.808	0.798	2.243	0.037
Treated bed net use				
No	0.000	0.000	1.000	
Yes	-2.587	0.500	0.075	0.000
Diseases				
Diarrhoea	0.000	0.000	1.000	
Anaemia	2.491	1.281	12.073	0.042
Malnutrition	2.168	1.340	8.741	0.093
Malaria	2.500	1.381	12.182	0.039
Pneumonia	1.912	1.384	6.767	0.378
Use of child vaccine				
No	0.000	0.000	1.000	
Yes	-0.580	0.241	0.560	0.001
Breast feeding				
None	0.000	0.000	1.000	
Exclusive	-4.022	1.917	0.018	0.036
Not-exclusive	-3.699	1.769	0.025	0.037

From the table, the estimated intercept of 3.714 with odds ratio of 41.018 is statistically not significant (p-value=0.307) at 5% level. For the parity factor only grandmultigravidae with estimated coefficient of 0.808 and corresponding p-value of 0.037 showed significant effect on under-five mortality at 5% level. The odds ratio of grandmultigravidae parity is 2.243. This suggests that theodds of under-five mortality among mothers of grandmultigravidae parity are 48.6% higher than those of primigravidae parity, controlling the effect of other factors.

Furthermore, treated bed-net use has significant negative effect on under-five mortality (coefficient=-2.587; p-value=0.000) with an odds ratio of 0.075. The value of the odds ratio gives an indication that the odds of under-five mortality is 92.5% lower for mothers who uses treated bed-net compared tothose who do not use treated bed-net.

Moreover, whilst malnutrition (p-value=0.093)and pneumonia (p-value=0.378) are not significant at 5% level, anaemia (p-value=0.042) and malaria (p-value=0.039) are statistically significant. The odds ratio of under-five mortality caused by anaemia, compared to diarrhoea is 12.073. This implies that the odds of under-five mortality caused by anaemia is 87.6% higher than that of diarrhoea. Also the odds ratio of malaria 12.182 indicates that the odds of under-five mortality with respect to malaria is 218.4% higher as compared to diarrhoea.

The use of child vaccine has significant (p-value=0.000) negative effect on under-five mortality with estimated odds ratio of 0.560. This depicts that the odds of under-five mortality is 44.0% lower for mothers who vaccinate their children as compared to those who do not vaccinate their children.

Similarly, both exclusive (p-value=0.036) and not-exclusive (p-value=0.037) breastfeeding showed significant negative effects on under-five mortality with respective odds ratio of

0.018 and 0.025. From the odds ratios it is evident that the respective odds of under-five mortality are 98.2% and 97.5% lower among mothers who practice exclusive and not-exclusive breastfeeding compared to those who do not breastfeed their children.

On the other hand, other factors including mothers' education, fathers' education, mothers' occupation, fathers' occupation, birth interval, mothers income, fathers income, marital status and health staff did not show significant effect on under-five mortality (appendix).

These findings clearly suggest that the main determinants of under-five mortality in the Tano South district are grandmultigravidae parity, treated bed-net use, anaemia, malaria, use of child vaccine, exclusive and not-exclusive breast feeding.

Therefore, using these determinants the fitted logitmodel for under-five mortality is

$$
\begin{aligned}
&log(odds\ of\ under-five\ mortality) \\
&\qquad = 2.714 + 0.808GMP - 2.587TBN + 2.491ANA + 2.500MAL \\
&\qquad - 0.580UCV - 4.022EBF - 3.699NEBF
\end{aligned}
$$

where

GMP- grandmultigravidae parity

TBN- treated bed net

ANA- anaemia

MAL- malaria

UCV- use of child vaccine

EBF- exclusive breastfeeding

NEBF- not exclusive breastfeeding

Presented in Table 4.7 are the values of -2log likelihood and Pseudo R square values for the fitted logistic model.

Table 4.7: Pseudo R Square of the Logit Regression Model for Under-five Mortality

Statistic	**Value**
-2 Log likelihood	199.210
Cox and Snell R Square	0.423
Nagelkerke R Square	0.531

The value of -2log likelihood is fairly large (199.210). Moreover, the Cox and Snell R square value of 0.423 and Nagelkerke R square of 0.531 are moderate. These therefore suggest that the fitted model is of moderate predictive power.

Table 4.8 presents results of the Hosmer and Lemeshow test for the fitted logistic regression model.

Table 4.8: Hosmer and Lemeshow Test of the LogitModel for Under-five Mortality

Chi-square	**Degrees of Freedom (d.f)**	**p-value**
7.213	8	0.514

From the Chi-square value of 7.213 with corresponding p-value of 0.514 is greater than the level of significance, therefore, suggesting a non statistical significance. The non-significance implies that the model is consistent with the data. Moreover, the most of the expected frequencies in cells of the contingency table of the Hosmer and Lemeshow test in the appendix are at least 5.0. These results are in line with the results presented in Table 4.6, therefore reinforcing the findings that the model is consistent with the data.

From the logit model, the estimated odds of under-five mortality among mothers of grandmultigravidaeparity (GMP=2), controlling the effect of other factors in the model is

$$log(odds\ of\ under-five\ mortality)$$
$$= 2.714 + 0.808 \times 2 - 2.587 \times 0 + 2.491 \times 0 + 2.500 \times 0 - 0.580 \times 0 - 4.022 \times 0 - 3.699 \times 0$$
$$log(odds\ of\ under-five\ mortality) = 4.330$$
$$odds\ of\ under-five\ mortality = \exp(4.330)$$
$$= 75.944$$

Therefore, from the odds the estimated probability is

$$\frac{75.944}{1 + 75.944} = 0.987$$

In addition, controlling the effect of other factors, the estimated odds of under-five mortality among mothers who uses treated bed nets (TBN=1) is

$$log(odds\ of\ under-five\ mortality)$$
$$= 2.714 + 0.808 \times 0 - 2.587 \times 1 + 2.491 \times 0 + 2.500 \times 0 - 0.580 \times 0 - 4.022 \times 0 - 3.699 \times 0$$
$$odds\ of\ under-five\ mortality = \exp(-0.227)$$
$$= 0.797$$

with estimated probability of

$$\frac{0.797}{1 + 0.797} = 0.444$$

Similarly, the estimated odds of under-five mortality among children infected with anaemia (ANA=1), controlling the effect of other factors in the model is

$$log(odds\ of\ under-five\ mortality)$$
$$= 2.714 + 0.808 \times 0 - 2.587 \times 0 + 2.491 \times 1 + 2.500 \times 0 - 0.580 \times 0 - 4.022 \times 0 - 3.699 \times 0$$

$$odds\ of\ under-five\ mortality = \exp(5.205)$$

$$= 182.2$$

The probability is given by

$$\frac{182.2}{1 + 182.2} = 0.995$$

4.6 Discussion

Children are the human resource bank of every nation. However, they are more vulnerable to diseases and other health risks. Under-five mortality therefore erodes the potential economic labour force of a country thus plunges the country into human resource crisis and retards development. The present thesis adapted Mosley and Chen (1984) conceptual framework to assess the determinants of under-five mortality under the broad factors: proximate factors, socio-economic factors and health system factors at the Tano South district in Ghana.

The findings of this thesis indicate that higher parity, in particular grandmultigravidae parity has adverse significant impact on under-five mortality. These findings are consistent with the study by Bicego, (1990) and Manda, (1998). Similarly, our results suggest that anaemia, malnutrition, malaria and pneumonia adversely affect under-five mortality. However, only the effect of anaemia and malaria were statistically significant. Anaemia and malaria increase the estimated odds of under-five mortality by 87.6% and 218.4% respectively. These findings clear depict that malaria impact strongly on under-five mortality.This is not surprising because evidence exist that malaria is a leading cause of deaths in children aged under-five years (Snow, et al. 2001).

However, several other determinants reduce the likelihoods of under-five mortality. In the present thesis we found that the use of treated bed-net reduces the odds of under-five mortality by estimated levels of 92.5% than not using treated bed-nets. A report by UNICEF anticipates that under-five mortality rates could be reduced by about 25-30% if all young children in malaria endemic areas were protected by treated bed-nets at night. This reduction may be due the fact that the use of treated bed-nets at night is likely to curb malaria infections in young children, therefore, following a corresponding decrease in under-five mortality as confirmed in one clinical study in Kenya by Alaii, et al. (2003).

Compared to mothers who do not vaccinate their children, vaccination significantly reduces the estimated odds of under-five mortality by 44.0%. Furthermore, breastfeeding is found to be one of the most important determinants of child survival (Kiros, et al. 2004). In this thesis both exclusive and not-exclusive breastfeeding significantly reduces the odds of under-five mortality by 98.2% and 97.5% respectively, compared to not practicing any of these. In line with these findings, in one study by Bbaale, (2011),it was also found that exclusive breastfeeding reduces the probability occurrence of both diarrhoea and acute respiratory infection (ARI) among under-fives in Uganda.

Also we have shown that several other factors like mothers' education, fathers' education, mothers occupation, fathers occupation, birth interval, mothers income, fathers income, marital status and health staff are not significant determinants of under-five mortality. To some extent, some of these findings correspond and also contradict some previous findings. For instance, Caldwell, (1979) reported on the effect of mothers' education on the reducing the child mortality. On the other hand, Hobcraft, (1993) explained that the effect of maternal education on child survival is weaker in sub-Saharan Africa. In addition, Adetunji (1995) showed in his study that infant mortality is higher in babies born to mothers with secondary education compared to uneducated mothers.In Ethiopia, Shamebo, et al. (1993), under-five mortality was found to be associated with paternal illiteracy. For the case of income, Houweling et al. (2005) showed that higher national incomes are associated with lower under-five mortality.Studies byBicego, (1990) and Manda, (1998) revealed that short birth intervals (less than or equal to 18 months), low maternal age (less than 20 years) and high maternal age (35 and more years) adversely impact infant and child mortality.

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CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.0 Conclusion

We have in this thesis explored thedeterminants of under-five mortality and utilized a logit model to predict under-five mortality in the Tano South district in Ghana.

Using a 5% level of statistical significance, the determinants were mainly explored by their p-values.

A sample size of 200 mothers who were aged 15 years and older in the Tano South districtwere interviewed to ascertain their background information. Information gathered from the mothers were grouped into socio-economic, demographic, biological and environmental factors. The mothers werepredominantly aged between 25-34 years (44.0%). This was followed by those aged 35 years and older (33.5%). Those aged 15-24 years (22.5%) were the minority.

Among the determinants of under-five mortality are grandmultigravidae parity, use of treated bed-net, anaemia, malaria, use of child vaccine, exclusive and not-exclusive breastfeeding. Whilst grandmultigravidae parity, anaemia and malaria increases the likelihood of under-five mortality with respective odds of 2.243, 8.741 and 12.182, the use of treated bed-net, use of child vaccine, exclusive and not-exclusive breastfeeding reduces under-five mortality by estimated odds of 0.075, 0.560, 0.018 and 0.025 respectively.

Based on the factors identified as the determinants of under-five mortality, the logit model formulated in this thesis is

$$log(odds\ of\ under - five\ mortality)$$
$$= 2.714 + 0.808GMP - 2.587TBN + 2.491ANA + 2.500MAL - 0.580UCV - 4.022EBF - 3.699NEBF$$

Results emerging from the Pseudo R square (i.e. Cox and Snell=0.423; Nagelkerke R Square=0.531) suggests that the determinants identified as significant factors in the model gives a moderate prediction of under-five mortality. Moreover, the Chi-square value of 7.213 with corresponding p-value of 0.514 from the Hosmer and Lemeshow test gives an indication that the fitted logit model is consistent with the data used in this thesis.

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From the fitted logit model, the probability ofunder-five mortality associated with grandmultigravidae parity, use of treated bed-nets, and anaemia is predicted as 0.987, 0.444 and 0.995 respectively. Finally, results presented in this thesis depicts that the objectives has been well treated with the framework of logit modeling.

5.1 Recommendation

More education and sensitization on precautionary measures and good health should be given to mothers, especially mothers of grandmultigravidae parity. In particular, education on the use treated bed-nets in the homes of mothers should be intensified. This should also target how to handle and use the treated bed-nets. Moreover, child vaccination should be promoted and extended to all the communities in the Tano South district.

Further studies are required to deepen our understanding of the phenomenon that drives the determinants of under-five mortality, in particular within the framework of statistical modeling. Moreover, since these models are normally built on data, we recommend effective data base system in the Tano South district.

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APPENDICES

Appendix A: Questionaire for Mothers/Caregivers

Introduction

We are students of Kwame Nkrumah University of Science and Technology (KNUST), Kumasi.

We are talking to several people like you to ascertain your views about "Determinants of under-five mortality" in the Tano South District of the BrongAhafo Region of Ghana.

The information will be used in a thesis for a Masters Degree.

Please, your opinions are very important and will be treated confidential. You are required to respond to some questions about the subject matter in order to make this exercise complete.

Thank you.

SECTION A: DEMOGRAPTHICFACTORS

A1. Age of mother at childbirth

1. 15-24 years
2. 25-34 years
3. 35 and above

A2. Religion of mother/caregiver

1. Christian
2. Moslem
3. Traditionalist

A3. Parity

1. Primigravidae
2. Multigravidae (2-5)
3. Grandmultigravidae (6+)

A4. Sex of child

1. Male
2. Female

A5. No. of children alive

1. None
2. 1-4
3. 5 and above

A6. Number of children under-five__________________

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A7. Number of children under-five alive__________________

A8. Number of children under-five dead __________________

A9. Where did the under-five child died?

1. Home
2. Traditional birth attendant
3. CHP compound
4. Clinic
5. Health centre
6. Hospital

A10. Birth interval (last child).

1. At least two years
2. More than two years

A11. When did you start giving the child water to drink? ________ (in months).

A12. Breastfeeding

1. Exclusive Breastfed
2. Not exclusive
3. None

SECTION B: SOCIO-ECONOMIC STATUS

B1. Education of mother/caregiver

1. None
2. Basic/JSS
3. Secondary
4. Tertiary
5. Other (specify) ______________________

B2. Education of Father.

1. None
2. Basic/JSS
3. Secondary
4. Tertiary
5. Other (specify) ______________________

B3. Occupation of mother/caregiver.

1. Civil/public servant
2. Farmer
3. Trader
4. Artisan
5. Unemployed

B4. Occupation of Father.

1. Civil/public servant
2. Farmer
3. Trader
4. Artisan
5. Unemployed

B5. Income of mother/caregiver________________

B6. Income of Father _______________________.

B7. Marital status of mother

1. Single
2. Married
3. Widowed/Separate

B8. On the average, how much do you spend in the household a day GH cedis ______ .

SECTION C: BIOLOGICAL AND ENVIRONMENTAL FACTORS.

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C1. How many Antenatal Clinic (ANC) visits did you do before your last birth? _____ (Verify from ANC card).

C2. Place of delivery

1. Home
2. Traditional birth attendant
3. CHP compound
4. Clinic
5. Health centre
6. Hospital

C3. Type of condition often reported to health facility

1. Diarrhoea
2. Anaemia
3. Malnutrition
4. Malaria
5. Pneumonia

C4. Which type of health staffs attend to you when you visit health facility?

1. Nurse
2. Doctor
3. Medical assistance
4. Midwife

C5. How many minutes do you take to get to the nearest health facility?________ minutes.

C6. How much did you pay in your last visit to a health facility? ______________________

C7. How long (hours) did you wait before attended to by a health staff? _________________

C8. Is the child fully vaccinated?

1. Yes
2. No

C9. What is your child's immunization status? Tick **Yes** or **No**

Vaccine	**Yes**	**No**
BCG	Yes	No
OPV1	Yes	No
OPV2	Yes	No
OPV3	Yes	No
DPT1/Penta1	Yes	No
DPT2/Penta2	Yes	No
DPT3/Penta3	Yes	No
Measles	Yes	No
Yellow Fever	Yes	No

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C10. Do your child sleep under Treated Bed Net?

1. Yes
2. No

C11. Are you a beneficiary of the National Health Insurance?

1. Yes
2. No

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Appendix B: Coding Scheme for study Variables

Codes	Variables
	Parity
0	Primigravidae parity
1	Multigravidae parity
2	Grandmultigravidae parity
	Sleep under treated bed net
0	No
1	Yes
	Mother/Father eduction
0	None
1	Basic/J.S.S
2	Secondary
3	Tertiary
	Mother/Father occupation
0	Civil/Public Servant
1	Farming
2	Trading
3	Artisanship
4	Unemployed
	Mother/ Father income
0	6000.00+
1	5999.00-1000.00
2	999.00-500.00
3	< 500.00
	Sickness type

0	Diarrhoea
1	Anaemia
2	Malnutrition
3	Malaria
4	Pneumonia
	Child Vaccine
0	No
1	Yes
	Birth interval
0	At least two years
1	More than two years
	Breastfeeding
0	Exclusive
1	Not exclusive
2	None
	Marital status
0	Single
1	Married
2	Widow/Separated
	Kind of Health Staff
0	Nurse
1	Doctor
2	Medical Assistant
3	Midwife

Appendix C1: Summary statistics from SPSS

Parity

			response		Total
			No	Yes	
Parity	Primigravidae	Count	27	25	52
		% within Parity	51.9%	48.1%	100.0%
	Multigravidae	Count	66	58	124
		% within Parity	53.2%	46.8%	100.0%
	Grandgravidae	Count	9	15	24
		% within Parity	37.5%	62.5%	100.0%
Total		Count	102	98	200
		% within Parity	51.0%	49.0%	100.0%

Sex of Child

Crosstab

			response		Total
			No	Yes	
sex of child	Male	Count	53	56	109
		% within sex of child	48.6%	51.4%	100.0%
	Female	Count	49	42	91
		% within sex of child	53.8%	46.2%	100.0%
Total		Count	102	98	200
		% within sex of child	51.0%	49.0%	100.0%

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Birth interval

Crosstab

			response		Total
			No	Yes	
Birthinterval		Count	27	14	41
		% within Birthinterval	65.9%	34.1%	100.0%
	Onetwoyear	Count	14	12	26
		% within Birthinterval	53.8%	46.2%	100.0%
	Moretwoyears	Count	61	72	133
		% within Birthinterval	45.9%	54.1%	100.0%
Total		Count	102	98	200
		% within Birthinterval	51.0%	49.0%	100.0%

Breastfeeding

Crosstab

			response		Total
			No	Yes	
Breastfeeding	None	Count	9	7	16
		% within Breastfeeding	56.2%	43.8%	100.0%
	Lesssix	Count	14	19	33
		% within Breastfeeding	42.4%	57.6%	100.0%
	Exclusive	Count	25	30	55
		% within Breastfeeding	45.5%	54.5%	100.0%
	3	Count	52	39	91
		% within Breastfeeding	57.1%	42.9%	100.0%
	6	Count	2	3	5
		% within Breastfeeding	40.0%	60.0%	100.0%

Total	Count	102	98	200
	% within Breastfeeding	51.0%	49.0%	100.0%

Sleep under bed net

Crosstab

			response		Total
			No	Yes	
SleepBTN	No	Count	46	78	124
		% within SleepBTN	37.1%	62.9%	100.0%
	Yes	Count	56	20	76
		% within SleepBTN	73.7%	26.3%	100.0%
Total		Count	102	98	200
		% within SleepBTN	51.0%	49.0%	100.0%

Mother education

Crosstab

			Response		Total
			No	Yes	
Motheredu	None	Count	26	16	42
		% within Motheredu	61.9%	38.1%	100.0%
	Basic	Count	37	54	91
		% within Motheredu	40.7%	59.3%	100.0%
	Secondary	Count	27	17	44
		% within Motheredu	61.4%	38.6%	100.0%
	Tertiary	Count	12	11	23
		% within Motheredu	52.2%	47.8%	100.0%

Total	Count	102	98	200
	% within Motheredu	51.0%	49.0%	100.0%

Father education

Crosstab

			Response		Total
			No	Yes	
Fatheredu	None	Count	7	4	11
		% within Fatheredu	63.6%	36.4%	100.0%
	Basic	Count	37	44	81
		% within Fatheredu	45.7%	54.3%	100.0%
	Secondary	Count	36	29	65
		% within Fatheredu	55.4%	44.6%	100.0%
	Tertiary	Count	22	21	43
		% within Fatheredu	51.2%	48.8%	100.0%
Total		Count	102	98	200
		% within Fatheredu	51.0%	49.0%	100.0%

Mothers' occupation **Crosstab**

			Response		Total
			No	Yes	
Motheroccu		Count	1	1	2
		% within Motheroccu	50.0%	50.0%	100.0%
	Poblicservant	Count	16	12	28
		% within Motheroccu	57.1%	42.9%	100.0%

	Farming	Count	33	36	69
		% within Motheroccu	47.8%	52.2%	100.0%
	Trading	Count	24	21	45
		% within Motheroccu	53.3%	46.7%	100.0%
	Artisan	Count	14	17	31
		% within Motheroccu	45.2%	54.8%	100.0%
	Unemployed	Count	13	10	23
		% within Motheroccu	56.5%	43.5%	100.0%
	5	Count	1	1	2
		% within Motheroccu	50.0%	50.0%	100.0%
Total		Count	102	98	200
		% within Motheroccu	51.0%	49.0%	100.0%

Fathers' occupation

Crosstab

			Response		Total
			No	Yes	
Fatheroccu		Count	1	1	2
		% within Fatheroccu	50.0%	50.0%	100.0%
	public servant	Count	36	29	65
		% within Fatheroccu	55.4%	44.6%	100.0%
	Farming	Count	37	43	80
		% within Fatheroccu	46.2%	53.8%	100.0%
	Trading	Count	7	12	19
		% within Fatheroccu	36.8%	63.2%	100.0%
	Artisan	Count	21	13	34
		% within Fatheroccu	61.8%	38.2%	100.0%

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Total	Count	102	98	200
	% within Fatheroccu	51.0%	49.0%	100.0%

Mothers income

Crosstab

			response		Total
			No	Yes	
Motherincome		Count	19	17	36
		% within Motherincome	52.8%	47.2%	100.0%
	6000-10000	Count	15	12	27
		% within Motherincome	55.6%	44.4%	100.0%
	1000-5000	Count	6	4	10
		% within Motherincome	60.0%	40.0%	100.0%
	500-900	Count	28	32	60
		% within Motherincome	46.7%	53.3%	100.0%
	500-	Count	34	31	65
		% within Motherincome	52.3%	47.7%	100.0%
	5	Count	0	2	2
		% within Motherincome	.0%	100.0%	100.0%
Total		Count	102	98	200
		% within Motherincome	51.0%	49.0%	100.0%

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Fathers' income

Crosstab

			response		Total
			No	Yes	
Fatherincome		Count	6	8	14
		% within Fatherincome	42.9%	57.1%	100.0%
	6000-10000	Count	28	22	50
		% within Fatherincome	56.0%	44.0%	100.0%
	1000-5000	Count	22	23	45
		% within Fatherincome	48.9%	51.1%	100.0%
	500-900	Count	45	44	89
		% within Fatherincome	50.6%	49.4%	100.0%
	500-	Count	1	1	2
		% within Fatherincome	50.0%	50.0%	100.0%
Total		Count	102	98	200
		% within Fatherincome	51.0%	49.0%	100.0%

Marital status

Crosstab

			response		Total
			No	Yes	
Maritalstatus	widow/separated	Count	13	9	22
		% within Maritalstatus	59.1%	40.9%	100.0%
	Married	Count	77	80	157
		% within Maritalstatus	49.0%	51.0%	100.0%
	Single	Count	12	9	21
		% within Maritalstatus	57.1%	42.9%	100.0%

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Total	Count	102	98	200
	% within Maritalstatus	51.0%	49.0%	100.0%

Type of sickness

Crosstab

			response		Total
			No	Yes	
Sicknesstype	Diarrhoea	Count	7	8	15
		% within Sicknesstype	46.7%	53.3%	100.0%
	Anaemia	Count	13	8	21
		% within Sicknesstype	61.9%	38.1%	100.0%
	Malnutrition	Count	10	10	20
		% within Sicknesstype	50.0%	50.0%	100.0%
	Malaria	Count	65	71	136
		% within Sicknesstype	47.8%	52.2%	100.0%
	Pneumonia	Count	7	1	8
		% within Sicknesstype	87.5%	12.5%	100.0%
Total		Count	102	98	200
		% within Sicknesstype	51.0%	49.0%	100.0%

Health staff

Crosstab

			response		Total
			No	Yes	
Healthstaff	Nurse	Count	11	5	16
		% within Healthstaff	68.8%	31.2%	100.0%

	Doctor	Count	34	42	76
		% within Healthstaff	44.7%	55.3%	100.0%
	medical assist	Count	49	43	92
		% within Healthstaff	53.3%	46.7%	100.0%
	Mid wife	Count	8	8	16
		% within Healthstaff	50.0%	50.0%	100.0%
Total		Count	102	98	200
		% within Healthstaff	51.0%	49.0%	100.0%

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Appendix C2: Results of Logit Model from SPSS

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	-.040	.141	.080	1	.777	.961

Omnibus Tests of Model Coefficients

		Chi-square	Df	Sig.
Step 1	Step	77.968	43	.001
	Block	77.968	43	.001
	Model	77.968	43	.001

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	199.210[a]	.423	.531

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	7.213	8	.514

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Contingency Table for Hosmer and Lemeshow Test

		response = No		response = Yes		Total
		Observed	Expected	Observed	Expected	
Step 1	1	19	18.845	1	1.155	20
	2	18	17.225	2	2.775	20
	3	11	15.269	9	4.731	20
	4	15	13.678	5	6.322	20
	5	13	11.358	7	8.642	20
	6	11	9.261	9	10.739	20
	7	7	7.227	13	12.773	20
	8	5	5.070	15	14.930	20
	9	2	2.745	18	17.255	20
	10	1	1.323	19	18.677	20

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Parity			4.966	2	.083	
	Parity(1)	.511	1.017	.252	1	.435	1.667
	Parity(2)	.808	.798	1.024	1	.037	2.243
	SleepBTN(1)	-2.587	.500	26.815	1	.000	.075
	Motheredu			6.351	3	.096	
	Motheredu(1)	-21.001	2.754E4	.000	1	.999	.000
	Motheredu(2)	-19.250	2.754E4	.000	1	.999	.000

Motheredu(3)	-19.763	2.754E4	.000	1	.999	.000
Fatheroccu			7.485	4	.112	
Fatheroccu(1)	16.068	2.754E4	.000	1	1.000	9.511E6
Fatheroccu(2)	-1.962	1.161	2.857	1	.091	.141
Fatheroccu(3)	1.380	.962	2.059	1	.151	3.973
Fatheroccu(4)	1.442	.901	2.560	1	.110	4.227
Disease			4.213	4	.048	
Disease(1)	2.491	1.281	3.781	1	.042	12.073
Disease(2)	2.168	1.340	2.618	1	.093	8.741
Disease(3)	2.500	1.381	3.763	1	.039	12.182
Disease(4)	1.912	1.384	1.909	1	.378	6.767
Childvaccine(1)	-.580	.241	5.792	1	.001	.560
Birthinterval			1.952	2	.377	
Birthinterval(1)	-.963	.801	1.445	1	.229	.382
Birthinterval(2)	-.613	.756	.656	1	.418	.542
Breastfeeding			5.721	4	.221	
Breastfeeding(1)	-4.022	1.917	4.402	1	.036	.018
Breastfeeding(2)	-3.699	1.769	4.372	1	.037	.025
Fatheredu			1.051	3	.789	
Fatheredu(1)	-1.338	2.219	.364	1	.546	.262
Fatheredu(2)	-1.834	2.000	.841	1	.359	.160
Fatheredu(3)	-1.471	1.866	.622	1	.430	.230
Motheroccu			7.060	5	.216	
Motheroccu(2)	-3.512	3.443	1.040	1	.308	.030
Motheroccu(3)	-4.605	3.212	2.055	1	.152	.010

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Motheroccu(4)	-2.262	3.181	.505	1	.477	.104
Motheroccu(5)	-2.350	3.152	.556	1	.456	.095
Motheroccu(6)	-4.224	2.928	2.081	1	.149	.015
Motherincome			3.662	5	.599	
Motherincome(1)	-22.863	2.450E4	.000	1	.999	.000
Motherincome(2)	-41.302	3.686E4	.000	1	.999	.000
Motherincome(3)	-23.092	2.450E4	.000	1	.999	.000
Motherincome(4)	-23.249	2.450E4	.000	1	.999	.000
Motherincome(5)	-21.711	2.450E4	.000	1	.999	.000
Fatherincome			1.826	4	.768	
Fatherincome(1)	1.800	2.330	.597	1	.440	6.052
Fatherincome(2)	1.533	2.724	.317	1	.574	4.630
Fatherincome(3)	1.153	2.027	.323	1	.570	3.168
Fatherincome(4)	.471	1.902	.061	1	.804	1.602
Maritalstatus			2.198	2	.333	
Maritalstatus(1)	-.799	1.032	.601	1	.438	.450
Maritalstatus(2)	.514	.853	.363	1	.547	1.672
Healthstaff			2.105	3	.551	
Healthstaff(1)	-.763	1.160	.432	1	.511	.466
Healthstaff(2)	.564	.943	.358	1	.550	1.757
Healthstaff(3)	.395	.855	.214	1	.644	1.484
Constant	2.714	1.183	2.294	1	.207	15.089

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