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PREVALENCE AND DETERMINANTS OF LOW BIRTH WEIGHT IN MASERU LESOTHO

A mini-thesis submitted in partial fulfillment of the requirements for the degree of Master of Public Health at the School of Public Health, University of the Western Cape

AZUBUIKE BENJAMIN NWAKO

SUPERVISOR: DR GAVIN REAGON

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DECLARATION

I, Nwako Azubuike Benjamin, do hereby declare that:

- The work in this dissertation is my own original work,
- All sources that were used or referred to have been documented and recognized appropriately, and
- This work has not been previously submitted for award of any degree or fellowship in any educational institution or published.

19/10/2017

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Nwako Azubuike Benjamin DATE

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ABSTRACT

Introduction: Low birth weight (LBW), affecting about 30 million newborns annually, is the commonest cause of severe morbidity and mortality amongst neonates globally, and is implicated in a high proportion of stillbirths. Neonatal deaths of LBW babies are mainly due to infection, prematurity and respiratory distress. Many factors affect LBW including maternal factors such as age, pregnancy associated factors such as illness in pregnancy, socio-economic factors such as housing type and foetal factors such as multiple gestations. In 2009, a national survey estimated that the prevalence of LBW was at 9.5% in Lesotho, based on a combination of actual birth weight measurements and birth weight estimations provided by the respondents. Given the high probability of non-differential misclassification arising in the national study, the prevalence of LBW arrived at was in doubt and only a limited number of factors potentially affecting LBW were assessed.

Problem: The true prevalence and the mix of factors affecting LBW in Maseru was unknown and therefore there was a need to determine these, in order to better inform health workers thereby assisting them to reduce low birth weight.

Aim: The aim was to determine the prevalence of LBW and the factors associated with LBW.

Study design: A cross sectional analytical study design was used.

Study population and sample: It involved newborns of 28 weeks gestation or more who were delivered in the sole tertiary hospital in Maseru to mothers who were resident in Maseru. A representative sample of 402 mothers and their 412 newborns was selected using time-delimited sequential sampling, with all babies born between February and May 2016, by when the required sample size was attained, being selected.

Data collection: Data collection was done by trained nurses via administered questionnaires and direct measurements such as birth weight. Demographic characteristics, social, environmental,

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physical, medical and other maternal variables were collected. Relevant newborn variables were also collected.

Analysis: Descriptive statistics of frequencies, percentages, mean, standard deviations and ranges were used. Prevalence rates were reported with 95% confidence intervals. The association of potential factors with LBW was assessed using prevalence ratios and adjusted prevalence ratios in bivariate and multivariate analyses respectively. Prevalence differences were used to measure the absolute risk posed by each of the potential factors affecting LBW.

Ethics: The participants gave informed consent after they were provided with information and were informed that refusal to participate would not result in any adverse consequences, that they could withdraw at any point and were guaranteed confidentiality. The University of the Western Cape (UWC) research and ethics committee and the Lesotho ministry of health ethics committee gave ethical clearances, while the hospital gave permission for the study.

Results: The prevalence of LBW was high at 24.75%. On multivariate analysis the following variables showed a very strong independent statistically significant association with LBW: multiple gestations (such as twins) with an adjPR = 26.39 (95% CI 5.29 -131.75); preterm delivery (adjPR = 11.64, 95% CI 5.88-23.04); and use of an unclean energy source (adjPR = 6.14, 95% CI 2.72-13.85). Mothers having hypertension in pregnancy (adjPR = 3.48, 95% CI 1.70- 7.11), being HIV positive (adjPR = 2.08, 95% CI 1.07- 4.08) and working in a low paid job (adjPR = 2.35, 95% CI 1.08-5.10) were also strongly independently associated with LBW. Maternal education, height, place of residence, number of antenatal visits and parity level were all statistically significant on bivariate analysis, but lost their significance on multivariate analysis. Other variables assessed, including maternal age, marital status, employment, income,

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weight, mid upper arm circumference, body mass index, alcohol use, smoking, birth interval, antepartum bleeding, working hours, and newborn sex, did not show any association with LBW.

Conclusions: There was a strong independent association between multiple gestations, prematurity and the use of an unclean source of energy and LBW. Mothers being HIV positive, having hypertension and working in a low paid job were also associated with LBW.

Recommendations: Preventable factors associated with LBW should be addressed with potential interventions being early detection and prompt treatment of mothers with hypertension during pregnancy, treating all those with HIV using antiretroviral therapy and encouraging pregnant women using an unclean energy to cook outside their homes.

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ABBREVIATIONS

ABW……………………………......Adequate Birth Weight

AdjPR …………………................. Adjusted Prevalence Ratio

AGA……………………………......Appropriate for Gestational Age

AIDS…………………………..…..Acquired Immune Deficiency Syndrome

ANC………………………………..Antenatal Care

BBW………………………………..Big Birth Weight

BMI………………………………...Body Mass Index

CBD………………………………..Central Business District

CI…………………………………..Confidence Interval

CM…………………………………Centimeter

F……………………………............Fisher Exact

ELBW……………………………...Extreme Low Birth Weight

GA…………………………………Gestational Age

GDP………………………………..Gross Domestic Product

Gm…………………………….......Gram

HIV………………………………...Human Immunodeficiency Virus

HAART……………………………Highly Active Anti-Retroviral Therapy

IUGR………………………………Intra-Uterine Growth Retardation

Kg/m^2……………………...........Kilogram per square meter

LBOS………………………………Lesotho Bureau of Statistics

LBW………………………………Low Birth Weight

LDHS……………………...........Lesotho Demographic and Health Survey

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LGA……………………………….Large for Gestational Age

MDG………………………………Millennium Development Goal

MUAC……………………….........Mid Upper Arm Circumference

n.d ………………………………….No Date (Undated)

NBW…………………….............Normal Birth Weight

NDHS……………………………...Nigeria Demographic and Health Survey

OECD……………………………...Organization for Economic Co-operation and Development

OR………………………………….Odds Ratio

PMTCT…………………….............Prevention of Mother to Child Transmission

PD…………………………..........Prevalence Difference

PR…..……………………………….Prevalence Ratio

RD%...Percentage Risk Difference

RR………………………………........Relative Risk

SGA………………………………….Small for Gestational Age

SOPH…………………………….….School of Public Health

Std Dev……………………………..Standard Deviation

TORCH'S Syndrome……………......Toxoplasmosis, Other Agents, Rubella, Cytomegalovirus, Herpes Simplex, Syphilis syndrome

UNICEF…………………….............United Nations Children's Fund

USA………………………………...United States of America

UWC………………………………..University of the Western Cape

VLBW………………………………Very Low Birth Weight

WHO………………………………..World Health Organisation

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CHAPTER ONE

INTRODUCTION

1.1 Background

Low birth weight (LBW) is a global public health problem with delivery of approximately 30 million LBW babies annually (UNICEF & WHO, 2004). This burden is especially worse in developing countries with low per capita income where women are exposed to inadequate nutrition. However, the World Health Assembly has a target of reducing LBW by 30% by the year 2025 (WHO, 2014).

LBW has been defined by the World Health Organization (WHO) as a weight at birth of less than 2,500 grams (up to and including 2,499 grams) irrespective of gestational age (WHO, 1992).

LBW has a variety of adverse effects on newborn babies. Newborn deaths, of which prematurity and LBW are the commonest causes, account for a massive 43% of under-five mortality world-wide (Kliegman, 2007; Lau et al., 2013; WHO, 2014). These deaths are mainly due to infection, prematurity and respiratory distress (Stoll et al., 2002; University of Alabama at Birmingham, 2013). LBW is also associated with more birth complications such as birth asphyxia (when compared with normal birth weight babies) and this translates into reduced or impaired intellectual development and general growth and developmental delay (Datar and Jacknowitz 2009; De et al., 2011; Soleimani et al., 2013; Class et al., 2014). Other consequences and complications of LBW are newborn malnutrition and poor weight gain especially in the first two years of life (Kliegman, 2007). There are many specific clinical complications resulting from LBW and a comprehensive list of these complications is shown in appendix 1(Kliegman, 2007).

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LBW also has adverse emotional effects on children and their parents (Singer et al., 1999; Hack et al., 2004). Additionally, the health facilities are drained of their limited resources during care of the LBW newborn babies, especially those with very low birth weights (below 1500 grams) that need long stays in intensive care units (Ettner, et al., 1997; WHO, undated). The families and the community are also faced with the economic impact of the burden of LBW, through the diversion of resources that would have otherwise been used for other activities (Ettner, et al., 1997; Singer et al., 1999; Hack et al., 2004; WHO, undated). Hence a decrease in low birth weight occurrence will improve children's survival, growth and psychosocial development and allow health facilities to divert resources to other much needed services, rather than on the expensive services required by those with LBW (Blanc and Wardlaw, 2005).

LBW can be due to preterm delivery before 37 completed weeks of gestation or due to intra-uterine growth retardation/restriction (Kramer, 1987). Many factors affect LBW including maternal factors such as age, educational level, economic status, marital status, parity, birth spacing, mid upper -arm circumference, weight, height and body mass index (BMI) of pregnant women (Kramer, 1987; LDHS, 2009; Chanders, 2013). Pregnancy associated factors affecting LBW are maternal stress, illness in pregnancy such as hypertension in pregnancy, abruptio placenta, placenta previa, and gestational age (Kramer, 1987; Chanders, 2013). LBW is also affected by environmental factors (such as housing condition, type of fuel used indoors such as paraffin, wood and gas), physical stress (physical abuse and long working hours), social factors (smoking, use of alcohol and illicit drugs) (Singer et al., 1999; Murphy et al., 2001; Vettore et al., 2010). Furthermore, medical factors such as maternal HIV status and intestinal infestations especially among HIV positive mothers are also associated with LBW (Dreyfuss et al., 2001).

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Finally, there are factors and conditions associated with the foetus which include congenital abnormality, fetal malnutrition, multiple gestations and associated syndromes (Kliegman, 2007).

1. 2. Setting

The study was done in Maseru city which is both the capital of Lesotho and the main city of Maseru district. It is made up of lowland terrain. Maseru district is the biggest district in Lesotho with an estimated population of 433, 127 (LBOS, 2010). The exact population, GDP per capita, fertility rate and life expectancy of Maseru city are not well known. However, Lesotho has a population of 1.9 million with a gross domestic product per capita of $1125 in 2013 and a Gini coefficient of 28 (LDHS, 2009). The total fertility rate in Lesotho is 3.2 children per female lifetime with a life expectancy at birth of 49 years. Lesotho had a high HIV prevalence of 23% in 2009 and currently 25% amongst the adult population in 2014 (LDHS 2009; LDHS, 2014).

Lesotho is totally surrounded by South Africa and Maseru city acts as a transit point between the countries with people moving relatively freely from one country to another (LBOS, 2010). This resulted in a high rate of migration from Lesotho to South Africa for better jobs with migration being a mix of permanent migration, temporary migration and long-term migration of mainly male workers, whose families remained behind in Lesotho. This in turn encouraged those in the higher socio-economic class to visit South Africa for better health services. However, for late stage antenatal care some women in the lower socio-economic rungs would join their husbands in South Africa and access health services there (LDHS, 2014).

Maseru city is located in the northwest region of Lesotho and is on the border of the Free State province of South Africa (Bulane, 2009). It comprises the central business district (CBD) and surrounding settlement areas such as Ha Thetsane, Ha Matala, Naleli, Qualing and Lithabaneng.

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The CBD is made up of the East comprising the old bus station and old Maseru Market. The West is mainly of the linear commercial street known as Kingsway (Bulane, 2009).

In 2014, 81% of women in Maseru delivered in a health facility and of these 73% delivered in a public sector facility (LDHS, 2014).

There are a few public hospitals, maternity homes and private hospitals which conduct deliveries in Maseru city, but most deliveries took place in the only tertiary hospital in the city, and hence was where this study was conducted. The tertiary hospital is run as a public private partnership. It has all cadres of health workers including nurses, doctors and specialists. It attends to referrals from all over the country and has a 425 bed capacity and provides for over 70 % of all deliveries in Maseru (The Lesotho Review, 2015). Most of the population who deliver in the tertiary hospital are from the lower socio-economic class and hence have their hospital bill subsidized by the government. The private hospitals account for about ten percent of deliveries in Maseru city, with the remaining women (20%) either delivering at home, at private maternity homes or outside of Maseru City, including other districts in Lesotho and in South Africa. There are many health centres and clinics in Maseru which provide antenatal out-patient services but which do not perform deliveries (LDHS2009; LBOS, 2010; The Lesotho Review, 2015).

Generally maternal and newborn services in Maseru are provided in all health facilities both in the private and public sectors. Pregnant women typically attend ANC services in facilities within 5 kilometers or 30 minutes' walk from their residence. Deliveries take place in facilities staffed by doctors and/or midwives and with adequate equipment for safe delivery. Pregnant women with complications are referred from facilities run by midwives to those run by doctors. Uncomplicated deliveries are handled by every facility where deliveries take place, however, newborns with complications are usually referred to the tertiary hospital in Maseru.

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In Lesotho the under-five mortality increased from 113 per 1000 live of 2004 to 117 per 1000 live birth in 2009. But it reduced and improved to 85 per 1000 live births in 2014 (LDHS, 2014). However, this improvement, although impressive, is not close to the millennium development goal (MDG) target of 29 per 1000 live births. The neonatal death rate also showed a decrease from 46 per 1000 live births in 2004, through 47 per 1000 live births in 2009 to 34 per 1000 live births in 2014 (LDHS, 2014). The newborn accounted for 40% and 37% of under five deaths in 2014 and 2015 respectively (LDHS, 2014; Lesotho Report, 2015)

There has been a consistent increase in the prevalence of LBW in Lesotho. In 2004 it was estimated to be 7% (LDHS, 2004). In 2009, the Lesotho Demographic and Health survey estimated that LBW was at 9.5% in Lesotho (LDHS, 2009). Currently, LBW is estimated to be at 10% (LDHS, 2014). The estimation of LBW was done in the Lesotho demographic and health survey using a combination of actual birth weight measurements and birth weight estimation based on the newborn size described by the respondents, hence the accuracy of the prevalence of LBW arrived at was in doubt. Neither the measured nor the estimated prevalence of LBW in Maseru is well known, but LBW has anecdotally been observed to be a common phenomenon in Maseru and it posed a strain on the children, their families and the health services. Tackling the factors that are mainly responsible for the presumed high levels of LBW in Maseru would therefore both reduce the burden of disease due to LBW and conserve scarce health resources. Effectively achieving this requires knowledge of the prevalence of LBW and the determinants of LBW operative in Maseru, so as to best be able to tackle them.

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1.3 Problem Statement

The prevalence of LBW in Maseru is unclear and hence there was a need to know the true prevalence of LBW, based on actual birth weight measurements, in Maseru. Similarly, the prevalence of the mix of factors known to be related to LBW and the association of these with LBW in Maseru was unknown and needed to be uncovered.

1.4. Purpose

The main purpose of the research was to identify the burden of LBW and its association with the identified determinants, so as to allow health services providers to come up with evidence based health planning towards improving the health outcomes of children in Maseru. The identification of associations between LBW and various suspected determinants would inform the need for improved health education and personal counselling of pregnant women during antenatal visits, by the nurses and other health workers. Another purpose was to have study-based evidence to support an advocacy campaign by advocacy groups on the need for policy action or policy change by the policy makers and other relevant authorities. For example, the identification of positive associations between LBW and various factors such as smoking would empower social advocates to push for policies and effective marketing strongly discouraging smoking in women during pregnancy. Similarly, a positive association of LBW with low maternal education would support advocacy groups who push for female literacy campaigns and women empowerment.

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1.5. Study Aim and Objectives

1.5.1. Aim

The study aim was to determine the prevalence of LBW and the factors affecting LBW in Maseru, Lesotho.

1.5.2. Objectives

1. To determine the prevalence of LBW of newborn babies in health facility where deliveries are conducted in Maseru Lesotho in 2016.
2. To determine the prevalence and association of maternal demographic, maternal social, maternal economic and maternal medical factors potentially affecting LBW of babies in Maseru Lesotho in 2016.
3. To determine the prevalence and association of maternal physical stress and the health services in the area with low birth weight in Maseru in 2016.
4. To determine the prevalence and association of gestational age, sex of newborn and number of gestations with low birth weight in Maseru in 2016.

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1.6 Thesis Structure

The thesis comprises six chapters. The first chapter gives an introduction of the research as well as the setting, problem, purpose, aim and objectives of the study. Chapter two reviews the relevant literature involving the prevalence of LBW and its associated potential factors. The third chapter describes the methodology used to achieve the aim and objectives. It further describes the design, population, sample size, sampling, data collection, variables and analysis of the study. Lastly, it describes the variability, reliability, generalizability and ethics. The fourth chapter presents the results of the analysis. The fifth chapter discusses the findings presented in the results of the analysis. The sixth and last chapter draws conclusions from the study and makes recommendations based on the findings of the study.

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CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter discusses low birth weight, the prevalence and burden of low birth weight and the factors associated with low birth weight. It also addresses the trends in low birth weight both in developing and developed countries in order to improve the illumination of the context in Maseru city.

2.2 Low birth weight

LBW is classified into three types. Birth weights from 1500g to 2499g, 1000g to 1499g and less than 1000g are classified as low birthweight (LBW), very low birthweight (VLBW) and extremely low birthweight (ELBW), respectively (Kliegman et al, 2007).

LBW is also classified as appropriate-for-gestational-age (AGA), small-for-gestational-age (SGA) and large-for-gestational age (LGA) (Kliegman et al, 2007). AGA is when the birth weight corresponds to the expected gestational age of the fetus or baby and hence the LBW was due to precipitate birth which in turn can be due to several factors (Kliegman et al, 2007). SGA is when the birth weight is less than that expected for the gestational age and can be caused by conditions such as chronic maternal illnesses (Kliegman et al, 2007). LGA is when the birth weight is more than the expected gestational age and can be caused by condition such as maternal diabetes (Kliegman et al, 2007). The babies with SGA (also known as intra-uterine growth retardation, IUGR) can be further classified as symmetric IUGR (head circumference, weight and length equally affected) or asymmetric IUGR (relative sparing of head growth) (Kliegman et al, 2007). All these types of LBW pose different types of problems to the child.

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Thus the degree of its occurrence and the problems need to be known in order to better understand the impact of LBW.

2.3 Prevalence and Burden of Low Birth Weight

The prevalence of LBW varies in different parts of the world. It had an average global prevalence of 15.5% in 2000, ranging from 6.4% in Europe to 18.3% in Asia as regional averages (UNICEF & WHO, 2004). Recent study has shown a slight improvement in global LBW rate to 15% (WHO, 2014). In 2000 LBW was 3% in Albania and 19% in Pakistan. In South Africa, LBW has declined from 15% in 1998 to 9% in 2006 (UNICEF & WHO, 2004; Berry & Hendricks, 2009).

The prevalence of LBW is about twice as high in low and middle income countries (16.5%) than in high income countries (7%). It is about 27% in South-Central Asia, 14% in sub-Saharan Africa and the Caribbean and 10% in Oceania (UNICEF and WHO, 2004). A recent study has also shown a decrease in LBW rates in sub-Saharan Africa to 13% (WHO, 2014).
Studies in low and middle income countries have shown different prevalent rates of LBW. The Nigeria demographic and health survey (NDHS) of 2003 showed a prevalence of 14% (NDHS, 2003). In Bengal India, a cross-sectional analytic study yielded a prevalence of 28.8% (Dasgupta and Bavu, 2011). Chanders in 2013 found a prevalence of 31.5% among LBW infants in a cross-sectional analytic study done in Sirte City of Libya (Chander, 2013).

According to a report from the US Department of Health, the USA has an average LBW of 7.99% (US Department of Health, 2013). This is an improvement when compared to the LBW of 8.26% it had in 2006, according to same report. Sweden has a low birth weight prevalence of 4.2% which has remained largely unchanged at this level since 1980 (OECD, 2012). The same

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report showed that Iceland has the lowest prevalence of low birth weight in the European Union with a prevalence rate of 3.6% (OECD, 2012).

LBW has been a global problem affecting both the high income and the low and middle income countries. It is of public health importance with various effects on infant morbidity and mortality. Of the 20 million LBW infants born yearly worldwide, 95.6% are from low and middle income countries. The difference in the prevalence between the high income and low/middle income countries may be multi-factorial. The majority of the LBW newborns in high income countries result from prematurity. This prematurity could be mainly due to placental previa and abruptio, fetal distress and drug abuse (cocaine). This is different from intra-uterine growth restriction (IUGR) seen more in the low and middle income countries. IUGR is mainly caused by placental separation, hypertension in pregnancy, chromosomal abnormalities and multiple gestations (Kramer et al, 1987). However, there could be interplay between the causes of prematurity and IUGR.

There is a dearth of and incomplete records in the low and middle income countries; hence LBW prevalence is generally gleaned from estimates from household surveys. Furthermore, most births are not within the health facilities in the low and middle income countries. However, in the high income countries, data are mainly extracted from the hospital or facility-based records and the registration systems (UNICEF and WHO, 2004). In the low and middle income countries LBW may also be higher due to adjustments in estimating birth weights, which is based on mothers' assessment of birth size, while in high income countries adjustments are usually not done as birth weights are known and well recorded (Blanc and Wardlaw, 2005).

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The occurrences of low birth weight and to some extent the differences in prevalence are affected by many factors. These factors affect the mother and the intrauterine environment during pregnancy and hence the newborn.

2.4 Factors Associated with LBW

The factors affecting the weight of the newborn could be associated with the baby or the mother.

2.4.1 Newborn Factors

Some of the newborn factors affecting the birthweight include sex of the baby, birth length and number of gestation in a particular pregnancy.

Sex of the newborn has been studied to determine its association with birth weight outcome. A study found females (OR = 1.76, 95% CI of 1.09 to 2.83) to have a greater risk of LBW than males (Thomre et al, 2012). However, the cause of the higher risk of low birth weight for females was not known.

Length of the baby has been strongly associated with the birth weight of newborns. The length of the fetus increases as the pregnancy advances which increases the weight of the fetus due to cell differentiation and also cell and organ maturity. Furthermore, association was shown between fetal growth (bi-parietal diameter and crown-rump length), gestational age, fetal maturity and birth weight (Kliegman et al, 2007).

Multiple gestations have been associated with low birth weight. A cross-sectional study conducted at Muhimbili National Hospital in Tanzania using 6931infants showed a strong relationship between multiple gestation and low birth weight (Adamson Harold, 2007). It is also shown that low birth weight occurs about 9 times more often in multiple gestations than in singleton pregnancies, as observed in Canada (Statistics Canada 2005).

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2.4.2 Maternal Factors

There are several studies on the factors affecting LBW both in the developing and the developed countries. These include the maternal sociodemographic, maternal toxic, maternal environmental and maternal economic factors. Others are maternal medical factors, physical stress and the health services in the area.

2.4.2.1 Maternal Sociodemographic Factors

LBW has been associated with some maternal related demographic factors. Younger maternal age (OR = 4.74; CI = 2.87-8.45) was associated with low birth weight in a cross-sectional survey in a Nigerian city using 1,138 pregnant women (Isiugo-Abanihe and Oke, 2011). However, a study by Chander done in Libya in 2013 using cross-sectional analysis in 269 participants did not find any association with maternal age (Chander, 2013). Furthermore, a study in Nigeria using a case-control methodology also did not find any association of LBW with maternal age.

The same Nigerian study showed that lower level of education was found to be a risk factor for low birth weight (OR = 2.37; C I= 1.19-4.50) (Isiugo-Abanihe and Oke, 2011).

A study in India has shown that those who live in rural areas (AOR = 5.37, 95% CI of 1.43 to 2.01) are more likely to have low birth weight babies than those in the urban areas in India (Dasgupta &Basu, 2011).

A recent systematic review was done on 106 published papers from 1999 to 2007 to determine the social disparities of adverse birth outcome in 2010 (Brumshine et al, 2010). Ninety-nine of the 106 studies found a significant association between socioeconomic disadvantage and LBW while two studies found a paradoxical association. Some of the socioeconomic factors studied included educational level, economic status, neighbourhood status and occupational class.

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Mothers from lower economic status have been positively associated with low birth weight in a household survey conducted in Lesotho for mothers with estimated LBW children (LDHS, 2009). Another study has shown positive association between economic status and LBW with the following measures of economic status such as housing (AOR=1.82, 95%CI of 0.97-3.42), poverty level (AOR =1.89, 95%CI of 1.05 to3.42), presence of sanitary latrine (AOR of 3.99, 95%CI = 1.01 to 15.75) and adequacy of food (AOR of 62.16, 95%CI = 10.51 to 367.7) being associated with LBW in India (Dasgupta & Basu, 2011).

A study in Chitral Pakistan demonstrated no association between occupation and low birth weight. In the study those classified as home makers or farmers (OR =1.22, 95%CI of 0.5 to 2.7) were not significantly more at risk of having low birth weight babies than those who were professionals or traders (Ahmed et al, 2012).

Marital status of mothers has been shown to have some association with birth outcome. A study conducted in North Carolina using birth certificates showed that unmarried women (AOR = 1.30, 95%CI of 1.23 to 1.38) had higher risk of having babies with low birth weight when compared with married women (Wood, 1997). A similar finding was observed in a recent study with unmarried women having higher risks for delivery of preterm low birth weight babies (OR of 1.57, 95%CI = 1.41 to 1.75) and term low birth weight babies (OR of 1.39, 95%CI = 1.21 to 1.61) using a birth registry in Virginia (Masho et al, 2010).

Several studies have demonstrated some associations between maternal socio-environmental factors and low birth weight (Grjibovskit al, 2004; Ugwuja et al, 2009; Omokhodion et al, 2010; Vettore, 2010). A case-control study was conducted in Bale zone hospitals in South-East Ethiopia to assess the relationship between types of energy source for cooking and low birth weight. The study found environmental factors such as using firewood for cooking (AOR = 2.7;

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95 % CI = 1.01–7.17) and using kerosene for cooking (AOR = 8.9; 95 % CI = 2.54–31.11) as being associated with low birth weight, after multivariate logistic regression analysis (Habtamu et al, 2015).

Physical stress such as number of hours spent at work could affect low birth weight. A cross-sectional study on 2663 mothers who delivered in three major hospitals in Mexico City and who worked for at least 3 months during pregnancy showed a significant association between working for more than 50 hours per week and small for gestational age (AOR = 1.59, 95%CI of 1.14 to 2.22) (Ceron-Milles, Harlow & Sanchez-Carrillo, 1996). Another prospective study interviewed 1327 mothers from the Southampton Women's Survey and found no association between SGA babies and working hours (Bonzini et al, 2009). However, both of the studies did not consider low birth weight specifically as babies who are not SGA could still be low birth weight even though their weight was adequate for their gestational age.

2.4.2.2 Maternal Behavioural Factors

Some maternal behavioural factors have been associated with LBW. Alcohol intake and smoking have been positively associated with LBW. A prospective study using 3,891 pregnant women between 1980 and 1982 in a hospital in Boston found an association with AOR of 2.17 (95%Cl of 1.05 to 4.50) between smoking and LBW (Martin & Bracken, 1986). This was seen both in active and passive smokers. Chander recently in a cross-sectional study also found a positive association between smoking and LBW (Chander, 2013). Alcohol was found to be positively associated with LBW in a systematic review of the determinants of low birth weight (Kramer et al, 1987). A population-based prospective cohort study done in Rotterdam, The Netherlands using 7141 participants further showed association of low birth weight with consumption of

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alcohol (AOR = 4.81, 95% CI of 1.10 to 21.08) especially in early pregnancy (Jaddoe et al, 2007).

2.4.2.3 Maternal Disease related Factors

There is an association between LBW and some maternal medical conditions. LBW was associated with maternal HIV infection. A cohort study done in Cameroon with 3737 mother-infant pairs showed a significantly higher frequency of small for gestational age and LBW among HIV-infected infants than in HIV-exposed uninfected infants (AOR = 4.1, 95% CI of 2.0 to 8.1) as well as significantly lower LBW and small for gestational age in HIV-unexposed uninfected infants (AOR = 0.5, 95%CI of 0.4 to 0.8) than HIV-exposed uninfected infants (Sofeu et al, 2014). This HIV effect is reducing due to the increasing availability of anti-retroviral drugs and Prevention of Mother to Child Transmission (PMTCT) of HIV infection as shown in a longitudinal cohort study of 11321 infants from 1989 to 2004 in the United States of America. The prevalence of LBW among HIV exposed infants decreased from 35% to 21% during that period in the same study, mainly due to antiretroviral therapy in pregnancy slowing down the intrauterine growth restriction through PMTCT (Schulte et al, 2007).

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However, a study showed an increased risk of LBW among infants exposed to maternal Tenofovir disoproxil fumarate-containing antiretroviral therapy during pregnancy (AOR = 1.76, 95% CI of 1.01 to 3.05) (Leach-Lemens, 2010). This is unlike other medications used in PMTCT which reduce the risk of low birth weight (Schulte et al, 2007).

Kramer, in a meta-analysis and using an a priori assessment methodology, reviewed studies from 1970 to 1984 retrieved from English and French language medical publications. The study identified 43 determinants of LBW (Kramer, 1987). They included maternal age, parity, infant sex, ethnicity, maternal height, pre-pregnancy weight, weight and height of father, mother's birth

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weight, history of prior low-birth-weight infants, gestational weight gain and caloric intake, cigarette smoking, alcohol consumption, and tobacco chewing. Others are poor gestational nutrition and short maternal stature. The study identified 921 relevant publications and reviewed 895 of them.

2.4.2.4 Maternal Pregnancy related Factors

Two cohort studies on the effect of the history of gestational duration in prior pregnancies on LBW gave relative risks (RR) of 3.08 for prematurity and 2.75 for IUGR after adjustment for confounders. The length of gestational age was further shown to be strongly associated with LBW. In a cross-sectional study done in West Bengal, India using a sample size of 250 and a cluster sampling technique, short gestational age (preterm delivery/gestational age less than 37 weeks) was very strongly associated with LBW (Dasgupta & Basu, 2011). Bivariate analysis showed a higher risk for short gestational age (<37 weeks) than term gestation (≥37 weeks) with risk ratio of 37.58 and 95% CI of 15.5 to 94.5 which rose much higher to risk ratio of 59.75 and 95% CI of 12.21 to 291.73 after multivariate analysis to exclude confounders. This is because the younger the fetus, the less the maturation of organs. It is common knowledge that the longer the gestational age the more time that the fetus grows by undergoing cell multiplication, differentiation and maturation over the period of pregnancy (Kliegman et al, 2007). A cross-sectional study with 509 newborns in Government Medical College and Hospital Miraj was done to identify the maternal risk factors determining the birth weight of newborns (Thomre et al, 2014). This study found a very significant association between low birth weight and the gestational age on multivariate regression analysis (AOR 32.47, 95% CI 17.06 – 61.81). Number of antenatal care (ANC) visits has been shown to affect the birth weight of infants. Mothers with 1 to 3 ANC visits (OR = 5.54, 95% CI of 3.8 to 8.) were more likely to have

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infants born with low birth weight than those with 4 or more ANC visits, in a study conducted in Pakistan (Ahmed et al, 2012). It therefore seems in this setting that the more ANC visits, the more likely that high risk pregnancies will be detected and managed appropriately.

The effects of hypertension and bleeding in pregnancy on low birth weight have also been studied. A case-control study in Lagos University Teaching Hospital Nigeria used 155 cases of low birth weight and 305 controls of normal birth weight babies and found a significant association between bleeding in pregnancy and low birth weight (OR 2.44, 95% CI 1.61-7.34, $p < 0.001$) (Awoleke, 2012). Bleeding can occur due to rupture of the placenta which will necessitate early delivery to save the mother and the fetus and thus results in early or preterm delivery. Pregnancy-induced hypertension was found to be significantly associated with low birth weight (AOR = 1.5, 95%CI of 1.3 to 1.8) in a study of 289,125 pregnancies among residents of North Carolina between 1988 and 1990 (Ananth et al, 1995). Those with pregnancy induced hypertension are more likely to have eclampsia and thus early delivery.

There are other maternal reproductive factors with a strong association with LBW. Parity has been associated with low birth weight. A cohort study in an urban community in India using 210 pregnant women found an association between primiparity and low birth weight with a risk ratio of 1.58 and 95% CI of 1.20 to 2.10 (Deshmukh, 1998). A recent systematic review and meta-analysis of the risks of pregnancy outcome among women of different parities found that nulliparity was associated with low birth weight, with an unadjusted odds ratio of 1.41(95% CI of 1.26 to 1.58) while multiparity did not, with an unadjusted odds ratio of 1.1 (95% CI of 0.95 to 1.32) (Shah, 2010).

Birth interval has been associated with low birth weight in many studies. Short birth intervals less than 18 months are associated with low birth weight (OR = 1.9, 95% CI of 1.0 to 3.5) (James

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Gribble, 1993; Adam et al, 2009). Zhu and Le in their retrospective cohort study of 565,911 infants in Michigan using a live birth database found that birth intervals of 18 to 23 months had the lowest risk of low birth weight (Zhu & Le, 2003). They found that longer and shorter intervals had higher risks of low birth weight. This finding remained the same after multiple regression analysis to control for other confounders. The AOR were 1.4, 1.5, 1.1and 1.5 for birth intervals less than 6, 24 to 59, 60 to 95 and 96 to 136 months respectively. These were compared with a birth interval of 18 to 23 months. The mothers may not have fully recovered nutritionally for shorter intervals. The explanation for longer interval could not be explained.

2.4.2.5 Maternal Constitutional Factors

Furthermore, there are maternal constitutional factors which have been shown to be associated with low birth weight. Height has been associated with low birth weight. A cross-sectional study of 2226 mother-child dyads from 2009 to 2010 in a shanty city, Maceo Alagoas, Brazil showed an association between maternal short stature and low birth weight (Britto et al, 2013). Women of height ≤152cm were at more risk than those >160.4cm (OR: 1.42, 95% CI: 0.96 - 1.09) but this was not statistically significant on bivariate analysis. However, multivariate analysis showed a statistically significant difference between association of short and tall stature mothers with low birth weight, when other confounders were controlled for (OR: 3.05, 95% CI:1.44 to 6.47). Studies have been done to determine the effect of weight of mothers on low birth weight. Greater maternal weight at birth (≥ 50Kg) (AOR =0.96, 95% CI of 0.92 to 0.97) was shown to have a protective effect against low birth weight babies compared with lower maternal weight (less than 50Kg) (Isiugo-Abanihe, 2011). A systematic review and meta-analysis study showed that women who are over-weight or obese (assessed by objective measurement, self-report, medical charts or database records) (RR = 0.84, 95% CI 0.75 to 0.95) are less likely to have low birth weight

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infants when compared with women with normal weight (MacDonald et al., 2010). However, the same study showed a higher risk for very low birth weight (<1500g) (RR = 1.61, 95% CI 1.42 to 1.82) and extreme low birth weight (1000g) (RR = 1.31, 95% CI 1.08 to 1.59) for over-weight or obese women than for normal weight women (MacDonald et al., 2010).

Maternal body mass index (BMI) showed some association with birth weight in a retrospective cohort study in Aberdeen with underweight (BMI < 20Kg/m^2) mothers having a higher risk (AOR: 1.7, 95% CI 1.2 to 2.0) than those mothers with a BMI of 20 to 24.90Kg/m^2. Notwithstanding, there were no statistical differences between mothers with BMI of 20 to 24.9Kg/ m^2 and those with higher BMIs of 25 to 29.9 Kg/m^2, or 30.0 to 34.9 Kg/m^2, or ≥35Kg/m^2 (Bhattacharya et al, 2007). However, in a prospective cohort study of seventy-two neonates in Oklahoma City, BMI did not significantly affect birth weight (Hull et al, 2008).

Mid upper arm circumference (MUAC) of the mother has been shown to be associated with birth weight outcome of the baby.

2.4.2.6 Maternal Nutrition related Factors

A study found that undernourished mothers (MUAC <22cm) (AOR = 2.56, 95% CI of 1.93 to 4.06) were more at risk of having LBW infants than those who were well nourished (MUAC ≥ 22cm) (Kapoor et al, 2012). Other forms of maternal nutrition have shown an association with LBW. In Nigeria mothers who did not use vitamin supplements were shown to have a higher risk of LBW babies than those who used vitamin supplements during pregnancy (AOR: 2.78, 95% CI 1.17 to 4.97) (Isiugo-Abanihe &Oke, 2011). The same study also showed that mothers who did not use iron supplements during pregnancy were more likely to have LBW babies than mothers who used iron supplements in pregnancy (AOR: 4.16, 95% CI 1.81 to 5.51). Furthermore, the study showed that mothers who observed food taboos (AOR: 2.73, 95% CI 1.94 to 5.11) had

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more risk of LBW babies than mothers who did not (Isiugo-Abanihe &Oke, 2011). However, the type of food taboo was not stated in the study.

2.5 Low Birth Weight in Lesotho

Generally LBW has been increasing in Lesotho. It was 7% in 2004, 9.5% in 2009 and 10% in 2014 (LDHS, 2004; LDHS, 2009: LDHS, 2014). This is of public health concern. Little research has been conducted on the prevalence and determinants of low birth weight in Lesotho. One was a national study on mothers and their newborns using a household survey. They were asked about births in the five years prior to the survey. They were asked if they weighed the baby and if yes, the actual measurement obtained was then requested. Those at and above 2.5kg were considered adequate birth weight babies while those below 2.5kg were considered LBW babies. Those who delivered outside the health facility or had no records or had forgotten the baby's birth weight were asked to estimate and classify the birth size into very large, larger than average, average, smaller than average and very small at birth. The 2014 survey using 2595 participants showed that LBW had an association with some socio-demographic, environmental and clinical factors (LDHS, 2014). Mothers with age less than 20 years (13.8%) had the highest prevalence of low birth weight babies when compared with those of age groups 20 to 34 years (9.8%) and those of 35 to 49 years (8. %). This was different from the 2004 and 2009 surveys which had the lowest prevalence of LBW babies among the under-20 years-old women. Mothers with an incomplete primary educational level had the highest risk of LBW babies at 15.2% which was similar to the 2009 survey of 12.4%%. However, the 2004 survey showed the highest prevalence of LBW among those with no education at 11.3% (LDHS, 2004; LDHS, 2009; LDHS, 2014). Smoking was not reported on in the LDHS of 2014 because of sample size insufficiency for this variable, but the 2009 survey showed that women who smoked had a higher

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prevalence of low birth weight babies of 10.8% when compared with those who had never smoked (9.2%) (LDHS, 2009). The 2004 survey did not study association of smoking with LBW. It was unfortunately not commented on in the report whether these differences were statistically significant or not.

The prevalence of LBW as well as the potential factors and their association with LBW were investigated methodologically to determine their significance in Maseru.

2.6 Summary

Low birth weight is a common condition both in Lesotho and globally. It is closely associated with many factors including gestational age and number of gestations. Its prevention will save morbidity and mortality among children. The next chapter will discuss the research methodology used for the study.

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CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

In this chapter the various sections comprising study design, population, sample size, sampling, data collection, variables and analysis are discussed. Furthermore, validity, reliability, generalizability and ethics are then discussed.

3.2 Study Design

The study was done using a cross-sectional analytical study design. This is an appropriate quantitative research methodology as it aimed at determining the magnitude of LBW and the association of LBW with several potential predisposing factors.

3.3 Study Population

The study population included neonates and mothers who delivered in the tertiary hospital in Maseru city and were resident in Maseru. The place of delivery was restricted to the tertiary hospital to ensure accurate and reliable measurement of birth weight was obtained. Newborns referred from other facilities to the tertiary hospital may lose some weight as there is a time lag from birth to arrival at the tertiary hospital, due to travel and referral logistics. This would thus have resulted in inaccurate and unreliable birth weights. Further, other health facilities were not included due to logistic and financial constraints. However, most of the deliveries in Maseru take place in the tertiary hospital and thus the bias from not including other facilities was minimal.

Other specific Inclusion criteria were:

- All deliveries with gestation up to 28 completed weeks and above. The gestational age was determined by using either the date of last menstrual period or an early ultrasound report when this was available. In Lesotho viability of a neonate is assumed to be a foetus

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of up to 28 weeks. Those foetuses below 28 weeks gestational age are considered as abortuses (products of abortion).

- Babies whose weights were measured in the first 12hours of birth. Babies lose significant volume of body water between 12 hours and 24 hours and this will alter the birth weight, to the extent that those weighed more than 12 hours after birth would have a much lower weight than their birth weight, hence strenuous efforts were made to weigh the newborns within the first hour of birth.

Exclusion criteria were:

- Physically or psychologically ill mothers such as mothers with puerperal psychosis. They were to be excluded as they would be unable to answer the questionnaire and indeed it would be unethical to request them to do so. The weight of the newborns of these mothers would however be included when assessing the prevalence of LBW, but data on the maternal factors potentially associated with LBW would not be captured and hence they were to be excluded from the analytical component of the study. However, no mothers with these conditions were encountered during the study.
- Babies with obvious physical deformities which increase their weight by >200g were to be excluded. This situation could arise due to various congenital abnormalities and they were to be excluded as it would be difficult to establish their weight separate from that of the abnormality. However, this situation did not arise in the study.
- Mothers of stillborns were excluded for ethical reasons, due to their very recent bereavement. The weights of the stillborns were however used in the LBW prevalence assessment.

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3.4 Sample Size

The annual number of newborns in Maseru city was not known. However, in Maseru district it was estimated to be more than 10,000. The factors considered in the sample size calculation were a confidence level of 95%, power of 80%, percentage outcome of LBW in the unexposed of 8% (using HIV status as the measure of exposure), a prevalence ratio of 2.5, ratio of unexposed to exposed of 5 to 1 (based on an assumption of a 16% prevalence of HIV positive pregnant women) and a non-response rate of 10%. Using the aforementioned criteria, the sample size was calculated via Epi-Info^{TM} 7.1.3.0 to be 402 mothers and their neonates.

3.5 Sampling

Time-delimited sequential sampling was used. All newborns delivered at the tertiary hospital in Maseru who met the inclusion criteria were selected over a time period of four months from February to May, 2016. Although there are in some contexts seasonality in birth numbers, and that might be the case in Maseru, there is no known seasonality in the occurrence of LBW and hence using a time period to obtain the sample should not have introduced any selection bias. Permission to access mothers in the postnatal ward was obtained from the hospital management. In Lesotho mothers with no birth complications routinely stay in the postnatal ward for 48 hours after delivery and those who experienced complications stay for a longer period of time. All those who met the inclusion and exclusion criteria were approached within six to 12 hours of delivery, depending on their state of comfort. The babies were also accessed within the first six hours of delivery when they were stable.

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3.6 Data Collection

Data were collected using a structured paper-based questionnaire, direct measurement and via extraction of data from medical records by trained research assistants. The data collected by questionnaire included demographic, social, medical, pregnancy related and environmental details of the mother. Data such as HIV status were collected from the antenatal medical records. Direct measurement of the weights of the newborns (in grams) and their respective mothers (in kg) were conducted at 1g and 0.5kg levels of accuracies respectively, with electronic and calibrated weighing scales. Babies were weighed naked by trained nurses/research assistants by gently placing them on the scale and taking readings after zero calibrating and correcting for parallax errors. Mothers were weighed in light clothing.

Similarly, measurements of the length of newborns and height of their mothers were in centimeters. Newborns were laid on a hard flat surface with their occiput, shoulders, buttocks, calves and back of feet touching the flat surface. The reading was taken while the newborn looked vertically straight upward (tragus and tip of nose aligned along an imaginary vertical line). Mothers stood on a stadiometer with their occiput, shoulders, buttocks, calves and back of feet touching the vertical surface. The reading was taken while the mother looked horizontally straight ahead (tragus and tip of nose aligned along an imaginary horizontal line).

The mid-upper arm circumference (MUAC) of the mothers was assessed using a measuring tape. The circumference of the left arm was measured at the mid-point of an imaginary line from the acromion process of the shoulder to the olecranon process at the elbow.

The sexes of the newborns were determined by physical examination.

Maternal anaemia was not done due to financial and logistic constraints.

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3.7 Variables

3.7.1 Socio-Demographics

The socio-demographic factors used in this study included age of mothers, marital status, highest level of education, residence, employment status, household income per month, mother's income per month, energy source for cooking, type of job and time spent at the job. The ages of the mothers were determined in years and then categorized by five-year age bands into 15-19, 20-24, 25-29, 30-34, 35-39, 40-44 and 45-49 years. Marital status was categorized as single, married, widowed, separated and divorced. Mother's highest level of education was grouped as none, primary, secondary and post-secondary. Residence was grouped as rural or urban setting. The employment status was categorized as either employed or unemployed. The household income per month was requested in actual amounts and were then categorized as low (<M1500.00), medium (≥M1500.00 to <M6000) and higher income group (M≥6000.00) depending on 25th, inter-quartile and 75th quartile ranges of the participants. The mother's income per month was also categorized as none, low (<M1230.00) and medium to high income group (M≥1230.00) depending on 25th, inter-quartile and 75th quartile ranges of the participants.

The energy source for cooking was categorized into electricity, gas, wood, coal and others (paraffin). The number of antenatal visits was graded into none, less than 4 and then four or above and finally graded into less than 2 and 2 and above.

Type of job was grouped into low pay work or adequate pay work. Factory, domestic and casual workers were grouped as having low pay (indecent) work as their remuneration is universally low and their working conditions are poor. Government and other white-collar jobs were

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classified as adequate (decent) jobs. Finally, time spent working per day was grouped into 8 hours or less and compared to those working greater than 8 hours per day.

3.7.2 Maternal factors

The suspected maternal factors that were studied included smoking, alcohol intake, number of antenatal visits, gestational age, parity, birth interval, height, left mid-upper arm circumference and body mass index BMI. Others were Human Immunodeficiency Virus (HIV) status, anti-retroviral therapy (HAART) status, gestational age (GA) on commencement of anti-retroviral therapy (HAART), bleeding in pregnancy and hypertension in pregnancy.

Smoking was categorized as having smoked or not during pregnancy. Alcohol intake was also categorized as having taken alcohol or not during pregnancy. Gestational age was graded into less than 37 weeks (preterm), 37 to 42 weeks (term) and greater than 42 weeks (post-term) and finally divided into either less than 37 weeks or group of 37 weeks and above. Parity was initially categorized into primiparity 1, 2 to 4 and above 4 and finally graded into group of four or below and then group above 4 deliveries. Birth interval was categorized into less than 24 months and group of 24 months and above. The height of mothers was grouped into less than 152cm and group equal to or above 152cm. The mid upper arm circumference was graded as less than 23cm and group of 23cm or above. The BMI was initially graded into less than 18.5kg/m2, 18.5 – 24.9kg/m^2 and equal to or above 25kg/m^2 (WHO, 2011). It was finally categorized into <23 kg/m^2 and ≥23kg/m^2. The HIV status of the mothers was categorized as positive or negative. Those who tested positive were categorized as being on anti-retroviral therapy (HART) or not. Bleeding during pregnancy was grouped into yes or no. Hypertension in pregnancy was grouped into ‘yes’ or ‘no’ depending on the recording in the ANC card or record.

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3.7.3 Neonate Measurements: Neonate measurements conducted were the sex, number of gestation, number of babies at the delivery, length of the newborn and the birth weight (main outcome measurement).

The sex of the baby was either male or female. The number of gestation was initially categorized as singleton, twin, and triplet but finally divided into either singleton or multiple gestations. The length of the babies was grouped as less than 46 cm and the group of 46cm and above. Birth weight of the babies was initially grouped into extreme LBW (less than 1000 grams), very LBW (1000 to 1499 grams), low birth weight (1500 to 2499 grams), adequate birth weight (2500 to 3999 grams) and large birth weight (4000 grams and above). Finally, the birth weight was categorized into low birth weight (less than 2500grams) and adequate birth weight (2500grams and above).

3.8 Analysis

The data management involved data entry, sorting, cleaning and storage using a spreadsheet. The analysis of the data was done by using Epi Info 7.1.3.0 statistical analysis package. Numerical data were analyzed as such and also categorized into relevant pre-determined categories, such as LBW and adequate birth weight. These derived categories were together with the categorical data, analyzed using frequencies. The prevalence of LBW and prematurity and all other potential determinants of LBW were calculated using frequency tables with accompanying 95% confidence intervals. Data summaries of continuous numerical variables were presented using the mean, standard deviation, median and inter-quartile range. Associations of the different variables with LBW were determined using a two-by-two (contingency) table. This was done by determining the prevalence ratios and prevalence differences of the variables and using the chi-square test to derive P values and 95% confidence intervals, in order to determine the statistical

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significance of any association found. Regression coefficients were determined by linear regression analysis of association of low birth weight and numerical variables. Finally adjusted prevalence odds ratios were determined using multivariate logistic regression analysis to control for confounding.

3.9 Validity

The participants were easily accessible with selection bias being unlikely and the sample size chosen was sufficiently large to minimize the vagaries of chance for most of the variables being assessed. There were clear definitions of all variables to avoid misinterpretations in the questionnaire and the questionnaire was piloted beforehand to assess the clarity of the questions. The research assistants were trained in a standardized manner and 3 research assistants were used throughout the study. Calibration of all measuring instruments took place daily and measurements were carried out in a standardized manner. The same instruments were used throughout the study. Potential confounders such as the age of the mothers and number of gestations were addressed within the multivariate analysis.

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A pilot study was conducted prior to the main study. Twenty mothers were interviewed after obtaining consent from them. The weights of their newborns were also measured. The questionnaire and data collected were examined for correction and modification. However, no modifications were made as the pilot study showed that the questionnaire was easily understood by the mothers and that it did not take an unduly long time to complete.

3.10 Reliability

All the variables were defined as accurately as possible to avoid ambiguity of meanings. The weight, length, height and arm circumference were measured twice and the average taken to avoid intra-observer error. The same measuring tape and weighing scales were used consistently

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and checked and calibrated at the beginning of every day. Questionnaires were administered about six hours after delivery to ensure that the mothers had recovered from childbirth labour pains and were emotionally stable. Newborn weight was measured within six hours of birth to ensure reliable birth weight was used. The questionnaire was piloted for necessary corrections to ensure clarity.

3.11 Generalizability

The findings of this study can be generalized to the middle and lower socioeconomic group of residents of Maseru in Lesotho. It cannot be generalised to the upper income group as they were effectively excluded from the study as they would have given birth in private facilities or in South Africa. The findings can also probably be generalised to populations with similar characteristics to that of the study population. Hence it can be generalised to other districts in Lesotho and to a lesser extent, and with caution, to other cities of developing countries.

3.12 Ethics

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The study did not involve harm to anyone, as those who could potentially be harmed by participating in the study were specifically excluded. Hence mothers of critically ill babies or stillborn babies, as well as critically ill mothers were not interviewed, because of their labile emotional state. The study would attempt to help in improving the well-being of newborns in Maseru. Any woman with postnatal depression (a common occurrence after child birth) incidentally noted during the interview process was to be assisted and then referred to an appropriate counsellor. Any other need (e.g. puerperal psychosis) identified while engaging with the mothers was similarly to be appropriately referred. The mothers were provided with information on the study in an easy to understand format and they were told of their right to

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refuse and that there would be no adverse consequences if they refuse. They were guaranteed confidentiality in that no names or other identifying data were collected and all information obtained was kept secure in a code protected computer database and was only accessible to the research assistants, the researcher and the thesis supervisor. Participants were additionally informed that they could withdraw from the study at any time, without having to provide a reason for their withdrawal. Informed consents were thereafter obtained from the mothers.

Permission to conduct the study was obtained from the hospital. Feedback was given to the hospital and to the ministry of health in Lesotho. Ethical clearance was obtained from the University of the Western Cape South Africa Research and Ethics Committee and from the Lesotho Ministry of Health Ethics and Research Committee.

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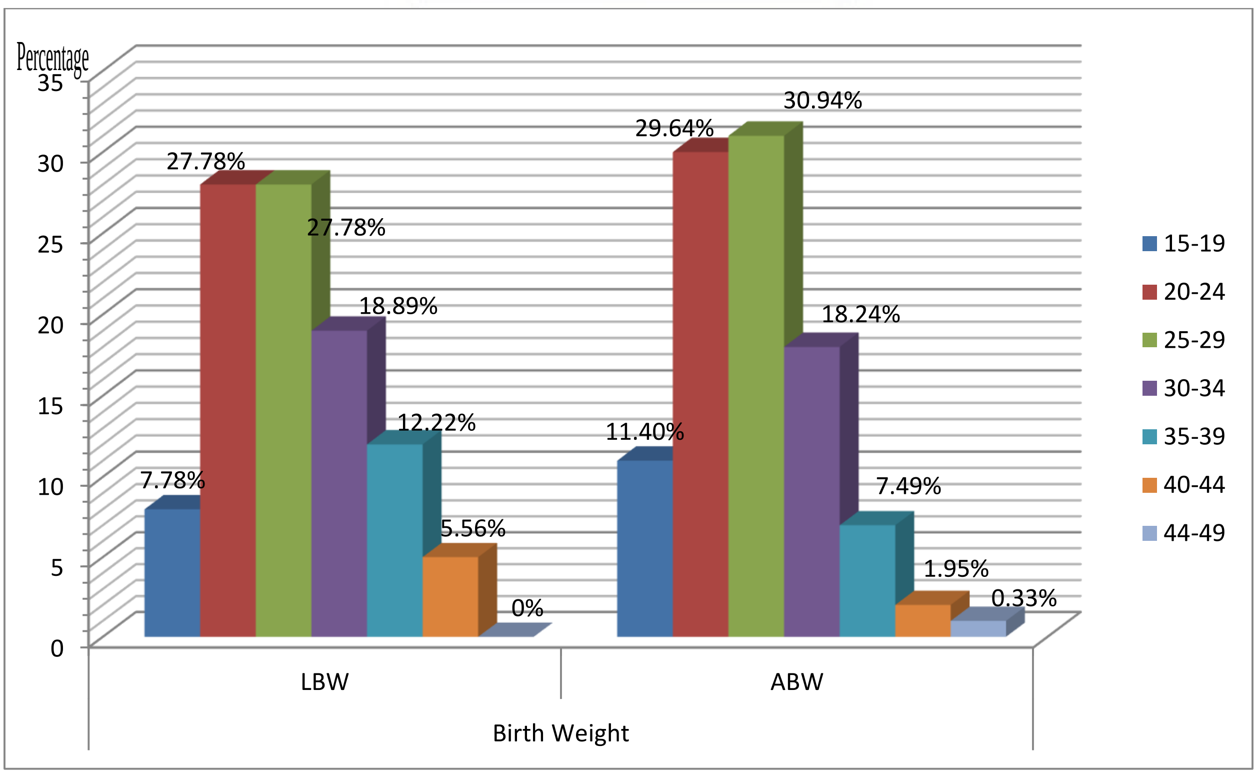
CHAPTER FOUR

RESULTS OF ANALYSIS

4.1 Sample Realization and demographic profile

A total number of 410 mother respondents were approached and 402 mother participants were selected for the study. Three mothers declined to participate and data was incomplete for 5 participants. There were 412 newborns in the study due to multiple gestation deliveries (twins and triplets). The age of maternal participants ranged from 15 to 48 years with a median age of 26 years, a mean age of 26.7 years and a standard deviation of ±6.0 years. The interquartile range was 22.5 to 31.5 years.

Figure 1 shows the age distribution in percentage of study participants (mothers) in 5-year age bands stratified by their delivery birth weight into mothers with Low Birth Weight, LBW deliveries (n =90) and mothers with Adequate Birth Weight, ABW deliveries (n =307).



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The majority of the maternal participants were in the age group of 20 to 29 years. Maternal age patterns did not vary between those with LBW deliveries and those with ABW deliveries

4.2 Characteristics of the newborn

The central tendencies and distribution of the gestational age, birth length and birth weight of all the newborns are summarized in table 1 with birth length grouped into short (<46cm) and adequate (≥46cm) birth length, birth weight into low birth weight (<2500 grams) and adequate birth weight (≥2500 grams) and gestational age into preterm (<37 weeks) and term (≥37weeks), as well.

Table 1: Birth length, weight and gestational age of the newborns

Factors	Mean	Std Dev.	Median	Inter-quartile Range	Range
Birth length (cm) (n=391)	48.20	4.28	49	46 – 52.50	31 – 53
Short length n = 75	41.01	3.64	42	39.00 – 44.50	31 – 45
Adequate length n = 316	49.85	2.11	50	48 – 52.00	46 – 53
Birth weight (gm) (n=412)	2871	706	2945	2500 – 3300	860 -4780
LBW n= 102	1912	431	1980	1590 – 2310	860 - 2490
ABW n= 310	3187	445	3160	2825 – 3440	2500 - 4780
Gestational age (n = 390) (weeks)	37.57	3.01	38.00	36 – 40	28 – 45
Preterm n = 87	33.34	2.43	34.00	32.50 – 36.00	28 – 36
Term n = 298	39.01	1.61	39.00	38.00 – 40.50	37 – 45

ABW = Adequate birth weight; LBW = Low birth weight; Std Dev. = Standard deviation

The mean birth weight was 2871 grams with weights ranging from 860 grams to 4780 grams. The prevalence of newborns with LBW was quite high at 24.75% and similarly preterm births were high at 22.3%. Further analysis of birth weight and length as well as other newborn parameters in categories are shown as frequencies with 95% confidence intervals in table 2 below.

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Table 2: Frequency Distribution of Newborn characteristics			
	Percentage	**95%CI**	**Number**
Baby sex (n=404)			
Male	51.98	46.99 – 56.93	210
Female	48.02	43.03 – 53.01	194
Birth length (cm) (n=391)			
<46	19.18	15.47 – 23.51	75
46 – 52	76.47	71.78 – 80.52	299
>52	4.35	2.63 – 7.01	17
Number of Gestation (n=400)			
Singleton	96.50	94.06 – 98.00	386
Twins	3.25	1.82 – 5.63	13
Triplets	0.25	0.01 – 1.61	1
Birth Weight (grams) (n=412)			
ELBW (<1000g)	0.24	0.01 – 1.56	1
VLBW (1000 – 1499g)	4.61	2.88 – 7.23	19
LBW (1500 – 2499g)	19.90	16.22 – 24.16	82
ABW 2500 – 4000g)	70.63	65.93 – 74.94	291
BBW (>4000g)	4.61	2.88 – 7.23	19
LBW and NBW (grams) (n=412)			
LBW (<2500)	24.75	20.72 – 29.27	102
ABW (≥2500)	75.25	70.73 – 79.28	310

ELBW = Extremely low birth weight; VLBW = Very low birth weight; LBW = Low birth weight ABW = Adequate birth weight; BBW = Big birth weight

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Amongst the 412 analysed newborns 52% of the babies were males and 48% were females. The vast majority (96.5%) of the deliveries were singletons with only a small percentage of babies having very low birth weight (4.61%) and extremely low birth weight (0.24%).

4.3 Sociodemographic characteristics of the mothers

Maternal sociodemographic characteristics and physical factors measured as continuous variables were summarized via their central tendencies and distributions, and they were then also grouped into categories and then analyzed descriptively by assessing frequencies and 95% confidence intervals. This analysis is shown in Tables 3 and 4.

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Table 3: Characteristics of maternal sociodemographic and physical factors analyzed as continuous variables					
Factors	**Median**	**Mean**	**Std Dev.**	**Inter-quartile Range**	**Range**
Mother monthly income (Maloti) (n = 386)	1230	1158	2672	0.000 – 1230	0 – 26000
Household monthly income (Maloti) (n = 292)	2650	4573	4900	1500 – 6000	0 – 30000
Mid-upper arm circumference (Centimeters) (n = 395)	26.2	26.9	3.5	24.5 – 29	18 – 40
Weight of mothers post-delivery (Kilograms) (n = 395)	64	65.8	12.8	57 – 72	41 - 109
Height of mothers (Centimeters) (n = 394)	160	159.9	7.9	154.5 – 166	130 – 180
BMI of mother (Kg/M^2) (n = 391)	25.2	25.6	4.4	22.7 – 28	17.2 – 41.7
ANC visits (n = 391)	4	3.7	1.5	3 – 4.5	0 – 12
Gestational age (Weeks) (n = 390)	38	37.5	3	36 – 40	28 – 45
Birth interval (Months) (n = 401)	48	60	33.8	36 – 78	15 – 204
Parity including the current birth (n = 401)	2	2	1.1	1 – 2.5	1 – 7
*GA at which HAART was Commenced. Diagnosed HIV positive in pregnancy (Weeks) (n=67)	20	20.58	9.59	12.5 – 28	8– 40
Mother's job hours (Per day) (n = 132)	9	8.96	2.1	8 – 10.5	2 – 12

*GA = Gestational age * HAART = Highly active antiretroviral therapy Std Dev, = Standard deviation

The majority of the respondents were low income earners with an average income of 1158 Maloti per month (1 Maloti = 1 South African Rands). Many of them attended ANC several times with an average of 3.7 ANC visits per pregnancy. Most of the mothers who were employed spent more than 8 hours per day at their workplace.

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Table 4: Characteristics of maternal sociodemographic and physical factors analysed as categorical variables via frequency distributions and 95% confidence intervals			
Factors (variables)	**Percentage**	**95%CI**	**Number**
Education completed (n=389)			
None	3.6	2.06 – 6.11	14
Primary	32.90	28.30 – 37.85	128
Junior/Senior Secondary	42.93	37.98 – 48.02	167
Tertiary	20.57	16.73 – 25.00	80
Marital status (n = 402)			
Single	18.91	15.27 – 23.15	76
Separated	1.24	0.46 – 3.05	5
Widowed	0.75	0.19 – 2.35	3
Divorced	1.0	0.32 – 2.71	4
Married	78.11	73.68 – 81.99	314
Residence (n = 401)			
Rural	28.43	24.12 – 33.16	114
Urban	71.57	66.84 – 75.88	287
Employment (n = 390)			
Unemployed	64.87	59.88 – 69.57	253
Employed	35.13	30.43 – 40.12	137
Household monthly income (Maloti) (n = 292)			
Lowest (<M1500)	21.92	17.31 – 27.11	64
Middle (M1500-M6000)	54.45	48.55 – 60.26	159
Highest (>M6000)	23.63	18.88 – 28.93	69
Mother's monthly income (n = 386)			
Lowest (<M1500)	80.05	75.64 – 83.85	309
Middle (M1500-M6000)	14.77	11.46 – 18.79	57
Highest (>M6000)	5.18	3.28 – 8.02	20
Mother height (cm) (n = 394)			
Less than 152	12.44	9.42 – 16.20	49
152 cm and above	87.56	83.80 – 90.58	345
BMI (391)			
Underweight (<23Kg/m^2)	27.88	23.54 – 32.65	109
Normal/Overweight (≥23Kg/m^2)	72.12	67.35 – 76.46	282
ANC visits (391)			
None	1.02	0.33 – 2.78	4
1 – 3	42.97	38.03 – 48.05	168
≥4	56.01	50.93 – 60.97	219
Gestational Age (weeks) (n=390)			
Very Preterm (28 – 34)	16.41	12.95 – 20.55	64
Preterm (35 – 36)	8.97	6.41 – 12.37	35
Term (37 – 42)	73.08	68.33 – 77.36	285
Post term (>42)	1.54	0.63 – 3.49	6

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Factors (variables)	Percentage	95%CI	Number
Birth interval (months) (n=222)			
Less than 24	3.15	1.28 – 6.39	7
(24 - 48)	52.25	45.46 – 58.98	116
(>48)	44.59	37.94 – 51.39	99
Parity (n=398)			
Primiparity (1)	44.47	39.54 – 49.51	177
2 – 4	52.01	46.98 -57.00	207
Multiparity >4	3.52	2.01 – 5.97	14
HIV Status (n=396)			
Positive	31.31	26.82 – 36.17	124
Negative	68.69	63.83 – 73.18	272
Use of HAART (n=118)			
Not on HAART	7.63	3.55 – 13.99	9
On HAART	92.37	86.01 – 96,45	109
GA for commencing HAART (weeks) (n=67)			
1st Trimester	30.30	20.56 – 43.84	20
2nd Trimester	34.85	23.15 – 46.94	23
3rd Trimester	34.85	23.15 – 46.94	23
History of bleeding during pregnancy (n=391)			
Yes (Bled)	11.25	8.38 – 14.91	44
No (No Bleeding)	88.75	85.09 – 91.62	347
Hypertension (n=393)			
Yes	21.88	17.96 – 26.37	86
No	78.12	73.63 – 82.04	307
Energy Source (n=397)			
Electricity	27.96	23.65 – 32.70	111
Gas	53.65	48.61 -58.62	213
Wood	11.34	8.47 – 14.97	45
Paraffin	7.0	4.82 – 10.15	28
Pay work type (n = 130)			
Low pay work	62.31	53.39 – 70.65	81
Adequate pay work	37.69	29.35 – 46.61	49
Smoking during pregnancy (n=402)			
Yes	0.25	0.01 – 1.60	1
No	99.75	98.40 – 99.99	401
Alcohol intake during pregnancy (n=401)			
Yes	1.25	0.46 – 3.06	5
No	98.75	96.94 – 99.54	396

There was a high marriage rate, high level of unemployment, low personal income and low household income among the respondents with most (76%) having less than 6000 maloti per

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household per month. Bleeding during the pregnancy was high at 11.25% and hypertension was even higher at 21.88%. The prevalence of HIV infection was high among the participants (31.08%), with 7.63% of those infected not receiving HAART.

Most of the participants used a clean source of energy (81.61%). Almost all the participants said they did not smoke or take alcohol during pregnancy. This may be due to social desirability bias where mothers would wish to present themselves as having a healthy lifestyle, especially during pregnancy.

4.4 Correlations with Socioeconomic status (SES)

There was a large positive association between mothers' employment and mothers' income (Spearman's correlation coefficient = 0.6515, $p<0.0001$). There was also a positive relation between education completed and mothers' income (Spearman's correlation coefficient = 0.3041, $p<0.0001$) as well as household income (Spearman's correlation coefficient = 0.3511, $p<0.0001$). Furthermore, there was an expected positive relation between the gestational age and birth weight (Correlation Coefficient = 0.37, $p<0.0000$).

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4.5 Relationship of various exposure factors and LBW

The relationships between maternal sociodemographic, physical factors, reproductive and constitutional factors, and newborn factors versus low birth weight were assessed using relative and absolute bivariate analysis, to ascertain the prevalence ratios and the prevalence differences with their 95% confidence intervals (CIs) respectively, with the results shown in Table 5.

Overall, maternal education, energy source, residence, antenatal visits, gestational age and parity were statistically significant on bivariate analysis. Also statistically significant were HIV status, hypertension, job type, number of deliveries and birth length.

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Table 5: Association of Maternal Sociodemographic, Reproductive, Constitutional and Newborn Factors compared to Low Birth Weight (<2500 grams) via bivariate analysis (n=402)

Factors	Sample size	LBW n (%)	NBW n (%)	PR	95%CI	PD%	95%CI
Age (years)							
Q1 Lowest quartile (15 – 22.5)	110	26 (23.64)	84 (76.36)	1.0			
Q2 Lower quartile (22.6 – 26)	96	15 (15.63)	81(84.38)	0.60	-	8.01	-
Q3 High quartile (26.1 – 31.5)	103	22 (21.36)	81 (78.64)	0.88	-	2.01	-
Q4 Highest quartile (31.6 – 48)	88	27 (30.68)	61 (69.32)	1.43	-	-7.04	-
p-value = 0.11							
Education completed							
<Junior secondary	141	45(31.91)	96 (68.08)	1.80	1.26 – 2.60	14.21	5.15 –23.29
≥ Junior secondary	243	43(17.70)	200 (82.30)				
p-value = **0.001***							
Marital status							
Not currently married	88	25(28.41)	63(71.9)	1.35	0.91 – 2.01	7.37	-3.09 -17.83
Currently married	309	65(21.04)	244(78.96)				
p-value = 0.14							
Residence							
Rural	113	36(31.86)	77(68.14)	1.67	1.16 – 2.40	12.78	3.02 -22.51
Urban	283	54(19.08)	229(80.9)				
p-value = **0.006***							

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Factors	Sample size	LBW n (%)	NBW n (%)	PR	95%CI	PD	95%CI
Employment							
Unemployed	250	55(22)	195(78)	0.87	0.60 – 1.27	-3.19	-12.13 -5.76
Employed	135	34(25.19)	101(74.81)				
p-value = 0.48							
Household income quartile (Maloti)							
Q1Lowest quartile (0-1500)	85	23 (27.06)	62 (72.94)	1.0			
Q2 Lower quartile (1501-2950)	65	17 (26.15)	48 (73.85)	0.95	-	0.91	-
Q3 Higher quartile (2951-6500)	71	15 (22.54)	55 (77.46)	0.74	-	4.52	-
Q4 Highest quartile (6501-3000)	68	11 (16.18)	57 (83.82)	0.52	-	10.88	-
p-value = 0.10							
Mothers' income quartile (Maloti)							
Q1-Q3 Lowest to third (≤1230)	298	71(23.83)	227(76.17)	1.33	0.81 – 2.20	6.39	-3.54 –15.48
Q4 Highest (>1230)	84	15(17.44)	69(82.14)				
p-value = 0.25							
Energy source							
Unclean (Wood/paraffin/coal)	72	31 (43.06)	41(56.94)	2.38	1.67 – 3.38	23.93	12.74 - 37.12
Cleaner energy (Electric/gas)	320	58 (18.13)	262 (81.88)				
p-value = **0.0000***							
Alcohol during pregnancy							
Yes	5	1(20)	4(80)	0.88	0.15 – 5.12	-2.76	-38.07 -32.54
No	391	89(22.76)	302(77.24)				
p-value = 0.88							

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Factors	Sample size	LBW n (%)	NBW n (%)	PR	95%CI	PD	95%CI
Smoking during pregnancy							
Yes	1	0(0)	1(100)	0.00	Undf – Undf	-22.73	-26.85 - 18.6
No	396	90(22.73)	306(77.27)				
p-value = 0.59							
Number of antenatal visits							
0-1	26	10(38.46)	16(61.54)	1.80	1.06 – 3.04	17.07	-2.10 – 36.25
≥2	360	77(21.39)	283(78.61)				
p-value = 0.044*							
Gestational age (weeks)							
Preterm (<37)	95	57(60)	38(40)	5.80	3.98 – 8.45	49.66	39.20 - 60.11
Term (≥37)	290	30(10.34)	260(89.66)				
p-value = **0.0000***							
Parity							
0-1	176	38(21.84)	134(78.16)	1.0			
2-3	182	36(19.78)	146(80.22)	0.87	-	2.06	-
≥4	37	15(40.54)	22(59.6)	2.40	-	-18.7	-
p-value = **0.02***							
Birth interval							
Short (<24months)	6	2(33.33)	4(66.67)	1.46	0.46 – 4.63	10.44	-27.70 - 48.57
Long (≥24month)	214	49(22.90)	165(77.10)				
p-value = 0.42							

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Factors	Sample size	LBW n (%)	NBW n (%)	PR	95%CI	PD	95%CI
MUAC (cm)							
Poorly nourished (<23cm)	41	13(31.71)	28(68.29)	1.45	0.89 – 2.4	9.93	-4.96 – 24.82
Well nourished (≥23cm)	349	76(21.78)	273(78.22)				
p-value = 0.40							
Mothers' height							
Short stature(<152)	47	19(40.43)	28(59.57)	2.03	1.3 – 3.05	20.54	5.89 - 35.20
Normal stature(≥152)	342	58(19.88)	274(80.12)				
p-value = **0.0015***							
Mothers' weight (Kg)							
Highest (>72 – 109)	97	15 (15.46)	82 (84.54)	1.0			
Higher (>64 – 72)	91	19 (20.88)	72(79.12)	1.44	-	-5.42	
Lower (>57 – 64)	100	25(25)	75(75)	1.82	-	-9.54	
Lowest (36 -57)	102	28(27.45)	74(72.55)	2.07	-	-11.99	
p-value = 0.18							
Body Mass Index (Kg/m^2)							
Lower (<23)	108	20(18.52)	88(81.48)	0.79	0.51 – 1.24	-3.35	-13.72- 3.99
Higher (≥23)	278	65(21.87)	213(78.13)				
p-value = 0.30							
HIV Status							
Positive	124	36(29.03)	88(70.97)	1.46	1.01 – 2.11	9.18	-0.13 – 18.49
Negative	267	53(19.85)	214(80.15)				
p-value = **0.04***							

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Factors	Sample size	LBW n (%)	NBW n (%)	PR	95%CI	PD	95%CI
Use of HAART							
No	9	4(44.44)	5(55.56)	1.56	0.71 – 3.44	16	-17.55 -49.56
Yes	109	31(28.44)	78(71.56)				
p-value = 0.25							
GA on HAART initiation							
1st trimester	20	8(40.00)	12(60.00)	1.15	0.59 – 2.24	5.22	-20.29 – 30.72
After 1st trimester	46	16(34.78)	30(65.22)				
p-value = 0.69							
History of bleeding in pregnancy							
Yes	43	13(30.23)	30(69.77)	1.36	0.83 – 2.24	8.08	-6.34 – 22.49
No	343	76(22.16)	267(77.84)				
p-value = 0.24							
History of hypertension in pregnancy							
Yes	85	41(48.24)	44(51.76)	3.04	2.17 – 4.28	32.39	21 - 43.78
No	303	48(15.84)	255(84.16)				
p-value = **0.0000***							
Type of job							
Low pay work (DFW^{0})	79	25(31.65)	54(68.35)	2.22	1.04 – 4.73	17.36	3.18 - 31.54
Adequate pay work	49	7(14.29)	42(85.71)				
(Professional) p-value = **0.03***							

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Factors	Sample size	LBW n (%)	NBW n (%)	PR	95%CI	PD	95%CI
Working hours per day							
Above ILO recommended (>8)	57	11(19.30)	46(80.70)	0.67	0.35 – 1.27	-9.47	-24.06 – 5.12
ILO recommended (≤8)	73	21(28.77)	53(71.23)				
p-value = 0.21							
Number of gestation							
Multiple	14	11(78.58)	3(21.43)	3.85	2.75 - 5.39	58.16	36.28 – 80.02
Singleton	382	78(20.42)	304(79.58)				
p-value = **0000***							
Length of baby (cm)							
Short babies (<46)	75	7(76)	18(24)	6.16	4.47 - 8.48	63.66	53.33-73.98
Normal length babes (≥46)	316	39(12.34)	277(87.66)				
p-value = **0000***							
Sex of baby							
Male	209	52(24.88)	157(75.12)	0.99	0.70 - 1.39	-0.25	-8.75-8.25
Female	191	48(25.13)	143(74.87)p-value = 0.95				

DFW$^{\theta}$ = Domestic and Factory Workers; ILO = International Labour Organization; LBW = Low Birth Weight; ABW = Adequate Birth Weight; PR = Prevalence Ratio; RD% = Risk Difference Percentage; 95%CI = 95% Confidence Interval. Statistical significant factors = Bolded p-values and with asterix (*).

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4.6 Linear Regression Analysis

The result of linear regression analysis of association of low birth weight and numerical variables is shown below in Table 6. Mother's height, ANC visit, gestational age and number of gestations were all statistically significantly associated with low birth weight.

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Table 6: Linear Regression Analysis of numerical variables potentially associated with Low Birth Weight (all numerical variables included)		
Factors	**Regression coefficient**	**P-value**
Mother's height	- 0.17	**0.0007**
ANC Visits	- 0.26	**0.0001***
Gestational Age (weeks)	- 0.61	**0.0001***
Number of Gestation	0.20	**0.0001***
Bolded figure and * = Statistically significant		

4.7 Multivariate Analysis

Multivariate analysis was done using a backward stepwise logistic regression analysis approach with initial insertion of all variables which were statistically significant in bivariate analysis in the first model and then iteratively withdrawing variables which showed no independent statistically significant association before running the next model. The final model is shown in Table 7 and all the other models are shown in appendix 12. Gestational age less than 37 weeks and multiple gestations were very strongly independently associated with low birth weight. Energy source, HIV status, hypertension and job type were also significantly independently associated with low birth weight.

However, maternal education level, urban residence, maternal height, number of ANC visits and parity of mothers, which were all associated with LBW on bivariate analysis were not independently associated with LBW on multivariate analysis.

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Table 7: Final Model: Multivariate Logistic Regression Analysis of the Statistically Significant Factors Associated with Low Birth Weight on bivariate analysis

Factors	**Adjusted Prevalence Ratio**	**95% CI**	**P-value**
Energy Source Unclean vs cleaner energy	6.14	2.72 – 13.85	**0.0000***
Mother's height Short vs normal stature	1.91	0.80 – 4.60	0.1472
Gestational Age (weeks) Preterm vs term	11.64	5.88 – 23.04	**0.0000***
HIV Status Positive vs negative	2.08	1.07 – 4.08	**0.0319***
Hypertension History of Hypertension vs No history of hypertension	3.48	1.70 – 7.11	**0.0006***
Job Type Low pay work vs adequate pay work	2.35	1.08 – 5.10	**0.0303***
Number of Gestation Multiple vs Singleton	26.39	5.29 – 131.75	**0.0001***
Bolded figure and * = Statistically significant			

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CHAPTER FIVE

RESEARCH DISCUSSION AND INTERPRETATION

5.1 Introduction

The discussion commences with commentary on the prevalence of low birth weight. It then proceeds to discuss the statistically significant and unconfounded associations of prematurity, energy source, hypertension, multiple gestation and HIV infection with low birth weight. Thereafter, the variables of mother's stature, mother's education level, residence, ANC visits, parity, mothers age, mid upper arm circumference and BMI (proxies for nutritional status), and birth interval, which were all significantly associated with low birth weight on bivariate analysis, but which all lost their statistical significance in the multivariate analysis, are commented on. Finally, the factors that had no association with low birth weight are discussed, followed by an exposition on the limitations of the study.

5.2 Prevalence of Low Birth Weight

The prevalence of low birth weight has been found to be decreasing globally with prematurity being common in high income countries and intra-uterine growth restriction prominent in the low and middle income countries (UNICEF &WHO, 2004). The prevalence of low birth weight in this study population was very high at 25% making this a very important public health problem in Maseru, as several studies have shown a much higher risk of increased mortality with low birth weight babies (Stoll et al, 2002; Kliegman et al, 2007; Lau et al, 2013). There are also long-term consequences, present throughout the life course of the individual, which are associated with low birthweight, such as, diabetes mellitus, hypertension and neurodevelopmental problems including cognition and attention deficits (Hack et al, 1995; Negrato & Gomes, 2013). The prevalence of low birth weight in this Maseru based study was

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much higher than the Maseru reports from the LDHS 2009 and the LDHS 2014 which gave prevalence rates of 10% and 10.4% respectively (LDHS, 2009:117; LDHS, 2014). The large difference in prevalence in LBW between this study and the LDHS studies could be because they were conducted on a sample representative of births that occurred at all types of facilities (from primary to tertiary), whereas this study was conducted at a tertiary hospital which would probably attract more complicated pregnancies, which in turn would probably result in more LBW babies. A study done at a tertiary hospital in Ethiopia had a LBW prevalence of 17% which was also high and was also attributed to a higher prevalence of complicated pregnancies which resulted in more LBW babies (Zeleke et al, 2012). Studies in South Africa have also shown different rates of low birth weight being recorded by different studies done on the same study population and done at the same time, but using different methodologies. According to a study in South Africa, using the routinely collected summary data by health facilities and using data derived from an audit of individual patient folders, produced differing prevalences of low birth weight of 9% and 16% respectively, for South Africa, both of which figures were way below the value we obtained for a tertiary hospital in Maseru (Berry & Hendricks, 2009). A study from India was conducted on low birth weight in 66 villages in a rural area in West Bengal which showed a high prevalence rate of 29% which was similar to this study (Dasgupta & Bavu, 2011). The high level of low birth weight among the participants in this current study could also be due to increased detection, as they delivered at a facility with weighing scales, which allowed accurate measurement and detection of the babies with true LBW. The lower rates of LBW found in the LDHS 2009 and LDHS 2014 might hence be because measuring scales were not available for those who delivered at home and therefore mothers were asked to estimate the weight of their babies for the survey. Thus some mothers could have wrongly estimated the

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weight of their babies as 'normal' when they were actually 'less than normal', due to both difficulty with estimating accurately, and possibly due to a social desirability effect.

The combination of the prevalence of VLBW and ELBW was approximately 5% which was again above that of the LDHS 2014 for very small babies, which was 3.9% (LDHS, 2014). The VLBW and ELBW babies have been shown to have both more short-term consequences such as increased infection risk and long-term consequences, such as neurological impairment, hypertension and diabetes (Stoll et al, 2002; Negrato & Gomes, 2013).

5.3 Prevalence of prematurity and its association with LBW

The prevalence of prematurity (birth before 36 weeks of gestation) in this study in Maseru was 25% which was higher than average for low income countries. The importance of prematurity to LBW was evident in the high level of correlation between it and LBW in the study, which was 0.37. The global prevalence of prematurity has remained high and has remained static over the years with 12% occurring in low income countries while 9% was seen in high income countries in 2012 and again in 2016 (WHO, 2012; WHO, 2016). Zimbabwe and Malawi had a preterm prevalence of 17% and 18% from the same WHO study, which were both less than that obtained in this study (WHO, 2016). The lower level of prematurity of 12% in the report by the World Health Organization could be because the study was conducted in facilities providing differing levels of care and it could also be due to a heaping effect caused by non-differential misclassification due to the inadequacies in estimation of the gestational age at delivery by mothers during the survey (WHO, 2012).

Prematurity was associated with LBW with a relative risk of 5.8 on bivariate analysis but became very strongly independently associated with LBW on multivariate analysis, with an adjusted prevalence ratio (adjPR) of 11.64 showing that babies delivered before 37 weeks of gestation

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were much more likely to have LBW than those delivered after 37 weeks of gestation. The absolute risk, assessed by the prevalence difference, was 49.7% which shows that half of all low birth weight children can be averted by interventions to prevent prematurity. Several studies have shown a strong linkage and association between low gestational age and low birth weight which is logically expected since the premature babies have had less time in utero to grow, translating into a lower birth weight (Kliegman, et al, 2007; Dasgupta & Basu, 2011; Thomre, et al., 2012).

The high level of prematurity in this study suggests that it is a serious public health challenge in Maseru, as there is high risk of increased neurological complications with higher prevalence of prematurity. Premature babies are exposed to both short- and long-term complications. The short-term or immediate consequences include intracerebral hemorrhage and retinopathy of prematurity, while some of the long-term complications are cerebral palsy, blindness and diminished mental cognitive ability (Kliegman et al, 2007). Prematurity could also lead to high morbidity (such as bronchopulmonary dysplasia) and mortality (Kattahs & Garovic, 2014; Hanke, et al 2015). The high level of premature delivery found could be due to a likely high rate of complicated pregnancies in the study population, evidenced for example by the high level of hypertension in pregnancy (22%) and bleeding complications, because being a tertiary hospital it is likely that complicated cases would be referred to it.

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The implication of this association of prematurity with LBW would be that management of this high level of prematurity will consume a lot of human, financial and material resources of the Department of Health of Maseru District, which already has limited resources. This was shown in a US study by Christiansen et al, 1998 where they showed that prematurity and LBW increases in-patient costs.

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Prematurity ideally needs to be prevented in Maseru to save babies from its short- and long-term complications, such as poor development, as well as to reduce mortality. The prevention would also break the inter-generational cycle of having a previously LBW mother who is at risk for delivering a LBW baby herself (Kramer et al, 1987).

Premature delivery in most cases may not be deferred but its causes such as hypertension in pregnancy may be controlled or medication can be given to mature the lungs of the fetus to reduce mortality and thus improve survival (Repke & Villar, 1991). The presence of cervical incompetence would also need to be referred and treated at the tertiary health facility by competent experts.

5.4 Prevalence of Hypertension and its association with LBW

Hypertension has been known to be one of the causes of adverse outcomes in pregnancy such as preterm birth, intrauterine growth restriction and still birth. This study showed that 22% of the mothers had a history of hypertension during the index pregnancy. A prospective study conducted at Bharati Hospital Pune India among pregnant women showed a prevalence of 8% for hypertensive disease in pregnancy (Sajith et al., 2014). The high prevalence of hypertension in Maseru could again be accounted for by the fact that the facility is a tertiary hospital and constituted a high burden of disease given the adverse outcomes of hypertension as enumerated above.

The association of history of hypertension in pregnancy and low birth weight was shown to be quite strong with an adjPR of 3.48 in the study sample showing a high likelihood of LBW delivery amongst mothers with a history of hypertension. The prevalence difference was also very high at 32% reflecting the excess risk of LBW due to hypertension. This demonstrates that appropriate management of hypertension would translate into a large decrease in LBW. This

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finding is of great public health importance and presents a practicable opportunity for the health services to influence LBW and other morbidities of pregnancy related to hypertension.

Presently hypertension in pregnancy is not preventable as the cause is still unknown. However it has been shown that controlled hypertension, with judicious use of medication, is less likely to result in prematurity and LBW than uncontrolled hypertension (Repke & Villar, 1991). However, incorrect medication provision as well as poor adherence to correct medication could result in poor control of hypertension in pregnancy, and these are challenges which would need to be addressed. Similarly detecting hypertension is in theory simple, but requires several ANC visits to detect it early as it could manifest at any point and the effectiveness of detection during these ANC visits requires availability of functional blood pressure monitoring machines as well as staff adherence to screening guidelines. Finally, severe hypertension in pregnancy has been linked with an increased risk of eclampsia which is associated with higher morbidity and mortality of mothers and fetuses, including the complications of prematurity and LBW as when eclampsia develops the pregnancy usually has to be terminated irrespective of the gestational age and weight of the fetus (Kattahs & Garovic, 2014).

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5.5 Prevalence of multiple gestations and its association with LBW

The prevalence of multiple gestations was 3.5% which was similar to a Nigerian study in a tertiary hospital with a rate of 3.25% (Akaba, et al., 2013). The association of multiple gestations with low birth weight was found to be extremely strongly associated with LBW with an adjPR of 26 showing the high risk of multiple gestations for LBW when compared with singleton deliveries. The absolute difference was 58% indicating the excess risk of LBW among multiple gestations over singleton deliveries. The association of multiple gestations with low birth weight

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has been shown by some studies (Harold, 2007; Kliegman et al, 2007) and is attributed to the limited intrauterine environment and competition for transplacental nutrients by each of the foetuses leading to intra-uterine growth restriction/retardation (IUGR) of the fetuses. Though the rate of multiple gestations is not very large in the study, the management is of high economic impact as they are associated with more complications such as preterm delivery, hypoglycaemia, poor growth, and death. Though multiple gestations are mainly familial and largely unpredicted, early ultrasound study and a family history of multiple gestation would help in preparation for the care of multiple gestation and their complications.

5.6 Prevalence of HIV and its association with LBW

HIV infection among the mothers was found to be very high with a prevalence of 31%. This is higher than the national average amongst all ages of 25%, but is similar to the prevalence among women of reproductive age (15 to 49 years) in Maseru (33%) and Lesotho (30%) (LDHS, 2014). These high rates could be due to a high level of poverty among both the women of reproductive age in the general population and in the study participants, which could expose most of the women to risky behaviours. The high level of HIV infection was also a reflection of the impact of HIV on society as a whole.

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There was a significant association between HIV status and LBW in the multivariate analysis. There was an adjusted relative risk of 2 showing that the HIV positive mothers had twice the risk of having a LBW baby when compared with HIV negative mothers. The absolute risk was 9% which showed the excess risk attributed to HIV in terms of LBW delivery. The high burden of HIV and its effects on newborns include a high risk of intrauterine infection, mother to child transmission of HIV infection during childbirth and HIV transmission through breastfeeding especially when the mother is not on HAART treatment. There is also poor foetal growth with a

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high likelihood of intra uterine growth retardation. Furthermore, a sick HIV infected mother would not be able to nurture her baby optimally because of her illness. These complications needed to be prevented by increased access and use of HAART. However, this current study did not show any association between use of HAART and LBW.

5.7 Prevalence of low paid work and its association with LBW

The prevalence of low paid work was 62% showing that the majority of the mothers had indecent jobs and were of low socio-economic status and had a high level of economic dependence. Low pay work was found to be associated with low birth weight with an adjPR of 2.4. The association is probably due to the lack of adequate nutrition which flows from the low wages which they receive. It could also be due to the majority of low paid jobs being factory and domestic work and these workers in Maseru have to stand for long hours even during pregnancy and in addition they do not usually receive adequate maternity leave benefits. Furthermore, the association could be that those on low pay work had a low level of education and thus received a lower salary. Though education did not show a protective association with LBW in this study, many of the educated mothers would have been unemployed. A study in Mexico City showed no significant association between clerks and professionals with regard to prematurity and LBW (Ceron-Milles et al, 1996). However, the same study showed a positive association of prematurity and LBW with standing long hours at work and with the absence of maternity benefits among workers paid an indecent wage (Ceron-Milles et al, 1996). However, a study done in Pakistan did not show any association between indecent or low paid jobs and low birth weight (Zahar et al, 2012).

The absolute difference was found to be 17% which showed the excess risk of LBW in mothers with low paid work over those with adequate paid work.

Though improving the pay of mothers' salaries might improve the outcome of low birth weight its implementation would be practically very difficult, requiring complex economic and labour

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law changes. However, the health department could advocate for improved salaries for mothers and social grants provided to mothers could lead to improvement in their nutritional state (Chersich, et al, 2016).

5.8 Prevalence of various socio-demographic characteristics and their associations with LBW

Energy source was very strongly associated with low birth weight (adjPR of 6.14), with those using electricity and/or gas (clean energy) to cook being at much less risk than those using paraffin, wood or coal (unclean energy). The absolute effect of unclean source of energy on LBW over clean source of energy was high with prevalent difference of 23.93. A study in Ethiopia showed a significant association between the energy source of cooking and low birth weight (Habtamu et al., 2015). Fortunately, the use of clean energy is quite common in Maseru with 82% of pregnant mothers using a clean source of energy. Maseru is the capital city of Lesotho thus making cleaner sources of energy easily assessable and available. Given the relatively high prevalence of the use of clean energy, energy source is a good proxy for severely adverse socio-economic circumstances in Maseru. This is the case as measuring socio-economic circumstances via income yielded a result of 80% of the mothers falling within a low socio-economic bracket, consequently making the sample very homogenous with regard to socio-economic circumstances and hence making it impossible to assess the effect of socio-economic circumstances on LBW. However, using type of energy source effectively splits the sample into low/moderate (clean energy) and very low socio-economic circumstances (unclean energy), allowing the effect of very low socio-economic circumstances to be assessed by proxy. It is of course not a perfect proxy for a socio-economic effect, as the air pollution caused by unclean energy sources might independently of socio-economic circumstance, affect LBW (Demelash, et al., 2015).

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Although providing clean energy sources to pregnant women without it could be a good way of reducing LBW, it would only reduce LBW by the degree to which LBW is affected by the air polluting effect of unclean energy sources. Counteracting the socio-economic circumstances of those pregnant women who are using unclean energy sources is a more complex proposition, but providing a social grant to cover basic income sufficient for adequate maternal nutrition would positively impact on LBW, as noted by Chersich et al. (2016) in a recent systematic review of pregnancy support programmes. Mothers using unclean sources of energy could cook outside their homes if they cannot afford to use cleaner sources of energy. There could be awareness on the adverse effect of unclean energy through public media houses, at public gatherings or during health education in health facilities.

More than four-fifths of the maternal study populations were aged between 18 and 35 years which is the acceptable safest age range for delivery. Less than 3% were under 18 years of age and 11% were more than 35 years of age. This is quite different from the age distribution in the Lesotho Demographic and Health Survey (LDHS, 2014) where the group aged between 18 and 35 years at delivery was just slightly over 50% of the study population (LDHS, 2014).

The age of the mothers was not found to be associated with low birth weight when the age was divided into quartiles. Age was not found to be associated with low birth weight in an Indian study when age was classified as those less than 20 years and those 20 years and above (Dasgupta and Basu, 2011). However, another study in India found a statistically significant association between age of mothers (less than 19 years and 19 years and above) and LBW, but they only assessed it using bivariate analysis (Thomre et al, 2012).

The study population had 43% of mothers who had completed their secondary education and 21% with tertiary education, suggesting a fairly well educated group. However a minority (less

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than 4%), had no education. The distribution was quite dissimilar to the LDHS 2014 with secondary, tertiary and no education groups constituting 59%, 6% and 3% respectively. Thus women who accessed the tertiary hospital in this study were better educated than pregnant women in general in Lesotho. This could be due to their higher education level allowing them to better negotiate access to tertiary care.

There was an initial statistically significant association between the level of mothers' education and low birth weight on bivariate analysis, but this association was not present on multivariate logistic regression analysis. A study in Nigeria also found no association with educational level and LBW (Awoleke, 2012). However, a study in India showed a significant association between maternal education and LBW (Dasgupta & Basu, 2011). The non-association found in our current study could be due to the high level of antenatal visits among mothers who delivered in the study center, as health education was provided to them during the antenatal visits.

The majority of the participants were married (78%) which suggested a stable social structure or could indicate that culturally it was unusual for women to give birth out of wedlock. Those who were either separated or divorced accounted for less than 3% of the population, reinforcing the view that marriage is a culturally desired state for young women and that they seldom terminate it. The distribution was slightly different from that of LDHS 2014 where those who were single (33%) had higher representation despite the married (54%) being the majority of the study population (LDHS, 2014).

The majority of the participants were living in an urban area (72%) which was different from the LDHS 2014 where rural dwellers (64%) outnumbered the urban dwellers (36.5%). The higher representation of urban dwellers in this study may be due to the location of the hospital in the urban area, with a predominantly urban catchment population.

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The study showed no association between rural dwellers and low birth weight when compared with urban dwellers. There was no association of residence with LBW by another study in India (Thomre et al, 2012). However, a study in South East Ethiopia showed a significant association between residence and low birth weight (Demelash et al., 2015).

The majority of the women who delivered in the study were unemployed (65%). This was similar to the finding in the LDHS 2014 where 62% of the participants were unemployed (LDHS, 2014). However, 55% of the study participants were from middle income households, suggesting that their partners have a higher employment prevalence, which provides the majority of them with some level of support and food security. This also shows a high level of dependence of the mothers on the household income. The majority being of middle income could account for their better negotiation of health care at the tertiary hospital.

Marital status did not show any association with low birth weight but a North Carolina study showed a significant association between marital status and LBW, with unmarried women having a higher risk of LBW babies than married women (Wood, 1997). A Virginia study further showed an association between unmarried women and preterm LBW as well as term LBW babies (Masho et al, 2010).

There was no statistically significant difference between those employed and those not employed in the prevalence of low birth weight. A study by Thomre, et al. also did not show any association with LBW. The majority of the participants were unemployed making employment status a poor measure of socioeconomic status in this group.

Household and maternal incomes were both not associated with low birth weight in this study. However, a study showed a strong association between social status based on income and LBW (AOR=5.2, 95%CI= 2.21-12.2) in India (Thomre et al, 2012). The non-association of incomes

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and LBW in this study could be because incomes were quite homogenous with only small differences between the lowest and highest income quartiles, making it difficult to assess any actual effect of income on LBW.

The effect of alcohol and smoking with low birth weight could not be validly assessed due to the low reported prevalence of both of these in this study, with alcohol and smoking prevalence being 1% and <1% respectively. A study in the District of Columbia in the USA showed that 8% of pregnant women had smoked one time in their pregnancy (Curtin & Mathews, 2014). A retrospective multicenter cohort study which was done in the USA from 1984 to 1989 had shown that more than half (52%) of pregnant women had taken alcohol during pregnancy (Shiono et al, 1995). Several studies have shown that alcohol and smoking in pregnancy are associated with low birth weight (Martin & Bracken, 1986; Deshmukh et al., 1998; Blake et al., 2000; Jaddoe et al., 2007). The low prevalence of smoking and alcohol intake during pregnancy could be because of a social desirability effect where most of the respondents could have denied smoking and alcohol intake in pregnancy, so as to be seen to have conformed to acceptable level of social responsibility. Another reason for the very low prevalence could be that smoking is actually not a common habit among women in Lesotho, especially when pregnant. There is still continued need for constant health education on the adverse effects of alcohol and smoking among pregnant women in Maseru so as to prevent their potential consequences on birth outcome including LBW.

5.9 Prevalence of maternal factors (mothers' height, ANC visits and parity) associated with LBW on bivariate but not on multivariate analysis

The prevalence of mothers with height less than 152cm was 12.4%. Mothers' height showed an association with low birth weight on bivariate analysis with PR of 2 and absolute difference of 21%. However, this association was lost on multivariate analysis in this study. Maternal height

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was also not found to be associated with LBW in studies conducted in Lagos, Nigeria and Miraj, India (Awoleke, 2012; Thomre et al., 2012). This lack of association could be due to the relative homogeneity of the height of the participants in the study group.

The number of antenatal care visits was not independently associated with LBW. Several studies have however shown an association between the number of antenatal visits and low birth weight (Thomre et al, 2012; Zahar et al, 2012). The loss in association between ANC visits and LBW could be because almost all the mothers in the study group attended antenatal care fairly frequently with an average of 3.7 visits, which then possibly obscured the effect of a lack of antenatal visits.

There was no independent association between parity and low birth weight. Similarly, a systematic review on the effect of different parities on low birth weight showed no association between multiparity and low birth weight (Shah, 2010). The long birth intervals between pregnancies, at an average of 5 years, could have contributed to the lack of effect of parity on LBW.

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5.10 Prevalence of various maternal factors (HAART, underweight, bleeding in pregnancy, MUAC, maternal weight, BMI, birth interval) that had no association with LBW

Malnutrition has been a common problem seen among pregnant women in low income countries (Okwu et al, 2007). This study showed that 28% of the women were underweight which is a proxy for malnutrition. In the LDHS 2014 only 4% of women of child bearing age were underweight. However, the survey used women who were not pregnant (LDHS, 2014). A cross-sectional study from Tanzania done among women of reproductive age showed a prevalence of 11% for under-nutrition (Mtumwa et al, 2016). The high level of underweight in the Maseru study could be due to the high level of unemployment and low income among the pregnant women and the low income levels in some of their households.

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The use of HAART was not associated with LBW in this study. The use of HAART especially during pregnancy has increased over the years. Lesotho has the policy of enrolling everyone that tests positive for HIV on HAART otherwise known as 'Test and Treat' (Lesotho National Guidelines for HIV & AIDS Care and Treatment, 2016). The study showed that the majority of HIV positive mothers (85%) were on HAART during pregnancy. About a third (30.3%) and two-third (69.7%) of those who commenced HAART during pregnancy did that in the first and second trimesters respectively. A study in Lesotho showed that 50% of mothers that were HIV positive started HAART (Option B+) in their first trimester (McDougal et al, 2012). Option B+ means that the pregnant women were started on lifelong HAART after being tested positive for HIV. The later commencement of HAART in this present study could be due to health system delays in providing HAART to the expectant mothers, or it could also be due to stock outs of medications. Furthermore, some pregnant women could present late in pregnancy for their first antenatal visit, or they could delay their decision making on whether to commence HAART, especially due to the fear of disclosure to partners and relatives. The lack of association could therefore be because those on HAART are quite similar to those not on HAART due to the short duration of time they have been on HAART. Moreover, a recent study showed that HIV status is losing its effect on low birth weight because of increased use of HAART (Schulte et al, 2007). In the study by Schulte et al., LBW among HIV-exposed infants reduced from 35% to 21% over the time period from 1989 to 2004.

Bleeding in pregnancy in the study was not shown to be significantly associated with low birth weight. The absence of statistical significance could be due to the high level of ANC visits in this study population which could have led to early detection and prompt intervention for the bleeding in pregnancy. Other facilities referring their patients to the referral hospitals due to

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bleeding could also have commenced early management of the bleeding before referral to the study center. This did not agree with the findings seen in another study in Nigeria which showed a significant association between bleeding in pregnancy and low birth weight (Awoleke, 2012). Mid upper arm circumference (MUAC) did not show any association with birth weight in the study, however a recent study in Ethiopia found a statistically significant association between MUAC and low birth weight (Demelash et al., 2015). The lack of association in this study might be because most of the mothers had a MUAC of greater than 23 cm after delivery, with very few being less than 23 centimeters.

Mothers' weight did not show any statistically significant risk of low birth weight in the study, but an Indian study showed an association of low maternal weight with low birth weight (Thomre et al., 2012).

The body mass index (BMI) of mothers was not found to be significantly associated with low birth weight and this finding was also noticed in a study conducted in Oklahoma City in the USA, where BMI was not found to be associated with low birth weight (Hull et al., 2008). However, an earlier study in Nagpur demonstrated a significant association between BMI and low birth weight (Deshmukh et al., 1998).

Birth interval was not associated with low birth weight. A similar study conducted in Khartoum Sudan, however, showed a statistically significant association between short inter-pregnancy intervals and low birth weight, when comparing those with a birth interval less than 18 months with those 18 months and above (Adam et al., 2009). Another study showed a statistically significant association between birth interval and LBW with increased risks at extremes of birth intervals of <18 months (OR=1.5) and 96-136 (1.5) months, when compared with a birth interval of 18-24 months, giving a J-shaped association (Zhu & Le, 2003). The absence of association in

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this study population could be because only very few of them had a birth interval less than 2years with the average being 5 years. The presence of low parity in the study population could have encouraged longer birth intervals, or vice versa, among the study participants.

5.11 Association of the gender of child with LBW

There was no association with low birth weight between male and female babies. However, a study in India showed an association even after correcting for confounding using multiple regression analysis, with females being more likely to be LBW than male babies (Thomre et al., 2012). Another study in Nigeria also showed females being more likely to have LBW than males (Isiugo-Abanihe, 2011).

5.12 Limitations of the Study

This study attempted to determine the true prevalence of LBW in Maseru. However, the birth weight of newborns delivered at home and that of residents who deliver elsewhere than in Maseru, were unable to be included in this study, due to cost and logistic complexities. The exclusion of those who deliver at home would probably underestimate the prevalence of LBW found in this study, as those who deliver at home are more likely to have LBW due to their lower socio-economic status. However, the exclusion of those who delivered outside of Maseru would probably result in an overestimate of the prevalence of LBW found in this study, as those who deliver elsewhere (usually South Africa) are more likely to have a higher socio-economic profile, and hence are less likely to have LBW. Similarly, the exclusion of those who deliver at a private facility would probably result in an overestimate of the prevalence of LBW found in this study. Refusal to participate in the study although potentially a limitation due to selection bias, had no appreciable effect on the study as less than 1% of the sample refused to participate in the study. Despite the efforts taken to ensure accurate and precise direct measurements, the inherent possibility of errors creeping in, due to different observers being used to measure the weight and

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height of the babies and height, weight and mid upper arm circumference of the mothers, would due to non-differential misclassification, have pushed any association towards the null effect. The causal effect of some of the variables could not be determined due to the absence of a temporal relationship in this cross-sectional study design. Such variables included HIV status, bleeding and employment. If mothers became HIV positive late in the pregnancy, then the period of infectivity would be too short to affect the weight of the newborn infants. Some bleeding could have just occurred around the perinatal period which could be too short a period to have an effect on low birth weight. Some of the mothers could have been recently employed or lost their job around the perinatal period; hence their current employment status would be too short a duration to affect the birth weight. There could have been some measurement error in the gestational age assessment, but care was taken to reduce it by crosschecking the date of the last menstrual period with an ultra sound estimation of gestational age when possible. BMI was used as a proxy estimation of maternal nutritional status, but it might be too coarse a measure of nutritional status to detect any nutritional effect on LBW. The effect of CD4 count on LBW was intended to be assessed, but its measurement was restrained by financial and logistic constraints. It could not be ascertained if hypertensive participants' blood pressures were controlled or not during pregnancy, hence the effect of adequately treated hypertension versus inadequately treated hypertension on LBW could not be assessed. Screening for the effect of syphilis and other common infections such as toxoplasmosis, rubella, cytomegalovirus and herpes simplex could not be done due to financial, time and logistic constraints.

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CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The prevalence of low birth weight in a tertiary public sector hospital in Maseru was shown to be high at 25% constituting a serious public health concern. This study showed that there were several preventable and/or controllable maternal reproductive and physical factors which were associated with low birth weight, among the participants in the study population. These modifiable factors associated with low birth weight were prematurity, unclean source of energy, maternal HIV infection and hypertension in pregnancy. Although multiple gestations (twins and triplets) were found to be associated with low birth weight, unfortunately little can be done to mitigate their effect on LBW. Similarly, although low paid work (indecent jobs), was positively associated with LBW, it is unlikely that the health department could mitigate this deeply entrenched socio-economic factor, although other departments such as social services could assist via social grants.

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6.2 Recommendations

Mothers using unclean sources of energy should be taught of ways of reducing the adverse effects of unclean sources of energy such as cooking outside their homes, if they cannot afford the use of cleaner sources of energy. This can be done through the use of public media houses, at public gatherings or during health education in health facilities.

The ministry of health should strengthen antenatal care programmes to enhance early detection and effective treatment of hypertension during pregnancy.

The test-and-treat programme for HIV testing and then treatment when pregnant women are found to have tested positive, should be implemented in every health facility in Lesotho.

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Health workers should promptly treat any complication occurring during pregnancy which could result in preterm birth, such as infections (chorioamnionitis), obstetric haemorrhage (placental previae and placenta abruptio) and cervical incompetence.

The ministry of health could advocate for a minimum wage to empower pregnant women to improve their nutrition and have increased access to cleaner sources of energy.

The provision of a state funded social grant to pregnant women with low income would additionally be beneficial.

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APPENDICES

APPENDIX 1: SEQUELAE OF LOW BIRTH WEIGHT

Shown below are a list of the typical "Sequelae of Low Birth Weight" and a detailed list of specific Neonatal Problems occurring amongst Premature Infants.

IMMEDIATE	LATE
Hypoxia, ischemia	Mental retardation, spastic diplegia, microcephaly, seizures, poor school performance
Intraventricular hemorrhage	Mental retardation, spasticity, seizures, hydrocephalus
Sensorineural injury	Hearing, visual impairment, retinopathy of prematurity, strabismus, myopia
Respiratory failure	Bronchopulmonary dysplasia, cor pulmonale, bronchospasm, malnutrition, subglottic stenosis, iatrogenic cleft palate, recurrent pneumonia
Necrotizing enterocolitis	Short-bowel syndrome, malabsorption, malnutrition, infectious diarrhea
Cholestatic liver disease	Cirrhosis, hepatic failure, hepatic carcinoma, malnutrition
Nutrient deficiency	Osteopenia, fractures, anemia, vitamin E, growth failure
Social stress	Child abuse or neglect, failure to thrive, divorce
Other	Sudden infant death syndrome, infections, inguinal hernia, cutaneous scars (chest tube, patent ductus arteriosus ligation, intravenous infiltration), gastroesophageal reflux, hypertension, craniosynostosis, cholelithiasis, nephrocalcinosis, cutaneous hemangiomas

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Neonatal Problems occurring amongst Premature Infants

Respiratory
Respiratory distress syndrome (hyaline membrane disease)[*] Bronchopulmonary dysplasia Pneumothorax, pneumomediastinum; interstitial emphysema Congenital pneumonia Pulmonary hypoplasia Pulmonary hemorrhage Apnea[*]
Cardiovascular
Patent ductus arteriosus[*] Hypotension Hypertension Bradycardia (with apnea)[*] Congenital malformations
Hematologic
Anemia (early or late onset) Subcutaneous, organ (liver, cranial, adrenal) hemorrhage[*]

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Disseminated intravascular coagulopathy Vitamin K deficiency Hydrops—immune or nonimmune
Gastrointestinal
Poor gastrointestinal function—poor motility[*] Necrotizing enterocolitis Hyperbilirubinemia—direct and indirect[*] Congenital anomalies producing polyhydramnios Spontaneous gastrointestinal isolated perforation
Metabolic-Endocrine
Hypocalcemia[*] Hypoglycemia[*] Hyperglycemia[*] Late metabolic acidosis Hypothermia[*] Euthyroid but low-thyroxine status

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Central Nervous System
Intraventricular hemorrhage[*]
Periventricular leukomalacia
Hypoxic-ischemic encephalopathy
Seizures
Retinopathy of prematurity
Deafness
Hypotonia[*]
Congenital malformations
Kernicterus (bilirubin encephalopathy)
Drug (narcotic) withdrawal

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Renal
Hyponatremia[*] Hypernatremia[*] Hyperkalemia[*] Renal tubular acidosis Renal glycosuria Edema
Other
Infections[*] (congenital, perinatal, nosocomial: bacterial, viral, fungal, protozoal)[*] Common.

* Common.

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APPENDIX 2: QUESTIONNAIRE

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Private Bag X 17, Bellville 7535, South Africa

Tel: +27 21-959 2809 Fax: 27 21-959 2872

E-mail: soph-comm@uwc.ac.za

QUESTIONNAIRE

Topic: Prevalence and Determinants of Low Birth Weight in Maseru Lesotho

(PLEASE TICK 'X' OR '√'IN THE APPROPRIATE BOX THAT BEST FITS YOUR ANSWER. YOU SHOULD ALSO FILL IN THE DOTTED BLANK SPACE)

Section A: Demographic Factors

1. Serial/Code number……………………………………….
2. Age of mother in years ……………………………………….
3. Birth date of the mother……………………………….
4. Marital Status : Single ☐ Married ☐ Widowed ☐ Separated ☐ Divorced ☐
5. Mother's highest level of education completed: ………………………………………….
6. Residence of the mother Urban ☐ Rural ☐
7. Is the mother employed? Yes ☐ No ☐

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8. Household (Family) income per month in Maloti (Rand)…………………………………

9. Mother's income per month in Maloti (Rand).……………………………………………

Section B: Social and Environmental Factors

10. Any smoking during pregnancy? Yes ☐ No ☐

10. b If Yes, How many packs per week?...

11. Any alcohol intake during pregnancy? Yes ☐ No ☐

11.b If Yes, how many bottles per week? ....

12. What is source of energy for cooking?

Electricity ☐ Gas ☐ Wood ☐

Coal ☐ Others ☐ (please specify)…………

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Section C: Maternal Factors

13. How many ante-natal visits did you attend during pregnancy? …………………………

14. Gestational age of index pregnancy in weeks ……………………………………..

15. Date of Last Menstrual Period…………………………………………………….

16. Date of Delivery……………………………………………………………………

17. How many times have you been pregnant (including present delivery) …………………

18. How old is your last child (birth interval)…………………………………………………

19. When last where you pregnant (birth interval) ……………………………………………

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20. Mother's height (cm) ……………………………………………………………………..

21. Mother's body weight (kg) …………………………………………………………

22. Mother's left mid upper arm circumference (cm)………………………………………

23. Mother's Body mass index (BMI) to be calculated by the researcher……………………

Section D: Medical Factors

24. Maternal HIV Status: Positive ☐ Negative ☐ Unknown ☐

25. If positive, is the mother on HEART/ART? Yes ☐ No ☐

26. How many weeks was the pregnancy when ART/HEART was commenced?

(Weeks).......................

27. History of bleeding during pregnancy? Yes ☐ No ☐

28. History of hypertension in pregnancy Yes ☐ No ☐

Section E: Physical stress:

29. If mother is employed, what type of work/job does she have? ....

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30. How many hours does she work in a day? ....

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31. What time does her work start? ....

32. What time does her work end? ....

Section F: Newborn:

33. What is the sex/gender of the baby? Male ☐ Female ☐

34. What is the birth weight of the baby in grams? ………………………………………

35. What is the birth length of the baby in centimetres? ....

36. Is the child alive or stillborn? ....

37. How many babies were born in this current delivery? ..……………………………

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APPENDIX 3: INFORMATION SHEET

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa

Tel: +27 21-959 2809 Fax: 27 21-959 2872

E-mail: soph-comm@uwc.ac.za

INFORMATION SHEET

Project Title: Prevalence and Determinants of Low Birth Weight in Maseru Lesotho

UNIVERSITY of the WESTERN CAPE

This is a research project being conducted by me, Azubuike Benjamin Nwako, at the University of the Western Cape. We are inviting you with your baby to participate in this research project because your baby and you meet the requirements for this study.

The purpose of this research project is to determine the seriousness of low birth weight and identify its potential risk factors in Maseru. This will help in better management of pregnant mothers and future health planning to reduce levels of low birth weight in Maseru.

You will be asked to answer some questions. Your weight will be measured with a weighing scale while you wear light clothing. Your height and arm will also be measured using a measuring tape. Your baby's weight and length will also be gently and carefully measured while

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naked by using weighing scale and measuring tape respectively. The sex of your baby will be determined by physical examination. The procedures will take place in the postnatal ward of this hospital here in Maseru. The duration of your participation will be about 25 minutes.

The questions that you will be asked include your age, date of birth, marital status, residence, employment status, income level, smoking habit, alcohol intake and source of fuel for energy. Others are last menstrual period, duration of pregnancy, age of last child, number of pregnancies, maternal HIV status, bleeding and hypertension in pregnancy. Furthermore, your type of job and duration of work per day will be asked.

The researchers undertake to protect your identity and the nature of your contribution.

To ensure your confidentiality, your names or your other identifying data will not be collected and all information obtained will be kept secure in a code protected computer database and will only be accessible to the research assistants, the researcher and the thesis supervisor.

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If we write a report or article about this research project, your identity will be protected.

There may be some risks from participating in this research study. All human interactions and talking about self or others carry some amount of risks. We will nevertheless minimise such risks and act promptly to assist you or your baby if you or your baby experience any discomfort, psychological or otherwise during the process of your participation in this study. Where necessary, an appropriate referral will be made to a suitable professional for further assistance or intervention.

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This research is not designed to help you personally, but the results may help the investigator learn more about low birth weight in Maseru. We hope that, in the future, other people might benefit from this study through improved understanding of the burden of low birth weight and its potential risk factors. It will help health services providers in the design of preventive services to address low birth weight. It will also help the advocacy groups to use information and evidence from the research in their campaign against some of the identified risk factors.

Your participation in this research is completely voluntary. You may choose not to take part at all. If you decide to participate in this research, you may stop participating at any time. If you decide not to participate in this study or if you stop participating at any time, you will not be penalized or lose any benefits to which you otherwise qualify.

This research is being conducted by Azubuike Benjamin Nwako of School of Public Health at the University of the Western Cape. If you have any questions about the research study itself, please contact Azubuike Benjamin at Flat 16 Lesedi Flats, +266 59813379, drabnwakomba@yahoo.com

Should you have any questions regarding this study and your rights as a research participant or if you wish to report any problems you have experienced related to the study, please contact:

Prof Helen Schneider

School of Public Health

Head of Department

UNIVERSITY of the
WESTERN CAPE

http://etd.uwc.ac.za/

University of the Western Cape

Private Bag X17, Bellville 7535

soph-comm@uwc.ac.za

Prof José Frantz

Dean of the Faculty of Community and Health Sciences

University of the Western Cape

Private Bag X17, Bellville 7535

chs-deansoffice@uwc.ac.za

This research has been approved by the University of the Western Cape's Senate Research Committee. REFERENCE NUMBER: ..15/7/9..

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APPENDIX 4: CONSENT FORM

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa

Tel: +27 21-959 2809 Fax: 27 21-959 2872

E-mail: soph-comm@uwc.ac.za

CONSENT FORM

Title of Research Project: Prevalence and Determinants of Low Birth Weight in Maseru Lesotho

UNIVERSITY of the WESTERN CAPE

The study has been described to me in language that I understand. My questions about the study have been answered. I understand what my participation will involve and I agree to participate of my own choice and free will. I understand that my identity will not be disclosed to anyone. I understand that I may withdraw from the study at any time without giving a reason and without fear of negative consequences or loss of benefits.

Participant's name…………………………….

Participant's signature………………………..

Date……………………………………….........

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APPENDIX 5: QUESTIONNAIRE SESOTHO VERSION

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa

Tel: +27 21-959 2809 Fax: 27 21-959 2872

E-mail: soph-comm@uwc.ac.za

LIPOTSO TSA LIPHUPUTSO

UNIVERSITY of the WESTERN CAPE

SEHLOOHO: Liphuputso mabapi le se bakang hore masea a hlahe a ena le boima bo tlaase ba ’mele Maseru, Lesotho.

(Tšoaea ‘x’ kapa ‘√’ ka har’a lebokosana le lokelang karabo ea hau. Ngola likarabo tse ling meleng e fanoeng ka pele ho lipotso)

KAROLOANA EA ‘A’: Lintlha tse amanang le uena u le motho

1. Nomoro ea cliniki………………………..
2. Lilemo tsa ‘mé……………………………..
3. Letsatsi la tlhaho la ’mé…………/…………../…………….

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4. Boemo ba lenyalo: Ha u oa nyaloa ☐ U nyetsoe ☐ U mohlolohali ☐

Le arohane ☐ U hlaluoe ☐

5. Lengolo la hau la ho qetela la thuto:……………………………………………………………

6. Sebaka seo u phelang ho sona: Mabalane ☐ Loting ☐

a) Ua sebetsa? Eee ☐ Chee ☐

b) U hiriloe kapa oa itšebetsa? Eee ☐ Chee ☐

7. Na 'M'e oa sebetsa?

8. Moputso oo u o amohelang ka khoeli (Maloti / Rand)…………………………………….

9. Chelete e kenang ka hare ho lelapa ka khoeli (Maloti / Rand)……………………….

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KAROLO EA 'B': Lintlha tse amanang le bophelo ba batho 'moho le tikoloho

10. Na u ne u tsuba nakong ea bokhachane? Eee ☐ Chee ☐

a) (haeba karabo e le ee) u ne u tsuba lipaketjana tse kae ka beke? ……………………

11. Na u ne u noa joala nakong ea bokhachane? Eee ☐ Chee ☐

11.b (haeba karabo e le ee) u ne u noa joala bo bo kae ka beke? ....

12. U sebelisa eng sebakeng sa ho apeha? Motlakase ☐ Khase ☐

Patsi ☐ Mashal ☐ Lintho tse ling *(hlalosa)*………….

KAROLO EA 'C': Lintlha tse amanang le bophelo ba 'mé le lesea

13. U ile cliniking makhetlo a makae nakong ea bokhachane? ………………………………

14. U ne u le libeke li kae u le mokhachane ha u pepa? …………………………………………

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15. U qetetse ho ea matsatsing neng? …………………………………………………………

16. U pepile neng (*hlalosa letsatsi le khoeli*)? ………………………………………………

17. U bile mokhachane makhetlo a makae, re balella le lekhetlo lee la hona joale? ………………

18. Ngoana oa hau oa ho qetela o nako e kae? …………………………………………………

19. U qetetse ho ba mokhachane neng? ....

20. Bolelele ba ‘mé ke linoko tse kae (cm)…………………………………………………….

21. Boima ba ‘mele ba ‘mé (kg)………………………………………………………………..

22. Botenya ba sephaka sa ‘mé (cm)…………………………………………………………..

23. Boima ba ‘mele ba ‘mé ho ipapisitsoe le bolele (BMI)………………………………………

KAROLO EA ‘D’: Lintlha tse amanang le kalafo

24. Boemo ba tšoaetso ea HIV nakong ea bokhachane: Tšoaetso e teng ☐
Tšoaetso ha e eo ☐
Ha ke tsebe ☐

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25. Ebang u e na le tšoaetso ea HIV, na u tsamaea litšebeletso? Eee ☐ Chee ☐

26. U qalile ho noa litlhare tse kokobetsang HIV neng? ....

a) Ebang u li qalile u se u le mokhachane, u ne u le libeke li kae? ....

27. Na u bile le bothatha ba ho ea matsatsing nakong ea bokhachane? Eee ☐ Chee ☐

28. Na u ne u ena le phallo e phahameng ea mali nakong ea bokhachane? Eee ☐ Chee ☐

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KAROLO EA 'E': Lintlha tse amanang le khatello ea maikutlo e bakoang ke ho sebetsa ka thata

29. Haeba u hiriloe, u etsa mosebetsi oa mofuta ofe? ....
30. 0U sebetsa lihora tse kae ka letsatsi? ....
31. U qala mosebetsi ka nako efe? ....
32. U qetela ho sebetsa ka nako efe? ....

KAROLO EA 'F': Lintlha tse amanang le lesea

(Tlatsa karolo ena ha fela eba lesea le hlahile le phela)

33. Lesea ke ngoanana kapa moshanyana? Moshanyana ☐ Ngoanana ☐
34. Boima ba lesea ba tlhaho (g)……………………………………………………………………
35. Bolelele ba lesea ba tlhaho (cm)……………………………………………………
36. Ngoana oa phela kappa u hlahile a hlokahetse?……………………………………………………
37. Bokhachaneng bo u pepile bana ba bakae? …………………………………………………

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APPENDIX 6: INFORMATION SHEET SESOTHO VERSION

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa

Tel: +27 21-959 2809 Fax: 27 21-959 2872

E-mail: soph-comm@uwc.ac.za

Sehlooho - Liphuputso mabapi le se bakang hore masea a hlahe a ena le boima bo tlaase ba 'mele Maseru, Lesotho.

Lipatlisiso tsena li etsoa ke 'na Azubuike Benjamin Nwako, Univesiting ea Western Cape. Re mema oena le lesea la hao ho nka karolo lipatlisisong tsena hobane oena le lesea la hao le na le tšusumetso liphuputsong tsena. Morero oa liphuputso tsena ke ho hlokomela ka tieo mabaka a etsang hore bana ba hlahe ka boima bo tlaase hakana le kotsi e bakoang ke sena seterekeng sa Maseru. Sena se tla thusa tsamaisong ea basali ba bakhachane nakong e tlang ho theola lenane la masea a hlahang a le ka tlase ho boima bo lebeletsoeng.

U tla koptjoa ho araba lipotso tse itseng. U tla nkoa boima, u apere liphahlo tse bobebe. Bolelele ba matsoho a hao le bona bo tla nkuoa ho sebelisoa tape (measuring tape). Ngoan'a hao le eena o tla nkoa boima 'moho le bolelele ho sebelisoa sekala le eona tape (measuring tape) a hlobotse liaparo ka hloko eohle. Botona kapa botšehali ba ngoana le bona bo tla shejoa. Lihlahlobo tsena li tla etsetsoa sepetlele Maseru sebakeng se khethehileng se raletsoeng mofuta ona oa litlhatlhobo. Tlhatlhobo ena e ka nka nako ea metsotso e mashome a mabeli a metso e mehlano.

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Lipotso tse tla botsoa li akarelletsa lilemo, letsatsi la tsoalo, hore na u nyetsoe kapa chee, sebaka sa bolulo, mosebetsi, chelete eo u e amohelang, maemo a ho tsuba, maemo a ho noa joala le seo u se sebelisang sebakeng sa ho pheha. Tse ling li kenyeletsa letsatsi la ho qetela la ho bona matsatsi a hao, u se u le mokhachane oa nako e kae, ngoan'a hao oa ho fela o lemo li kae, u bile mokhachane makhetlo a makae, u na le tšoaetso ea HIV na, na u na le phallo ea mali e phahameng u bile u le mokhachane. Hape u tlo botsoa hore na mofuta oa mosebetsi oa hao ke ofe, u sebetsa nako e kae ka letsatsi.

Ba liphuputso ba tlilo etsa bo'nete ba hore ba ke ke ba hlahisa lebitso la hao le ka moo u ba phehisitseng ka teng. Tsena tsohle e tla ba lekunutu la bona. Ho tiisa taba ena, lebitso la hao ha le na ho botsoa 'me le litaba tseo u tla phehisa ka tsona li tla bolokoa ka thata comporong (computer) li koalloe ka thata ka senotlolo, moo li tla fumanoa feela ke mofuputsi le ea mo tšoaeang.

Haeba re ngola tlaleho ka liphuputso tsena, boleng ba hao bo tla sireletsoa ka hoohle. Ho ka nna ha eba le kotsi ho nkeng karolo liphuputsong tsena. Ho botsaneng lipotso ka motho ho ka ba kotsi. Re tla etsa ka hohle ho fokotsa lintlha tse ka bakelang 'me le ngoana kotsi ka hore mohlomong motho a se ikutloe a lokolohile. Moo ho hlokahalang, motho ea joalo o tla fetisetsoa lefapheng le khethehileng moo a tla thusoa teng.

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Tlatsetso ea hao liphuputsong tsena kea boithaopo. U ka khetha ho se nke karolo hohang. Haeba u ikhethela ho nka karolo liphuputsong tsena, u ka nna oa emisa motsotso ofe le ofe ha eba u ikutloa u so sa lokoloha. Le teng ha u khetha ho emisa ho nka karolo, ha ona lahleheloa ke litšebeletso ka tsela efe kapa efe.

Liphuputso tsena li etsoa ke Azubuike Benjamin Nwako oa Sekolong sa Public Health University ea Western Cape. Haeba u na le lipotso ka liphuputso a ko ikopanye le Azubuike Benjamin atereseng e latelang:- Flat 16 Leseli Flats, kapa nomorong ena ea mohala:- +266 59813379, kapa emailing ena:- drabnwakomba@yahoo.com

http://etd.uwc.ac.za/

Haeba u bile le mathata lipotsong tse mabapi le liphuputso tsena ka tsela efe kapa e fe, o ka tlaleha bothata ba hao mona:-

Prof Helen Schneider

School of Public Health

Head of Department

University of the Western Cape

Private Bag X 17, Bellville 7535

Soph-comm@uwc.ac.za

Prof José Frantz

Dean of the Faculty of Community and Health sciences

University of the Western Cape

Private Bag X 17, Bellville 7535

Chs-deansoffice@uwc.ac.za

UNIVERSITY of the
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Liphuputso tsena li lumeletsoe ke komiti ea Senate sa University ea Western Cape.

NOMORO EA BONA EA BOITSEBISO (REFERENCE NUMBER) : **15 / 7/9**

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APPENDIX 7: CONSENT FORM SESOTHO VERSION

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa

Tel: +27 21-959 2809 Fax: 27 21-959 2872

E-mail: soph-comm@uwc.ac.za

TOKOMANE EA TUMELLO (CONSENT FORM)

Sehloho: Liphuputso mabapi le se bakang hore masea a hlahe a ena le boima bo tlaase ba ’mele Maseru Lesotho

Liphuputso tsena li entsoe ka leleme leo ke le utluisisang. Lipotso tsohle tsa ka mabapi le liphuputso tsena li arabetsoe. Kena le kutluisiso ea hore na ho phehisa hoaka ho molemo joang. Ka hona ke nka karoro ka bokhethelo ba ka. Kea utluisisa hore boitsibiso ba ka, kapa mabitso a ka le boemo bohle ba ka bo ke ke ba beoa pepeneneng, hore mang kapa mang a li bone. Kena le kutluisiso ea hore kena le tokelo ea ho ikhula neng kapa neng ntle le ho fana ka mabaka, le ntle le tšabo ea letho, kapa hona ho lahleheloa ke litokelo tsa ka tsa litšebeletso tsa bophelo tse hlokoang ke nna le lesea la ka.

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Lebitso……………………………………..

Moitekeno………………………………….

Letsatsi…………………………………….

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APPENDIX 8: CATEGORIES FOR ANALYSIS

For the analysis the applied categories were:

Demographics

- Age – 1. Less than 18 years   2. 18 – 35years   3. Over 35 years
- Marital status – 1. Single   2. Separated   3. Widowed   4. Divorced   5. Married
- Education completed – 1. None   2. Primary   3. Secondary/high school   4. Tertiary
- Residence – 1. Rural   2. Urban
- Employment – 1. Unemployed   2. Employed
- Household income – 1. Lower = Less than M1500.00   2. Middle = R1500.00 to R6000.00   3. Higher = Greater than R6000.00
- Mother's income – 1. Lower = Less than M1500.00   2. Middle = R1500.00 to R6000.00   3. Higher = Greater than R6000.00

Maternal factors

- Smoking – 1. Yes   2. No
- Packs per day – 1. Above one   2. Less than one
- Alcohol – 1. Yes   2. No
- Bottles per day – 1. Above one   2. Less than one
- Source of energy – 1. Electricity   2. Gas   3. Wood   4. Coal   5. Others
- Number of antenatal visits – 1. Less than four   2. Four and above
- Gestational age – 1. Below 37 weeks   2. 37 to 42 weeks
- Parity – 1. Primipara   2. Two to four   3. Multipara (greater than 4)
- Birth Interval – 1. Less than 24 months   2. 24 months and above   9. No birth interval for primiparity

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- Mother's height – 1. Less than 152cm 2. 152cm and above
- Mother's weight – 1. Highest (>72 – 109) kg 2. Higher (>64 – 72) kg 3. Lower (>57 – 64) kg 4. Lowest (36 -57) kg
- Left mid upper arm circumference – 1. Less than 27cm 3. 27cm and above
- BMI – 1. Less than 18.5kg/m^2 2. 18.5 – 25 kg/m^2 3. Greater than 25kg/m^2
- HIV status – 1. Positive 2. Negative 3. Unknown
- HIV mother on HAART – 1. No 2. Yes 3. Unknown
- Weeks in pregnancy when started HAART – 1. Before pregnancy 2. First trimester 3. Second trimester 4. Fourth trimester
- When HAART was commenced in all HIV +ve women (1. Pregnancy HAART 2.Pre-pregnancy HAART 3. Not on HAART 4.Unknown)
- Bleeding in pregnancy – 1. Yes 2. No
- Hypertension in pregnancy – 1. Yes 2. No
- Type of job – 1. Factory worker 2. House help 3. Other petty jobs 4.Government worker 5. Other collar job (Later grouped as 1. Low pay work/Indecent 2. Adequate pay work/Decent)
- Working hours per day – 1. Less than 2. and above

Newborn factors

- Sex of baby – 1. Male 2. Female
- Birth weight of baby – 1. Less than 2500g 2. 2500 to 4200g 3. Greater than 4200g
- Birth length of baby – 1. Less than 46cm 2. 46 – 52cm 3. Greater than 52 cm
- Baby's Outcome – 1. Alive 2. Stillborn
- Number of babies delivered – 1. One 2. Two 3. Three 4. Four and above

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APPENDIX 9: ETHICS CLEARANCE FROM UNIVERSITY OF WESTERN CAPE

OFFICE OF THE DEAN
DEPARTMENT OF RESEARCH DEVELOPMENT

UNIVERSITY *of the* WESTERN CAPE

09 November 2015

To Whom It May Concern

I hereby certify that the Senate Research Committee of the University of the Western Cape approved the methodology and ethics of the following research project by:
Dr A Nwako (School of Public Health)

Research Project:	Prevalence and determinants of low birth weight in Maseru Lesotho.
Registration no:	15/7/9

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

The Committee must be informed of any serious adverse event and/or termination of the study.

Ms Patricia Josias
Research Ethics Committee Officer
University of the Western Cape

Private Bag X17, Bellville 7535, South Africa
T: +27 21 959 2988/2948 . F: +27 21 959 3170
E: pjosias@uwc.ac.za
www.uwc.ac.za

A place of quality,
a place to grow, from hope
to action through knowledge

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APPENDIX 10: ETHICS CLEARANCE FROM MINISTRY OF HEALTH LESOTHO

LESOTHO

Ministry of Health
PO Box 514
Maseru 100

REF: ID 84 - 2015

Date: 21st January 2016

To: A. Benjamin Nwako
Mph Candidate
University of Western Cape
Western Cape
South Africa

Category of Review:
[×] Initial Review
[ ] Continuing Annual Review
[ ] Amendment/Modification
[ ] Reactivation
[ ] Serious Adverse Event
[ ] Other ______________

Dear A. Benjamin Nwako

RE: Prevalence & determinants of Low Birth Weight in Maseru Lesotho (ID 84-2015)

This is to inform you that on 21st January 2016 the Ministry of Health Research and Ethics Committee reviewed and **APPROVED** the above named protocol and hereby authorizes you to conduct the study according to the activities and population specified in the protocol. Departure from the approved protocol will constitute a breach of this permission.

This approval includes review of the following attachments:
[×] Protocol version 17th November 2015
[ ] English consent forms *[insert all consent form titles, versions, dates]*
[ ] Sesotho consent forms *[insert all consent form titles, versions, dates]*
[ ] Data collection forms *[insert all form titles, versions, dates]*
[ ] Participant materials *[insert types, versions, dates]*
[ ] Other materials *[insert types, versions, dates]*

This approval is **VALID** until 20 January 2017.

Please note that an annual report and request for renewal, if applicable, must be submitted at least 6 weeks before the expiry date.

All serious adverse events associated with this study must be reported promptly to the MOH Research and Ethics Committee. Any modifications to the approved protocol or consent forms must be submitted to the committee prior to implementation of any changes.

We look forward to receiving your progress reports and a final report at the end of the study. If you have any questions, please contact the Research and Ethics Committee at rcumoh@gmail.com (or) 22226317.

Sincerely,

Dr. N. Letsie
Director General Health Services (a.i)

Mrs. V. T. Lehana
Chairperson NH-IRB

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APPENDIX 11: QMMH HOSPITAL PERMISSION LETTER

NETCARE You're in safe hands

BOPHELO

TSEPONG (PTY) LTD

LETTER OF PERMISSION TO CONDUCT RESEARCH AT QUEEN 'MAMOHATO MEMORIAL HOSPITAL AND THE FILTER CLINICS

TO: DR NWAKO AZUBUIKE BENJAMIN

Cc: Human Resources Manager
Unit manager: Postnatal (Ward L)

Dear Dr Nwako,

Re: Research on the Prevalence and Determinants of Low Birth Weight in Maseru Lesotho

It is with pleasure that we inform you that your application to conduct research at Queen 'Mamohoato Memorial Hospital has been successful, subject to the following:

i) All information with regards to Facility will be treated as confidential.

ii) Tsepong and Netcare's name will not be mentioned without written consent from the Hospital's management.

iii) Where Tsepong and, or Netcare's name is mentioned, the research will not be published without written consent from the Hospital Management.

iv) A copy of the research will be provided to the Hospital Management once it is finally approved by the tertiary institution, or once complete.

v) All legal requirements with regards to patient rights and confidentiality will be complied with.

We wish you success in your research.

Yours faithfully,

OPERATIONS DIRECTOR

16/2/16

DATE

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APPENDIX 12: DIFFERENT MODELS OF BACKWARD STEPWISE REGRESSION MODELLING OF THE LINEAR REGRESSION ANALYSIS FOR NUMERICAL VARIABLES

Table 6.1: Model 1:Linear Regression Analysis of the Statistically Significant Numerical Factors Associated with Low Birth Weight on bivariate analysis (All Numerical variables included)

Factors	Adjusted Prevalence Ratio	95% CI	P-value
Mother's height Short vs normal stature	0.05	-0.01 – 0.10	0.11
ANC Visits <4 vs ≥4	0.053	-0.053 – 0.16	0.32
Gestational Age (weeks) Preterm vs term	0.47	0.38 – 0.55	**0.0000***
Number of Gestation Multiple vs Singleton	0.46	0.27 – 0.65	**0.0000***
Parity High (>4) vs Low (≤4)	0.05	-0.15 – 0.25	0.61
Bolded figure and * = Statistically significant			

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Table 6.2: Model 2:Linear Regression Analysis of the Statistically Significant Numerical Factors Associated with Low Birth Weight on bivariate analysis (All Numerical variables included)			
Factors	**Adjusted Prevalence Ratio**	**95% CI**	**P-value**
Mother's height Short vs normal stature	0.05	-0.01 – 0.10	0.13
ANC Visits <4 vs ≥4	0.05	-0.06 – 0.16	0.36
Gestational Age (weeks) Preterm vs term	0.47	0.39 – 0.55	**0.0000***
Number of Gestation Multiple vs Singleton	0.46	0.27 – 0.65	**0.0000***
Bolded figure and * = Statistically significant			

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APPENDIX 13: DIFFERENT MODELS OF BACKWARD STEPWISE REGRESSION MODELLING OF THE MULTIVARIATE LOGISTIC REGRESSION ANALYSIS

Table 7.1: Model 1:Multiple Logistic Regression Analysis of the Statistically Significant Factors Associated with Low Birth Weight on bivariate analysis (All variables included)			
Factors	**Adjusted Prevalence Ratio**	**95% CI**	**P-value**
Mothers' Education Below Junior secondary vs Junior secondary and above	1.10	0.74 – 1.64	0.63
Residence Rural vs Urban	1.35	0.63 – 2.91	0.44
Energy Source Unclean vs cleaner energy	6.36	2.51 – 15.89	**0.0001***
Mother's height Short vs normal stature	**2**.45	0.97 – 6.21	0.06
ANC Visits <4 vs ≥4	1.38	0.44 – 4.31	0.58
Gestational Age (weeks) Preterm vs term	15.79	7.35 – 33.94	**0.0000***
HIV Status Positive vs negative	2.32	1.09 – 4.93	**0.03**
Hypertension History of Hypertension Vs No history of hypertension	3.43	1.58– 7.46	**0.0018***
Job Type Low pay work vs adequate pay work	2.72	0.96 – 5.30	0.06
Number of Gestation Multiple vs Singleton	32.30	5.98 – 174.57	**0.0001***
Parity High (>4) vs Low (≤4)	0.60	0.08 – 4.35	0.62
Bolded figure and * = Statistically significant			

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Table 7.2: Model 2:Multiple Logistic Regression Analysis of the Statistically Significant Factors Associated with Low Birth Weight on bivariate analysis (Maternal education not included)			
Factors	**Adjusted Prevalence Ratio**	**95% CI**	**P-value**
Residence Rural vs Urban	1.31	0.62 – 2.79	0.48
Energy Source Unclean vs cleaner energy	7.36	3.00 – 18.09	**0.0000***
Mother's height Short vs normal stature	2.50	0.99 – 6.31	0.053
ANC Visits <4 vs ≥4	1.42	0.45 – 4.47	0.54
Gestational Age (weeks) Preterm vs term	16.05	7.49 – 34.42	**0.0000***
HIV Status Positive vs negative	3.23	1.51 – 6.91	**0.0025***
Hypertension History of Hypertension Vs No history of hypertension	3.93	1.87– 8.27	**0.0003***
Job Type Low pay work vs adequate pay work	2.72	0.98 – 5.28	0.055*
Parity <4 vs ≥4	0.70	0.11 – 4.62	0.72
Number of Gestation Multiple vs Singleton	33.62	6.21 – 182.06	**0.0000***
Bolded figure and * = Statistically significant			

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Table 7.3: Model 3:Multiple Logistic Regression Analysis of the Statistically Significant Factors Associated with Low Birth Weight on bivariate analysis (Parity not included)			
Factors	**Adjusted Prevalence Ratio**	**95% CI**	**P-value**
Residence Rural vs Urban	1.34	0.64 – 2.79	0.44
Energy Source Unclean vs cleaner energy	6.32	2.6 – 15.08	**0.0000***
Mother's height Short vs normal stature	2.27	0.91 – 5.62	0.0771
ANC Visits <4 vs ≥4	1.16	0.40 – 3.34	0.79
Gestational Age (weeks) Preterm vs term	14.53	7.01 – 30.09	**0.0000***
HIV Status Positive vs negative	2.52	1.23 – 5.16	**0.01***
Hypertension History of Hypertension Vs No history of hypertension	3.09	1.46– 6.54	**0.003***
Job Type Low pay work vs adequate pay work	2.16	0.94 – 4.93	0.0685*
Number of Gestation Multiple vs Singleton	31.12	5.89 – 164.44	**0.0001***
Bolded figure and * = Statistically significant			

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Table 7.4: Model 4:Multiple Logistic Regression Analysis of the Statistically Significant Factors Associated with Low Birth Weight on bivariate analysis (ANC visits not included)			
Factors	**Adjusted Prevalence Ratio**	**95% CI**	**P-value**
Residence Rural vs Urban	1.29	0.64 – 2.61	0.48
Energy Source Unclean vs cleaner energy	5.71	2.48 – 13.16	**0.0000***
Mother's height Short vs normal stature	1.88	0.78 – 4.53	0.1585
Gestational Age (weeks) Preterm vs term	11.50	5.80 – 22.79	**0.0000***
HIV Status Positive vs negative	2.18	1.10 – 4.32	**0.025***
Hypertension History of Hypertension Vs No history of hypertension	3.51	1.72– 7.19	**0.0006***
Job Type Low pay work vs adequate pay work	2.29	1.05 – 4.98	**0.0375***
Number of Gestation Multiple vs Singleton	**27**.48	5.41 – 139.46	**0.0001***
Bolded figure and * = Statistically significant			

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Table 7.5: Model 5: Multiple Logistic Regression Analysis of the Statistically Significant Factors Associated with Low Birth Weight on bivariate analysis (Residence not included)			
Factors	**Adjusted Prevalence Ratio**	**95% CI**	**P-value**
Energy Source Unclean vs cleaner energy	6.14	2.72 – 13.85	**0.0000***
Mother's height Short vs normal stature	1.91	0.80 – 4.60	0.1472
Gestational Age (weeks) Preterm vs term	11.64	5.88 – 23.04	**0.0000***
HIV Status Positive vs negative	2.08	1.07 – 4.08	**0.0319***
Hypertension History of Hypertension Vs No history of hypertension	3.48	1.70– 7.11	**0.0006***
Job Type Low pay work vs adequate pay work	2.35	1.08 – 5.10	**0.0303***
Number of Gestation Multiple vs Singleton	**26**.39	5.29 – 131.75	**0.0001***
Bolded figure and * = Statistically significant			

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Table 7.6: Model 6: Multiple Logistic Regression Analysis of the Statistically Significant Factors Associated with Low Birth Weight on bivariate analysis (Gestational age and number of gestation not included)			
Factors	**Adjusted Prevalence Ratio**	**95% CI**	**P-value**
Energy Source Unclean vs cleaner energy	4.05	2.12 – 7.75	**0.0000***
Mother's height Short vs normal stature	2.15	1.02 – 4.51	**0.0444**
HIV Status Positive vs negative	1.53	0.87 – 2.70	0.14
Hypertension History of Hypertension Vs No history of hypertension	5.07	2.84– 9.07	**0.0000***
Job Type Low pay work vs adequate pay work	0.55	0.29 – 1.05	0.0685
Bolded figure and * = Statistically significant			

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