1-5-2018

The Association between Maternal HIV Status and Low Birth Weight Offspring, Malawi DHS 2010

Sterner Msamila

ABSTRACT

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By

Sterner Moses Msamila

INTRODUCTION: Low birth weight (LBW) is a public health problem in developing countries including Malawi. It is an intermediate endpoint of maternal lifestyles and health status, and a powerful predictor of newborn's survival. Over 30 risk factors have been associated with LBW, but the role of maternal HIV infection as an underlying factor for LBW is not yet well established. Understanding whether or not maternal HIV status is a risk factor for LBW is key in the prevention of LBW and its life time health effects.

AIM: The purpose of this study was to examine the association between maternal HIV status and LBW in Malawi using DHS 2010 data.

METHODS: This study analyzed 7716 mother-child pairs from the 2010 Malawi Demographic and Health Survey (DHS) data using SAS 9.4 program. Student's t-test and Chi-square test were applied, for continuous and categorical variables respectively, to compare maternal and child characteristics by HIV status and LBW status separately. Bivariate logistic regression was performed and crude odds ratios were determined to ascertain the relative measure of effect of maternal and fetal characteristics on outcome variable (LBW). Then, multivariable logistic regression analyses were performed to examine the association between maternal HIV infection and LBW adjusting for covariates. Statistical assessment of interaction between HIV infection and covariates on LBW was made. A p-value of <0 .05 or 95% confidence intervals were used to determine statistical significance throughout all the analyses performed.

RESULTS: The proportion of LBW infants was 9.45% in total, with 13.60% among HIV positive women and 9.26% among HIV negative women (*p* 0.0337). A multivariable logistic regression model showed that HIV positive mother was 77% more likely [odds ratio (OR) 1.77, 95% confidence interval (CI) 1.17-2.67] than HIV negative mother to give birth to LBW infant. The odds of LBW also increased among teenage women (OR = 1.86; 95% CI = 1.47, 2.35), women without education (OR = 1.66; 95% CI = 1.13, 2.43), low income (OR = 1.37; 95% CI = 1.05, 1.78), and Chewa ethnicity (OR = 1.92; 95% CI = 1.39, 2.66). However, LBW was not associated with child sex, marital status, or prenatal care. Though not statistically significant, the association between HIV infection and LBW was modified by increase in age, unmarried marital status, and inadequate prenatal care.

DISCUSSION: These findings are consistent with other previous studies that showed that maternal HIV status is a significant risk factor for LBW.

CONCLUSION: The study has substantiated the need to recognize HIV-positive pregnant mothers as high risk obstetric patients who need extra support and care during pregnancy and delivery, and the need to intervene with supplemental nutritional interventions during antenatal clinics and strengthen HIV prevention among women of child bearing age to reduce LBW infants.

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Bsc in Environmental Health
University of Malawi, the Polytechnic

A Thesis Submitted to the Graduate Faculty
of Georgia State University in Partial Fulfillment
of the
Requirements for the Degree

MASTER OF PUBLIC HEALTH

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Acknowledgements

I am thankful to God who always guide and bless me through each step of my life. I want to thank my wife, son, parents and the rest of my family members for all their support and love. I would like to acknowledge my thesis committee, Dr. Okosun and Dr. Ido for their guidance and support throughout this thesis. I am also thankful to the Institute of Public Health for believing and supporting me in my journey.

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CHAPTER I

INTRODUCTION

1a. Background

Human Immunodeficiency Virus (HIV) is an infection of public health problem with about 36.9 million people living with the virus in 2014, and about 25.8 million (70%) of them live in sub-Saharan region (SSA) (Joint United Nations Programme on HIV/AIDS, 2015). In 2003, the global prevalence of HIV among 15-49 age group was 1.1% with the sub-Saharan region having the prevalence of 7.5% while the rest of regions/countries having the prevalence of less than 1% (UNICEF, 2005). Globally women remain the most vulnerable group with prevalence of 52% of all HIV infected persons (Joint United Nations Programme on HIV/AIDS & World Health Organization, 2013) and it is estimated that in 2012, SSA harbored 92% of all HIV-infected women and 90% of all HIV-infected pregnant mothers. In 2013, about 1.4 million pregnant women were HIV infected globally, many of which were from SSA (World Health Organization, 2014). Malawi, just like other sub-Saharan countries, has high prevalence of HIV/AIDS. In 2010 the prevalence among adults aged 14-49 was 10.6% at national level, 12.9% among women, and 8.8% among pregnant women (National Statistical Office (NSO) and ICF Macro, 2011).

LBW, defined as a birth weight below 2500 grams, is also a global public health problem since it is both a sequelae of maternal health and a predictor of child's health. Globally, the prevalence of LBW is 15.5%, and about 20 million children are born with a low birth weight (LBW) every year and 95.6% of these children are born in low-income countries (Wardlaw, WHO, & UNICEF, 2004). Estimates shows that the incidences range as high as 25% in countries like India, to as low as 7.6% in United States, 5–6% in the Scandinavian countries, and 6% in the United Kingdom (UNICEF, 2005). In Malawi, it is estimated that about 12-15% of 600,000 babies are LBW infants (National Statistical Office (NSO) and ICF Macro, 2011, Oestergaard et al., 2011). LBW has adverse effects on child's health and is the leading cause of death in children under 5 years (Blencowe et al., 2012). It is reported that about 60-80% of neonatal deaths is due to LBW (WHO, 2004). Therefore, attempts to determine factors that are associated with LBW in low-income countries are needed to contribute towards reduction of morbidity and mortality of children.

Many studies conducted on LBW have focused and acknowledged the effects of maternal age, education, marital status, income, body mass index (BMI), alcohol drinking, child sex, and smoking status has on the child's development and resulting LBW. However, the role of maternal HIV status as an underlying factor for LBW remain an area where strong evidence is lacking. For most low-income countries like Malawi where HIV in the general population and among pregnant mothers, and LBW are prevalent, a thorough description of the association between maternal HIV and LBW is lacking.

Published studies indicate that maternal factors including maternal HIV status are associated with a higher risk of LBW infants (Salihu et al., 2012; Ndirangu et al., 2012; Nkhoma et al., 2012; Wilkinson et al., 2015). However, these studies are conducted in countries where there is much lower prevalence of HIV pandemic than Malawi. For instance, the retrospective study conducted in Japan in 2011 reported prevalence of LBW to be 4% (Murai et al., 2017) while survey based on general population reported LBW prevalence of 12.3% in Malawi (National Statistical Office (NSO) and ICF Macro, 2011). Similar studies from Malawi were facility-based which limited generalizability of the results. As the prevalence of HIV among Malawian women is reported to be significantly higher, the overall impact of HIV on LBW is expected to be much higher. Previous studies also relied on findings based on smaller sample sizes and controlled for fewer risk factors. Due to these methodological issues, such studies tend to underestimate the association between maternal factors and LBW.

1b. Purpose of Study

More than 30 maternal characteristics such as obesity/overweight, underweight, diet, physical activity, drug, alcohol drinking, smoking, and socioeconomic status (SES) have been associated with an increased risk of LBW (Valero de Bernabé et al., 2004). Some of these risk factors can be hypothesized to modify the association between HIV infection and LBW.

Considering the public health importance of HIV infection and the fact that LBW is an important risk factor for infant mortality in sun-Saharan Africa, this study assess whether maternal HIV infection/status is associated with a low birth weight infants. This thesis will supplement the limited amount of research done with regards to impact of maternal HIV infection on infants' birth weight. While controlling for several variables, the association between maternal HIV status and LBW among Malawian population will be examined using 2010 Demographic and Health Survey (DHS) data. A better understanding of maternal HIV infection as a risk factor for LBW is of great importance for prevention of LBW and development and/or strengthening of future HIV/AIDS interventions, guidelines, and policies.

1c. Hypothesis

This study posits that HIV-infected mothers would have greater odds of giving birth to low birth weight offspring than HIV-uninfected mothers. There are several pathophysiological mechanisms that support this hypothesis. Firstly, HIV infection lowers the immune systems of the mother thereby predisposing the mother to more illnesses. Even though with appropriate interventions HIV virus is not transmitted from mother to child/fetus, the lowered immunity of the mother might affect fetal development resulting in LBW. Secondly, due to frequent illnesses the HIV positive mothers end up being of lower SES, earn less wages, have less education, and have fewer antenatal visits than their counterparts. These factors have consistently shown in many studies to be risk factors for delivering LBW offspring. The null hypothesis for this study is that maternal HIV infection is not an independent risk factor for low birth weight offspring.

CHAPTER II

REVIEW OF THE LITERATURE

The literature review examined risk factors for LBW as well as immediately and long term effects of having low birth weight to the infants. The following chapter is dedicated to presenting scientific literature that supports inclusion of the variables of interest in this study. These factors include; child's sex, maternal age, marital status, maternal education, family income, prenatal care, and ethnicity.

2a. Low Birth Weight

Birthweight is a precursor for many health outcomes. It explains child mortality and later morbidity. It is also an intermediate endpoint of maternal lifestyles and health status. It is a powerful predictor of an individual baby's survival. Generally, the lower the birth weight, the higher the risk of infant mortality (McCormick, 1985). Due to its implications on health outcomes, birthweight is dichotomized; 'Low birth weight' (LBW) as a category of babies weighing less than 2500 grams at birth regardless of gestational age and its cause, and 'Normal birth weight (NBW)' which is a birth weight of 2500-6000 grams (WHO, 1961).

LBW do occur because an infant is born too early in pregnancy (pre-term birth (PTB)) or is born at full-term but is growth restricted. It is estimated that about two-thirds of LBW infants are born preterm (Dunkel Schetter & Tanner, 2012). LBW is sometimes further divided into three categories; moderate LBW (1500-2499 g), very LBW (1000-1499 g) and extreme LBW (less than 1000 g). In 2010, PTB was the second leading cause of child deaths worldwide (Liu et al., 2012) and Malawi had the highest prevalence of PTB in the world (Blencowe et al., 2012)

Various studies have shown LBW to be a significant cause of infant morbidity and mortality (McCormick, 1985). For instance, McCormick found that LBW babies are typically 20 or more times more likely to die than NBW babies. It is also reported that about 38% of child mortality that occurs in the first month is directly related to birth weight (Nazari et al., 2013), and that between 60-80% of all neonatal deaths is attributed to low birth weight (Sachdeva et al., 2013). Even though the effect of LBW is so prevalent during first days of life, serious health and non-healthy consequences have been documented across the life course. Such consequences include physical, intellectual, and behavioral difficulties (Waldman, 2001), and poor educational attainment (Conley 2000).

2b. Maternal HIV

One of risk factors for LBW is maternal HIV infection. Women who are HIV positive were more likely than HIV-uninfected women to give birth to LBW infants (Salihu et al., 2012; Ndirangu et al., 2012; Nkhoma et al., 2012; Wilkinson et al., 2015). A study conducted by Jess and colleagues in Florida, it was found that the rate of LBW significantly differed between HIV-infected and non-infected women. The infants born to HIV-infected women were on average 303 grams smaller than their fellow counterparts born to HIV negative women (Salihu et al., 2012).

Another study conducted in southern part of Malawi found similar findings (Nkhoma et al., 2012). The facility-based prospective study registered LBW prevalence of 9% and there was significant statistical association between maternal HIV status and LBW. Compared to HIV negative women, the HIV positive women were thrice more likely to give birth to LBW infants. Similarly, in Tanzania, Wilkinson and colleagues conducted a prospective cohort study of 44 HIV-positive and 70 HIV-negative pregnant women who attended antenatal clinics in rural dispensaries in Magu district. In their study, HIV-positive mothers experienced a higher proportion of adverse birth outcomes including low birth weight. The infected women delivered babies with lower average weight and length than their counterparts (Wilkinson et al., 2015).

Some studies done in Malawi and Zambia have even demonstrated the association between severity of HIV-1 and LBW (Turner et al., 2013; Kuhn et al., 2005; Lambert et al., 2000). These studies have postulated that the more severe the HIV-1 infection the higher risk of giving birth to LBW infants. Even though the mechanism on how HIV infection cause LBW remain unknown, it has been speculated that it facilitates placental inflammation, as a result of coinfection, and it disrupts the tenuous immunological balance thereby causing LBW. In short, it is believed that complications related to HIV infection impairs placental functions resulting in LBW (Nazli et al., 2010).

Most studies conducted on association between maternal HIV and LBW were done in developed countries where the prevalence of HIV is very low. In addition, most studies were facility/hospital based, had smaller samples sizes, and controlled for few covariates in their multi-logistic regression analysis. Due to aforementioned limitations, the findings could not be generalized to sub-Saharan region where the prevalence of HIV pandemic is extremely high. This study will supplement the existing literature by addressing some of the methodological issues observed in previous studies. Hence using population level data and controlling for many confounding variables to maximize generalization of results.

2c. Maternal Age

Studies conducted worldwide have provided evidence that maternal age is an important independent risk factor for LBW. LBW infants were more likely than NBW children to be born from women aged less than 20 years or greater than 35 years (Li et al., 2013; Negandhi et al., 2014; Oladeinde et al., 2016; Makgoba et al., 2012; Reime et al., 2006; Dahlui et al., 2016; Mohammad et al., 2014). In a hospital based cross-sectional study conducted in Central Women Hospital, Mandalay during 2008-2009 conducted by Oo and Moe, it was found that the prevalence of LBW decreased with increasing age until age of 35 and increased thereafter (Oo & Moe, 2015). The overall prevalence was 7.8% with LBW proportion of 8.6%, 5.7%, and 11.3% in ages <25, 25-34, and 35-39 years respectively.

In a study conducted in Nigeria, the variation of the prevalence of LBW according to maternal age was also observed (Oladeinde et al 2016). The results of the study indicated that the women of age group 14-18 years had very high risk for LBW, followed by 19-23 age group after controlling for potential confounding variables. Even though overall prevalence of LBW was 6.3%, there was great variation of prevalence of LBW. The prevalence was found to be 33.3%, 9.1%, 6.2%, 5.5%, 4.1% and 4.2% in age-group 14-18, 19-23, 24-28, 29-33, 34-38, and >39, respectively.

Likewise, in India, the study that used routine hospital data collected in 2008-2014, lower maternal age was also correlated with high risk of LBW (Ahankari et al., 2017). The study that utilized 655 live births found 13.8% prevalence of LBW. In that study women of age less than 22 years of age at time of delivery had twice the odds of giving birth to LBW infants compared to older women. Another study conducted in 2011 in Fatima Hospital in northeast Iran showed similar findings (Chaman et al., 2013). The cross-sectional study recorded 7.2% prevalence of LBW of neonates and there was significant statistical association between maternal age and LBW. Compared to 19-35 year age group, the women of age group more than 35 years were 5 times more likely to give birth to LBW.

A number of explanations have been speculated as to why incidence of LBW increases in the both ends of reproductive life; between 15 and 19 years and those over 35 years of age. In adolescence, the intrinsic biological factors (immature body) as well as high levels of social disadvantages are believed to be responsible for their high prevalence of LBW. Most adolescent mothers are single, earn less income, have fewer prenatal care, and lower maternal weight, which are associated with high incidences of LBW (Roth, Hendrickson, Schilling, & Stowell, 1998). However, as regards women older than 35 years, it is speculated that pregnancy complications are responsible for LBW. Other authors suggest, it is not age itself, but high prevalent of chronic diseases such as hypertension and diabetes are responsible for high prevalence of LBW among older women (Cnattingius, Forman, Berendes, & Isotalo, 1992).

2d. Marital Status

Accumulating scientific evidence have consistently shown that women who are not married have increased risk of giving birth to LBW infants (Oladeinde et al, 2016; Frimmel & Pruckner, 2014). However, there are others studies that had failed to show any correlation between marital status and birth weight (Bacci, Bartolucci, Chiavarini, Minelli, & Pieroni, 2014). These inconsistency might be due to differences in methodologies and characteristics of study population.

Oladeinde et al (2016) studied 780 women and live singleton infants in Nigerian traditional birth homes. In the study that studied different risk factors associated with low birth weight, the prevalence of LBW was 6.3% with 10.2% in unmarried women and 5.1% in married women. This study showed that unmarried women were twice more likely to give birth to LBW infants than married women.

Frimmel & Pruckner (2014) also studied determinants of LBW with focus on family status. They studied Austrian birth data of 1984 - 2007 and the study population included 82% of married mothers. In the study, the married women gave birth to infants who had the mean birth weight of 89.8 grams higher than those born to unmarried women. The study also found significant lower birth weight among newborns of women divorced during pregnancy than birth weight of single mothers. Similar findings were also found in Singapore (Kang, Lim, Kale, & Lee, 2015), Germany (Reime et al., 2006), and Tanzania (Siza, 2008).

However, some studies do not find significant association between marital status and LBW. The study conducted in Italy comprised of 792 women who gave birth twice between year 2005 and 2008 of which 87.5% of them were married (Bacci et al., 2014). In this study they controlled for many covariates including mother's age, birth intervals, term of deliveries, antenatal visits, education level, and other variables. After controlling for covariates, the prevalence of birth weight for infants born to married women were not significantly different from those born from unmarried (p=0.787).

Marital status has shown to be an important risk factor for LBW and it is closely interrelated with other factors such as social economic level, age, culture, and race. In sum, LBW babies are generally children of single mothers who happens to be mostly of younger maternal age (adolescence) and without husband during the pregnancy, hence economically disadvantaged (Reichman et al 2008). This partly explains why unmarried mothers have high risk of giving birth to LBW infants.

2e. Ethnicity

Previous studies showed that certain groups of people are at more risk of giving birth to LBW infants (Makgoba et al., 2012; Dahlui et al., 2016; Watson-Jones et al., 2007). Even though it is not clear why there are racial differences in prevalence of LBW, it is postulated that behavioral, environmental, socioeconomic, genetic, and/or physiologic risk factors are responsible for the differences (Fuller, 2000; Valero de Bernabé et al., 2004).

In a study conducted by Makgoba et al (2012), they found that women of non-white racial origin had higher risk of LBW infants than their counterparts. The black populations delivered smaller babies than white population did despite the former having significant higher average BMI than the latter. Similar findings were documented in many other studies conducted in United States. The Non-Hispanic Blacks and Hispanic Americans have higher prevalence of LBW offspring than Non-Hispanic Whites do (Okosun et al 2000). The African Americans are twice more likely to give birth to LBW infants than White women would. However, foreign born mothers are significantly less likely to give birth to LBW infants than U.S. born women (Acevedo-Garcia, et al 2007).

Dahlui et al (2016) also observed variation in prevalence of LBW among different ethnic groups in Nigeria. The study that utilized 2013 demographic health survey data observed 6.3% national prevalence of LBW with significant difference across ethnicities. The Yoruba ethnic group had lowest prevalence of 4.3% while Hausa ethnicity had highest prevalence of 15.4%. The Igbo ethnic group was found to have a prevalence of 6.0% while the rest of ethnic groups registered 12.5% prevalence of LBW.

2f. Education

Education remain a significant risk factor for LBW. The higher the education level of the mother the lower the risk of giving birth to LBW infants (Oo & Moe, 2015; Demelash et al., 2015; Mohammad et al., 2014; Taha et al., 2012a). A 2016 study conducted in Nigeria by Dahlui and colleagues showed that the prevalence of LBW infants had an inverse association with educational level in women and the proportion of LBW was 14.9% among women without education, 8.0% among those with primary education, and 7.7% among those with high school or higher. In developing countries, the odds of giving birth to LBW infants among illiterate mothers was 1.5 times that of literate mothers (Mahumud et al.,2017). Likewise, Oo and Moe (2015) found similar trend where the prevalence of LBW was 14%, 8.4%, and 4.5% in women of low, middle, and high level of education, respectively. Again, in Tanzania, women without formal education had four-fold risk of LBW infants than those who had formal education (Siza, 2008).

Education level influences birth outcomes in a number of ways; age and economic activities. Young women are typically of lower education status and this lower age group is a strongly associated with high risk of LBW. Secondly, women of low education find it difficult to get well-paying jobs which offers better medical insurance. Low education also limit uptake of health services, hence low educated mothers are less likely to take adequate health care including prenatal care due to lack of capacity to make right decisions about their health and health of unborn child (Silvestrin et al., 2013). In short, minimum of high school level of education is important for better health care utilization and birth outcomes.

2g. Socioeconomic Status /Family Income

One of the factors influencing health status of the populations is the socio-economic level. It is measured using different variables most of which are education, income, and occupation.

Women of low SES have poorer health and more likely to give birth to LBW infants than their counterparts (Demelash et al., 2015; Hirschman & Fernandez, 1980; Lund et al., 1999). Income variable is a known risk factor for LBW as disadvantaged circumstances may lead to inadequate access to healthcare, poor nutrition, low educational attainment, more smoking and drug abuse, and more stress which all contribute to poor fetal growth (Mohammad et al., 2014).

Income may also affect prevalence of LBW offspring by its influence on prenatal and perinatal factors. Mothers of low income tend to have no or poor health insurance which result in poor health seeking behaviors and consequently having poor birth outcome including low birth weight (Mahmoodi et al., 2013). However, the association between offspring birth weight and income may be confounded by Age and race. Young women generally have lower socioeconomic status when compared to older women. In addition, income levels varies across different ethnic groups (Reichman et al., 2008). Studies that examined association between LBW and SES within different strata of Age and race, suggest a strong direct and indirect inverse association between income of household/mother and prevalence of LBW offspring (Mahmoodi et al., 2013).

2h. Prenatal Care

Health of women is critical for birth outcomes including birth weight. A small improvement in health care of mothers lead to important benefits derived from better and earlier diagnosis of risk factors for LBW. Adequate prenatal care is generally measured in terms of date of the first antenatal visits, total number of antenatal visits, and length of pregnancy. Pregnant women are recommended to start attending antenatal clinic (ANC) during the first trimester, attend at least four (≥4) clinics/visits for normal pregnancy (World Health Organization, 2009). ANC visits gives pregnant mothers the opportunity to receive services and interventions that are very important for mother and neonate well-being. It is also vital for identifying women who have increased risk of adverse pregnancy outcomes and be assisted accordingly (Raatikainen et al., 2007).

Previous studies have established a link between these factors and LBW infants (da Fonseca et al., 2014; Negandhi et al., 2014; Mahumud et al., 2017; Hendryx et al., 2014; Bacci et al., 2014), with a stronger association when first visit is not done in first trimester or when the number of ANC visits is less that the recommended 4 ANC visits. For instance, in Zimbabwe, the mothers who had inadequate ANC visits had 34% higher odds of having LBW infants than those with adequate ANC visits (Yaya et al., 2017). Similar findings were also noted in Ghana where attending less than four ANC visits was associated with 2.55 odds of LBW compared to attending at least four ANC visit, after adjusting for confounders (Asundep et al., 2014). Study also shows that high risk women have up to 25% inadequate prenatal care while those low-risk women have less than 10% (Halpern et al., 1998). In sum, adequate prenatal care prevents LBW regardless of presence of any confounding variables (Joyce, 1999; Zimmer-Gembeck & Helfand, 1996; Coria-Soto et al., 1996).

2i. Child Sex

Previous studies have shown variation of LBW prevalence among child sex. Some studies found association between infant sex and LBW (Dubois & Girard, 2006; Mohammad et al., 2014; Abubakari et al., 2015) while other studies found no significant relationship (Oladeinde et al., 2016). In Nepal, female infants were 1.5 time more likely to have LBW than male infants (Khanal et., 2014). Significant higher proportion of LBW in female than male infants was also found in Italy (Dubois & Girard, 2006), Ghana (Abubakari et al., 2015), Jordan (Mohammad et al., 2014). However, a follow up study conducted in Nigeria showed no significant association between child gender and LBW(Oladeinde et al., 2016)

It is still unclear why there is gender differences on LBW prevalence (higher risk in female infants). However, researchers postulate that such variation can be explained by the specific intrauterine growth patterns. For instance, Lampl et al in their longitudinal study found that the growth of male fetuses is more sensitive to maternal weight and height, varying with gestational age (lampl et al., 2009). Thus, the authors suggested that biological and non-biological determinants of intrauterine growth might be regulated by fetal sex resulting in LBW sex differences.

2j. Long Term Effects

Apart from increased under-five morbidity and mortality, LBW has shown to be associated with many long terms effects. These effects include increased risks of illnesses in adulthood (Barker 1999, Erik 2001), worse self-reported health at 23 and 33 years of age (Currie & Hyson, 1999), increased risk of high school drop-out (Conley 2000), decreased health and IQ leading to negative effect on labor market outcomes, education attainment and earning (Currie & Moretti, 2007; Black et al., 2007), and consequently impacting on birth weight of future generation (Royer, 2009). Previous studies indicate that LBW children have greater chance of repeating a grade in school as well as more difficulty graduating from high school. According to Conley and Bennet (2000), children of low birth weight are 34% less likely to graduate from high school at an appropriate age.

LBW is postulated to facilitate deposition of adipose tissues in the abdomen thereby causing overweight/obesity which consequently lead to metabolic syndrome, diabetes mellitus, and insulin resistance (Begum et al., 2013). These changes result in development of cardiovascular diseases and metabolic diseases in adulthood of LBW babies (Barker, 2007). Hence, LBW infants are more likely to have hypertension, diabetes mellitus, and other chronic diseases in adulthood than NBW infants (Katsuragi et., 2017; Eriksson et al., 2003; Roseboom et al., 2000). In short, there are many health and non-health complications associated with low birth weight.

2k. Prevention Strategies

There are both modifiable and non-modifiable risk factors for low birth weight. Early maternal age, education, marital status, income, maternal HIV, and prenatal care, are some of modifiable risk factors while ethnicity and child sex are non-modifiable factors. Therefore addressing the prevalence of low birth weight requires focus on changing or addressing modifiable risk factors.

Prevalence of LBW can be reduced by delaying motherhood until appropriate age is reached. This can be achieved by avoiding getting into marriage during teenage period or using appropriate family planning methods until normal/appropriate maternal age is reached. When adolescents delay pregnancy they increase better pregnancy and birth outcomes since they will give birth at time their body is mature enough.

Since poverty associated with unmarried marital status make such women to have high odds of giving birth to LBW offspring, preventing prevalence of LBW require unmarried women to be financially well and/or avoiding motherhood before they get married. Early start of ANC visits and attending the ANC clinic at least 4 times during pregnancy also help in preventing LBW. The educated women earn more income, and since both of these factors are associated with LBW, women should wait to get adequate education before getting married and giving birth.

Even though maternal HIV positive status cannot be changed, efforts can be made to reduce LBW by reducing HIV positive women who give birth and preventing HIV infection among HIV negative women. If those who have the virus avoid motherhood, and the prevalence of HIV is reduced through appropriate policies, guidelines, and interventions, the prevalence of LBW can greatly be reduced. Some important interventions might include strengthening health education, and provision of supplemental nutrition during antenatal clinics.

CHAPTER III

METHODS AND PROCEDURES

3a. Data source

The data source for this thesis was the 2010 Malawi Demographic and Health Survey (2010 MDHS). The survey was conducted by the National Statistical Office (NSO) in partnership with the Ministry of Health Community Sciences Unit (CHSU). However, the data was obtained from the United States Agency for International Development (USAID) website at http://www.dhsprogram.com/data/available-datasets.cfm, after Demographic and Health Survey Program and ICF International granted permission when the purpose of study was explained.

Malawi DHS survey is a large, nationally representative household-based survey, implemented to obtain detailed information on fertility levels, nuptiality, fertility preferences, knowledge and use of family planning methods, breastfeeding practices, nutritional status of mothers and children, childhood illnesses and mortality, use of maternal and child health services, maternal mortality, and domestic violence. The main objective of the 2010 MDHS was to provide up-to-date information for policymakers, planners, researchers, and programme managers to help them evaluate and improve existing programs (National Statistical Office (NSO) and ICF Macro, 2011).

The sample for the 2010 MDHS was designed to provide population and health indicator estimates at the national, regional, and district levels. The 2008 Malawi Population and Housing Census (PHC) was used as sampling frame. The sample was selected using a stratified, two-stage cluster design, with clusters used as sampling units for the first stage, and households list in each cluster as sampling units for the second stage. In the first stage, sample of 849 clusters was selected, and a representative sample of 27,345 households were selected in the second stage. A third of households were sampled for HIV testing for eligible women.

3b. Study design

A cross sectional study was conducted to assess the association between Low birth weight and maternal HIV status, adjusting for child sex, maternal age, maternal education, marital status, prenatal care, family income, and ethnicity. The Standard Demographic and Health Surveys (DHS) phase VI data for Malawi was used.

3c. Study population and sample size

The sample for this thesis consisted of 7716 mother-child pairs who had answered all the questions for the variables used in the analysis. Analysis was restricted to under-five live singleton children who had birth weight and their gender documented, and to their mothers who had known HIV status, maternal age, marital status, highest education level, total antenatal visits, family income (wealth index), and race/ethnicity. Birth file had children ranging from birth to 37 years old, but only those of 5 years old and less were used in this study since the older ones had many missing values on variables of interest. The maternal age was restricted to 15-49 years old while birth weight was restricted to 200-6000 grams. All participants who did not have complete information on the selected variables were eliminated from the study.

3d. Variables of Interest

The dependent variable in this study was low birth weight. This variable was recorded in the dataset as a continuous variable but for sake of this study it was dichotomized (i.e. changed into categorical variable). Low birth weight was defined as birth weight less than 2500 grams.

The maternal HIV status was independent variable for the current study. Although in 2010 DHS the HIV status included those who refused and those with unknown status, this study was restricted to those women who had known HIV status.

In order to examine unbiased association between LBW and maternal HIV status, the following covariates were included in this study. These variables were selected based on literature review and their availability in the DHS data set.

CHILD GENDER: child's sex was self-reported as male child and female child.

MATERNAL AGE: Age was reported as a whole number in years at the time of interview. Since this study was interested in maternal age, it was derived from mother current age and child current age. The derived/calculated maternal age was then recoded into three categories based on literature review. These three categories were 15-19 (young age), 20-34 (middle age) and 35-49 (old age).

MARITAL STATUS: Women were classified either as; never in union, married, living with partner, widowed, divorced, or no longer living together. This study dichotomized this variable; married and unmarried.

PRENATAL CARE: Total antenatal visits during pregnancy was determined and dichotomized into inadequate (<4 ANC visits) and adequate (≥4 ANC visits).

EDUCATION: Maternal highest education level attained was self-reported and was categorized into 4 groups; No education, primary, secondary, and Higher. This study re-categorized into 3 groups by combining the last two groups into one group called 'secondary or higher'.

FAMILY INCOME: DHS categorized family wealth index into 5 groups; poorest, poor, middle, richer, and richest. This study re-categorized wealth index into 3 groups by combining the first two groups and last two groups.

ETHNICITY: Malawi has more than 10 ethnic groups and DHS documented all of them. This study was restricted to the 5 major ethnic groups; Tumbuka, Chewa, Ngoni, Yao, and Lomwe, and grouped the rest of ethnic groups into one group called ‘other races’.

3e. Data Analysis

Statistical Analysis System -SAS® (SAS Institute Inc., Cary, NC, USA) software program version 9.4 was used for all data analyses. In the descriptive analysis, frequency procedure was used to provide the descriptive characteristics of independent and dependent variables, and covariates. Means of normally-distributed continuous variables; birth weight and maternal age, between HIV-positive and HIV-negative mothers, were compared using student’s t-test. Proportions of categorical variables between HIV positive and HIV negative women were compared using Pearson chi-square tests. The prevalence estimates of LBW among different categories of child gender, maternal HIV status, maternal age, marital status, education level, prenatal care, income, and ethnicity were performed using Pearson chi-square test. Bivariate logistic regression was performed and crude odds ratios (COR) or 95% confidence interval (CI) were determined to ascertain the relative measure of effect of each variable on outcome variable. Then, multivariable logistic regression analyses were performed and adjusted odds ratios (AOR) or 95% CI were computed to determine the effect of maternal HIV status on LBW, adjusting for child and maternal socio-demographic factors. Statistical assessment of interaction between maternal HIV infection and other cofactors of interest on the risk of LBW was made using homogeneity strategy. Throughout all the analyses performed, a p-value of <0.05 or confidence interval of 95% were used to determine any statistical significance.

In 2010 DHS survey, stratified sampling was used and the 849 clusters were not allocated among the districts in proportion to their contribution to national population. In Malawi, more than 90 percent of population resides in rural areas, and some districts and regions are small. In order to have enough clusters to represent such sections, the Northern region and urban areas were oversampled (National Statistical Office (NSO) and ICF Macro, 2011). Therefore, in order to take into account/adjust for disproportionate sampling, and to restore the representativeness of the sample, so that the total sample distribution “look like” the country actual population, the sample weights were included in all statistical analyses performed.

CHAPTER IV

RESULTS

4a. Descriptive Statistics

The total sample of DHS respondents that met the study eligibility criteria was 7716 live singleton children and their mothers of whom 331 (4.29%) women were HIV positive. The demographic characteristics of the respondents who were included in the study with respect to birth weight, child sex, maternal age, marital status, education, prenatal care, family income, and ethnicity stratified by maternal HIV status are presented in Table 1. Overall, the majority of study population were married (86%), middle aged (71%), had primary education (66%), richer wealth index (44%), and were of Chewa tribe (34%). About half of infants were female children, and just over half of women had inadequate prenatal care. The mean (±standard deviation [SD]) birth weight of live birth was 3271 (±723) and infants born to HIV negative mothers were, on average, 83 grams heavier than those born to HIV positive mothers.

Statistically, the mean birth weight of infants born to HIV positive was statistically significantly lower than that of infants born to HIV negative mothers. Similarly, when birth weight was dichotomized, the frequency of LBW infants among HIV-uninfected mothers was statistically significantly lower from their counterparts. There was also significant difference between HIV infected mothers and uninfected ones in terms of maternal age at delivery, marital status, and race/ethnicity. HIV positive mothers were significantly much older at delivery, unmarried, and from Lomwe tribe than their counterparts. However, the frequencies of child sex, total ANC visits, highest education level attained, and family income did not statistically differ significantly by maternal HIV status.

Table 4.1 Characteristics of study participants among 7716 mother-infant pairs according to maternal HIV status[a]

Characteristics	**HIV+[b] (n=331)**		**HIV-[b] (n=7385)**		**Overall**		**P-Value**
	Mean	**STD**	**Mean**	**STD**	**Mean**	**STD**	
Birth weight, g	3192	724	3275	723	3271	723	**0.0412[c]**
Maternal Age, y	29.6	5.96	26.18	6.49	26.33	6.5	**<.0001[c]**
	n	**%**	**n**	**%**	**n**	**%**	
Low birth weight	45	13.60	684	9.26	729	9.45	**0.0337[d]**
Female Child	180	54.38	3698	50.07	3878	50.26	0.1746[d]
Unmarried mothers	111	33.53	967	13.09	1078	13.97	**<.0001[d]**
Inadequate ANC visits	163	49.24	3776	51.13	3939	51.05	0.5544[d]
Maternal Age at delivery							**<.0001[d]**
< 20 years	27	8.16	1514	20.50	1541	19.97	
20-34 years	233	70.39	4978	67.41	5211	67.53	
>34 years	71	21.45	893	12.09	964	12.49	
Maternal Education							0.0653[d]
No education	54	16.31	888	12.02	942	12.21	
Primary	216	65.26	4843	65.58	5059	65.57	
Secondary or higher	61	18.43	1654	22.40	1715	22.23	
Family Income							0.2201[d]
Poor	124	37.46	2653	35.92	2777	35.99	
Average	62	18.73	1511	20.46	1573	20.39	
Richer	145	43.81	3221	43.62	3366	43.62	
Ethnicity							**< .0001[d]**
Tumbuka	26	7.85	756	10.24	782	10.13	
Chewa	70	21.15	2549	34.52	2619	33.94	
Ngoni	32	9.68	935	12.66	967	12.53	
Yao	43	12.99	983	13.31	1026	13.30	
Lomwe	102	30.82	1166	15.79	1268	16.43	
Others races	58	17.52	996	13.49	1054	13.66	

[a]Significant values are in bold font
[b]HIV+ HIV positive mothers, HIV- HIV negative mothers
[c]Student's t-test for comparisons of means between groups based on maternal HIV status as HIV-positive vs HIV-negative mothers
[d]Pearson chi-square test for comparison of proportions

A total of 7,716 singleton babies born 5 years preceding the survey were analyzed, of which 729 were LBW. Therefore, the prevalence of LBW was estimated as 9.45% in this study. Chi-square analyses showed that maternal HIV status, maternal age, maternal education, family income, and ethnicity were statistically related to LBW [Figure 2]. However, child sex, marital status, and prenatal care was not statistically related to LBW. The prevalence of LBW was higher among infants born to HIV infected mothers, as compared to those born to HIV negative mothers. Female children had statistically non-significant higher prevalence of LBW than their male counterparts. Teenage mothers registered the highest percentage of LBW followed by the older mothers, and least among the middle-aged mothers. The proportion of LBW babies was slightly higher among unmarried mothers than married mothers, but it was not a statistically significant difference. The prevalence of LBW decreased with increasing maternal education, mothers with secondary or higher education having the least prevalence and those who had no education having the highest prevalence. Women who had inadequate prenatal care had statistically non-significant higher proportion of LBW infants than their counterparts. There was also a statistically significant difference in LBW rates by ethnicity with Chewa and Ngoni tribes having highest and lowest prevalence of LBW infants, respectively.

Table 2: LBW prevalence by maternal and Child factors : results of chi-square tests[a]

Variables	Low birth weight		P-Value
	n	%	
Maternal HIV status			**0.0337**
Positive	45	13.60	
Negative	684	9.26	
Child sex			0.3344
Female	347	9.85	
Male	382	9.04	
Maternal Age at delivery			**< 0.0001**
< 20 years	207	13.43	
20-34 years	424	8.14	
>34 years	98	10.16	
Marital status			0.4085
Unmarried	112	10.39	
Married	617	9.29	
Maternal Education			**0.0040**
No education	113	12.00	
Primary school	497	9.82	
Secondary or higher	119	6.94	
Prenatal care			0.6845
< 4 ANC Visits	378	9.60	
≥ 4 ANC Visits	351	9.29	
Family Income			**0.0001**
Poor	326	11.74	
Average	132	8.39	
Richer	271	8.05	
Ethnicity			**< 0.0001**
Tumbuka	63	8.06	
Chewa	333	12.71	
Ngoni	65	6.72	
Yao	82	7.99	
Lomwe	107	8.44	
Others races	79	7.50	

[a]Significant values are in bold font

4b. Logistic analyses

Bivariate logistic regression analysis was performed using the dataset to examine the influence of each risk factor on low birth weight. The unadjusted odds ratios showed statistically significant associations between LBW and maternal sociodemographic characteristics: maternal HIV status, maternal age, maternal education, family income, and ethnicity [Table 3]. HIV positive mothers had significantly elevated risk for low birth weight offspring in this study. Teenage maternal age was also associated with increased risk for LBW. Having primary education, being illiterate, and belonging to poor wealth-index were also statistically significantly associated with higher risk for LBW infants. Among the six ethnic groups in this study, only Chewa women had a statistically significant higher risk for LBW, when compared to Ngoni women. However, mothers who gave birth to female child, who were unmarried, gave birth at old age, had inadequate ANC visits, had richer wealth-index, and belonged to Lomwe, Tumbuka, Yao, or other races did not have statistically significantly higher risk to have LBW offspring than their counterparts.

After adjusting for the covariates selected based on literature review and their availability in the dataset, a multivariable logistic regression model revealed that Maternal HIV positive status, young maternal age at delivery, lower maternal education level, poor wealth index, and Chewa ethnicity were independently associated with a higher odds of LBW [Table 3]. However, child sex, single (unmarried) motherhood, old age motherhood, and inadequate prenatal care were not significantly associated with LBW. According to this model, Chewa ethnicity was strongest factor associated with LBW, followed by teenage motherhood, and then maternal HIV positive status. These results show that maternal HIV status is an independent risk factor for LBW and support the hypothesis that HIV positive mothers have greater risk for LBW offspring compared to HIV negative mothers even after controlling for known confounders.

Table 3. Results of Bivariate and Multivariate Logistic Model for Maternal and Child factors associated with LBW

Variables	Crude Odds Ratio		Adjusted Odds Ratio**	
	OR	**95% CI***	**AOR**	**95% CI**
HIV positive mothers	1.55	**1.03-2.33**	1.77	**1.17-2.67**
Female Child	1.10	0.91-1.34	1.11	0.91-1.36
Maternal Age at delivery				
20-34 years (Referent)				
< 20 years	1.75	**1.38-2.22**	1.86	**1.47-2.35**
>34 years	1.28	0.94-1.74	1.07	0.78-1.47
Unmarried mothers	1.13	0.85-1.50	1.01	0.76-1.34
Maternal Education				
Secondary or higher (referent)				
No education	1.81	**1.28-2.58**	1.66	**1.13-2.43**
Primary school	1.45	1.08-1.95	1.29	0.94-1.77
Inadequate prenatal care	1.04	0.87-1.24	1.05	0.87-1.26
Family Income (Wealth index)				
Average (referent)				
Poor	1.45	**1.12-1.88**	1.37	**1.05-1.78**
Richer	0.96	0.72-1.26	1.09	0.82-1.40
Ethnicity				
Ngoni (Referent)				
Chewa	2.01	**1.45-2.78**	1.92	**1.39-2.66**
Lomwe	1.27	0.88-1.83	1.21	0.84-1.75
Tumbuka	1.20	0.76-1.89	1.30	0.82-2.05
Yao	1.20	0.82-1.76	1.10	0.76-1.61
Others races	1.12	0.78-1.61	1.08	0.77-1.55

*CI confidence interval. Significant values are in bold font.

** Adjusted for all variables listed in the table

4c. Interaction of maternal HIV infection with maternal factors

Further analyses were carried out to assess homogeneity effects between maternal HIV status and the covariates on the risk of LBW. As table 4 shows, HIV positivity tended to interact with maternal age, prenatal care, and marital status on the risk of LBW, although the interactions were not statistically significant. In comparison with HIV negative mothers, the risk of LBW for HIV positive mothers increased with increasing maternal age, inadequate antenatal visit, and unmarried marital status.

Table 4.4 Homogeneity effects of maternal HIV infection and maternal factors on the risk of LBW in a sample of 7716 mother-child pairs, Malawi 2010 DHS

Covariates	Maternal HIV status	LBW		Odds Ratio		
		Yes	No	Crude	Adjusted*	95% CI
Maternal Age						
< 20 years	Positive	4	23	1.12	1.22	0.35 - 4.29
	Negative	203	1311	1.00		
20-34 years	Positive	28	205	1.58	1.78	1.09 - 2.91
	Negative	396	4582	1.00		
> 34 years	Positive	13	58	2.13	2.39	1.02 - 5.58
	Negative	85	808	1.00		
Prenatal care						
≥ 4 ANC Visits	Positive	20	148	1.34	1.46	0.78 - 2.75
	Negative	331	3278	1.00		
< 4 ANC Visits	Positive	26	137	1.85	2.13	1.30 - 3.56
	Negative	352	3424	1.00		
Marital status						
Unmarried	Positive	21	90	2.25	2.79	1.37 - 5.70
	Negative	91	876	1.00		
Married	Positive	25	195	1.26	1.45	0.89 - 2.46
	Negative	592	5826	1.00		
	Negative	254	2967			

*adjusted for remaining covariates in the model

CHAPTER V

DISCUSSION AND CONCLUSION

5a. Discussion

This is one of few studies that examined the relationship between maternal HIV infection and LBW in a setting with highest prevalence of HIV infection. The results indicate that HIV positive women are at statistically significantly increased risk for giving birth to low birth weight infants even after adjusting for confounders such as maternal age, marital status, maternal education, prenatal care, family income, race, and child sex. The risk is more pronounced as the mother gets older and among unmarried women. On the other hand, having adequate prenatal visits mitigates the effect of HIV positivity on low birth weight.

The prevalence of LBW in this representative cross-sectional study was 9.45%, which is similar to national reports (National Statistical Office (NSO) and ICF Macro, 2011). Although this proportion of LBW is lower than 19.9-21.5% reported in previous facility based prospective study (Taha et al., 2012b), it is still a major challenge to reduce neonatal mortality in Malawi. Apart from neonatal mortality, LBW is also likely to significantly increase developmental disabilities such as learning difficulties, visual and auditory deficits, and cerebral palsy (Currie & Moretti, 2007; Black et al., 2007).

The finding of an increased risk of LBW among HIV-positive mothers is consistent with those reported in previous studies (Salihu et al., 2012; Siza, 2008) including studies done in Malawi (Nkhoma et al., 2012). In a population-based retrospective study in Florida, Salihu and colleagues found 40% greater likelihood for LBW among HIV-positive mothers (Salihu et al., 2012). Likewise, a facility-based cross-sectional study (n = 648) in Tanzania (Siza, 2008) found that HIV-positive mothers had a twice increased risk of LBW (OR = 2.4; 95% CI 1.1-5.1). Similarly, NKhoma and colleagues followed up 831 Malawian pregnant women, and maternal HIV status was associated with increased risk of LBW (OR=3.08; CI 1.40-6.79). HIV infection might influence LBW through placental inflammation which disrupt placental function. This observed association between LBW and maternal HIV status might have been strengthened by poor maternal nutrition, and poverty due to limited economic productivity, and co-morbidity with other illnesses, which are common among HIV positive women and are well-known determinants for LBW in developing countries (Watson-Jones et al., 2007).

This study has shown that maternal age, maternal education, wealth index, and ethnicity were statistically significantly associated with the birth weights of the infants. A large number of epidemiological studies have shown similar findings (Dahlui et al., 2016; Taha et al., 2012b). High prevalence of LBW in younger mothers might be due to their incomplete physical development as well as due to their social disadvantages such as low social economic status, low education, poor nutrition, and low BMI (Roth et al., 1998). Low maternal education might influence LBW through low finances associated with it and limited ability for such mothers to make right decisions about their health (Silvestrin et al., 2013). In short, low education influences poor maternal feeding practices and maternal health service utilization. Lower wealth index is associated with poor nutrition and tend to influence prenatal and perinatal factors hence leading to high rates of LBW (Mohammad et al., 2014). However, it is not clear why Chewa women had significant higher risk for LBW than other tribes, but it might be due to differences in environmental and genetic factors.

However, the present study did not find a statistically significant association between LBW and child sex, marital status, or prenatal care. These result are inconsistent with the following findings that found statistically significant association between infant sex and LBW (Dubois &

Girard, 2006; Mohammad et al., 2014; Abubakari et al., 2015), and strong association between marital status and LBW (Oladeinde et al, 2016; Frimmel & Pruckner, 2014). Likewise, they are contrary to the other findings that found inadequate antenatal visits to be strongly associated with LBW (da Fonseca et al., 2014; Negandhi et al., 2014; Mahumud et al., 2017; Hendryx et al., 2014; Bacci et al., 2014; Khanal et al., 2014). One of the reasons for this inconsistency might be due to free health services in Malawi which render women equal access to health care regardless of their income level. Previous researchers speculated that married mothers have better income which enable them to have necessary prenatal care than their counterpart hence lower rates of LBW reported in previous studies.

This is the first study that assessed the interaction of maternal HIV infection and maternal factors: maternal age, prenatal care, and marital status income on the risk of LBW. Increase in maternal age, inadequate antenatal visit, and unmarried marital status modified the effect of HIV infection of LBW. Previous studies found the significant association between severity of HIV infection and risk of LBW (Turner et al., 2013; Kuhn et al., 2005; Lambert et al., 2000), therefore, it can speculated that the increase in maternal age modify the association between HIV infection and LBW by increasing the severity of the infection, since the HIV positive older mothers are more likely to have been lived with the HIV virus for longer period than young HIV positive mothers. In addition, increase in age result in decrease in body immunity to infections thereby exacerbating the effect of HIV on LBW. Inadequate antennal visits and unmarried marital status might modify the association through poor maternal nutrition and poverty due to inadequate health education and limited economic productivity (Watson-Jones et al., 2007). These findings support the need to intervene with supplemental nutrition interventions during antenatal clinics in order to successfully reduce LBW babies.

5b. Study strengths and Limitations

The major strength of this study was the availability of a large sample size, nationally representative dataset. This is one of the largest study in terms of study participants that determine the association between maternal HIV status and LBW. The large, ethnically diverse sample enhances the generalizability of the findings. The population-level study design reduced selection bias and limitation of generalization of results that commonly impact facility-based studies. Another strength is that many of well-known risk factors for LBW were taken into account when determining the association between maternal HIV status and LBW.

Certain limitations need to be taken into consideration when interpreting the results of this analysis. One of them is the use of secondary data which limited the researcher from adjusting for other confounders such as chronic diseases, alcohol use, and nutritional factors since they were not included in the dataset. It is possible, for instance, that HIV positive women were more alcoholic or underweight resulting in high odds of LBW. Another inherent weakness of the study is the fact that there is possibility of misclassification bias due to recall bias since variables such as age, education, and family income were self-reported in DHS. Such bias is likely to be a non-differential misclassification, resulting in underestimation of the association. However, the DHS has been collecting data by similar methods for more than two decades, and there has been a substantial improvement in the completeness and reliability of the dataset (ICF International, 2012)

In addition, cigarette smoking and body mass index, known risk factors, were not assessed due to many missing values and too few smokers in dataset, respectively, even though 10% of adult general population in Malawi smoke cigarettes (Muula et al., 2008). Finally, due to cross-sectional nature of the study design, causal relationship between the maternal HIV status and LBW could not be stablished.

5c. Implications of Findings

The findings of this study has a public health implications. Women most likely to be infected with HIV in pregnancy mirror those living with HIV in the general population – namely, women who are unmarried, with lower educational attainment, lower income, and younger than 20 years of age. In addition, we found a strong association between LBW and maternal HIV status. Therefore, consideration of HIV risk and status should be thought of when providing the continuum of care to women for healthier outcomes for mothers and offspring. Essentially, preconception care is of paramount importance since HIV positive women of reproductive age require appropriate preventive measures for disease transmission, and protective strategies for better pregnancy outcome. Therefore, the findings from this study will provide insights for public health professionals and policy makers to implement HIV prevention strategies or interventions programs to reduce the prevalence of LBW in the future. Therefore, these findings should be thought of by policy makers and prompt the development of effective public health interventions that could reduce the adverse effects of maternal HIV infection on newborn body weight.

5d. Recommendations for Future Research

Future research is necessary to examine if the association between the maternal HIV infection and LBW is confounded by the HIV treatment during the preconception period, as well as during pregnancy. In addition, other factors for LBW, such as body mass index, food security, nutritional status during pre-pregnancy and pregnancy, pregnancy-induced hypertension, and other health related factors should be controlled in the future investigations.

5e. Conclusion

In conclusion, this study demonstrated that being maternal HIV positive was independently associated with LBW. In Malawi, where prevalence of maternal HIV is high, clinicians, public health practitioners, and policy makers should be actively involved in health education to increase awareness among HIV-negative mothers of importance of preventing HIV infection for better birth weight offspring. The awareness to HIV positive women can help them to make informed decision on whether to get pregnant or not, and when they are pregnant, to attend antenatal clinics regularly and follow nurses recommendations on good maternal nutrition, for them to reduce the risk of LBW. In short, current study has substantiated the need to recognize HIV-positive pregnant mothers as high risk obstetric patients who need extra surveillance during pregnancy and delivery, and the need to strengthen HIV prevention among women of child bearing age in order to reduce the prevalence of LBW infants.

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