UNIVERSITY FOR DEVELOPMENT STUDIES

PROXIMATE DETERMINANTS OF LOW BIRTH WEIGHT INCIDENCE IN SUNYANI MUNICIPALITY, GHANA

B Y

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THESIS SUBMITTED TO THE DEPARTMENT OF APPLIED STATISTICS, FACULTY OF MATHEMATICAL SCIENCES, UNIVERSITY FOR DEVELOPMENT STUDIES IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN BIOMETRY.

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DECLARATION

I hereby declare that this dissertation is based on my own research and has been presented under the supervision of Dr (Mrs) Atinuke O. Adebanji. It has not been submitted previously either wholly or partially for degree in University for Development Studies (UDS) or anywhere else. Related works by others which served as a source of knowledge has been duly referenced.

Candidate's Signature .... Date 02-06-2011

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Supervisors' Declaration

I hereby declare that I have supervised this student and that he has my permission to submit this dissertation for the award of a degree in MSc. Biometry.

Principal Supervisor's Signature .... Date 8th June 2011

Name: Dr (Mrs) Atinuke O. Adebanji

Co-Supervisor's Signature .... Date ....

Name:

ABSTRACT

Birth weight is one of the key indicators of the health and viability of the newborn infant and a person's personality. It is desired that birth weight should be in the range of 2.5kg and 4.0kg. Low Birth Weight (LBW) has been defined by the World Health Organisation (WHO) as weight at birth less than 2.5kg. This study considered causal variables of LBW among infants in the Sunyani Municipality and sought to postulate a statistical model for predicting the likelihood of giving birth to Low Birth Weight infants using selected maternal demographic, socioeconomic and anthropometric variables. Two additional factors (distance to source of drinking water and domestic fuel) were introduced to determine their possible role in having a LBW infant. A purposive sample of one hundred and eighty (180) mothers with singleton deliveries between January and March 2010 was taken for the study. These respondents were interviewed at the maternity blocks of the Sunyani Regional and Municipal hospitals respectively. The results obtained showed that gestational age at birth, maternal nutrition and alcohol intake during pregnancy were significant with p-values (0.000, 0.013 and 0.004 respectively at0.05 level of significance) in predicting the likelihood of a Low Birth Weight baby. The stress factors though significantly correlated with LBW were not significant in the postulated model. The analyses were carried out using SPSS version 16.0.

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DEDICATION

This work is dedicated to my mother Madam Adjei Lucy for her foresight in bringing me to this level of educational achievements with love and support.

ABBREVIATIONS/ACRONYMS

ACC- Administrative Committee Coordination
ACOG- American College of Obstetricians and Gynaecologists
AIDS- Acquired Immune Deficiency Syndrome
BMI- Body Mass Index
DF-Degree of Freedom
GHS-Ghana Health Service
IUGR-Intrauterine Growth Restrictions
LBW- Low Birth Weight
MLBW- Moderately Low Birth Weight
NBW- Normal Birth Weight
NEC- Necrotizing Enterocolitis
NGOs- Non Governmental Organisation
NICU- Neonatal Intensive Care Unit
OR- Odd Ratio
PDA-Patent Ductus Arteriosus
RDS- Respiratory Distress Syndrome
ROP-Retinopathy of Prematurity
SCN-Sub-Committee on Nutrition
SMH- Sunyani Municipal Hospital
SPSS-Statistical Software for Social Sciences
SRH- Sunyani Regional Hospital
UNICEF- United Nations Children's Emergency Fund
VLBW- Very Low Birth Weight
WHO- World Health Organisation
WWW- World Wide Web

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CHAPTER ONE

1.0 Introduction

Birth weight is the first weight of the newborn obtained after birth. For live births, birth weight should preferably be measured within the first hour of life, before significant postnatal weight loss has occurred. Weight at birth is a strong indicator of the likelihood of survival for any infant and a person's personality.

The Normal Birth Weight (NBW ≥2.5kg) and below 2.5kg (up to and including 2.49kg) described as Low Birth Weight constitute the two categories of weight at birth. LBW has been defined by the WHO as less than 2500g regardless of gestational age. It is based on epidemiological observation that infants weighing less than 2500g are approximately 20 times more likely to die than normal birth weight babies.

LBW is one of the major determinants of neonatal survival as well as postnatal morbidity. Low birth weight neonates are further sub-grouped according to the degree of smallness at the first weight determination after birth:

Low birth weight (LBW): < 2500 g.

Moderately low birth weight (MLBW): between 1500 and 2499g.

Very low birth weight (VLBW): < 1500 g.

A reduction of at least one-third in the proportion of infants with low birth weight is one of the seven major goals for the current decade of the "World Fit for Children" programme of the United Nations (UNICEF and WHO, 2004). Moreover, nutritional deprivation (the major determinant of low birth weight) is a clear obstacle to the Millennium Development Goals. Monitoring improvements in LBW is thus being given high priority within the UN system, as well as by national governments and the international nutrition community.

Wilcox A. J. (2001) reports that although the significance and interpretation of low birth weight has recently been debated, most experts agree that weight at birth is an indicator of a newborn's chances for survival, growth, long - term health and psychosocial development. Babies whose birth weight is low as a result of under nourishment face a greatly increased risk of death during their first months and of life.

Though the major and primary determinant of birth weight is gestational age, there are other secondary factors that also bear, either directly or indirectly on determining the weight of a baby at birth. These are maternal weight gain, maternal height, parity, age, marital status, smoking, heredity, gender of baby, working hours and various socioeconomic factors (Steyn K et al., 2006) and Institute of Health Economics report (2008).

Low birth weight in developing countries like Ghana occurs primarily because of poor maternal health and nutrition. In addition, diseases such as diarrhea, malaria, aneamia and respiratory infections, which are common incidences in developing countries, can significantly impair fetal growth when women become infected during pregnancy (Shah and Ohlsson - 2008). In Ghana, the issue of birth weight and factors influencing it has not received the much needed attention. This should not be the case given the importance of birth weight as an indicator of an individual baby's survival and a person's personality. W.H.O and UNICEF (2004), reports that from 1998 to 2004, Ghana recorded higher LBW cases of 16 per cent compared to the 14 per cent for sub-Saharan Africa.

In this study, we used logistic regression to study the interactive nature of maternal demographic and anthropometric factors in addition to socio-economic factors in identifying subgroups of women who are at a high risk of a LBW outcome in Sunyani Municipality, Brong Ahafo region, Ghana. The outcome variable consisted of two classes, namely LBW (<2500g) and normal birth weight (>=2500g) cases, while risk factors were examined. Two additional stress factors (distance to source of water and type of cooking fuel) were introduced to examine their importance as predictors for pregnancy outcomes.

1.1 Background to the study

The creation and development of human life, that is the birth of a new human being is an event that has always remained the same over centuries. It is where we all begin. Pregnancy and childbirth are normal, everyday occurrences that are miracles. The process of anthropogenesis is a natural event, developing in a period of nine months inside the mother's body without any outside help. The result is a small miracle; complete, fully developed human being.

Childbirth all over the world mostly comes with joy not only for the infant's parents but the whole family at large and also attracts attention from both close relations and community members. In Ghana, to be specific, the family members, especially the women clad themselves in white clothing from headgear to footwear.

The major determinants of LBW infants are racial origin, nutrition, low pre - pregnancy weight, short maternal stature, and malaria. Pregnant women and their unborn children are particularly vulnerable to malaria, as a result of LBW and maternal anaemia. Infants born to mothers with malaria are likely to have low birth weight — the single greatest risk factor for death during the first months of life. Survival chances, mortality and morbidity of low birth weight infants are related to their birth weight and gestational age. (Kramer M. - 1987)

LBW related to intrauterine growth retardation (IUGR) is known to carry high morbidity and mortality. IUGR is a clinical description of a state in which the infant at birth is malnourished or appears to have lost weight during the latter stages of the pregnancy. In the developing countries, it has been suggested that a substantial number of LBW infants also have IUGR. This may have a negative impact on the survival rates of LBW infants in these countries. (Pollack and Divon - 1992).

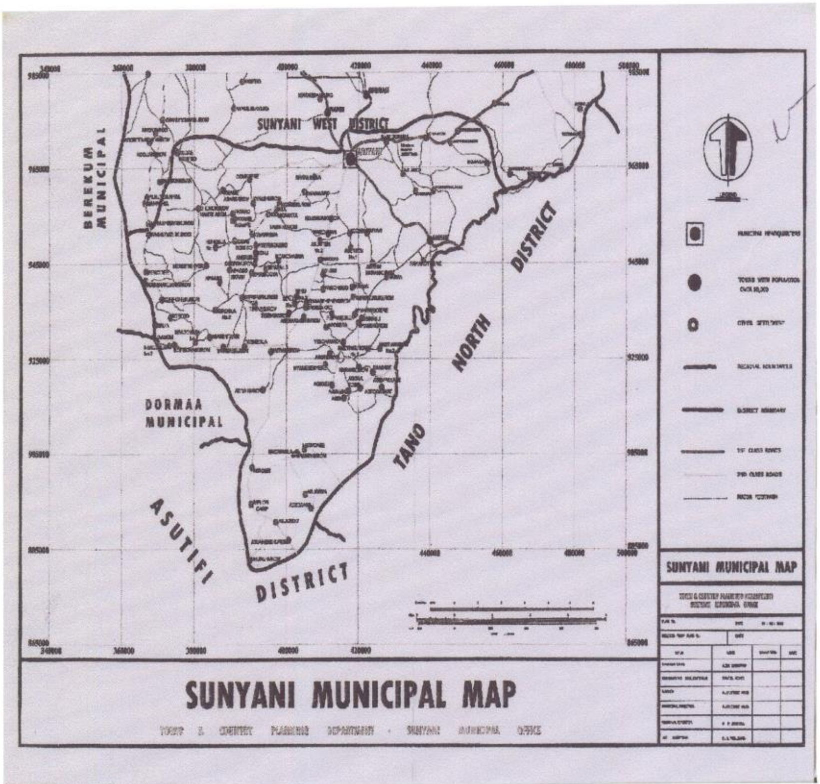
In the industrialized countries, continued improvements in the quality of care have resulted in improvements in survival rates for these infants. In contrast, the developing countries while shouldering 90 per cent of the world's burden of low birth weight infants have only 10 per cent of the world's resources for their care. It is well noted that trained health care workers can largely prevent asphyxia (responsible for 23 percent of newborn deaths), while infections (36 percent of newborn deaths) can be prevented through clean delivery practices (UNICEF and WHO - 2004).

1.2 Description of the study area

The study was carried out in Sunyani Municipality, Brong Ahafo Region of Ghana, where there are high incidences of LBW (Brong Ahafo Regional Health Directorate Annual Report, 2007). This study was carried out in this region because it is deprived in terms of resources and has high rates of malnutrition especially in the northern parts. LBW data were collected from Sunyani Regional and Municipal hospitals for the study.

The Brong Ahafo Region is one of the ten regions of Ghana. It lies within longitude 0° 15'E to 3° W and latitude 8° 45"N to 7° 30'S. The Region shares common boundaries with five others - Northern Region to the North, Ashanti and Western Regions to the South, the Volta Region to the East and the Eastern Region to the South East. It has an international boundary to the West which it shares with La Côte d'Ivoire.

It is the second largest Region in Ghana and has an area of 39,557 sq. Km with 152.4m and 712.6m above sea level as its lowest and highest elevation points respectively. The 2000 Ghana population census puts population of the region at 2,053,988 with an annual growth rate of 2.5 % pa. The municipality has a population of 79,165.



Source: Archives (Sunyani Municipal Assembly)

Figure 1: Sunyani Municipal Map

1.2.1 History of Sunyani regional and municipal hospitals

The Regional Hospital was established on 11th May 1927 by the then Colonial masters as a Hospital for the people of Western Ashanti. Since the establishment of the hospital the population of Sunyani and, Brong Ahafo had increased more than 10 fold. The Hospital had undergone a long transformation and expansion from the time the Brong Ahafo Region was carved out of the Ashanti Region 50 years ago. On the 4th of August 2003 the hospital moved its services from the 79 years old facility into an ultramodern hospital with the state of art medical equipment and diagnostic facilities and was christened it the Sunyani Regional Hospital. The old facility was transformed to the Sunyani Municipal hospital. The new Regional Hospital is a Ghana Health Service facility and as such not - for - profit.

As the only secondary level and a referral institution in Brong Ahafo Region, it receives referrals from all the districts in the Brong Ahafo region. The hospital has a bed capacity of 280, ten well equipped operating theatre units and provides 24 hour accident and emergency services. It is a teaching hospital.

On monthly bases, the hospital sees averagely 15,950 outpatients, 1,120 inpatients and about 68 deaths occurring. About 59% of the attendances were revisits, re-admissions accounting for about 1.5% of all admissions while 24.3% of admissions were due to delivery.

1.3 Problem Statement

LBW is a major public health problem. Compared to normal weight infants, LBW is positively associated with infant mortality and negatively associated with normative childhood cognitive and physical development (Kramer -1987, Kitsantas et al. -2006).

It is estimated that 16.0% (17.0 million infant annually) are born with LBW at term. Healthy growth and development of every child is dependent to some extent on his or her foetal growth. LBW has also been linked to the high prevalence of stunting seen in developing countries and may be important in the aetiology of chronic dietary diseases in adulthood (SCN/ACC, 2000).

Studies have shown that infants with a LBW are 40 times more likely to die than infants with NBW and infants with a VLBW are 200 times more likely to die. Infants with LBW are at a much higher risk of being born with cerebral palsy, mental retardation, and other sensory and cognitive impairments, compared with infants of NBW (ACOG, 2002). UNICEF and WHO (2004), also reports that more than 20 million infants are born with LBW globally. It is estimated that 3.7 million children fell victim to neonatal mortality in 2004. Similar to maternal mortality, neonatal mortality is heavily concentrated in South Asia and West and Central Africa.

LBW levels in sub-Saharan Africa are around 13 to 15 per cent, with little variation across the region as a whole. While few countries have very high or very low rates, the majority fall between 10 per cent and 20 per cent. Ghana, from 1998 to 2004, recorded higher LBW cases of 16 per cent compared to the 14 per cent for sub-Saharan Africa. These rates are higher than in most other sub-region in the world, presenting a major challenge. (UNICEF and WHO, 2004)

LBW cases continue to be a major problem for the Sunyani Municipality and the Brong Ahafo region at large. The Ghana Health Service (Reproductive and Child Health Department) 2007 annual report showed that the total number of babies born weighing less than 2.5kg in 2007 was 30,206, representing 7.0% of all live births nationwide. The reduction in the proportion of low birth weights achieved in the previous, 2006 could not be sustained. Upper West region recorded the least proportion of LBW (3.9%) for 2007. Upper West region maintained its status of having the least proportion of LBW since 2005. Brong Ahafo region recorded the highest proportion of LBW (9.5%), followed by Western region (9.0%) and Ashanti region (8.8%).

The concern raised by the relative prevalence of LBW in Brong Ahafo region in comparison to the other regions has necessitated the focus and location of this study. The inclusion of distance to source of water and type of domestic fuel (as possible stress factors) is premised on the fact that firewood (and/or charcoal) is the main source of cooking fuel in the region. One hundred and twenty two (122 - 67.8%) of the women in the sample data use fire wood and charcoal. Also, 140 (77.8%) of the women spend between 1 to 20 minutes to their source of water and the balance of 40 spend 21minutes or more. The relative importance of the selected variables (and the additional stress factors) in predicting pregnancy outcomes in Sunyani using Logistic regression constituted the main focus of this study.

1.4 Significance of the study

1. The derived model is to serve as a tool for determining the likelihood of the outcome of a pregnancy being a LBW infant in Sunyani and it is intended to assist the hospitals in providing intervention measures that would minimize the likely occurrence of a LBW infant.

2. Heightened awareness of LBW risk will help pregnant women to understand what precautionary measures that can be taken to prevent LBW incidence.

3. The findings could also help auditing the quality of care and identify factors that can be selectively modified to improve the quality of care to reduce the occurrences of LBW among infants.

1.5 Research questions

1. What is the inter-relationship between the causal variables of the incidence of Low Birth Weight in Sunyani Municipality?

2. Can we postulate a statistical model for predicting the likelihood of giving birth to a Low Birth Weight infant using selected demographic, maternal anthropometric and socio-economic variables?

1.6 Objectives of the study

The objectives of the study are:

1. To study the contribution of common anthropometric, demographic and socio-economic variables in determining the likelihood of a pregnancy resulting in a LBW infant in Sunyani Municipality.

2. To determine the relative influence of stress factors on the incidence of LBW infants in Sunyani.

3. To postulate a statistical model for predicting the likelihood of giving birth to a Low Birth Weight infants using selected demographic and socio-economic variables in the Sunyani municipality.

1.7 Limitations of the study

The study was limited to the mothers of singleton births in Sunyani Regional and Municipal hospitals. Since collection of data was restricted mainly to these two main hospitals, (though the Regional hospital is a referral hospital), the findings of this study could be generalized (cautiously) to represent the regional pattern. Any comparative studies should also be with respect to other areas with similar characteristics.

1.8 The data set

The variables used in this study are, birth weight of the fetus (bweight), baby's group of classification (bwtgroup), gestational age at birth (gesage), maternal illness (matill), maternal age (matage), maternal weight gain (mweight), parity (nchild), maternal nutrition (nutri), maternal weight (mweight), type of fuel used for cooking (tfuel), body mass index of the mother (bmimother), educational level of the mother (edulevel), income per month in Gh0 (income), alcohol intake during pregnancy (alcom), place of residence (reside), type of residence (typres), sex of baby (sexb), occupational status (moccup), source of drinking water (swater).

1.9 Outline of thesis

This thesis is divided into five chapters. The first chapter is the introduction; Chapter 2 presents a review of the literature. Chapter 3 is devoted to the methodology and review of basic theory and methods. Chapter 4 is devoted to empirical results and the outputs of Logistic regression. Chapter 5 gives the summary of the findings, conclusion and recommendation.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

Birth weight is crucial to the survival of the infant. It has been estimated that normal birth weight infants in industrial countries have a mortality rate of 2 per thousand while low birth weight infants have a mortality rate of 86 per thousand (Wynn et al., 1991). If low birth weight babies survive, they have greater rates of morbidity and poorer neurological development (poor vision, decreased educational attainment, and more cerebral palsy, deafness and autism). Damage to the nervous system increases as birth weight falls. Babies with birth weights greater than 3.5kg have 6.8 cases of neurological problems per 1000 live births compared to babies with weights less than 1.5kg who have 200 cases of neurological problems per 1000 live births (Hackney Hospital, 1991).

Though there are multiple aetiologies of IUGR, maternal malnutrition, anaemia, malaria infection and low gestational weight gain are key determinants in many developing countries (Kramer, 1987; SCN, 2000; Steketee et al., 2001). Maternal malnutrition in early pregnancy can result in poor expansion of plasma volume and inadequate development of maternal tissues that support foetal growth. Gestation is a critical period that involves rapid cell division, protein synthesis and organ development. Adequate maternal nutrition is therefore essential for normal foetal growth.

Mother’s pre-pregnancy nutrition affects intrauterine growth and birth weight. Thus, under conditions of deprivation a vicious cycle can be set up which perpetuates malnutrition generation by generation — this is shown in figure 4. Here, small maternal size is shown leading to low birth weight, hence growth failure in children, leading to small adults. This vicious cycle of malnutrition between the generations requires intervention at many stages: for example, initially to prevent low birth weight; and, when birth weight is low, to assure as much growth as possible particularly in girl children such that as a mother she is better able to have adequate birth weight infants herself. Interacting with all this is the need for more attention to education and literacy in women, itself helped by better nutrition. (Martorell et al., 1992)

Malaria in pregnancy is particularly critical because it increases placental accumulation of the malaria parasites, thus obstructing free exchange of nutrients and oxygen between the placenta and the foetus and this can lead to LBW. Malaria causes a decrease in iron absorption and causes hemolytic aneamia by destroying the red blood cells (Wilcox A.J, 2001). Malaria and maternal malnutrition including aneamia are therefore important challenges requiring effective public health strategies.

Most studies have identified LBW as an important risk factor for neonatal and infant mortality and impaired postnatal growth (Kramer, 1987). Apart from its impact on child growth and mortality, LBW is reported to contribute substantially to child morbidity such as diarrhea and pneumonia (Fonseca et al., 2007). LBW infants are also more likely than those of normal birth weight to suffer from intellectual impairment.

The consequences of LBW are reported to continue through to adulthood. It has been suggested that the long term consequence of LBW is an increased risk of adult chronic diseases, including cardiovascular disease, obesity, hypertension and adult-onset diabetes (Barker, 1998). Thus, the persisting high incidence of LBW along with a worldwide increase in obesity may contribute to an epidemic rise of cardiovascular disease and type II diabetes in developing countries. Emerging evidence however indicates the problem of Type II diabetes may affect very high birth weight as well. One recent meta-analysis examined the relationship between birth weight and the risk of Type II diabetes and reported that high birth weight was equally a source of concern as it was associated with increased risk of type II diabetes in later life to the same extent as LBW (Harder et at, 2007).

Cheryl et al. (2001), used logistic regression models adjusting for age, education, race/ethnicity, marital status, household income, area of residence, 1st trimester entry into prenatal care, 3rd trimester smoking or drinking alcohol, illegal drug use, and being the victim of physical abuse during pregnancy. They estimated model coefficients by using unconditional maximum likelihood methods and estimation of relative risks by calculating adjusted odds. They found out that there were significant differences in mother's age, education, marital status, and whether or not she was a 3rd trimester alcohol drinker were associated with LBW.

Additionally, significant differences in the mother's age, race, and marital status were associated with preterm delivery. No significant differences in area of residence, household income, or whether the mother was a 3rd trimester smoker, used illegal drugs during her pregnancy, had been the victim of physical abuse during her pregnancy, or entered prenatal care in the first trimester were noted when either LBW or preterm delivery was the outcome examined. They found that risk factors for low birth weight and preterm delivery among singleton infants in Hawaii were not different from risk factors reported for mainland populations, namely maternal age, education and marital status.

Madani et al. (1995) in their study of LBW infants, used logistic regression to assess, for LBW and NBW, whether there was a correlation between the pregnancy outcome and certain maternal variables, some of which were found to have a significant relationship to fetal weight at birth. They test the hypothesis whether parity, age of the mother, body mass index (BMI) and educational level were associated with birth weight independently, a multiple logistic regression model with birth weight as the dependent variable (LBW = 0, NBW = 1) together with parity, age of the mother, BMI and educational levels as predictors were run. All the variables were independently and significantly associated with birth weight except parity, which became insignificant when it was entered in a logistic regression model.

In this present study we use logistic regression models (adjusted for marital status and maternal age) to examine the interdependencies of the explanatory variables thus, distance to source of water, gestational age at birth , maternal illness, maternal age, maternal weight gain, parity, maternal nutrition, maternal weight, body mass index of the mother, educational level of the mother, income per month in GNI, alcohol intake during pregnancy, place of residence (reside), type of residence, sex of baby, occupational status, source of drinking water to determine the influence of stress factors on the incidence of LBW infants and predicting the likelihood of giving birth to a Low Birth Weight infants in Sunyani Municipality. We estimated model coefficients using likelihood and deviance methods and we estimate relative risks by calculating odds ratios (ORs).

2.1 LBW: A public health problem

LBW has long been used as an important public health indicator. LBW is not a proxy for any one dimension of either maternal or perinatal health outcome. Globally, the indicator is a good summary measure of a multi faceted public health problem that includes long-term maternal malnutrition, ill health, hard work and poor pregnancy health care.

Preterm infants are at disadvantage because their internal organs are immature, with a higher risk to develop respiratory illness, hyaline membrane diseases, hyperbilirubinemia, hypocalcemia; anemia and other alterations that affect health and growth.

The role LBW plays in the prevalence of childhood stunting, morbidity, mortality and adult chronic diseases patterns justifies the need for research to identify effective primary prevention strategies despite its documented adverse outcomes, there appears to be some uncertainty about how best to reduce the incidence of LBW (Martorell et al., 1992).

2.2 Determinants of LBW

A baby's low weight at birth is either as a result of preterm birth (before 37 weeks of gestation) or of restricted foetal growth (Kramer, 1987). It has been reported that LBW in developing counties is largely due to intra-uterine (IUGR) growth restriction while LBW in the developed countries is mostly due to preterm births (Ashworth, 1985). In developing countries, an estimated 30 million infants are born every year with IUGR, representing 24% of all new born babies.

The following are some factors found to be determinant of LBW

- **Parity:** For the same gestational age, girls weigh less than boys, first born are lighter than subsequent infants and twins weigh less than singletons.
- **Maternal age:** There is a tendency for a mother below the age of 20 or over 35 years to have lighter babies. Pregnancy during adolescence caries many health risks. Most teen pregnancies are unplanned, and evidence exists that pregnancy among very youngest age group (< 15) may be the result of coercion and abuse (Spitz A.M et al., 1996 and Boyer D and Fine D, 1992).

  Wiemann and associates, 1996 determined that unwanted pregnancies are frequently accompanied by feelings of shame, fear, and isolation. Consequently, this young constituency who could benefit the most from early obstetrical care may be the group least likely to seek it. The young teenager face a number of disincentives that prevent them from seeking prenatal care and counselling are cited frequently as a major link in the causal chain to LBW babies: young gynaecologic age→ reproductive immaturity→ late prenatal care→ poor nutrition→ inadequate weight gain (Scholl T. O. et al., 1992).
- **Maternal height:** Women of short stature, women living at high altitudes, and young women have smaller babies.
- **Multiple pregnancies:** This is a well-recognized factor in connection with growth retardation and in general terms the greater the number of babies per pregnancy the lighter they are. Multiple birth babies are at increased risk of low birth weight because they often are premature. Over half of twins and other multiples have low birth weight.
- **Maternal disease in pregnancy:** Any disorder where there is interference in the maternal blood supply to the placenta is likely to result in the baby being light for

dates. Such disorders include pre-eclampsia, antipartum haemorrhage, hypertension and renal disease. Others are maternal malaria, anaemia, HIV/AIDS.

- Ethnic origin: Certain ethnic groups such as Asians have a tendency to have much smaller babies than Caucasians, although nutrition may be a complicating factor. African-American babies are two times more likely to have low birth weight than Caucasian babies.
- Previous obstetric history: A history of previous mid-trimester miscarriage is not uncommon in women who have a preterm birth. Controversy continues regarding the effect of therapeutic abortion on subsequent pregnancy but in practice a proportion of women having had previous terminations does experience LBW infants.
- Birth defects: Babies with certain birth defects are more likely to be growth restricted because genetic conditions and structural abnormalities may limit normal development (ACOG Practice Bulletin, 2000 and Berghella V, 2007). Babies with birth defects also are more likely to be born prematurely (Honein M.A., et al., 2008).
- Chronic health problems in the mother: Maternal high blood pressure diabetes, and heart, lung and kidney problems sometimes can reduce birth weight (ACOG Practice Bulletin, 2000 and Berghella V., 2007).
- Smoking: Pregnant women who smoke cigarettes are nearly twice as likely to have a low-birth weight baby as women who do not smoke. Smoking slows fetal growth and increases the risk of premature delivery (U.S. Department of Health and Human Services, 2004).
- Alcohol and illicit drugs: Alcohol and illicit drugs can limit fetal growth and can cause birth defects (ACOP Practice Bulletin, 2000 and Berghella V., 2007). Some drugs, such as cocaine, also may increase the risk of premature delivery.

- **Infections in the mother:** Certain infections, especially those involving the uterus, may increase the risk of preterm delivery (Goldenberg and Culhane, 2007).
- **Infections in the fetus:** Certain viral and parasitic infections, including cytomegalovirus, rubella, chickenpox and toxoplasmosis, can slow fetal growth and cause birth defects delivered early to prevent serious complications in mother and baby. (ACOG Practice Bulletin, 2000 and Berghella, V., 2007).
- **Placental problems:** Placental problems can reduce flow of blood and nutrients to the foetus, limiting growth.
- Inadequate maternal weight gain: Women who don't gain enough weight during pregnancy increase their risk of having a low-birth weight baby (ACOG Practice Bulletin, 2000, Goldenberg and Culhane, 2007). Women of normal weight should usually gain 25 to 35 pounds during pregnancy.
- **Socioeconomic factors:** Low income and lack of education are associated with increased risk of having a low-birth weight baby, although the underlying reasons for this are not well understood. Black women and women under 17 and over 35 years of age also are at increased risk (ACOG Practice Bulletin, 2000).

2.3 Problems associated with LBW

Low-birth weight babies are more likely than babies of normal weight to have health problems during the newborn period. Many of these babies require specialized care in a newborn intensive care unit (NICU). Serious medical problems are most common in babies born at very low birth weight.

- **Respiratory distress syndrome (RDS):** This breathing problem is common in babies born before the 34th week of pregnancy. Babies with RDS lack a protein called surfactant that keeps small air sacs in the lungs from collapsing.

- **Bleeding in the brain (called intraventricular hemorrhage or NH):** Bleeding in the brain occurs in some very low- birth weight premature babies, usually in the first three days of life. Brain bleeds usually are diagnosed with an ultrasound. Most brain bleeds are mild and resolve themselves with no or few lasting problems. More severe bleeds can cause pressure on the brain that can lead to brain damage.
- **Patent ductusarteriosus (PDA):** PDA is a heart problem that is common in premature babies. Before birth, a large artery called the ductusarteriosus lets the blood bypass the baby's nonfunctioning lungs. The ductus normally closes after birth so that blood can travel to the lungs and pick up oxygen.

When the ductus does not close properly, it can lead to heart failure

- **Necrotizing enterocolitis (NEC):** This potentially dangerous intestinal problem usually develops two to three weeks after birth. It can lead to feeding difficulties, abdominal swelling and other complications.
- **Retinopathy of prematurity (ROP):** ROP is an abnormal growth of blood vessels in the eye that can lead to vision loss. It occurs mainly in babies born before 32 weeks of pregnancy. Most cases heal themselves with little or no vision loss.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter deals with the methodology of the study, under the following subheadings: Source of data, Method of data collection, Sampling technique and sample size determination, Statistical software and tools for the analyses and review of basic theories and methods.

3.1 Source of Data

The relevant data on LBW infants admitted to the New Born Unit (NBU) at the Sunyani Regional Hospital (SRH), Sunyani Municipal Hospital (SMH) from January 2010 to March 2010 extracted from patient hospital records. Antenatal history, perinatal data, and neonatal outcome until hospital discharge were also extracted. From these, all with LBW were identified by registration numbers. Questionnaires were administered to all the women included in the sample.

3.2 Method of data collection

For this study the researcher relied on both primary and secondary sources. Monthly data on number of deliveries and number of LBW infants from January 2007 to December 2009 were also collected from these hospitals for descriptive analyses.

In addition, questionnaires were administered to collect information from a sample of mothers who had given birth to singleton babies in these facilities from January 2010 to March 2010. The very clear and unambiguous questionnaires were administered by the researcher himself and qualified Midwives and as a result reduced the incidence of biasness. A copy of the questionnaire is attached in the Appendix (A).

3.3 Sampling Technique and Sample Size Determination

A purposive sample of one hundred and eighty (180) mothers with singleton deliveries between January and March 2010. These respondents were interviewed at the maternity blocks of the Sunyani Regional and Municipal hospitals respectively.

The sample size of 180 subjects was used for the study on the basis of 4.0% precision at expected prevalence (LBW cases) of 10.33%. A population of 1002 life births was recorded in the Sunyani Regional and Municipal hospitals in the period of the study was used in calculating the sample size at 95% confidence level and a margin of error of 5%. In calculating the sample size, we adopted the method used by (Amagloh, F. K. et al., 2009) given below:

$$n = \frac{NZ^2P(1 - P)}{d^2 (N - 1) + Z^2 P(1 - P)} \qquad [1]$$

Where n= sample size

N= Total population=1002

P=Expected proportion in the population= 10.33%

Z= Z-value (corresponding to the confidence level of 95%) =1.96

d = Absolute precision =4.0%

$$n = \frac{1002(1.96)^2(0.1033)(1 - 0.1033)}{4.0^2(1002 - 1) + 1.96^2(0.1033)(1 - 0.1033)}$$

n = 180.34 ≈180

3.4 Statistical data analysis Software

The main statistical software package which was used for data entry and analysis was SPSS version 16.0. The data collected were all coded and entered in SPSS 16.0. Outcome variables were given numeric codes. Binary variables (e.g. birth weight was coded 0 for normal birth weight and 1 for low birth weight). Gender was coded as 1 for male and 2 for female babies.

SPSS 16.0 was used for basic descriptive (mean, mode, standard deviation), correlation, cross tabulation, logistic regression and further inferential analyses.

3.5 Basic Theories and Methods of Logistic Regression

Logistic regression is a multivariate prediction method that is most likely to use all or some categorical predictors to explain a categorical, usually dichotomous, outcome. It is a method that allows several independent variables, either categorical or continuous, and a categorical dependent variable. The goal is to assess the likelihood of falling into one of the categories, given a set of predictor. Logistic regression is also similar to discriminant function analysis in that they both allow multiple predictor independent variables and a single categorical dependent variable.

Logistic regression and discriminant function analysis differ in the nature of their assumptions, goals, and their output. Traditional assumptions of linearity, homoscedasticity, and normality are usually required for discriminant function analysis. Logistic regression, in contrast, does not require these assumptions, and outcome categories must be exclusive and exhaustive so that each participant must be classified into one, and only one, of the outcome categories. As for objectives and output, discriminant function analysis usually is focused on the variable weights for prediction, and the percentage of correct classification of individuals, into group membership. Logistic regression is used, particularly in health research, to assess the odds or likelihood of disease given certain characteristics or symptoms. Logistic regression is often used in one of the three ways suggested below:

a. Logistic regression can be used as a prediction method whenever there are several independent variables (either categorical or continuous), and a single dichotomous outcome. This is the simplest and probably the most commonly used form of logistic regression. The goal would be to test whether the set of independent variables is significantly related to falling into one of the two outcome categories ((Rose et al., 2000).

b. Logistic regression also can be used when there are multiple outcome categories and a set of predictor independent variables (either categorical or continuous). The goal, similar to the dichotomous logistic regression, is to assess whether the set of independent variables is significantly related to falling into one of the set of outcome categories. Tabachnick and Fidell (2001) present an example to investigate whether a set of demographic and attitudinal independent variables can significantly predict group membership into one of three outcome categories (wife employed outside home, satisfied unemployed housewife, dissatisfied unemployed housewife).

c. Logistic regression can be used as an exploratory model-building method in which a number of nested models (models that are subsets of a larger model) are compared to determine the most parsimonious set of predictors needed to adequately predict the likelihood of falling into one of two or more outcome categories. This method is used quite often, but it is the most controversial because it capitalizes on chance variation and often overfits a model to the data. Although it is sometimes advantageous to explore the data to test a variety of models, the problems with this form of logistic regression is that researchers may treat the results with greater generalizability and validity than may be warranted. As with any method, it is always best to cross-validate results on independent samples before generalizing beyond a specific sample and set of variables.

3.5.1 Logistic Regression Model

The logistic model relates the probability of occurrence P of the outcome counted by Y to the predictor variables X. The model takes the form

$$P(X) = \frac{1}{1 + \exp[-(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_k x_k)]} \quad [2]$$

Alternatively, the model can be written in the form

$$\log[\frac{P(X)}{1 - P(X)}] = \exp(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_k x_k) \quad [3]$$

where the L.H.S of equation (3) is referred to as logit transformation.

$$\Rightarrow In\left[\frac{P(X)}{1 - P(X)}\right] = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_k x_k \quad [4]$$

$$\Rightarrow In\left[\frac{P(X)}{1 - P(X)}\right] = \beta_0 + \beta_i' \begin{bmatrix} x_1 \\ x_2 \\ . \\ . \\ . \\ x_k \end{bmatrix} \quad [5]$$

where i=1, 2,…,k , β_0 is the intercept, $x_1, x_2, x_3, ..., x_k$ are the explanatory variables while $\beta_1, \beta_2, \beta_3, ..., \beta_k$ are significant ($p<0.05$) estimates of the coefficients.

3.5.2 Odds Ratio (OR)

Another interpretation of the logistic regression parameter β uses the odds ratio measure of association. If we assume that the independent variable, x, is coded as either zero or one. The difference in the logit for a subject with x=1 and x=0 is $g(1)-g(0)=(\beta_0+\beta_1-(\beta_0)=\beta_1$. [6]

In this case the logit difference is equal to β_1.

The measure of association termed as the odd ratio (OR) is introduced to interpret the results. The odds of the outcome being present among individuals with x=1 and x=0 are $P(1)/[1-P(1)]$ and $P(0)/[1-P(0)]$ respectively.

Thus OR= $$\frac{P(1)/[1-P(1)]}{P(0)/[1-P(0)]}=\frac{[\frac{e^{\beta_0+\beta_1}}{1+e^{\beta_0+\beta_1}}]/[\frac{1}{1+e^{\beta_0+\beta_1}}]}{[\frac{e^{\beta_0}}{1+e^{\beta_0}}]/[\frac{1}{1+e^{\beta_0}}]}=\frac{e^{\beta_0+\beta_1}}{e^{\beta_0}}=e^{(\beta_0+\beta_1)-\beta_0}=e^{\beta_1} \qquad [7]$$

This exponential relationship implies that every unit increase in x has a multiplicative effect of e^{β} on the odds.

Hence, for logistic regression with a dichotomous independent variable coded 1 or 0, the relationship between the odds ratio and the regression coefficient is e^{β_1}. This simple relationship between the coefficient and the odds ratio is the fundamental reason why logistic regression has proven to be such a powerful analytic research tool.

The odds ratio is a measure of association which has found wide use, especially in epidemiology, as it approximates how much more likely (or unlikely) it is for the outcome to be present among those with x=1 than among those with x=0. For example, if y denotes a woman giving birth to a LBW infant or not and x denotes whether the woman consumed alcohol during the pregnancy, then $\hat{OR}=2$ estimates that LBW is twice as likely to occur among drunkards during pregnancy than among non-drunkards during pregnancy in the population.

3.5.3 Maximum Likelihood Estimation

In multiple regression analysis, the parameter estimates are obtained using the least-squares principle and assessment of fit is based on significance tests for the regression coefficients as well as on interpreting the multiple correlation coefficients. The parameters that must be estimated from the available data are the constant, β_0, and the logistic regression coefficients, β_j. Because of the nature of the logistic model, estimation is based on the maximum likelihood principle rather than on the least-squares principle. In the context of logistic regression analysis, maximum likelihood estimation (MLE) involves the following. We define the likelihood, L, of the sample data as the product, across all sampled cases, of the probabilities for success or for failure or probabilities for giving birth to LBW or NBW infants:

$$L = \prod_{i=1}^{n} P(Y_i / X_{i1},\ldots,X_{ik}) = \prod_{i=1}^{n} [(\frac{e^{\beta_0+\sum_{j=1}^{k}\beta_j x_j}}{1+e^{\beta_0+\sum_{j=1}^{k}\beta_j x_j}})^{Y_i} \times (\frac{1}{1+e^{\beta_0+\sum_{j=1}^{k}\beta_j x_j}})^{1-Y_i}] \qquad [8]$$

Where Y is the 0/1 outcome for the i^{th} case and $X_{i1},\ldots;X_{ik}$ are the values of the predictor variables for the i^{th} case based on a sample of n cases.

3.5.4 Likelihood Ratio Test

For the model with k predictor variables plus the constant, we denote the maximised likelihood by

$$L_{\max} = L(\hat{\beta}_0, \hat{\beta}_1, \ldots, \hat{\beta}_k) \qquad [9]$$

If the null hypothesis is $H_0 = \beta_r = 0$, numerical calculations again give the maximum likelihood estimate of the reduced model and, in turn, the maximized value of the likelihood

$$L_{\max,\mathrm{Reduced}} = L(\hat{\beta}_0, \hat{\beta}_1, \ldots, \hat{\beta}_{r-1}, \beta_r, \hat{\beta}_{r+1}, \ldots, \hat{\beta}_r) \qquad [10]$$

When doing logistic regression, it is common to test H_0 using

$$-2In\left(\frac{L_{\max,\mathrm{Reduced}}}{L_{\max}}\right)$$

The expression above is called the deviance. Deviance compares the likelihood function for a model to the largest value that the likelihood function could achieve, in a manner such that a perfect model would have a deviance equal to 0. It is approximately distributed as chi-square with 1 degree of freedom when the reduced model has one fewer predictor variables. H_0 is rejected for a large value of the deviance.

An alternative test for the significance of an individual term in the model for logit is due to Wald Test. The Wald Test of $H_0 = \beta_r = 0$ uses the test statistic

$$Z = \left[\frac{\hat{\beta}_r}{SE(\hat{\beta}_r)}\right] \qquad [11]$$

or its chi-square version Z^2 with 1 degree of freedom (df).

3.5.5 Percentage of Deviance

The percentage of deviance explained by the model, is calculated by

$$R^2 = \frac{\lambda(\beta_1, \beta_2.....\beta_k / \beta_0)}{\lambda(\beta_0)} \quad [12]$$

It is similar to an R-squared statistic in multiple regressions, in that it can range from 0% to 100%. An adjusted deviance is also computed from

$$R^2_{adjusted} = \frac{\lambda(\beta_1, \beta_2.....\beta_k / \beta_0)}{\lambda(\beta_0)} - 2p \quad [13]$$

where p equals the number of coefficients in the fitted model, including the constant term. It is similar to the adjusted R-squared statistic in that it compensates for the number of variables in the model.

3.5.6 Goodness-of-fit measures and model comparisons

Maximum likelihood estimation for log-linear and linear logistic models leads, in addition to estimates for the parameters β_j, to a set of estimated or predicted cell counts under the model currently being entertained. The goodness-of-fit of this model is then assessed by comparison of the observed counts by means of other of two statistics, given as

$$x^2 = \frac{\sum(observed - expected)^2}{expected} \quad [14]$$

or

$$G^2 = 2\sum(observed)\, In\frac{(expected)}{\text{expected}} \quad [15]$$

Where the summation in both cases is over cells in the tables x^2 is the familiar Pearson chi-square statistics; G^2 is a log-likelihood ratio criterion or deviance. If the current model is adequate and the sample is relatively large, both statistics are approximately distributed as z^2 with degree of freedom (d.f) given by d.f = number of cells in the table of independent parameters estimated.

Thus, if G^2 (a) is the value for a model with n_o d.f and G^2 is the value for a more n_b d.f then the quantity

$$G^2 (b \backslash a) = G^2 (\mathrm{a}) - G^2 (b) \quad [16]$$

could be used to assess whether the second model has significantly improved the fit.

This change in deviance can be complex with x^2 with n_a - n_b d.f. This procedure is analogous to the use of regression sum-of-squares and F-tests and the forward and backward selection procedures described here may also be used in attempting to find an adequate model.

CHAPTER FOUR

RESULTS

4.0 Introduction

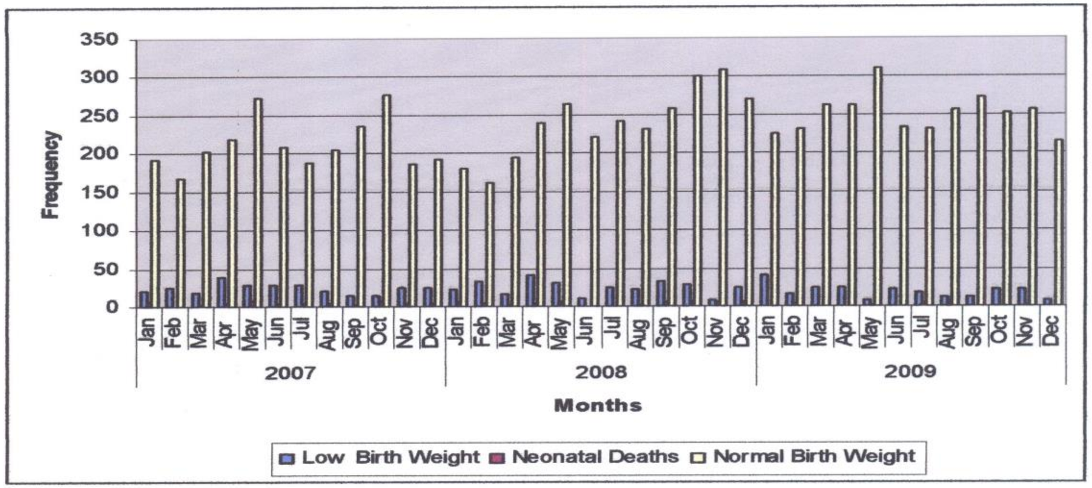
This chapter contains the results from empirical data analysis and the model fitting using both the primary and secondary data collected from the questionnaires and hospital records respectively. The questionnaires were administered on 180 women who had given birth to singleton babies in these facilities January to March 2010. An additional monthly data on the number of singleton deliveries from January 2007 to December 2009 was collected from the Sunyani regional and municipal hospitals for descriptive analysis.

The data collected was edited in order to help identify omissions and to correct errors where necessary. Frequency counts of each category was done and presented in tabular forms showing frequency and percentage distributions of the trend of responses through the use of Statistical Package for Social Sciences (SPSS 16.0) and Microsoft Excel (2003).

4.1 Empirical Results

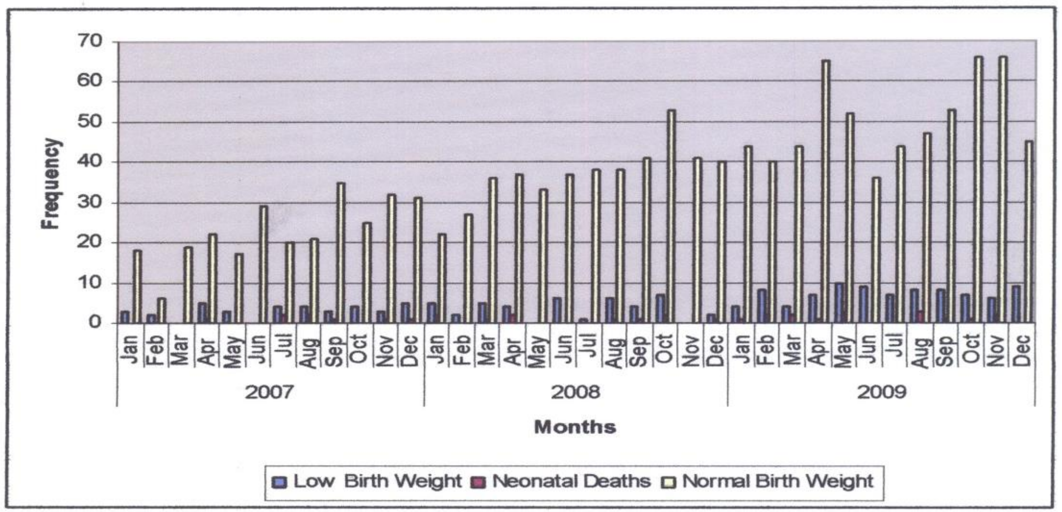
In this section, descriptive statistics (mean, modes, standard deviations, percentages), cross tabulations, correlation are performed to assess relationship of some determinants of low birth weight.

Figures 1 and 2 are the diagrammatical representations of LBW incidence in the two hospitals in comparison with the NBW deliveries and neonatal deaths from January 2007 to December 2009. (See appendix B and C)



Source: Biostatistics Department, Sunyani Regional Hospital

Figure 2: Monthly records of LBW, NBW and Neonatal Deaths at Sunyani Regional Hospital (2007-2009)



Source: Biostatistics Department, Sunyani Municipal Health Directorate.

Figure 3: Monthly records of LBW, NBW and Neonatal Deaths in Sunyani Municipal Hospital (2007-2009)

The component bar charts on the no of singleton births from January 2007 to December 2009 are presented in Figures 2 and 3 while the frequency distribution of birth weights is presented in Table 4.1.

Table 4.1: Frequency distribution of Birth weight

Birth weight groupings	Frequency	Percentage	Maximum	Minimum
NBW(>=2.5kg)	113	62.7	4.2	2.5
LBW(<2.5kg)	67	37.2	2.4	1

The mean maternal age and age at first birth for the 180 respondents were 28.38 years and 22.36 years respectively as presented in Table2. The average gestational age was observed to be 35.22 weeks indicating that most of the respondents did not have full term delivery. In all the average Body Mass Index calculated was 26.14${}^{Kg}/_{m^2}$ indicating that most the women were overweight. The modal gestational age was 38weeks which occurred 34 times. The modal maternal age and age at first birth were 30years and 20years respectively. The table 4. 2 below shows the means, modes, standard deviations of the variables described above.

Table 4.2: Statistics of some of the variables

	N	Minimum	Maximum	Mean		Std. Deviation
matagelgeg esage	Statistic	Statistic	Statistic	Statisti	Std. Error	Statistic
bweight	180	1	4	2.93± 0.078	0.078	1.05
mweigh	180	24	42	35.22 ± 0.285	0.285	3.829
tnchild	180	1	4.3	2.704 ± 0.0581	0.0581	0.7797
diswater	180	50	97	67.43± 0.585	0.585	7.846
Valid N	180	0	7	1.78 ± 0.128	0.128	1.718
(listwise)	180	0	6	1.96± 0.078	0.078	1.043
	180					

Of the 180 respondents, 67 (32.2%) of them gave birth to LBW infants of which 16 were lost to neonatal deaths) and 113 (62.8%) gave birth to NBW infants. On the whole, the minimum birth weight recorded was 1.0kg and the maximum was 4.3kg. The distribution was bi-modal, at birth weights 2.4kg and 3.0kg and they both occurred 14 times each.

Table 4.3: Frequency distribution of maternal illness

Maternal illness	Frequency	Percentages	Cumulative Percentages
Malaria	45	26.2	26.2
Bleeding	25	13.7	39.9
Anaemia	18	9.8	49.7
Asthma	13	7.1	56.8
Syphilis	4	2.2	59
HIV/AIDS	2	1.1	60.1
Chickenpox	2	1.1	61.2
Hypertension	2	1.1	62.3
None	69	37.7	100

The frequency distribution of occurrence or non-occurrence of maternal illness is presented in Table 4.3. Forty-five of the mothers interviewed had malaria during their pregnancies representing 26.2%. 9.8% got anaemia during their pregnancy 2 (1.1%) were HIV/AIDS patients. In all 69 (37.7%) had no disease during the pregnancy. These were recorded from respondents' folders in consultation with the Midwives on duty.

The bar chart is presented in Figure 4 below.

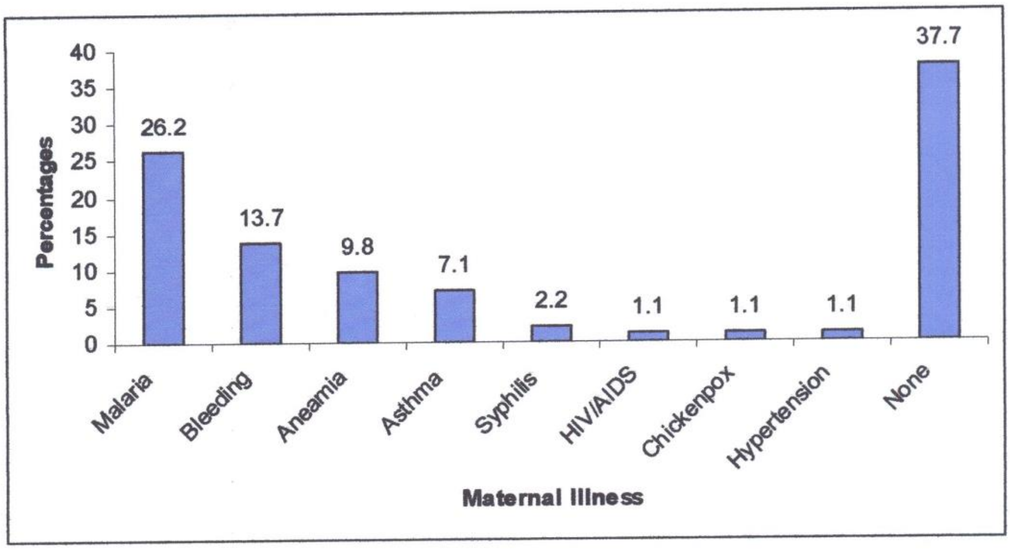


Figure 4: Percentage bar Chart of Maternal Illness

The educational level of the respondents was moderate. It was revealed that 20.0% of the (180) women interviewed did not have formal education while 26.1% had theirs up to Junior High School level. Also, 37 (55.3%) out of the 67 respondents who gave birth to low birth weight infants were in this group. 24% and 16.1% of the (180) respondents had their education up to Senior High School and Tertiary respectively. There figures have been displayed in table 4 below.

Table 4. 4: Frequency table of Educational level of respondents

Educational Level of Mothers	Frequency	Percentages	Cumulative Percentages
None	36	20	20
Junior High School	47	26.1	46.1
Senior High School	44	23.1	69.2
Other Professional Institutions	24	14.7	83.9
Tertiary	29	16.1	100

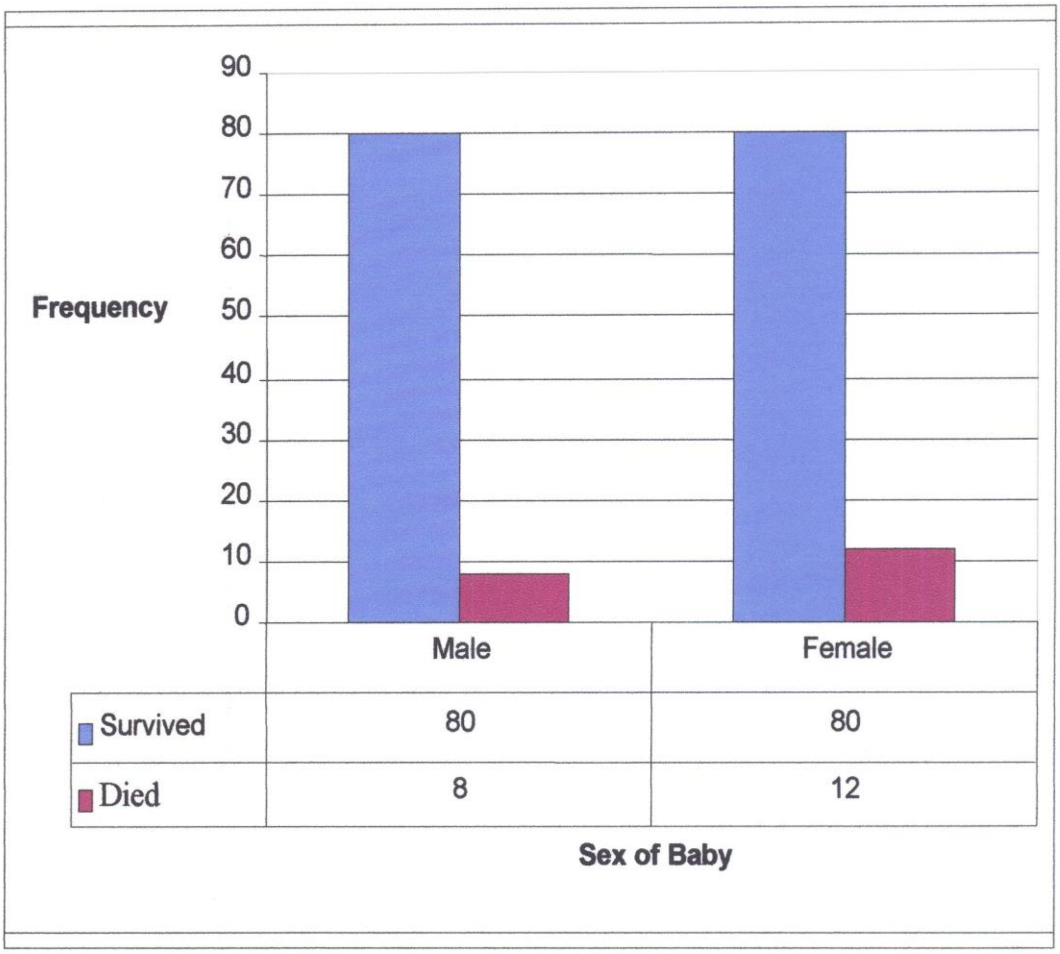


Figure 6 : Frequency of survival of infants

Of the 180 respondents, 63(35%) and 59(32.8%) of the mothers had firewood and charcoal respectively as their source of fuel for cooking. Also 5(2.8%) and 53(29.4%) use kerosene stove and LPG respectively for cooking. This is shown in table 4.5 below

Table 4.5: Type of fuel used for cooking

Fuel type	Frequency	Percent	Valid Percent	Cumulative Percent
firewood	63	35	35	35
charcoal	59	32.8	32.8	67.8
kerosene stove	5	2.8	2.8	70.6
LPG	53	29.4	29.4	100
Total	180	100	100	

Figure (7) shows that the highest source of drinking water of the respondents is pipe-borne. It is interesting to know that 72.6% of the 180 respondents live in the urban areas and this in the view of the researcher might have contributed to this. The other sources and their corresponding percentages are bore-hole (28.34%), well (21.1%) and 7.8% for streams. The percentages of sources of drinking water for the urban folks are 1.67%, 12.22%, 20.56% and 38.89% for stream, well, bole-hole and pipe-borne respectively. On the other hand rural folks had their sources of drinking water to be 2.78%, 7.22%, 7.78% and 8.89% for pipe-borne, stream, bole-hole and well respectively.

Majority, 140 (77.8%) of the respondents spend between 1 to 20 minutes to get to their source of drinking water. A few 13 (7.2%) of them spend between 31 and 60minutes to get to their source of drinking water. The rest 27(15%) spend between 21 and 30 minutes as shown in Table 4.6.

Table 4.6: Distance to source of water

Time(mins)	Frequency	Percent	Cumulative Percent
1-10	65	36.1	36.1
11-20	75	41.7	77.8
21-30	27	15	92.8
31-40	7	3.9	96.7
41-50	4	2.2	98.9
51-60	2	1.1	100
Total	180	100	

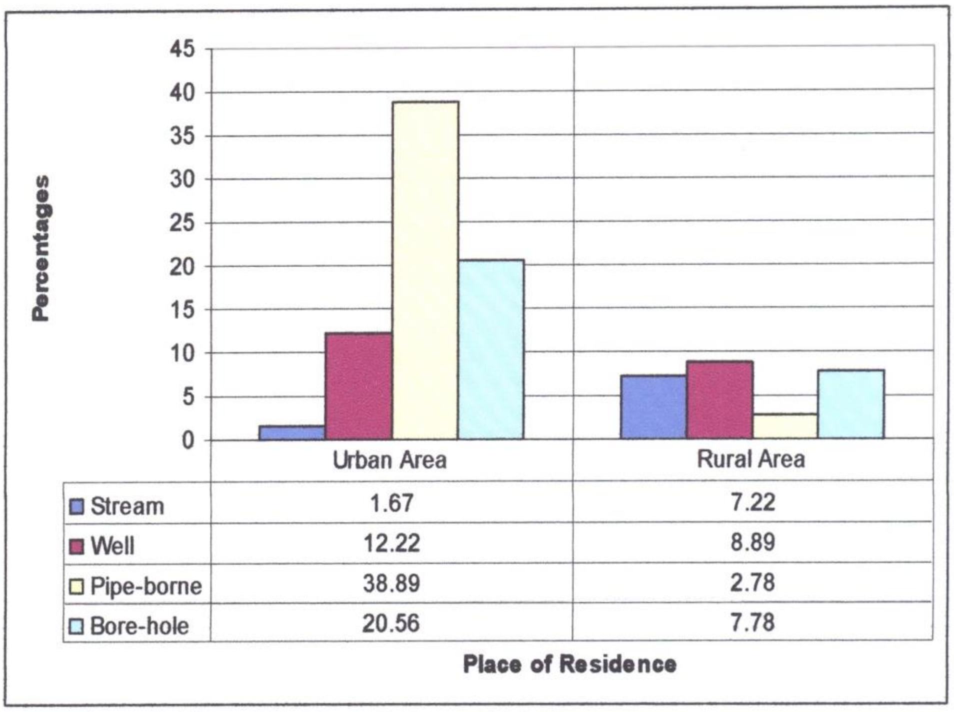


Figure 7: Place of Residence/ Sources of drinking water

The time spent in obtaining portable water had significant ($p<0.01$) negative correlation with the weight of the newborns. The type of fuel used for cooking had significantly ($p<0.026$) positive correlation with the weight of the newborns.

Table 4.7: Relations between Birth weight, type of fuel for cooking and time spent to get water.

Control Variables			weight of fetus at delivery in kilograms	Time spent to source of drinking water(grouped)	type of fuel used in the house *for cooking*
marital status & maternal age in years	weight of fetus at delivery in kilograms	Correlation	1	-0.193	0.167
		Significance (2-tailed)	.	0.01	0.026
		df	0	176	176
	Time spent to source of drinking water(grouped)	Correlation	-0.193	1	-0.289
		Significance (2-tailed)	0.01	.	0
		df	176	0	176
	type of fuel used in the house for cooking	Correlation	0.167	-0.289	1
		Significance (2-tailed)	0.026	0	.
		df	176	176	0

The body mass index of the mother is not significant ($p<0.05$) and had negative correlation with the weight of the newborn as shown in table 4.8 below.

Table 4. 8: Relations between birth weight and Body Mass Index of Mother

Control Variables			weight of fetus at delivery in kilograms	BMI of mother
marital status & maternal age in years	weight of fetus at delivery in kilograms	Correlation	1	-0.057
		Significance (2-tailed)	.	0.45
		df	0	176
	BMI of mother	Correlation	-0.057	1
		Significance (2-tailed)	0.45	.
		df	176	0

Table 4.9 shows the correlation between the determinants of low birth weight which are gestational age at birth, maternal nutrition and alcohol intake during pregnancy. The negative sign shows inverse relations and vice versa. All the variables were not strongly correlated. They are all significantly correlated (p –values <0.05).

Table 4.9: Relations between birth weight, gestational age at birth, maternal nutrition and alcohol intake during pregnancy

Control Variables			weight of fetus at delivery in kilograms	gestational age in weeks	nutritional status	drinking alcohol during the pregnancy
marital status & maternal age in years	weight of fetus at delivery in kilograms	Correlation	1	0.755	-0.518	-0.325
		Significance (2-tailed)	.	0	0	0
		df	0	176	176	176
	gestational age in weeks	Correlation	0.755	1	-0.468	-0.27
		Significance (2-tailed)	0	.	0	0
		df	176	0	176	176
	nutritional	Correlation	-0.518	-0.468	1	0.249

Status	Significance (2-tailed)	0	0	.	0.001
	df	176	176	0	176
drinking alcohol during the pregnancy	Correlation	-0.325	-0.27	0.249	1
	Significance (2-tailed)	0	0	0.001	.
	df	176	176	176	0

Table 4.10 shows the correlation between the determinants of low birth weight which were found to be significant. These are: gestational age at birth, maternal malnutrition and alcohol intake during pregnancy.

Table 4.10: Correlation matrix for some determinants of low birth weight

	Gestational age at birth	**Maternal nutrition**	**Alcohol intake during pregnancy**
Gestational age at birth	1.000	-0.900	0.019
Maternal malnutrition	-0.900	1.000	0.003
Alcohol intake during pregnancy	0.019	0.003	1.000

4.2 Further Analysis

The usual strategy for statistical analysis of categorical response data is either on hypothesis testing (e.g. tests of association) or modeling (determining the nature of association). Hence, analysis of categorical data may be classified into those concerned with hypothesis testing (Wald's chi-square statistic) and those concerned with modeling (logistic models). In this section, multiple variables are examined using appropriate logistic models to determine the nature of association and also to identify variables through modelling that may be used to account for the response variable.

4.2.1 Logistic Regression

In this section, we discuss the predicted model using the dependent variable and the predictors or independent variables.

The binary random variable as used in the analysis is defined as:

Y = {1 if outcome is low birth weight

0 if outcome is normal birth weight} , where P(Y=1) = P(X) is the underlying probability of giving birth to low birth weight infant and P(Y = 1) = 1- P(X) is the underlying probability of giving birth to normal birth weight infant. The logistic model used is:

$$\text{P (low birth weight infant)} = \text{P(X)} = \frac{e^{\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k}}{1 + e^{\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k}} \quad [17]$$

$$\text{P(normal birth weight infant)} = 1 - \frac{e^{\beta_0 + \beta_1 x_1 + \ldots + \beta_k x_k}}{1 + e^{\beta_0 + \beta_1 x_1 + \ldots + \beta_k x_k}} \quad [18]$$

Then the logistic equation will be

$$\log_e\left[\frac{P(X)}{1 - P(X)}\right] = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k \quad [19]$$

To estimate the odds, equation (18) is exponentiated

$$\frac{P(X)}{1-P(X)} = e^{\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_k x_k} \qquad [20]$$

where β_0 is the intercept, $x_1, x_2, x_3, \dots, x_k$ are the explanatory variables while $\beta_1, \beta_2, \beta_3, \dots, \beta_k$ are significant ($p<0.05$) estimates of the responds variables and "e" is the antilog of the exponents.

The outcome variable (birth weight) is dichotomous with "1" representing low birth weight and "0" representing normal birth of the infant. Using Forward Stepwise(Likelihood Ratio) method, these predictors or the independent variables gestational age (gesage), body mass index of the mothers, (bmimo), alcohol intake during pregnancy (alcom), maternal nutrition (nutri), place of residence(reside), marital status (mstat), source of drinking water(swater), mothers educational level (edulevel), employment status (estatus), alcohol intake by spouse (alpatn), type of fuel used for cooking (tfuel), malaria infection(mfac), number of children ever born (nchild), sex of the baby (sexb), type of residence (typres), vomiting during pregnancy(vomit) were entered in SPSS 16.0 for the analysis.

Using this set of predictors, the logistic regression equation for the log-odds in favor of low birth weight is estimated to be (note: the SPSS LOGISTIC REGRESSION printouts for this block as provided in Table 4.11 below. See appendix D

Table 4.11: Models of Low Birth Weight

Variables		Estimate (B)	Standard Error	Wald ChiSquare	DF	Significant level	Exp (B)	95.0%C.I. for EXP(B) Lower	Upper
Step 1 [a]	gestational age	-0.83	0.13	40.766	1	0.000	0.436	0.338	0.562
	constant	28.786	4.636	38.551	1	0.000	3.18E15		
Step 2 [b]	gestational age	-0.838	0.136	37.964	1	0.000	0.433	0.331	0.565
	alcohol intake during pregnancy	-2.241	0.7	10.243	1	0.001	0.106	0.027	0.42
	constant	30.941	4.969	38.772	1	0.000	2.737E13		
step 3 [c]	gestational age	-0.757	0.136	30.933	1	0.000	0.469	0.359	0.612
	maternal nutrition	1.410	0.569	6.14	1	0.013	0.244	0.08	0.745
	alcohol intake during pregnancy	-2.095	0.735	8.134	1	0.004	0.123	0.029	0.519
	constant	28.934	4.951	34.153	1	0.000	3.679E12		

From the table 4.11 above, the logistic regression model can then be written as;

$$\log_e\left[\frac{P(X)}{1-P(X)}\right] = 28.943 - 0.757x_1 - 2.095x_2 + 1.410x_3 \qquad [21]$$

Where x_1 = gestational age at birth, x_2 = alcohol intake during pregnancy and x_3 = maternal nutrition

The odds are then estimated by exponentiating;. the logistic regression model in [21].

$$\left[\frac{P(X)}{1-P(X)}\right] = e^{28.934 - 0.757x_1 - 2.095x_2 + 1.410x_3} \qquad [22]$$

Since the coefficient for gestational age at birth is negative, the log odds (and, therefore, the probability) of low birth weight decreases with an increase in gestational age at birth. Also, since the coefficient of alcohol intake during pregnancy is negative it indicates that high intake of alcohol is associated with decrease in birth weight.

A better nutrition of the mother has a positive impact on the weight of the newborn baby as illustrated by the positive coefficient associated with the maternal nutrition.

Finally, the probability of the outcome being low birth weight infant is obtained by applying the logistic transformation:

$$P(X) = \frac{e^{28.943 - 0.757x_1 - 2.095x_2 + 1.410x_3}}{1 + e^{28.943 - 0.757x_1 - 2.095x_2 + 1.410x_3}} \qquad [23]$$

4.2.2 Likelihood Ratio and Percentage Deviance

The -2 log likelihood is a measure of how well the model explains variations in the outcome of interest, in this research birth weight. The -2 log likelihood (sometimes called, deviance) has a chi squared distribution. The p value for the result of adding alcohol intake to the model is given in the table (7) below and we can see that this is 0.013 which is less than the conventional significance level of 0.05. Hence we would conclude that the addition of alcohol intake to the model is statistically significant. In other words this variable explains variations in birth weight.

The percentage of deviance accounted for in the model is 98.4. This clearly indicates that it is a good model. Also the Cox and the Snells R- Square as well as the Nagelkerke R-square do the same work as the coefficient of determination in Ordinary Least Square regression. This explains the proportion of the Log Odds of the dependent variable explained by the independent variables. The inclusion of maternal nutrition explains between 52.3 and 71.3 of the variation in birth weight. Also, the inclusion of alcohol intake during pregnancy and explains between 53.9 and 73.5 of the variation in birth weight. These values indicate that independent variables adequately explain the dependent variables. This is shown in table 4.12 below.

Table 4.12: Test of model coefficients

		Chi-square	Degree of freedom	Significance level
Step 1		121.86	1	0.000
	Block	121.86	1	0.000
	Model	121.86	1	0.000
Step 2	Step	11.274	1	0.001
	Block	133.134	2	0.000
	Model	133.134	2	0.000
Step 3	Step	6.119	1	0.013
	Block	139.254	3	0.000
	Model	139.254	3	0.000

Table 4.13: Model summary

Step	-2 log likelihood	Cox and Snell R square	Nagelkerke R Square
1	115.786[a]	0.492	0.671
2	104.511[a]	0.523	0.713
3	98.392[a]	0.539	0.735

4.2.3 Odds Ratio Estimates of variables in the Model

This section discusses the odd ratios of the variable in the model using 2x2 contingency tables. The model in equation (22) indicates that gestational age at birth, maternal nutrition and alcohol intake during pregnancy are significant causes of low birth weight among infants in the sample. The cross tabulation of birth weight and maternal nutrition is presented in Table 4.14 and this shows that women with poor diet tend to have smaller babies as one would naturally expect.

Table 4.14: Cross tabulation of Birth weight and Maternal nutrition

	Balanced Diet	Unbalanced diet	Row total
Normal birth weight	**101**	**12**	**113**
Low birth weight	**26**	**41**	**67**
Column total	**127**	**53**	**180**

Table 4.15 below presents the cross tabulations of the consumption of alcohol and the weight of the baby. Although there were women who did not consume alcohol that had LBW infants, the likelihood of its occurrence increased with the consumption of alcohol.

Table 4.15: Cross tabulation of Birth weight and Alcohol intake during pregnancy

	Yes	No	Row total
Normal birth weight	**5**	**108**	**113**
Low birth weight	**22**	**45**	**67**
Column total	**27**	**153**	**180**

The Odds of a mother taking alcohol having a LBW infant are 0.49. Also, the odds of a mother not taking alcohol having a LBW infant are 2.05. The estimate of the odd ratio of taken alcohol compared with not taking alcohol during pregnancy being seen as a cause of LBW is 0.23 as shown in table 4.16.

Table 4.16: Odds of alcohol consumption and NBW/LBW

	Alcohol Intake during pregnancy	Was not taking alcohol during pregnancy
NBW infant mother	5	108
LBW infant mother	22	45
The Odds of a mother taking alcohol having a NBW infant	0.05	
The Odds of a mother taking alcohol having a LBW infant	0.49	
The Odds of a mother not taking alcohol having a LBW infant	2.05	
The Odds of a mother not taking alcohol having a NBW infant	21.6	
The odds ratio of the mother taking alcohol having LBW infant	0.23	

The Odds of a mother taken balanced diet having a LBW infant are 0.63. Also the Odds of mother taken unbalanced diet having a LBW infant are 1.58. The estimate of the odd ratio of taken unbalanced diet compared with taken a balanced diet during pregnancy being seen as a cause of LBW is 0.398 as shown in table 4.17.

Table 4.17: Odds of women on diet having NBW/LBW

	Taken balanced diet	Taken unbalanced diet
NBW infant mother	101	12
LBW infant mother	26	41
The Odds of a mother taken balanced diet having a NBW infant	8.41	
The Odds of a mother taken balanced diet having a LBW infant	0.63	
The Odds of a mother taken unbalanced diet having a LBW infant	1.58	
The Odds of a mother taken unbalanced die having a NBW infant	0.119	
The odds ratio of taken unbalanced diet having LBW infant	0.398	

4.2.4 Hypothesis Testing

The Wald's chi-squared statistic as taken from table 4.11, suggest that there are significant relationships between LBW and gestational age at birth, alcohol intake during pregnancy and maternal nutrition. This is because their p-values (0.000, 0.004 and 0.013 respectively) were significant at 0.05 level of significance. It is shown that gestational age at birth is the most significant among the other predictors in the model. From the research hypotheses,

Null hypothesis; none of the variables have an effect on LBW.

Alternate hypothesis; at least one of the variables have an effect on LBW.

Mathematically,

$H_0 : \beta_0 = \beta_1 = \beta_2 = \beta_3 = 0$

$H_A : \beta_0 \neq \beta_1 \neq \beta_2 \neq \beta_3 \neq 0$

The decision rule is that we failed to accept the null hypothesis (H_0) because from the Wald's chi-squared statistic gestational age at birth, alcohol intake during pregnancy and maternal nutrition has significant relations with low birth weight.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter provides a summary of the findings, the conclusion of the study and some recommendations.

5.1 Summary

The main objectives of this study was to determine the inter dependencies of some maternal demographic, anthropometric and socio-economic factors in the determination of the likelihood of a pregnancy resulting in a low birth weight infant in Sunyani Municipality and also to postulate a statistical model for predicting this likelihood. The contribution of two stress factors (distance to source of drinking water and source of cooking fuel) were of particular interest.

The variables though had significant correlations with LBW, they were not found to be significant in the overall model.

Three variables (gestational age, maternal nutrition and alcohol intake during pregnancy were the variables that contributed significantly in explaining the outcome of LBW infants.

Gender did not play a significant role in the model either. Moreso, there was no observed gender difference between male and female LBW babies. The three variables in the final model were significantly correlated with gestational age and maternal nutrition having the highest of -0.9.

The postulated model was $\log_e\left[\frac{P(X)}{1 - P(X)}\right] = 28.943 - 0.757; - 2.095x_2 + 1.410x_3$.

5.2 Conclusion

This study though could not confirm the role played by source of firewood and the distance to the source of drinking water, it did show that these factors were significantly correlated with the birth weight of an infant. It is also common knowledge that poorer women travelled farther distances for their drinking water and hence more likely to be on poor diets. Undernourished women are also more predisposed to having preterm babies.

In addition to this, if in the sample of 180 mothers, 67 (37.2%) having LBW babies calls for concern. Efforts should therefore be geared towards improving the living standards of the women in Sunyani in order to reduce the problem of LBW infants. Furthermore, the women should the enlightened of the dangers posed by the consumption of locally fermented drinks which many unfortunately believe to have medicinal values and thus do not perceive them to be alcoholic drinks.

5.3 Recommendations

The risk associated with LBW cannot be overemphasized. A woman can do the following before and during pregnancy to reduce her risk of having a low birth weight baby:

1. See her health care provider for preconception checkups. Her provider can help make sure the woman is as healthy as possible before she conceives. At this visit, the provider can screen her for certain health problems (diabetes, high blood pressure, thyroid disease) and various infections, make sure her vaccinations are up-to-date, and discuss her health habits and nutrition. The provider can make sure any medications the woman takes are the safest possible choices during pregnancy

2. Take a multivitamin containing 400 micrograms of folic acid daily, starting before pregnancy. When taken before and early in pregnancy, folic acid helps prevent certain serious birth defects of the brain and spine. When taken throughout pregnancy, folic acid may help reduce the risk of having a premature and low birth weight baby.

3. Stop consuming locally fermented drinks before and during pregnancy, and remain cigarette smoke and alcohol -free throughout pregnancy.

4. Get early and regular prenatal care. 6. Pregnant women should eat well and make sure their foods are well balanced with all the nutrients at their right proportion.

Further investigations are however recommended to decipher the contributions (or lack of it) of stress factors, especially a study involving a larger sample size.

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APPENDIX

(A) INTERVIEW QUESTIONNAIRE

QUESTIONNAIRE DESIGNED FOR MOTHERS WHO HAVE GIVEN BIRTH TO SINGLETON BABIES AT SUNYANI REGIONAL AND MUNICIPAL HOSPITALS ON THE TOPIC:

PROXIMATE DETERMINANTS OF LOW BIRTH WEIGHT INCIDENCE IN SUNYANI MUNICIPALITY, GHANA

ANSWERS TO THESE QUESTIONS WILL BE USED FOR ACADEMIC PURPOSE ONLY

PLEASE TICK [ ] WHERE APPLICABLE

SECTION A: BACKGROUND INFORMATION ABOUT THE PREGNANT WOMAN.

(1) Maternal age (last birthday).

(2) Marital

status:

Married [ ]

Not Married [ ]

(3) Age at first birth

(4) Place of residence:

Rural Urban [ ]

(5) Type of residence:

Compound [ ] Detached [ ]

Semi-detached [ ]

Thatched [ ]

(6) Source of water: Stream [ ]

Well [ ]

Pipe-borne [ ] Bole-hole [ ]

(7) Distance from home to source of water (expressed in minutes)……………..

(8) Number of Children ever born

(9) Educational level: Indicate the highest educational level attained

None [ ]

J.S.S [ ]

S.S.S [ ]

Tertiary [ ]

Other Professional Training [ ]

(10) Employment status: State the category of employment applicable to you

Employed [ ]

Unemployed (seeking for job) [ ]

Housewife [ ]

Self employed [ ]

(11) Main Occupation: … … … … … … … … . .

(12) Indicate the category of main occupation above Public/Civil servants [ ]

Private [ ] Agric [ ]

Apprenticeship [

(13) a. Tribe……………………………… b. Tribe of spouse…………………………..

(14) Income level in Gh¢ per month:

1-9.9 [ ]

10-99 [ ]

100-above [ ]

SECTION B: INFORMATION ABOUT CURRENT PREGNANCY/DELIVERY.

(1) Apgar score.............. (2) Date of delivery....................

(3) Gestational age (wks)

(4) Weight of fetus (baby) at delivery (kg)

(5) Weight of mother at the last trimester (kg)

(6) Height of the mother (m)

(7) Date of last report to prenatal/antenatal clinic

(8) Date of first report to prenatal/antenatal clinic

(9) Number of visits to prenatal clinic

(10) Use of traditional health care: specify type

(11) Nutrition: Balanced [ ], Not balanced [ ]

(12) Meals per day: 3 times [ ], 2 times [ ], 1 time [ ]

(13) Mode of delivery/Indications: Caesarian [ ] Vaginal [ ]

(14) Outcome of pregnancy: Live birth [ ] Still birth [ ]

(15) If live birth, specify type: survival after 28days [ ], dead on/or before 28days [ ]

(16) State of mother at delivery: Sick [ ] Healthy [ ]

(17a) Maternal illness....................................

(17b) If malaria, did you use treated mosquito net during the pregnancy? Yes [ ], No [ ]

(17c) Which of these methods did you use to treat the illness in (a) above?

Scientific [ ]

Traditional [ ]

Did not treat it at all [ ]

(3) Medical history

(4) Number of days spent in the hospital/clinic after delivery

(5) Number of days spent in the hospital/clinic before delivery

(21) Did the mother survive? Yes [ ] No [ ]

(22a) Did you have access to an incubator? Yes [ ], No [ ]. If yes, how long

(22b) If no, specify other option...........

(23) .... Place of delivery: Hospital [ ] Non-hospital [ ] specify...

(24) Sex of baby: Male [ ] Female [ ]

(25) Mode of transportation to hospital:

Taxi [ ]

Personal car [ ]

Motor bike [ ]

Bicycle [ ]

On foot [ ]

(26) Type of fuel used in the house for cooking:

Fire wood [ ]

Charcoal [ ]

Kerosene [ ]

LPG [ ]

(27a) Did you ever smoke during the pregnancy? Yes [ ], No [ ] (27b)

(27b) Did you ever drink alcohol during pregnancy? Yes [ ], No [ ]

(28) Does your partner drink alcohol? Yes [ ], No [ ] If yes specify type

(29) How often did you vomit?

Most often [ ]

Rarely [ ]

Not at all [ ]

Thank you for your time

(B) DESCRIPTION OF THE VARIABLES

BIRTH WEIGHT OF FETUS

Birth weight is the first weight of the newborn obtained after birth. For live births, birth weight should preferably be measured within the first hour of life, before significant postnatal weight loss has occurred. This is usually measured in grams or kilograms. It could be normal (>2500g or 2.5kg) and Low (<2500 or 2.5kg). For the purpose of this study, only birth weights below 2.5kg were considered.

BABY'S WEIGHT CLASSIFICATION

Low birth weight neonates are sub-grouped according to the degree of smallness at the first weight determination after birth; Low birth weight (LBW): just below 2500 g, moderately low birth weight (MLBW): between 1500 and 2400g, very low birth weight (VLBW): between 1000g and 1499g and extremely low birth weight (ELBW) : <1000g.

GESTATIONAL AGE AT BIRTH

This is the period of development of the offspring during pregnancy. The gestational age can be classified as full-term (> 37 completed weeks of gestation) or preterm (<37 completed weeks of gestation). If the date of the last menstrual period was reliably known and/or there was ultrasound confirmation of gestational age. Where gestational age could not be determined by any of these means but delivery was obviously preterm the neonatal estimation of gestational age (ex-panded Ballard score) by the pediatrician, on admission of the baby to the neonatal intensive care unit (NICU), was used. The gestational ages were recorded in respondents' folders.

MATERNAL ILLNESS

Any disorder where there is interference in the maternal blood supply to the placenta is likely to result in the baby having low birth weight. Such disorders include malaria, aneamia, hypertension, asthma, bleeding, antipartum haemorrhage, renal disease, HIV/AIDS, chicken pox and other infections like syphilis, gonorrhea, guinea worm infection. Most of these diseases were recorded in the respondents' folders.

MATERNAL AGE

Maternal age is the age of the mother at which she became pregnant. There is a tendency for a mother below the age of 20 or over 35 years to have LBW infants. In most cases respondents were asked to provide their ages if not recorded in their folders.

NUMBER OF CHILDREN EVER BORN

This is popularly known in the field of midwifery as parity. First babies are normally lighter than those born subsequently. There is a tendency for a mother who has given birth to many children at least 6 including miscarriages and abortions to give to a LBW infant. Where they were not recorded respondents willingly provided answer.

MATERNAL NUTRITION

Inability of a pregnant woman to eat enough balanced diets may go a long way to affect the unborn child. To this end, respondents were given the opportunity to indicate whether they took in enough balanced diets or not during their pregnancy. They were also asked the number of meals they could take during a day.

BODY MASS INDEX OF THE MOTHER

This is an index that expresses weight in relation to height. It is calculated as weight in kilograms divided by height in meters squared *(Kg/m^2)* (Microsoft Encarta Encyclopaedia, 2009). A body mass index below 18.5 is considered as underweight. If it is between 18.5 and 24.9 inclusive is described as healthy, from 25.0 to 29.9 is overweight, from 30.0 to 39.4 is obese and over 40.0 is morbidly obese.

ALCOHOL INTAKE DURING PREGNANCY

Alcohol intake during pregnancy can limit fetal growth and can cause birth defects.

(C) MONTHLY DATA ON SINGLETON DELIVERIES AT SUNYANI REGIONAL HOSPITAL (2007-2009)

YEAR	MONTHS	LOW BIRTH WEIGHT	NORMAL BIRTH WEIGHT	NEONATAL DEATHS	TOTAL
2007	JANUARY	20	192	6	212
	FEBRUARY	24	168	0	192
	MARCH	18	203	3	221
	APRIL	39	220	4	259
	MAY	29	273	8	302
	JUNE	28	208	5	236
	JULY	28	189	5	217
	AUGUST	20	205	5	225
	SEPTEMBER	14	235	3	249
	OCTOBER	14	276	8	290
	NOVEMBER	24	187	5	211
	DECEMBER	25	192	4	217
2008	JANUARY	22	181	6	203
	FEBRUARY	32	162	5	194
	MARCH	16	194	3	210
	APRIL	40	240	4	280
	MAY	30	265	7	295
	JUNE	10	221	0	231
	JULY	24	241	0	265
	AUGUST	22	231	3	253
	SEPTEMBER	32	258	7	290
	OCTOBER	28	301	6	329
	NOVEMBER	9	309	6	318
	DECEMBER	25	271	6	296
2009	JANUARY	40	226	0	266
	FEBRUARY	17	231	4	248
	MARCH	25	262	0	287
	APRIL	25	262	0	287
	MAY	8	311	2	319
	JUNE	22	234	1	256
	JULY	19	232	4	251
	AUGUST	13	255	8	268
	SEPTEMBER	13	273	0	286
	OCTOBER	23	252	0	275
	NOVEMBER	23	256	2	279
	DECEMBER	8	215	0	223

(D) MONTHLY DATA ON SINGLETON DELIVERIES AT THE SUNYANI MUNICIPAL HOSPITAL (2007-2009)

YEAR	MONTHS	LOW BIRTH WEIGHT	NORMAL BIRTH WEIGHT	NEONATAL DEATHS	TOTAL
2007	JANUARY	3	18	0	21
	FEBRUARY	2	6	0	8
	MARCH	0	19	0	19
	APRIL	5	22	1	27
	MAY	3	17	0	20
	JUNE	0	29	0	29
	JULY	4	20	2	24
	AUGUST	4	21	2	25
	SEPTEMBER	3	35	1	38
	OCTOBER	4	25	0	29
	NOVEMBER	3	32	1	35
	DECEMBER	5	31	1	36
2008	JANUARY	5	22	2	27
	FEBRUARY	2	27	0	29
	MARCH	5	36	1	41
	APRIL	4	37	2	41
	MAY	0	33	0	33
	JUNE	6	37	0	43
	JULY	1	38	0	39
	AUGUST	6	38	1	44
	SEPTEMBER	4	41	1	45
	OCTOBER	7	53	2	60
	NOVEMBER	0	41	0	41
	DECEMBER	2	40	1	42
2009	JANUARY	4	44	1	48
	FEBRUARY	8	40	2	48
	MARCH	4	44	2	48
	APRIL	7	65	1	72
	MAY	10	52	3	62
	JUNE	9	36	0	45
	JULY	7	44	0	51
	AUGUST	8	47	3	55
	SEPTEMBER	8	53	1	61
	OCTOBER	7	66	1	73
	NOVEMBER	6	66	2	72
	DECEMBER	9	45	0	54

(D) SPSS LOGISTIC REGRESSION OUTPUT

(1)

Categorical Variables Codings

		Frequency	Parameter coding (1)	(2)	(3)	(4)
educational level	none				0	0
	jss	47	0	1	0	0
	sss	44	0	0	1	0
	tertiary	29	0	0	0	1
	Other Professional. institution	24	0	0	0	0
Body mass index category	underweight	1	1	0	0	
	normal/healthy	66	0	1	0	
	overweight	97	0	0	1	
	obese	16	0	0	0	
source of drinking water	stream	14	1	0	0	
	well	38	0	1	0	
	pipe-borne	76	0	0	1	
	bole-hole	52	0	0	0	
type of fuel used in the house for cooking	firewood	63	1	0	0	
	charcoal	59	0	1	0	
	kerosene stove	5	0	0	1	
	LPG	53	0	0	0	
employment status	employed	62	1	0	0	

	unemployed	12	0	1	0
	housewife	8	0	0	1
	Self employed	98	0	0	0
place of residence	rural	48	1	0	
	urban	132	0	1	
how often did you vomit	most often	59	1	0	
	rarely	52	0	1	
	not at all	69	0	0	
smoking during the pregnancy	no	176	1	0	
	yes	4	0	1	
use of traditional medicine	no	139	1		
	yes	41	0		
nutritional status	balanced diet	127	1		
	unbalanced diet	53	0		
malaria factor	no	127	1		
	yes	53	0		
does your partner drink alcohol	no	132	1		
	yes	48	0		
drinking alcohol during the pregnancy	no	153	1		
	yes	27	0		
sex of baby	male	83	1		
	female	97	0		
marital status	married	126	1		
	not married	54	0		

(2)

Classification Table[a,b]

	Observed		Predicted: baby's group classification: Normal birth weight	Predicted: baby's group classification: Low birth weight	Predicted: Percentage Correct
Step 0	baby's group classification	Normal birth weight	113	0	100
		Low birth weight	67	0	0
	Overall Percentage				62.8

a. Constant is included in the model

b. The cut value is .500

(3)

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	-0.523	0.154	11.492	1	0.001	0.593

(4)

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	Maternal age	0.081	1	0.776
		Marital status(married)	5.39	1	0.02
		Age at first birth	1.482	1	0.223
		Place of resident	5.12	2	0.077
		Rural area	3.204	1	0.073
		Urban area	3.983	1	0.046
		Source of drinking water	12.295	3	0.006
		Stream	7.601	1	0.006
		Well	0.656	1	0.418
		Pipe borne	5.178	1	0.023
		Number of children ever born	10.213	1	0.001
		Mothers educational level	11.294	4	0.023
		None	3.144	1	0.076
		JSS	0.031	1	0.859
		SSS	1.689	1	0.194
		Tertiary	8.121	1	0.004
		Employment status	15.078	3	0.002
		Employed	10.694	1	0.001
		Unemployed	2.452	1	0.117
		Housewife	5.113	1	0.024
		Gestational age at birth	92.763	1	0
		Traditional health	12.82	1	0

	care (yes)			
	Nutritional status (balanced)	51.786	1	0
	Sex of baby (male)	0.117	1	0.732
	Fuel used in the house	11.546	3	0.009
	Fire wood	9.531	1	0.002
	charcoal	2.656	1	0.103
	kerosene	3.049	1	0.081
	Maternal smoking	6.9	2	0.032
	Maternal smoking(yes)	6.9	1	0.009
	Maternal smoking(no)	5.145	1	0.023
	Maternal alcohol intake (yes)	26.628	1	0
	Partner taken alcohol (yes)	31.644	1	0
	Vomiting during pregnancy	4.529	2	0.104
	Vomit(most often)	1.76	1	0.185
	Vomit(rarely)	0.809	1	0.368
	Maternal malaria(yes)	20.159	1	0
	Body mass index of mother	3.665	3	0.3
	BMI(healthy)	1.696	1	0.193
	BMI(overweight)	1.302	1	0.254
	BMI(obese)	0.077	1	0.782
Overall Statistics		123.595	33	0

Block 1: Method = Forward Stepwise (Likelihood Ratio)

(5)

Iteration History[a,b,c,d]

Iteration		-2 Log likelihood	Coefficients			
			Constant	Gestational age at birth	Alcohol intake during pregnancy	Maternal nutrition
Step 1	1	137.582	12.291	-.364		
	2	119.902	20.420	-.595		
	3	116.072	26.382	-.763		
	4	115.788	28.574	-.824		
	5	115.786	28.785	-.830		
	6	115.786	28.786	-.830		
	7	115.786	28.786	-.830		
Step 2	1	130.544	12.185	-.335	-1.048	
	2	110.140	20.675	-.562	-1.681	
	3	104.997	27.619	-.748	-2.082	
	4	104.517	30.576	-.828	-2.225	
	5	104.511	30.936	-.838	-2.241	
	6	104.511	30.941	-.838	-2.241	
	7	104.511	30.941	-.838	-2.241	
Step 3	1	124.579	10.969	-.287	-.884	-.893
	2	104.105	18.873	-.492	-1.511	-1.190
	3	98.914	25.572	-.668	-1.925	-1.337
	4	98.398	28.549	-.747	-2.077	-1.400
	5	98.392	28.929	-.757	-2.095	-1.410
	6	98.392	28.934	-.757	-2.095	-1.410
	7	98.392	28.934	-.757	-2.095	-1.410

(6)

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	121.860	1	.000
	Block	121.860	1	.000
	Model	121.860	1	.000
Step 2	Step	11.274	1	.001
	Block	133.135	2	.000
	Model	133.135	2	.000
Step 3	Step	6.120	1	.013
	Block	139.254	3	.000
	Model	139.254	3	.000

(7)

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	115.786[a]	.492	.671
2	104.511[a]	.523	.713
3	98.392[a]	.539	.735

(8)

Contingency Table for Hosmer and Lemeshow Test

	baby's group classification = normal birth weight		baby's group classification = low birth weight		Total
	Observed	Expected	Observed	Expected	
Step 1	22	21.645	0	0.355	22
	32	31.992	2	2.008	34
	25	24.476	3	3.524	28
	24	24.806	9	8.194	33
	6	7.795	12	10.205	18
	4	2.079	14	15.921	18
	0	0.202	18	17.798	18
	0	0.006	9	8.994	9
Step 2	21	20.776	0	0.224	21
	31	31.639	2	1.361	33
	24	22.738	1	2.262	25
	23	24.429	7	5.571	30
	8	8.912	9	8.088	17
	6	4.097	16	17.903	22
	0	0.401	19	18.599	19
	0	0.009	13	12.991	13
Step 3	20	19.8	0	0.2	20
	29	29.948	2	1.052	31
	21	19.532	0	1.468	21
	25	25.912	5	4.088	30
	11	11.562	7	6.438	18
	6	5.129	13	13.871	19
	1	1.074	17	16.926	18
	0	0.043	23	22.957	23

(9)

Classification Table[a]

			Predicted		
			baby's group classification		
	Observed		Normal birth weight	Low birth weight	Percentage Correct
Step 1	baby's group classification	Normal birth weight	107	6	94.7
		Low birth weight	16	51	76.1
	Overall Percentage				87.8
Step 2	baby's group classification	Normal birth weight	105	8	92.9
		Low birth weight	12	55	82.1
	Overall Percentage				88.9
Step 3	baby's group classification	Normal birth weight	104	9	92
		Low birth weight	14	53	79.1
	Overall Percentage				87.2

(10)

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	Gestational age at birth	-0.83	0.13	40.766	1	0	0.436	0.338	0.562
	Constant	28.786	4.636	38.551	1	0	3.18E15		
Step 2[b]	Gestational age at birth	-0.838	0.136	37.964	1	0	0.433	0.331	0.565
	Alcohol intake during pregnancy	-2.241	0.7	10.243	1	0.001	0.106	0.027	0.42
	Constant	30.941	4.969	38.772	1	0	2.74E13		
Step 3[c]	Gestational age at birth	-0.757	0.136	30.933	1	0	0.469	0.359	0.612
	Maternal nutrition	-1.41	0.569	6.14	1	0.013	0.244	0.08	0.745
	Alcohol intake during pregnancy	-2.095	0.735	8.134	1	0.004	0.123	0.029	0.519
	Constant	28.934	4.951	34.153	1	0	3.68E12		

a. Variable(s) entered on step 1: gesage.

b. Variable(s) entered on step 2: alcom.

c. Variable(s) entered on step 3: nutri.

(11)

Relationship between the variables in the model

Correlation Matrix

		Constant	Gestational age at birth	Maternal nutrition	Alcohol intake during pregnancy
Step 1	Constant	1	-0.999		
	Gestational age at birth	-0.999	1		
Step 2	Constant	1.000	-0.992	-0.283	
	Gestational age at birth	-0.992	1.000	0.169	
	Alcohol intake during pregnancy	-0.283	0.169	1.000	
Step 3	Constant	1.000	-0.987	-0.271	0.007
	Gestational age at birth	-0.987	1.000	-0.09	0.019
	Maternal nutrition	-0.271	-0.09	1.000	0.003
	Alcohol intake during pregnancy	0.007	0.019	0.003	1.000