Maternal HIV Status and Birth Weight in Zambia. Is there an association?

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A dissertation submitted to the University of Zambia in partial fulfilment of the requirements of a degree of Master of Arts in Population Studies

THE UNIVERSITY OF ZAMBIA

Lusaka

DECLARATION

I, **RONALD MUNGONI** hereby declare that this dissertation.

(a) Represents my work.

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The dissertation of RONALD MUNGONI is approved as fulfilling part of the requirements for the award of the degree of Master of Arts in Population Studies by the University of Zambia.

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DEDICATION

To my family, friends and to you Christine, this is for you.

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Gratitude goes to my family members for their support and encouragement. To my parents Mr. and Mrs. Mungoni, thank you for the financial and moral support you provided me with throughout my studies, I am deeply indebted.

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ABSTRACT

Background: The prevalence of low birth weight (LBW) in any population reflects its socio-economic development and it is a good proxy to gauge the developmental status of the country. This study aimed at examining the association between Maternal Human Immunodeficiency virus (HIV) status and Birth Weight in Zambia. The study was undertaken to inform health policies which are directed towards the global nutrition target of achieving a 30 per cent reduction in the number of LBW by the year 2025.

Methods: Data from the 2018 Zambia Demographic Health Survey (ZDHS) was utilized, and Stata version 14 was used for analysis. The analysis was done at two levels: descriptive and inferential. In descriptive analysis, univariate analysis of selected background characteristics of women and children was conducted. Under inferential analysis, bivariate and multivariate logistic regression analysis was conducted to ascertain the association between the outcome variable and selected background characteristics.

Findings: The study findings indicate that 12.9 per cent of women who reported the birth weight of their infants were HIV positive and that 7.7 per cent of infants were born with LBW. The results in a multivariate analysis reveal that the likelihood of giving birth to LBW infants among HIV positive women was significantly high when compared to HIV negative women. This is because HIV positive women are immunocompromised and prone to different diseases as well as undernutrition. Furthermore, the findings have shown that women who were married, those who had attended secondary or higher education, and those that attended antenatal care (ANC) 4 or more times had significantly reduced odds of delivering LBW infants. However, female infants were significantly more likely to be born with LBW compared to male infants. In addition, a sub population analysis of HIV positive women indicates that the risk of bearing LBW infants was significantly high among women who lived in rural areas, those that belonged to the middle wealth index and those that were from regions with a high prevalence of HIV infection like Lusaka and the Copper belt.

Conclusion: It can, therefore, be concluded that maternal HIV status is significantly associated with LBW and there is need to raise awareness on the effects of the HIV infection on birth weight, so that any untoward consequences of the infection can be averted

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ACRONYMS

LBW	Low Birth Weight
NLBW	Non Low Birth Weight
HIV	Human Immunodeficiency virus
AIDS	Acquired Immune Deficiency Syndrome
PMTCT	Prevention of Mother to Child Transmission
ZAMPHIA	Zambia Population Based HIV Impact Assessment
ZDHS	Zambia Demographic and Health Survey
DBS	Dried Blood Spot
CDC	Centre for Disease Control and prevention
ANC	Antenatal care
HUU	HIV unexposed uninfected infants
HEU	HIV exposed uninfected infants

CHAPTER 1: INTRODUCTION

1.1 Background

HIV infection has remained one of the major public health challenges in the world. Globally, around 36.9 million people were living with HIV in 2017 alone and the sub-Saharan Africa region accounted for over two third of the global estimate of persons living with HIV/AIDS (Stringer et al., 2018). It is further estimated that more than 1.5 million women with HIV give birth annually (Stringer et al., 2018).

HIV infection in women raises susceptibility to LBW through predisposing to obstetric complications including anemia that can independently restrict birthweight (Zenebe et al., 2020) Furthermore, under nutrition including micronutrient deficiencies which are more frequently observed in HIV infected pregnant women may predispose to LBW. HIV infection reduces appetite, causes malabsorption of nutrients, alters metabolism, and increases the demand for essential nutrients to cause wasting syndrome and thus LBW (Zenebe et al., 2020). In most parts of southern Africa, more than 30 per cent of pregnant women attending antenatal clinics are infected with HIV, thus making HIV infection one of the most common complications of pregnancy which is likely to impact the birth weight of an infant (Global HIV & AIDS statistics, 2018).

On one hand, the number of children infected with HIV is decreasing given the success of the prevention of mother to child transmission (PMTCT) programs of HIV. However, the number of uninfected children exposed to HIV through their infected mothers is on the rise. For this reason, interest has been growing on the birth weight outcomes of children exposed to HIV but are uninfected in the past decade, as evidence from several studies suggesting that these infants are more likely to be born with LBW compared to HIV unexposed infants (Evans et al., 2016).

In Africa, over a third of women of childbearing age are HIV infected**.** And even though HIV is not a direct cause of LBW, maternal HIV infection causes an increased risk of giving birth to LBW babies. This increased risk often extends to those babies who do not become HIV positive. The interaction of HIV with other infections and the indirect effects of maternal characteristics, such as poverty and the mother's level of education, contribute to LBW outcomes of these newborns (Hussen, 2017).

Literature reveals that HIV infection in women who have not received antiretroviral therapy (ART) has been associated with LBW. For example, in the year 2010, it was estimated that 32.4 million children were born with Small for Gestational Age (SGA) in low and middle income countries, of whom 10.6 million infants were born with LBW (González et al., 2017).

LBW is defined as a birth weight of less than 2500 g (up to and including 2499 g), as per the World Health Organization (WHO) (Cutland et al., 2017). LBW is a global public health problem, since it is both a sequel of maternal health and a predictor of a child's health (Cutland et al., 2017). Globally, it is estimated that 15 to 20 per cent of all births worldwide are LBW every year which corresponds to more than 20 million births a year, over 95 per cent of these are born in low income countries (Mvunta et al., 2019).

Furthermore, demographic studies estimate that chances of giving birth to LBW infants among children born to HIV infected mothers is higher than among infants born to mothers without HIV infection (Evans et al., 2016). This makes LBW associated with death in children under 5 years especially in high HIV endemic regions (WHO, 2015).

According to Xiao et al. (2015) women in developing countries particularly sub Saharan Africa have higher risks of giving birth to LBW infants than those in developed countries. Evidence from the meta-analysis study revealed that HIV infected women were 2 times more likely to be at risk of giving birth to LBW babies in sub–Saharan Africa compared to their uninfected counterparts.

Recent data from the Zambia Demographic Health Survey (ZDHS) survey indicates that HIV prevalence has continuously been on a decline, with overall adult HIV prevalence of 11.2 per cent in 2018 from 15.6 per cent in 2001-2002. Despite this progress, there are distinct gender related inequalities in HIV burden, with 14.2 per cent prevalence among women compared to 7.5 per cent prevalence among men. This difference is prominent among young adult females in the reproductive age group (Ministry of Health, 2018).

The heavy burden of HIV among women particularly those in the reproductive age group in Zambia is likely to affect the birth weight outcomes of infants. This is because HIV infected mothers who may give birth to HIV negative children are at high risk of impacting the birth weight of these children because HIV exposure directly or indirectly in utero, intrapartum, and during breastfeeding may confer risks to children, such as LBW even in the absence of vertical transmission (Ramokolo et al., 2017).

1.2 Statement of the problem

LBW is a valuable public health indicator of maternal health, nutrition, healthcare delivery, and poverty. It is associated with long-term neurologic disability, impaired language development, impaired academic achievement, and increased risk of chronic diseases including cardiovascular disease and diabetes later on in life (Cutland et al., 2017).

According to Thorne and Aebi-Popp (2016) more than one in ten babies are born with LBW and these neonates with LBW have a 20 times greater risk of dying than neonates with a birth weight of above 2500g. Most of these cases of LBW are concentrated in low and middle-income countries, especially in the sub-Saharan Africa region, as deliveries to pregnant women living with HIV. The causes of LBW are multifactorial, with maternal risk factors including smoking, body mass index, environmental exposures, socioeconomic status, and malnutrition, as well as infectious diseases like malaria and tuberculosis play a vital role. However, in Zambia the role of maternal HIV status as an underlying factor for LBW remains an area where strong evidence is lacking.

According to the Zambia Statistics Agency et al., (2019), 1 in 11 children in Zambia were born with LBW. But none of this could be attributed to maternal HIV status, despite evidence from ZDHS (2018) that prevalence of HIV is still relatively high and that women have disproportionately been affected by HIV around 11.1 per cent (Zambia Statistics Agency et al., 2019). As a result, the overall impact of HIV on LBW in Zambia lacks significant evidence to ignite policy response to redress the situation

Numerous studies carried out earlier provide literature on maternal HIV status and vertical transmission of the infection and its effect but have not fully explored the influence of maternal HIV status on LBW in Zambia.

Considering the public health importance of HIV infection and the fact that LBW is an important risk factor for infant mortality in sub-Saharan Africa, it is evident that maternal HIV status plays a significant role in birth weight outcomes of children and there is need to investigate LBW by maternal HIV status.

1.3 Research questions

1.3.1 General research question

What is the association between maternal HIV status and LBW in Zambia?

1.3.2 Specific research questions

1. What are the levels of LBW by maternal HIV status, demographic, and socio-economic characteristics?
2. What is the influence of maternal HIV status, demographic, and socio-economic characteristics on LBW in Zambia?

1.4 Research objectives

1.4.1 General objective

To examine the association between maternal HIV status and LBW in Zambia.

1.4.2 Specific objectives

1. To establish the levels of LBW by maternal HIV status, demographic, and socio-economic characteristics.
2. To examine the influence of maternal HIV status, demographic, and socio-economic characteristics on LBW in Zambia.

1.5 Significance of the study

Children born to HIV-positive mothers are at a substantially higher risk of LBW and mortality than children born to mothers without HIV, and the risk is greatest amongst children of mothers with a more advanced HIV disease (Hussen, 2017).

Studies from around the world have established that HIV exposure in utero without subsequent infection is likely to affect birth weight outcomes of infants (Ramokolo et al., 2017). Since there are limited studies in Zambia that have examined the link between maternal HIV status and LBW, a study of this nature would give insights into the influence of maternal HIV status on LBW, because most studies that have examined mother's HIV status have only linked it to fertility intention or contraceptive use and not LBW.

Furthermore, the results from this investigation can be used as a steppingstone for further studies and help inform health policies to improve maternal child health care by promoting good nutrition among mothers and their infant pairs like the Scaling Up Nutrition program endorsed by the government of Zambia under the Ministry of Health (UNICEF 2016). This would ultimately contribute to the global nutrition target of achieving a 30 per cent reduction in the number of infants born with a weight lower than 2500 g by the year 2025 (WHO, 1992).

The reduction of LBW also forms an important contribution to the Sustainable Development Goal number 3 (SDG 3) target 3.2 aimed at reducing child and infant mortality, since LBW is one of the leading causes of child and infant mortality. Activities towards the achievement of the SDGs will ensure a healthy start in life for children by making certain that women commence pregnancy healthy and are well-nourished to go through pregnancy and childbirth safely.

CHAPTER 2: LITERATURE REVIEW, THEORETICAL AND CONCEPTUAL FRAMEWORK

2.1 Introduction

This chapter presents empirical literature of different studies conducted to examine the association between maternal HIV status and LBW. It also reviews a conceptual framework adapted from Magadi et al (2004) which is a theoretical framework explaining the factors associated with unfavorable birth outcomes. The focus of this chapter is on maternal socio-demographic characteristics and biological factors of infants and how these relate to LBW.

2.2 Empirical literature

The presence of HIV in pregnant women puts infants at risk for exposure through placental infection and contact with contaminated maternal blood and genital secretions. Therefore, HIV exposed infants, including those who do not become infected, have higher chances of being born with LBW than HIV unexposed infants (Ramokolo et al., 2017).

2.3 Maternal HIV status

One of the risk factors for LBW is maternal HIV infection. Women who are HIV positive are more likely to give birth to LBW infants than HIV uninfected women (Wilkinson et al., 2015). Bagkeris et al., (2015) conducted a continuing observational cohort study to investigate the association between maternal HIV status and LBW on 8,884 HIV positive mothers and live born infant pairs in Ukraine from 2000-2012. Of the 8,884 babies, 1092 (12 per cent) infants were classified as being LBW. Based on the findings at the end of the study period, it was estimated that roughly 720 infants born to HIV positive women per year were born with LBW. The study, however, was limited by the potential for confounding and bias, including social desirability bias. For example, respondents were likely to incorrectly report the use of drugs like alcohol and smoking leading to systematic biases in estimating their effects on LBW.

A cross-sectional study conducted at the University of Gondar Teaching Hospital, North West of Ethiopia in 2019 revealed that in a multivariate analysis, the odds of being born with LBW for infants who were delivered from HIV uninfected mothers were reduced by 2.5 per cent compared to their infected counterparts (Ekubagewargies et al., 2019)

Another study conducted in Gauteng province of South Africa in 2014 found similar findings and indicated that about 11.4 per cent of women who tested positive for HIV had an increased risk of delivering LBW infants (OR 1.4) compared to women who tested negative for HIV. Further, women with unknown HIV status had increased odds of about 2.0 of delivering a LBW infant, but the association was not statistically significant (Tshotetsi et al., 2019).In addition, a facility-based prospective study in Tanzania revealed that women infected with HIV had significantly three times higher odds of giving birth to LBW infants compared to HIV negative women (Wilkinson et al., 2015).In contrast, a systematic review and meta-analysis of the scientific literature on perinatal outcomes associated with maternal HIV infection found no association was identified between maternal HIV infection and LBW, although few data were available for these outcomes (Wedi et al., 2016).

A study carried out in Zambia on the effects of the severity of HIV disease in HIV infected mothers on mortality and morbidity among their uninfected infants showed that there was an association between severity of HIV and LBW (Kuhn et al., 2005). This study postulated that the more severe the HIV infection the higher risk of giving birth to LBW infants.

Maternal HIV infection in utero or at birth plays a crucial role in influencing birth outcomes of infants. Bagkeris et al., (2015) established a strong association between maternal HIV infection and LBW. Infants born to HIV positive mothers are said to have a higher chance of being born with LBW than those born to HIV negative women. This could be because HIV alters the immune system of the mother. A compromised immune system may have an impact on the birth weight of an infant because HIV patients are prone to different diseases as well as malnutrition which are known risk factor for LBW (Feresu SA, et al., 2015). However, Wedi et al., (2016) found no significant associations between maternal HIV status and LBW. The possible explanation could be the differences in methodologies employed. Bagkeris et al., (2015) used a cohort study to examine the association between maternal HIV status and LBW while Wedi et al. (2016) employed a systematic review of scientific literature.

2.4 Maternal age

Literature from around the world has provided evidence that maternal age is an important independent risk factor for LBW (Msamila, 2018). Most of the young girls begin bearing children at an early age before they are emotionally and physically prepared and this could affect the birth outcomes of their children (Dennis and Mollborn, 2013).

In India a study conducted using routine hospital data collected between 2008 and 2014 showed that lower maternal age was significantly associated with high risk of LBW (Ahankari et al., 2017).

Likewise, a study on birth weight and preterm delivery outcomes of perinatal versus non perinatal HIV infected pregnant women in the United States found that HIV positive women in the 13 to 17 age category, had a higher proportion of LBW infants compared to women aged 18 to 22 years with 22 per cent versus 16 per cent between the two age groups. Nevertheless, there was no significant association between maternal age and LBW (Jao et al., 2017).

A cross-sectional study among mothers tested for HIV infection between January and November 2013 in Nigeria indicated that there was a significant association between maternal age and birth weight of infants and incidences of LBW were decreasing with increasing maternal age. The findings in this study indicated that the number of LBW newborns in older mothers was significantly lower when compared to mothers who were 20 years, of age and below. For example, among women aged less than 20 years 10 per cent of infants were born with LBW while women aged 35 years and above, only 2.5 per cent were born with LBW (Amosu , et al., 2014). Equally, a study conducted in Lusaka, Zambia by Chibwesha et al. in 2016 on predictors and outcomes of LBW among women who were tested for HIV established a statistically significant association and that women aged less than 20 years were 30 per cent more likely to deliver LBW infants when compared to women aged 25-30 years (Chibwesha et al.,2016).

Studies reviewed above have documented the negative health consequences for women who bear children during the adolescent years. More recently, attention has also focused on the wellbeing of children born to these young women. Evidence from the literature reviewed indicates that adolescent mothers are more likely to give birth to LBW infants compared to those aged between 20 and 35 years. This could be attributed to biological immaturity that aggravates the increased risk of LBW among teenage mothers and the fact that they are not emotionally and physically prepared to bear children.

2.5 Mother’s level of education

Maternal education is important in understanding the prevalence of LBW. The higher the education level of the mother the lower the risk of giving birth to LBW infants (Msamila, 2018).

Momeni et al., (2017) in a study on the prevalence and risk factors of LBW in the South East of Iran established that women with no education had increased odds of 1.9 of having LBW infants and it was established that lack of education was significantly associated with LBW when compared to women with primary, secondary, or higher levels of education.

Similarly, a descriptive retrospective study among women in Tanzania established significant differences between lower levels of education and secondary or higher levels of education. Among births that were exposed to HIV through their mothers, very LBW deliveries were associated with lower levels of education. Nonetheless, there was a significantly substantial number of clients with incomplete data which might have affected the results obtained and therefore making it hard to draw valid conclusions (Kamala et al., 2018).

Another study conducted in South Africa in 2017 on 6,179 HIV unexposed uninfected (HUU) and 2,599 HIV exposed uninfected (HEU) infants based on a cross-sectional study, found that higher odds (OR, 1.3) of LBW were observed among HEU infants versus HUU infants. Most of these infants were births to mothers with primary education compared to mothers with secondary education. Furthermore, there was a significant association between maternal education and LBW (Ramokolo et al., 2017).

A nationally representative cross-sectional survey of mother infant pairs attending week 6 infant immunization visits conducted by Karki, (2016) discovered that HIV exposed infants born to mothers with primary and secondary/higher education had lower odds of being born with LBW with 0.64 and 0.27 respectively, compared to those with no education.

From the studies reviewed, it is evident that high and medium level of maternal education has a significant protective effect against LBW compared to low or no maternal education. This could be because education enables mothers to be employed and provides a source of income which can help them access quality health care services and better nutrition since it is assumed that each additional year of schooling is associated with increased income (Turčín and Stávko, 2012).

2.6 Employment status

Employment provides a means of earning a living for the mother and have access to nutritional needs which may help reduce the chances of giving birth to LBW infants (Turčín and Stávko, 2012).

A retrospective analysis of cohort data in Kenya among pregnant HIV infected women on preterm birth, LBW, and SGA in HEU infants found that there were no significant differences between employed and unemployed women, and they both had a 50 per cent chance of bearing LBW infants

(Slyker et al., 2014).Similarly a study conducted by Petraro et al., (2018) established that there was no significant association between mother's employment status and LBW.

The above findings established no significant differences in the prevalence of LBW between employed and unemployed mothers. This could be attributed to the fact that the association between employment status and LBW may be confounded by other maternal characteristics like maternal age and level of education. Since, young women generally have lower levels of education, they are more likely to be unemployed when compared to older women (Msamila, 2018).

2.7 Religion

Religion is a social-cultural system of designated behaviors and practices, morals and ethics that relates humanity to supernatural and spiritual elements. Religious affiliation has the power to dictate the way people live such as smoking, alcohol consumption and the kind of food consumed especially among women, which in turn, may influence their birth outcomes (John and Tamara, 2013).

A study conducted in the United States of America found that maternal religious attendance is protective against LBW. In fact, each unit increase in the frequency of religious attendance reduces the odds of LBW by 15 per cent. This is because religious attendance was also found to be associated with lower odds of cigarette use and alcohol consumption which are likely to negatively affect the weight of the baby at birth (Burdette et al., 2012).

These findings suggest that health benefits of religious involvement may extend across generations (from mother to child) because most mothers who are deeply religious do not engage in risky behavior like cigarette smoking and alcohol use, which have the potential to influence birth outcomes of infants. However, there is still need for more evidence to fully explain the association between maternal religious attendance and LBW. It is, therefore, important for future research to consider the extent to which the apparent health advantages of religious adults might be attributed to health advantages in early life, especially those related to healthy birth weight even in the absence of cigarette use, poor nutrition, and alcohol use.

On the other hand, a study conducted in Nigeria in 2017 on pregnancy outcome of HIV infected women on Anti-Retroviral Therapy (ART) at a treatment center in port Harcourt established no significant association between religion of the mother and LBW (Mark Moore and Tobin-West, 2017).

2.8 Marital Status

Accumulating scientific evidence has consistently shown that women who are not married have an increased risk of giving birth to LBW infants (Oladeinde et al., 2016). In confirmation of the above assertion a registry-based study conducted in Russia in 2017 in a highly endemic HIV area established a strong and significant association between marital status and LBW. Single women and those that were cohabiting were 84 and 90 per cent more likely to bear LBW infants. (Usynina et al., 2017).

Another study conducted among HEU infants and infected mothers in Kenya in 2014 supports the above findings, that women who were married and were infected with HIV were 35 per cent less likely to bear LBW babies. A possible explanation is that mothers who are married are likely to have the support from their partners socially and economically. Consequently, they may have better nutrition thereby reducing the likelihood of giving birth to LBW infants significantly. Nonetheless, the study observed that marital status of infected women was not significantly associated with LBW. It would therefore, be right to assume that the effect caused by HIV infection during pregnancy and at birth may be offset by better maternal nutrition that married women are likely to have because of the support from their partners (Slyker et al., 2014). The study was limited in the sense that data were a decade old, therefore this cohort was targeted and selected during a time when antiretroviral treatment was only rarely available in Kenya. Further, Oladeinde et al., (2016) also revealed that unmarried women were two times more likely to give birth to LBW infants than married women.

2.9 Parity

Evidence from literature shows that there is an inverse relationship between number of children ever born and LBW (Slyker et al., 2014). The above assertion is validated by a cross-sectional study in China on impact of maternal HIV infection on pregnancy outcomes which found a significant relationship between parity and LBW. Women with a parity less than 2 were 33 per cent less likely to bear children with LBW. A possible explanation is that higher parity mothers have experiences to draw on to improve their pregnancy outcome since their first pregnancy primes the body and with each subsequent pregnancy the body becomes more efficient among multiparous women.

However, this study suffered from several limitations. For example, because of the cross-sectional nature of the study, no causal conclusions can be drawn between potential influential factors and adverse pregnancy outcomes (Yang et al., 2019).

Another study carried out in Nigeria at the HIV treatment center, observed no significant differences between women with zero parity and those with a parity of one and above (Ezechi et al., 2015). This could be because intrapartum care for these women was not done at the same facility where ANC care was conducted. This might have impacted on the birth outcomes of infants depending on the quality of services received during ANC. In addition, a study conducted in Lusaka, Zambia by Chibwesha et al. in 2016 on predictors and outcomes of LBW among women who were tested for HIV found that primiparous women had significantly higher odds of delivering LBW infants (AOR=1.8).

Likewise, a study on adverse obstetrical outcomes among women living with HIV in the Ottawa area showed that, out of the 27 births with adverse obstetrical outcomes (LBW and still births) 70 per cent were born to women with a parity of 1 whereas 19 (9 per cent) of infants were born to women with a parity of 2 and 3 respectively. However, there was no significant association between parity and LBW (Buchan et al., 2016).

2.10 Residence

Residence is a place or abode where a family lives and provides childcare and it has the potential of determining the birth outcomes of children depending on the social amenities available in that particular place (Yang et al., 2019).

Findings from a cross sectional study in China in 2019 among mothers who were HIV positive show that infants born to women in rural areas had increased odds of 1.4 of LBW compared to those born to women in urban areas, but the differences between rural and urban were not statistically significant. However, when adjusted for other predictor variables, the differences between urban and rural areas in terms of LBW were statistically significant. In addition, women living in rural areas were twice more likely to give birth to LBW infants than those in urban areas (Yang et al., 2019).

These findings are supported by an institution based retrospective cross-sectional study in Ethiopia in 2019 were LBW was high among women in rural areas. Mothers in rural areas were 39 per cent more likely to bear LBW infants than in urban areas (Ekubagewargies et al., 2019).

Evidence generated from the studies indicates that mothers in rural areas have a higher likelihood of bearing LBW children. This could be due to the fact that, in rural areas there are inadequate health care facilities and services and women have to walk long distances causing stress among pregnant women which may have unfavorable effects on birth weight (Macfarlane et al., 2006). In addition, women in rural areas lack access to relevant information on how to effectively prevent adverse birth outcomes and this may prove detrimental on birth weight outcomes.

2.11 Wealth index

Wealth index is a composite measure of a household's cumulative living standard. The wealth index is calculated using easy to collect data on a household's ownership of selected assets, such as televisions and bicycles; materials used for housing construction; and types of water access and sanitation facilities (Shea and Johnson, 2004)

Wealth status of the mother can therefore influence the birth weight of a child**.** Tlou et.al (2018) investigated the risk factors for under five mortality in an HIV hyper endemic area of rural South Africa and established that LBW deliveries occurred in households of poor wealth quintile.

A similar study in Nigeria in 2015 established a statistically significant association between wealth index and LBW. Women in the upper social class were 15 per cent less likely to have adverse pregnancy outcomes (LBW and perinatal mortality) compared to those in the middle social class. Whereas, women in the working class were 3 per cent less likely to have LBW infants (Ezechi et al., 2015). The limitation that was observed in this study was that the intrapartum care of these women was not done at the same facility where ANC was conducted.

The high prevalence of LBW among women in lower wealth quintiles could be as a result of poor maternal nutritional intake among mothers with lower socioeconomic status (Manyeh, et al., 2016).

2.12 Region

Regional differentials are likely to influence health outcomes of children depending on the geographical and environmental factors that are found in those regions. Hence disparities between regions with regards to LBW can be observed (Thompson et al., 2005)..

According to a study conducted on regional variation in rates of LBW in the United States of America in 2005, LBW rates markedly varied across US regions of neonatal health services for both black and nonblack mothers. These differences were still apparent even after controlling for known maternal and area risk factors (Thompson et al., 2005)

Xiao et al. (2015) in a meta-analysis of the association between maternal HIV infection and LBW and prematurity, observed significant differences in the prevalence of LBW by region. It was concluded that women who lived in high HIV endemic areas especially those in developing countries were twice more likely to deliver LBW infants compared to those who lived in areas with low prevalence of HIV.

Similarly, studies in Ethiopia by Siyoum, and Melese, (2019) have shown variation in the prevalence of LBW by region. The prevalence of LBW was 16.5 per cent in rural Sidama zone, 17.9 per cent in South Western Ethiopia, 14.6 per cent in Tigray region and 9.1 per cent in Arsi zone (Siyoum, and Melese, 2019). The possible explanation for the variations could be the differences in economic status of the mothers in these different regions and other geographical and environmental factors which can increase the cost of living and hinder the necessary care pregnant women need in terms of nutrition and health care.

2.13 Birth order

The order a child is born has the potential to significantly affect their birth weight outcomes. Kheirouri and Alizadeh, (2017) in investigating the impact of prenatal maternal factors and birth order in Iran confirmed the above assertion by concluding that a significantly higher LBW rate was observed in first born infants (7.4 per cent) compared to second birth infants (2.4 per cent). The odds of being LBW in the first birth order were 5.97 ($p = 0.001$) times greater than those of second birth order infants, after adjusting for confounding factors (maternal BMI, age, and gestational age).

The differences observed in LBW by the birth order of an infant maybe because of the fact that after the first child, the body of a woman gets used the process of childbirth. Therefore, LBW among first born infants may be a direct consequence of physiological conditions associated with nulliparity.

One important point to note is that, most studies on HIV infection that were reviewed in this study left out birth order because it was correlated with parity (Chibwesha et al 2016, Buchan et al., 2016).

2.14 Antenatal Care (ANC)

Health of women is critical for birth outcomes of children. According to literature, number of ANC visits can influence the birth weight of the baby (Mvunta et al., 2019). A study done in India 2011 on the impact of maternal HIV infection on pregnancy and birth outcomes found that ANC was an important risk factor, as those not having received any antenatal care prior to delivery were at an increased risk of having LBW infants (Patil et al., 2011). Based on this study, regular ANC provided to HIV-infected women can reduce the risk of adverse birth outcomes for their infants, of which without adequate ANC attendance these risk factors may remain undiagnosed during pregnancy (Tshotetsi et al., 2019b).

Mvunta et al., (2019) conducted a registry-based study among women tested for HIV study in Tanzania on the incidence and recurrence risk of LBW. The study established that mothers who had inadequate ANC visits had significantly higher odds of delivering LBW infants than those with adequate ANC visits.

Furthermore, a cross sectional study in Malawi analyzed the association between Maternal HIV Status and LBW Offspring using Malawi DHS 2010 and established that HIV positive women who had attended 4 or more ANC visits were 34 per cent more likely to have LBW infants than HIV negative women, while HIV positive women who had attended less than 4 ANC visits were 85 per cent more likely to have LBW infants compared to their HIV negative counterparts. None the less, the study also found that ANC visits were not associated with LBW. (Msamila, 2017)

A study conducted in Zambia on the risk of recurrent LBW among women in Lusaka found similar results that there was no statistically significant association between ANC attendance and LBW (Smid M et al., 2015). This study was limited by the fact that the study utilized Electronic Perinatal Record System (ZEPRS) to review pregnancy outcomes of which researchers had no control over the quality of data entered.

From the literature reviewed, the possible explanation for inadequate number of ANC visits being a risk factor for LBW is that, during ANC visits, potential risk factors are screened for, and preventive interventions to avoid LBW are often implemented.

2.15 Sex of child

A study conducted by Muchemi et al. in 2015 in Kenya, on factors associated with LBW among neonates established that female infants were independently associated with LBW. Likewise a study conducted in the United States of America among infants who were born to HIV infected women indicated that male infants were 22 per cent less likely to be born with LBW, as male gender was predictive of normal birth weight (NBW) (Schulte et al., 2007).

Furthermore, a retrospective analysis of a cohort study conducted in Kenya among HEU infants found that the delivery of a female infant was a significant correlate of LBW (Slyker et al., 2014), while, other studies found no significant relationship between sex of child and LBW (Oladeinde et al., 2016).

From the findings above it is, however, still unclear on the possible explanation on the relation between female infants and LBW, as being female is a non-modifiable factor which is inherently biological.

2.16 Smoking and alcohol consumption

Smoking and the intake of alcohol among pregnant women have the potential of influencing the birth outcomes of infants. Many studies conducted in western countries have found a significant relationship between active maternal smoking and alcohol consumption during pregnancy and the risk of LBW. Mothers who had smoked or consumed alcohol throughout their pregnancy had a reduced birth weight of 169.6 g (Miyake et al., 2013).

Miyake et al., (2014) further found no significant relationships were observed between maternal alcohol consumption during pregnancy and the risk of LBW, as there was no significant association between maternal alcohol consumption during pregnancy and birth weight.

These studies suggest that smoking during pregnancy can cause harm to the unborn baby, through the different chemicals contained in cigarettes and ultimately affect the birth weight. However, strong evidence still lacks to ascertain the impact of smoking and alcohol consumption on birth weight because limited research has been conducted on this topic and needs to be explored further.

2.17 Gaps in Literature

After extensive literature review, generally it has been established that, study findings have been consistent and reliable however, in a few cases there has been contradictions.

Most studies conducted in Zambia of this nature (Smid M et al., 2015; Kuhn et al., 2005) have ignored the effects of geographical variations in the prevalence of HIV among women and its influence on LBW. This study, therefore, attempts to fill this gap in knowledge by examining how differences in the prevalence of HIV by geographical location might influence the likelihood of bearing LBW infants by categorizing regions according to the prevalence of HIV.

In addition, Miyake et al (2014) did not account for the influence that the interaction between maternal HIV infection and cigarette smoking may have on the birth weight of infants. This study aims to address this vacuum in knowledge by assessing the effect of cigarette smoking in the presence of HIV on LBW.

2.18 Theoretical Framework

To examine the association between maternal HIV status and LBW in Zambia, a conceptual framework as described by Magadi et al (2004) was adapted which was based on factors associated with unfavorable birth outcomes. According to Magadi (2004) et al, the number of probable factors which are associated with pregnancy outcomes are vast.

These factors have been categorized into four distinct blocks, ordered to form a chain. At the end of the chain is the fourth block consisting of indicators of unfavorable birth outcomes which is the dependent variable and consists of premature delivery, small baby at birth, and Caesarean section delivery. The birth outcomes are assumed to be directly influenced by maternal health care and nutritional status grouped in the third block. Together with these factors are the biological factors, such as multiple births and sex of child, which may also have a direct influence on the birth outcomes. The second block comprises of factors concerning reproductive behavior and accessibility of health services. These factors may contribute to adverse birth outcomes either directly or indirectly through the factors in the third block. Finally, in the first block, we have the socio-economic and demographic factors, which may influence birth outcomes through the intermediate factors, but may at the same time have a direct influence on the birth outcomes.

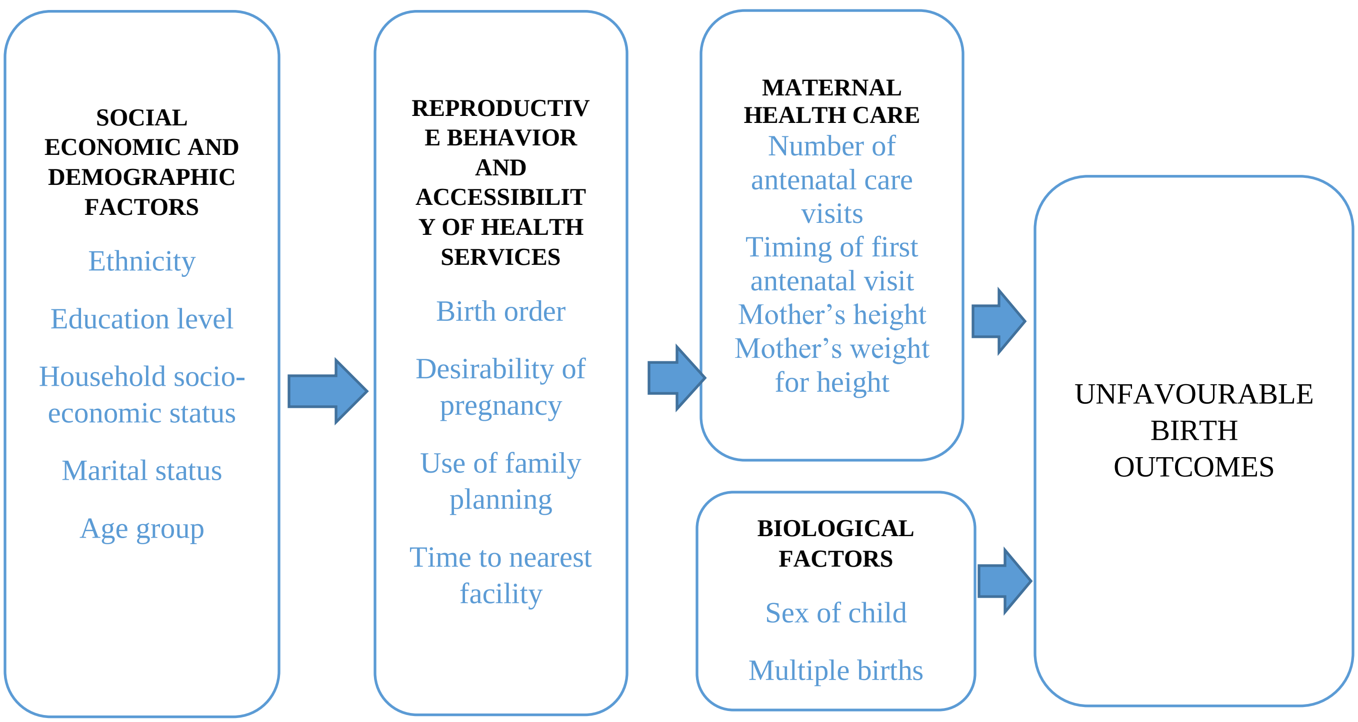


Figure 2.1: Theoretical Framework of the inter-relationships between potential risk factors and unfavorable birth outcomes by magadi 2004.

Source: adapted from Magadi et al, 2004 the inter-relationships between potential risk factors and unfavorable birth outcomes.

The theoretical framework by Magadi et al 2004 was adapted for this study because it provides evidence on the characteristics of women and infants that have been identified as potential risk factors likely to affect birth outcomes of infants and how these factors interact with each other to cause unfavorable birth outcomes in infants. In addition, a theoretical framework of this nature provides a foundation for testing the theory constructed by Magadi concerning unfavorable birth outcomes and how it may be applicable to similar studies which try to examine other unfavorable birth outcomes like LBW which might not have been examined by Magadi in developing this framework.

2.19 Conceptual Framework

The study's conceptual framework adopted some variables from Magadi et al 2004 theoretical framework and some these include mother's level of education, maternal age, marital status, number of ANC visits, sex of child and birth order.

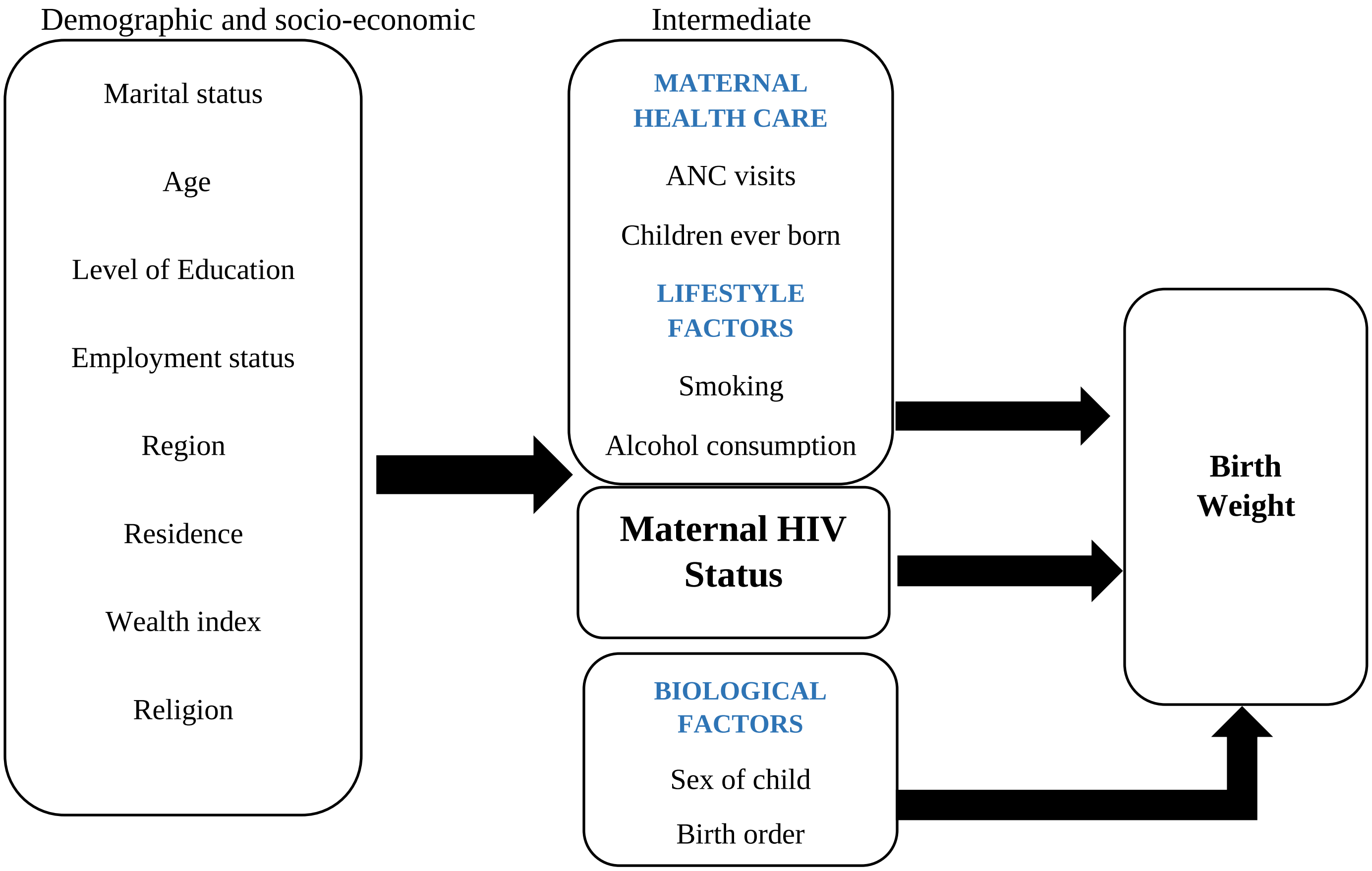


Figure 2.2: Conceptual framework illustrating the effect of socio demographic and immediate factors on birth weight

This study uses measures of birth weight to explore the effects of demographic and social economic, reproductive, and maternal health care factors on birth weight of children in Zambia.

The prospect of a pregnant woman having a LBW baby is dependent on intermediate determinants which are classified as reproductive (ANC visits, Children ever born) and maternal health care factors (Smoking, Alcohol consumption and most importantly Maternal HIV status).

The intermediate determinants of LBW are, in turn, influenced by demographic and socio-economic determinants manifesting themselves in the form of (marital status, maternal age at birth, level of education, mother's employment status, region, residence, wealth index and religion, these demographic and socio-economic determinants are likely to determine the reproductive choices availed to women in form of ANC visits and children ever born. Further, demographic, and socio-economic determinants also influence the kinds of lifestyles that impacts on women's health such as smoking, and alcohol intake coupled with HIV infection which may have a bearing on the birth outcomes of children.

In addition, biological characteristics of children are also important in influencing LBW by assessing if the sex of a child and birth order number have any effect on birth weight outcomes.

This conceptual framework provides an elaborate approach to the study of LBW in Zambia, and elaborates the different factors associated with LBW of infants.

CHAPTER 3: METHODOLOGY

3.1 Introduction

This chapter presents the study setting, study population, sample size and the study design as well as methods that were employed to achieve the objectives of the study and help answer the research questions. These methods involve how the independent variables have been operationalized to help ascertain their association with the study outcome. In addition, this chapter further presents the different levels of analysis (univariate, bivariate and multivariate) that were performed in attempting to answer research questions

3.2 Study setting

Zambia is a landlocked sub-Saharan African country situated in Southern Africa with a total surface area of 752,612 sq.km. According to the Central Statistical Office, the country's total population is expected to grow from 13.7 million in 2011 to 17.9 million by 2020 (Central Statistical Office et al., 2014). Zambia is divided into 10 provinces, up until October 2011, Zambia had nine 9 provinces. A tenth province, Muchinga was established based on districts formerly located in Northern and Eastern province. In Zambia, majority of people live in poverty, 54 out of every 100 Zambians are poor, and poverty in Zambia has continued to be more of a rural than an urban phenomenon (Central Statistical Office et al., 2014). This is because, the proportion of the population that is poor in rural areas is three times higher (76 per cent) than what is obtaining in urban areas, at 23.4 per cent. Furthermore, poverty levels by sex of household head indicate that there are higher levels of poverty for households that are female headed at 56.7 per cent compared to those headed by their male counterparts at 53.8 per cent (Central Statistical Office et al., 2014). Zambia Statistics Agency report (2019) further indicates that information on birth weight of infants was obtained for approximately 80 per cent of the births in the last 5 years preceding the survey. Among infants whose birth weight was reported, 9 per cent had LBW (less than 2.5 kg). Regarding HIV prevalence, 11.1 per cent of women and men aged 15 to 49 years in Zambia are infected with HIV. However, the prevalence of HIV is higher among women (14.2 per cent) and the burden is more predominant among women who are at the peak of their reproduction (25-40 years) ranging from 14 to 23 per cent (Zambia Statistics Agency et al., 2019).

3.3 Study design

This study utilized secondary data from Zambia Demographic and Health Survey 2018, which was a retrospective cross-sectional survey. A cross-sectional study is a research design used to source for information based on data gathered at a specific point in time.

3.4 Sources of data

The Zambia Demographic Health Survey (ZDHS) 2018 was the main sources of information for this study. The ZDHS is a national representative population based on a cross sectional survey of 16,411 women aged 15-49 and 14,993 men aged 15-49. The file that was used with regards to the respective topic on the association between maternal HIV status and LBW in Zambia was a combination of two datasets/files which were because of merging the women's record (ZMIR71FL) to the HIV dataset/file (ZMAR71FL). In addition, all women who were eligible for interviews were asked if they would voluntarily give a finger prick blood sample for HIV testing from dried blood spot (DBSs) (Zambia Statistics Agency et al., 2019).

A representative sample of 13,625 households was drawn for the 2018 ZDHS. The 2010 Population and Housing Census served as the sampling frame for the ZDHS. For more details about the sample selection, size, stratification, data collection procedures, and pre-tests, refer and check the 2018 ZDHS (Zambia Statistics Agency et al., 2019).

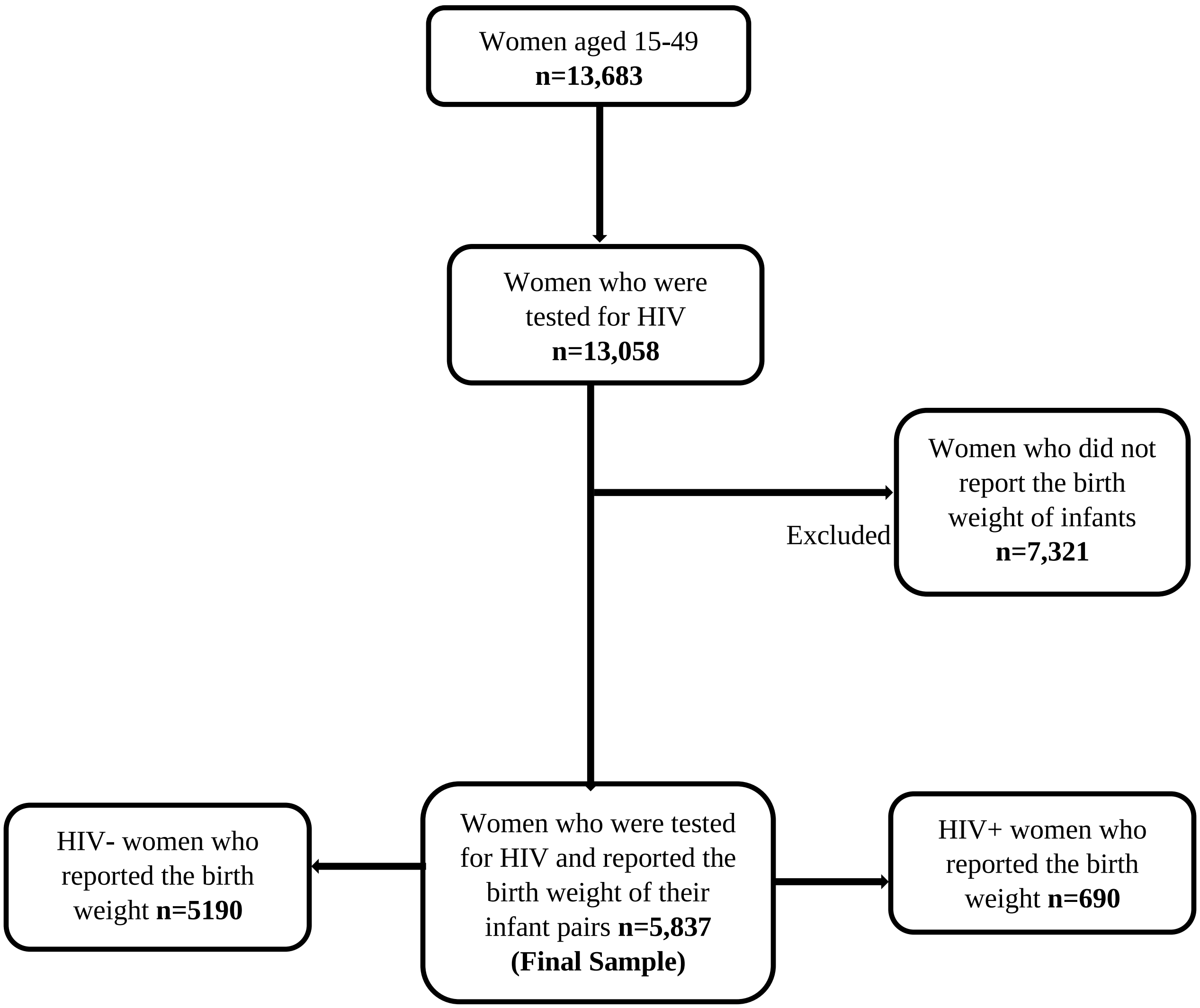
The sample for the 2018 ZDHS was designed to provide estimates at the national and provincial levels, as well as for rural and urban areas within the provinces. The enumeration areas (EAs) for the 2010 Population and Housing Census provided the sampling frame for the survey. The frame comprises 25,631 EAs and 2,815,897 households (Zambia Statistics Agency et al., 2019).

Three questionnaires were used namely, the Household questionnaire, women's questionnaire, and the men's questionnaire. For this study, the women's questionnaire was used. It is from the women's questionnaire that the children's file/dataset was drawn. Regarding this study, the ZDHS survey collected information on HIV prevalence of women and maternal health care and their child's weight at birth (Zambia Statistics Agency et al., 2019).

3.5 Study population and sample size

The study population included all women aged 15-49 who reported having had given birth to live infants within the five years preceding the survey but only those women who were voluntarily tested for HIV and their infant pairs were included in the analysis**.** The sample size for the analysis was 5,837 and out of this 5150 tested HIV negative and 690 tested HIV positive.

Figure 3.1 Inclusion/exclusion criteria



3.6 Variable identification and operationalisation

3.6.1 Dependent variable

The dependent variable, birth weight was measured by the question of how much the child weighed at birth:

1. How much did (NAME) weigh?
   Low birth weight is weight less than 2500g
   Normal birth weight is weight above 2500g

Birth weight comprises of two outcomes: low birth weight and non-low birth weight which will be used as a dependent variable, as shown below.

Dependent variable	**Variable name in dataset**	**Definition**	**Coding**
LBW	m19	Birth weight less than 2500 grams	1= Low Birth Weight **(LBW)** 0=Non low birthweight **(NLBW)**

Definition of terms

1. LBW has been defined by the World Health Organization (WHO) as weight at birth of less than 2,500 grams. This is based on epidemiological observations that infants that weigh less than 2,500 g or 2.5kg are almost 20 times more likely to die than heavier babies (WHO, 1992).
2. HIV is the retrovirus that causes AIDS in humans and stands for Human Immunodeficiency virus (UNAIDS 1998).
3. AIDS is the last and most severe stage of the clinical spectrum of HIV-related disease and stands for Acquired Immune Deficiency Syndrome (UNAIDS 1998).

3.6.2 Independent variables

The independent variables have been selected based on literature, their availability in the ZDHS data set, and as guided by the conceptual framework. The main independent variable of the study is HIV status of the mother. The control variables used in the study include the following: maternal age, birth order, sex of child, parity, ANC; maternal education, marital status, religion, smoking cigarettes, place of residence, region, and wealth index

Explanatory Variables	**Variable name in dataset**	**Conceptual/Operational Definition**	**Categories**
Maternal HIV status	hiv03	Represents the HIV status of mothers based on the test results	1. HIV negative 2. HIV positive
Marital status	v501	Are you currently married or living together with a man as if married? Marital status is the discrete option of describing a person's relationship status with a significant other such as single, married, divorced, and widowed	0. Never in union 1. Married/Living with partner 2. Widowed/Divorced/No longer living together/separated
Maternal age at birth		Age at birth of a child was computed by subtracting age of the mother by age of a child	1. Less than 20 years 2. 20-29 years 3. 30-49 years
Level of Education	v106	Education is the highest level of education attended	0. No education 1. Primary 2. Secondary/Tertiary
Employment status	v714	Whether the respondent is currently employed (having worked in the past 7 days, including women who did not work in the past 7 days but who are regularly employed and were absent from work for leave, illness, vacation, or any other such reason)	1. Yes 2. No
Region	v024	Region of residence is typically the first administrative level within the country, or a grouping of the first administrative level.	1. High 2. Middle 3. Low This categorization is based on the prevalence of HIV in Zambia to account for differences in HIV prevalence.
Residence	v025	Type of residence is the designation of the cluster or enumeration area as an urban area or a rural area.	1. Rural 2. Urban
Wealth index	V190	Wealth index is a composite measure of a household's cumulative living standard. The wealth index is calculated using easy-to-collect data on a household's ownership of selected assets, such as televisions and bicycles; materials used for housing construction; and types of water access and sanitation facilities.	1. Poor 2. Middle 3. Rich
Religion	v130	Religious group to which the respondent associates himself or herself	1. Catholic 2. Protestant 3. Other
ANC visits	m14	How many times did you receive antenatal care during this pregnancy?	1. Less than 4 2. 4 and above
Children ever born (Parity)	v201	Now I would like to ask about all the births you have had during your life. Have you ever given birth?	1. Less than 2 2. 2-4 3. 5+
Smoking	v463a	Do you currently smoke cigarettes?	1. Yes 2. No
Sex of child at birth	b4	Male or Female	1. Male 2. Female
Birth order	bord	Birth order (bord) is the order number of the births from first to last	1. Less than 2 2. 2-4 3. 5+

3.7 Data analysis

Analysis of data was done using a statistical package called STATA (version 14). The file that was used for analysis was a combination of two datasets/files which were because of merging the women's record (ZMIR61FL) to the HIV dataset/file (ZMAR61FL). During the merging process three key identifier variables were used and these include, cluster number (v001), household number (v002) and the respondents line number (v003).

Data analysis was done at three levels: univariate, bivariate and multi variate. Using univariate analysis descriptive statistics were produced on background characteristics of the mother and the infants. Bivariate analysis was conducted using a chi square test of independence to show the level of association between the outcome variable birth weight and independent variables, to establish the levels of LBW by maternal HIV status, demographic, and socio-economic characteristics, in an attempt to achieve the first objective of the study.

Further, bivariate logistic regression was also performed to produce unadjusted odds ratios (UOR) at 95% confidence interval (CI) to determine and ascertain the relative measure of effect of each variable on the outcome variable. Then, multivariable logistic regression was performed using a stepwise forward model building strategy to produce adjusted odds ratios (AOR) at 95% CI to determine the effect of maternal HIV status on LBW, adjusting for all independent variables. This level of analysis examined the influence of maternal HIV status, demographic, and socio-economic characteristics on LBW in Zambia as per objective number two of the study

In using binary logistic regression, as a method of analysis, there are assumptions that must be fulfilled, and these include a dichotomous dependent variable, with two possible outcomes. Secondly, logistic regression requires observations to be independent of each other, meaning they should not come from repeated measurements or matched data. In addition, logistic regression requires little or no multicollinearity among the independent variables (Szumilas, 2010).

Binary logistic regression uses Odds Ratios (OR) which is a measure of association between exposure and an outcome. Therefore, OR represent the odds that an outcome will occur given a particular exposure, compared to the odds of the outcome in the absence of that exposure. OR greater than 1 indicates increased occurrence of an event while OR less than 1 indicates decreased occurrence of an event (Szumilas, 2010).

$$\frac{\mathrm{LOgP(x)}}{1-\mathrm{P(x)}} = \mathrm{B}_0 + \mathrm{B}_1\mathrm{x}_1\mathrm{t}\ldots + \mathrm{Bkxk}$$

P(x) denote the probability of the risk of LBW.

1-p(x) denote the probability of the risk of LBW not occurring

B0... Bk is the coefficient of the independent variables.

X1...Xk denote the independent variables

3.7.1 Model building strategy

As a model building strategy, all variables which had a p-value less than 0.1 were included in the model using stepwise forward model building strategy. This is a method of fitting a model by adding variables at each step using the forward selection technique and checking to see if their significance is still within or above the specified level. Then all insignificant variables are removed in the final model to remain with the best fitted model because a variable entered at an early stage may become superfluous at a later stage due to its relationship with other variables that have subsequently been added to the model (Harrell, 2001)

To start with, a model of HIV positive women only was fitted and included demographic and socio-economic factors that were associated with maternal HIV status to ascertain their influence on LBW

Model for HIV positive women: *Log (LBW) = B0+ B1 (maternal age) + B2 (marital status) + B3 (education) + B4 (region) + B5 (residence) + B6 (wealth index) + B7 (ANC visits) + B8 (parity)*

Then model 1 was fitted and included only maternal HIV status which is the primary exposure variable to ascertain the effect of HIV infection on LBW.

Model 1: *Log (LBW) = B0+B1 (Maternal HIV status)*

Model 2 included maternal HIV status and demographic and socio-economic factors that were associated with LBW, to measure the association of these factors on LBW in the presence of maternal HIV infection.

Model 2: *Log (LBW) = B0+B1 (maternal HIV status) + B2 (maternal age) + B3 (education)+ B4 (employment status) + B5 (marital status).*

Model 3 was a full model of maternal HIV status, demographic and socio-economic and intermediate factors that were associated with LBW. This was done to measure the interaction effect of these factors combined on LBW.

Model 3: *Log (LBW) = B0+B1 (maternal HIV status) + B2 (maternal age) + B3 (education) + B4 (employment status) + B5 (marital status) + B6 (ANC visits) + B3 (parity) + B4 (sex of child/infant).*

The final model comprised only factors that were significantly associated with LBW to represent the best fitted model.

Once a logistic regression model has been fitted, a global test assessing the goodness of fit of the resulting model should be performed. The purpose of a goodness of fit test is to assess the fitted model's overall departure from the observed data. For this study, the Hosmer and Lemeshow F-adjusted mean residual goodness of fit test was applied to the survey data from the 2018 ZDHS to examine the adequacy of the fitted model for binary response models. For this test, a small p-value indicates a lack of fit while a p-value above alpha=0.05 indicates that a model appropriately fits the data (Hosmer and Lemeshow, 1980).

Further, during data analysis weights were applied to account for the degree of sampling errors during data collection by generating the sample weights (gen sampwt=hiv005/1000000) using the HIV sample weight.

For purposes of data quality, the merged dataset/file were checked for missing values, incomplete cases and multi collinearity.

3.8 Ethical consideration

Authorization was sought from ICF, Inc. LLC and then approval was granted to download and have access to the Zambia Demographic and Health Survey data from the Demographic and Health Surveys (DHS) Program. The authorization letter provides that all DHS data should be treated as confidential, and no effort should be made to identify any household or individual respondent interviewed in the survey and that data obtained may be used only for the purpose of statistical reporting and analysis, and only for the registered research. All other interested users are required to register for a download account to access the data. For more details on the authorization acquired see the authorization letter issued by ICF in the appendix.

In terms of ethical approval, the DHS program already sought ethical approval from the Tropical Disease and Research Center in Ndola, Zambia, and the US center for Disease Control and prevention (CDC) to carry out the survey in Zambia. For more details on ethical approval check the ZDHS 2018 report.

3.9 Study limitations

The ZDHS was a cross-sectional study, and therefore, it is not possible to show seasonal variation in birth weight. Further, being a retrospective study, the study mostly relied on individual recall of exposure to risk variables, and recall may be inaccurate and subject to biases which may compromise the quality of data collected.

The primary limitation of the cross-sectional study design is that because the exposure and outcome are simultaneously assessed, it is not possible to establish a true cause and effect relationship between exposure and outcome (Yang et al., 2019).

Another limitation of the study is that ZDHS data set does not have information on the use PMTCT services and uptake of ART among HIV positive women. Therefore, it is not possible to estimate the impact of such services on the birth weight of infants.

3.10 Data quality assessment

The ZDHS data was checked with regards to the distributions of HIV positive women in the reproductive age groups 15-49 for the 2007, 2013/14 and 2018 datasets. A close observation of the ZDHS datasets reveal that the age specific distribution of HIV positive women has generally been consistent across all different age groups with regards to the total number of women. As a result, this gave the much-needed confidence to use the ZDHS data because it is a nationally representative survey and has been consistent in the way data has been collected to represent and reflect the actual Zambian population (Table 3.1).

Table 3.1: Percent distribution of HIV by age of the mother for the 2007, 2013/14 and 2018 ZDHS

ZDHS Phase	**2007**		**2013/14**		**2018**	
Age group	**Per cent HIV+**	**Total number of women**	**Per cent HIV+**	**Total number of women**	**Per cent HIV+**	**Total number of women**
15-19	5.7	1202	4.8	3273	2.6	2818
20-24	11.8	1023	11.2	2745	8.9	2574
25-29	19.9	1058	15.0	2521	14.2	2080
30-34	26.0	819	20.7	2199	21.1	1751
35-39	24.9	585	24.1	1774	21.9	1579
40-44	18.3	445	24.1	1300	27.0	1185
45-49	12.1	369	19.5	907	22.7	831
Total		**5502**		**14719**		**12818**

Source: 2007, 2013/14 and 2018 ZDHS datafiles

Figure 3.2 shows the distribution of HIV by age of the mother and many studies have indicated that lower maternal age is associated with high risk of LBW. From figure 3.1, the 2018 ZDHS data seems to follow a similar trend, except for the age group 40-44 were there is a sudden increase in the per cent of LBW infants. Since the ZDHS is a retrospective study, it is prone to non-sampling errors and as such, the increase might have been due to misreporting of births and how much the child could have weighed at birth.

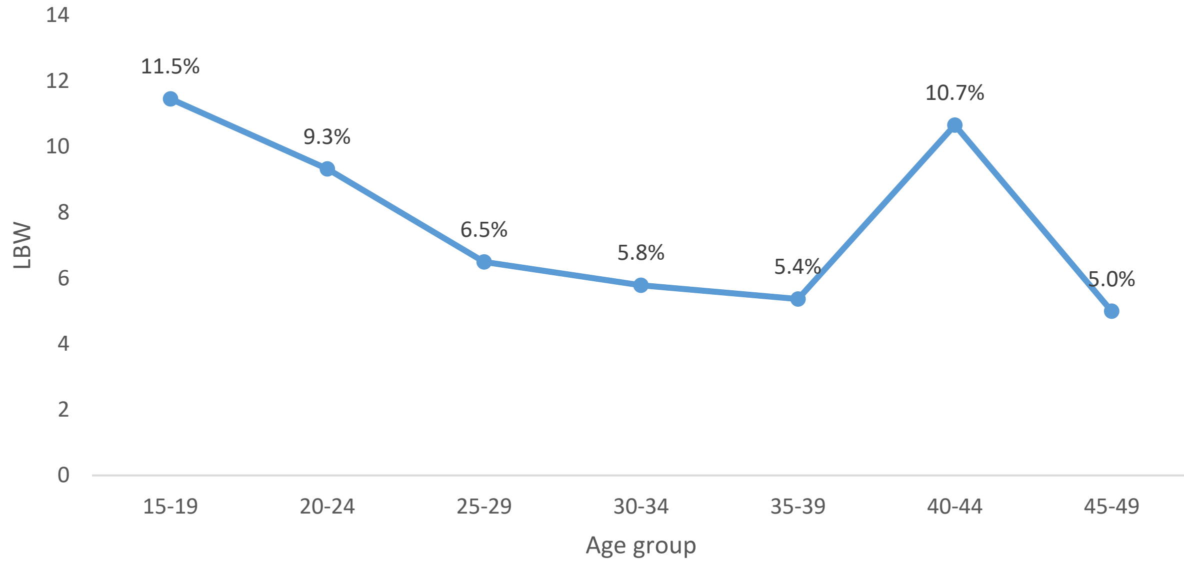


Figure 3.2: Percent distribution of low birth weight by mother's age group.

Source: 2018 ZDHS datafile

CHAPTER 4: STUDY FINDINGS

4.1 Introduction

This chapter presents the results that were obtained from the different levels of analysis that were conducted in line with the objectives. It highlights the levels of LBW and how it is associated with maternal HIV status, demographic, and socio-economic characteristics of women, thus, providing answers to the research questions of this study.

Table 4.2 shows the HIV prevalence of all women who were tested for HIV and the results show that most of the women (85.7 per cent) were HIV negative compared to 14.2 per cent of women who were HIV positive.

Table 4.2: HIV prevalence of women

	Number (Unweighted)	Per cent (Unweighted)	Number (Weighted)	Per cent (Weighted)
HIV Status				
HIV negative	11,348	86.9	10905	85.7
HIV positive	1,710	13	1821	14.2

Source: 2018 ZDHS datafile author's computations

4.3 Background characteristics of respondents of study population

Table 4.3 shows the distribution of women by background characteristics who reported the birth weight of their infants. Most of the women (87.1 per cent) were HIV negative compared to 12.9 per cent of women who were HIV positive. In terms of birth weight, 7.7 per cent of infants were born with LBW compared to 92.3 per cent born with none-low birth weight (NLBW). Forty-seven per cent of women were aged between 20 and 29 years and only 20.2 percent were aged less than 20 years.

Typically, most women were married (75 per cent) and, 46.9 per cent had attended primary education. In terms of employment status, over half (52.2 per cent) of women reported that they were currently not working and 40.2 per cent of women were from regions with a low prevalence of HIV. Regarding place of residence, majority of women were from rural areas (56.3 per cent) and 35.2 per cent of the total number of women belonged to the rich wealth index. Most of the women were Protestants (82.1 per cent) and majority (66.8 per cent) of women had attended ANC more than 4 times. The distribution of women also shows that 47.1 per cent had a parity of 2 to 4 and almost all women (99.1 per cent) were non-smokers. About half of the infants were females (50.4 per cent) and 47.1 per cent of infants were of the birth order of 2 to 4.

Table 4.3: Univariate analysis of background characteristics of the study population

	Number (Unweighted)	Per cent (Unweighted)	Number (Weighted)	Per cent (Weighted)
HIV Status				
HIV negative	5,105	88.1	4,986	87.1
HIV positive	690	11.9	739	12.9
Birth weight				
NLBW	5,366	91.9	5,316	92.3
LBW	471	8.1	444	7.7
Mother's age at birth				
Less than 20	1,192	20.4	1,165	21.0
20-29	2,724	46.7	2,498	45.0
30-49	1,921	32.9	1,882	33.9
Marital status				
Never in Union	876	15	851	14.8
Married/Living with Partner	4,339	74.3	4,318	75.0
Widowed/Divorced/No longer living pa	622	10.7	592	10.3
Highest educational level				
No education	414	7.1	385	6.7
Primary	2,798	47.9	2,700	46.9
Secondary/Higher	2,625	45	2,675	46.4
Respondent currently working				
No	3,060	52.4	3,008	52.2
Yes	2,777	47.6	2,753	47.8
Region				
Middle	1,579	27.1	1,516	26.3
High	1,376	23.6	1,930	33.5
Low	2,882	49.4	2,314	40.2
Residence				
Urban	2,171	37.2	2,517	43.7
Rural	3,666	62.8	3,243	56.3
Wealth index				
Poor	2,552	43.7	2,198	38.1
Middle	1,231	21.1	1,131	19.6
Rich	2,054	35.2	2,432	42.2
Religion				
Catholic	957	16.4	935	16.2
Protestant	4,803	82.3	4,728	82.1
Other	77	1.3	97	1.7
Number of antenatal visits				
Less than 4	1,873	32.1	1,915	33.2
Equal/greater than 4	3,964	67.9	3,845	66.8
Parity (CEB)				
Less than 2	1,541	26.4	1,536	26.7
2-4'	2,703	46.3	2,713	47.1
5+	1,593	27.3	1,512	26.2
Smokes cigarettes				
No	5,798	99.3	5,722	99.3
Yes	39	0.7	38	0.7
Sex of child				
Male	2,909	48.8	2,859	49.6
Female	2,928	50.2	2,901	50.4
Birth order				
Less than 2	1,541	26.4	1,536	26.7
2-4'	2,703	46.3	2,713	47.1
5+	1,593	27.3	1,512	26.2

NLBW=Non Low birth weight **LBW=Low birth weight**

Source: 2018 ZDHS datafile author's computation

4.4 Bivariate relationship birth weight and selected background characteristics

Table 4.4 shows bivariate relationships between selected background characteristics and birth weight. The results indicate that 9.6 per cent of infants born to HIV positive mothers were born with LBW compared 7.4 per cent of infants born to HIV negative mothers. However, the difference was not statistically significant (p=0.095). By age of the mother at birth, 10.2 per cent of women aged less than 20 years gave birth to LBW infants and only 7.5 per cent of women aged 20-29 gave birth to LBW. The association between age of the mother at birth and birth weight was, statistically significant (p=0.003).

Regarding marital status, women who had never been in a union (10.8 per cent) gave birth to LBW infants compared to 7.2 per cent of those who were divorced, widowed, no longer living with partner and there was a statistically significant association between marital status and birth weight of infants (p=0.006). Further, 8.6 per cent of women who reported that they were not currently working reported having given birth to LBW infants compared to 6.8 per cent of those who were currently working and the association between employment status and birth weight was statistically significant (p=0.015).

In terms of number of ANC visits, 9.1 per cent of women who had attended ANC less than 4 times had given birth to LBW infants compared to 7.7 per cent of those who had attended more than 4 times. There was a significant association between number of ANC visits and birth weight (p=0.012). Additionally, 9.3 per cent of women with a parity less than 2 gave birth to LBW infants while 6.5 per cent of women with a parity of 2 to 4 and 5 and above, had LBW infants respectively and the association between parity (CEB) and birth weight proved to be significant (p=0.033).

Furthermore, the bivariate relationship between sex of child and LBW shows that 7.7 per cent of female infants were born with LBW compared to 6.5 per cent of male infants and the difference between male and female infants was statistically significant (p= 0. 0.004). By order of birth, 9.3 per cent of infants of birth order less 2 were born with LBW and only 6.5 per cent of infants of the fifth and above birth order were born with LBW. The differences in LBW by birth order were statistically significant (p=0. 0.033). On the other hand, the results also indicate that mother's education, religion wealth index, region, smoking cigarettes, and residence were not significantly associated with birth weight of infants.

Table 4.4: Bivariate relationships between birth weight and selected background characteristics

	Number (Unweighted)		Per cent (Unweighted)		Total (Unweighted)	P-value
HIV Status	**NLBW**	**LBW**	**NLBW**	**LBW**		
HIV negative	4,701	404	92.6	7.4	5,105	0.095
HIV positive	627	63	90.4	9.6	690	
Mother's age at birth						
Less than 20	1,066	126	89.8	10.2	1,192	0.003
20-29	2,509	215	92.5	7.5	2,724	
30-49	1,791	130	92.3	7.7	1,922	
Marital status						
Never in Union	777	99	89.2	10.8	876	0.006
Married/Living with Partner	4,016	323	92.8	7.2	4,339	
Widowed/Divorced/No longer living pa	573	49	92.8	7.2	622	
Highest educational level						
No education	371	43	90.5	9.5	414	0.086
Primary	2,563	235	91.7	8.3	2,798	
Secondary/Higher	2,432	193	93.1	6.8	2,625	
Respondent currently working						
No	2,785	275	91.4	8.6	3,060	0.015
Yes	2,581	196	93.2	6.8	2,777	
Region						
Middle	1,446	133	91.7	8.3	1,579	0.701
High	1,267	109	92.7	7.3	1,376	
Low	2,653	229	93.3	7.7	2,882	
Residence						
Urban	1,992	179	92.6	7.4	2,171	0.618
Rural	3,374	292	92.1	7.7	3,666	
Wealth index						
Poor	2,340	212	92.0	8.0	2,552	0.279
Middle	1,125	106	91.3	8.7	1,231	
Rich	1,901	153	93.0	7.00	2,054	
Religion						
Catholic	883	74	92.9	7.1	957	0.622
Protestant	4,413	390	92.2	7.8	4,803	
Other	70	7	89.8	10.2	77	
Number of antenatal visits						
Less than 4	1,693	180	90.9	9.1	1,873	0.012
Equal/greater than 4	3,673	291	92.2	7.7	3,964	
Parity (CEB)						
Less than 2	1,392	149	90.6	9.3	1,541	0.033
2-4'	2,489	214	92.5	6.5	2,703	
5+	1,485	108	93.5	6.5	1,593	
Smokes cigarettes						
No	5,330	468	92.3	7.7	5,798	0.599
Yes	36	3	89.6	10.4	39	
Sex of child						
Male	2,714	195	93.5	6.5	2,909	0.004
Female	2,652	276	92.3	7.7	2,928	
Birth order						
Less than 2	1,392	149	90.7	9.3	1,541	
2-4'	2,489	214	92.5	7.5	2,703	0.033
5+	1,485	108	93.5	6.5	1,593	

NLBW=Non Low birth weight **LBW=Low birth weight**

Source: 2018 ZDHS datafile author's computation

4.5 Bivariate relationship between maternal HIV status and selected background characteristics

Table 4.5 shows bivariate relationships between maternal HIV status and selected background characteristics of respondents. The results show that 16 per cent of LBW infants were born from HIV positive mothers compared to 12.6 per cent of infants born with NBW. However, the association between maternal HIV status was not statistically significant. Further, 19.1 per cent of women who were aged 30 to 49 years were HIV positive while only 6 per cent of women aged below 20 years were HIV positive, and it is evident that the differences in age were statistically significant with maternal HIV status (p=0.000). Regarding marital status, women who were divorced widowed or no longer living with a partner had the highest prevalence of HIV with 28.5 per cent and only 9.7 per cent of women who had never been in a union were HIV positive and there was a significant association between marital status and maternal HIV status (p=0.000).

By maternal level of education, the percentage of women who were HIV positive kept on reducing from 14.2 per cent among women with secondary or higher education to 9.1 per cent among women with no education. There was enough evidence to prove the association between maternal level of education and HIV status (p=0.040).

In terms of region, significant differences were observed among women from regions with a high, medium, and low prevalence of HIV (p=0.000). With regards to residence, 19.5 per cent of women who resided in urban areas were HIV positive compared to 8.9 per cent in rural areas. The differences in HIV prevalence by residence were statistically significant (p=0.000). Additionally, 18.9 per cent of women in the rich wealth index were HIV positive while only 7.0 per cent of women in the poor wealth index were HIV positive and the differences in wealth indices by maternal HIV status proved to be statistically significant (p=0.000).

Furthermore, a bivariate relationship between parity and maternal HIV status shows that 15.5 per cent of women with a parity of 2 to 4 were HIV positive, while only 7.6 per cent of women with a parity less than 2 were HIV positive. The differences in parity by maternal HIV status were statistically significant (p= 0.000). By order of birth, 15.5 per cent of infants of birth order of 2 to 4 were HIV positive while only 7.6 per cent of infants of birth order less than 2 were HIV positive and association between maternal HIV status and birth order was statistically significant (p=0.000).

Table 4.5: Bivariate relationships between Maternal HIV status and selected background characteristics

	Number (Unweighted)		Per cent (Unweighted)		Total (Unweighted)	P-value
Birth weight	**HIV negative**	**HIV positive**	**HIV negative**	**HIV positive**		
NLBW	4,701	627	87.4	12.6	5,328	0.095
LBW	404	63	84.0	16.0	467	
Mother's age at birth						
Less than 20	1,124	62	94.0	6.0	1,186	0.000
20-29	2,416	286	88.4	11.6	2,702	
30-49	1,565	342	80.9	19.1	1,907	
Marital status						
Never in Union	786	81	90.3	9.7	867	0.000
Married/Living with Partner	3,867	448	88.6	11.4	4,315	
Widowed/Divorced/No longer living partner	452	161	71.5	28.5	161	
Highest educational level						
No education	375	39	90.9	9.1	414	0.040
Primary	2,475	302	87.8	12.2	2,777	
Secondary/Higher	2,255	349	85.8	14.2	2,604	
Respondent currently working						
No	2,707	331	87.6	12.4	3,038	0.303
Yes	2,398	359	86.5	13.5	2,757	
Region						
Middle	1,351	213	85.9	14.1	1,564	0.000
High	1,129	234	81.4	18.6	1,363	
Low	2,625	243	92.6	7.4	2,868	
Residence						
Urban	1,745	407	80.5	19.5	2,152	0.000
Rural	3,360	283	92.2	7.8	3,643	
Wealth index						
Poor	2,348	190	92.9	7.0	2,538	0.000
Middle	1,085	135	88.4	11.6	1,220	
Rich	1,672	365	81.1	18.9	2,037	
Religion						
Catholic	853	99	88.6	11.4	952	0.113
Protestant	4,190	577	87.0	13.0	4,767	
Other	62	14	76.6	23.3	76	
Number of antenatal visits						
Less than 4	1,602	260	85.5	14.5	1,862	0.088
Equal/greater than 4	3,503	430	87.9	12.1	3,933	
Parity (CEB)						
Less than 2	1,423	107	92.4	7.6	1,530	0.000
2-4'	2,302	380	84.5	15.5	2,682	
5+	1,380	203	86.3	13.7	1,583	
Smokes cigarettes						
No	5,071	685	87.2	12.8	5,756	0.180
Yes	34	5	76.1	23.9	39	
Sex of child						
Male	2,539	352	86.7	13.3	2,891	0.395
Female	2,566	338	87.5	12.5	2,904	
Birth order						
Less than 2	1,423	107	92.4	7.6	1,530	0.000
2-4'	2,302	380	84.5	15.5	2,682	
5+	1,380	203	86.3	13.7	1,583	

NLBW=Non Low birth weight **LBW=Low birth weight**

Source: 2018 ZDHS datafile author's computation

4.6 Unadjusted Odds Ratios (UORs) of the association between LBW and selected background characteristics

Table 4.6 shows the unadjusted logistic regression model of the association between LBW and selected background characteristics. The results indicate that HIV positive mothers were 32 per cent more likely to give birth to LBW infants compared to HIV negative mothers, but the association was not statistically significant (UOR= 1.32, 95%C.I.= 0.952-1.828). Infants born to mothers of age 20 to 29 and 30 to 49 years were 28 and 39 per cent less likely to bear LBW infants compared to those aged less than 20 years respectively and the differences in maternal age at birth proved to be statistically significant (UOR=0.72, 95%C.I. = 0.546-0.947 and (UOR=0.61, 95%C.I. = 0.454-0.811).

Results further show that there was a significant reduction in odds by 36 per cent of giving birth to LBW infants among mothers who were married or living with a partner (UOR=0.66, 95%C.I. =0.484-0.838) compared to those that had never been in a union. Newborns of mothers who were currently employed had significantly reduced odds of been born with LBW compared to those with mothers who were not employed (UOR=0.77, 95%C.I. =0.629-0.952).

The results of a bivariate logistic regression analysis also indicate a significant association between mothers who had attended ANC 4 or more times and LBW. Mothers who attended ANC 4 or more times were 25 per cent less likely to give birth to LBW infants compared to those that attended ANC less than 4 times (UOR=0.75, 95%C.I. =0.603-0.939). In addition, mothers with a parity of more than 5 had significantly reduced odds of 0.68 of having LBW infants compared to mothers with a parity of less than 2 (UOR=0.68, 95%C.I. =0.506-0.906).

Female newborns were 39 per cent more likely to be born with LBW than male newborns. The association between female neonate and LBW was statistically significant (UOR= 1.39, 95%C.I. =1.112-1.746). In terms of birth order, infants of the fifth and above birth order were 32 per cent less like to be born with LBW compared to infants of the birth order less than 2 (UOR=0.68, 95%C.I. =0.506-0.906).

Table 4.6: Unadjusted Odds Ratios (UORs) of the association between LBW and selected background characteristics

	UORs	P-value	95% Conf. Interval
HIV Status			
HIV negative (Ref)	1		
HIV positive	1.32*	0.096	0.952-1.828
Mother's age at birth			
Less than 20 (Ref)	1		
20-29	0.72**	0.019	0.546-0.947
30-49	0.61**	0.001	0.454-0.811
Marital status			
Never in union (Ref)	1		
Married/ Living with partner	0.64***	0.001	0.484-0.838
Widowed/Divorced/No longer living tog	0.64*	0.052	0.411-1.061
Highest educational level			
No education (Ref)	1		
Primary	0.87	0.485	0.580-1.295
Secondary/Higher	0.70*	0.093	0.463-1.061
Respondents currently working			
No (Ref)	1		
Yes	0.77**	0.015	0.629-0.952
Region			
Middle (Ref)	1		
High	0.87	0.436	0.608-1.239
Low	0.97	0.601	0.675-1.256
Residence			
Urban (Ref)	1		
Rural	1.07	0.618	0.824-1.385
Wealth index			
Poor (Ref)	1		
Middle	1.09	0.542	0.825-1.442
Rich	0.87	0.295	0.666-1.132
Religion			
Catholic (Ref)	1		
Protestant	1.1	0.522	0.822-1.469
Other	1.49	0.404	0.584-3.786
Number of antenatal visits			
Less than 4 (Ref)	1		
Equal/greater than 4	0.75**	0.012	0.603-0.939
Parity (CEB)			
Less than 2 (Ref)	1		
2-4'	0.79*	0.067	0.611-1.017
5+	0.68***	0.009	0.506-0.906
Smokes cigarettes			
No (Ref)	1		
Yes	1.4	0.600	0.400-4.860
Sex of Child			
Male (Ref)	1		
Female	1.39**	0.004	1.112-1.746
Birth Order			
Less than 2 (Ref)	1		
2-4'	0.79*	0.067	0.611-11.017
5+	0.68***	0.009	0.506-0.906

Source: 2018 ZDHS datafile author's computations

***** p<0.01, ** p<0.05, * p<0.1**

4.7 Adjusted Odds Ratios (aORs) of the association between LBW and selected background characteristics.

Nine factors were taken to the multivariate sub-population analysis of HIV positive women. All variables which had a p-value less than 0.1 from the bivariate analysis of maternal HIV status and selected background characteristics were included in the model.

Table 4.7 shows the adjusted logistic regression model of the association between LBW and selected background characteristics of HIV positive women only. The results indicate that women who were from the region with high prevalence of HIV were 2 times likely to give birth to LBW infants (aOR=2.39, 95%C.I. =1.117-5.131) compared to those who were from regions with a medium prevalence of HIV and the association between a region with high HIV prevalence and LBW proved to be significant while holding other factors constant. Women who resided in rural areas were twice more likely to deliver LBW infants compared to those in urban areas and the association was statistically significant (aOR=2.80, 95%C.I. = 1.105-7.097).

The results also indicate a significant reduction in the odds of bearing LBW infants among women who attended ANC 4 or more times compared to those that attended ANC less than 4 times (AOR=0.52, 95%C.I. = 0.273-0.987).

Table 4.7: Adjusted Odds Ratios (aORs) of the association between LBW and selected background characteristics.

	AORs	P-value	[95% Conf. Interval]
Mother's age at birth			
Less than 20 (Ref)			
20-29	1.06	0.922	0.313-3.606
30-49	0.85	0.811	0.221-3.234
Marital status			
Never in Union (Ref)	1		
Married/Living with Partner	0.76	0.623	0.251-2.291
Widowed/Divorced/Nolonger living with par	0.74	0.652	0.205-2.69
Highest educational level			
No education (Ref)	1		
Primary	0.62	0.449	0.177-2.155
Secondary/Higher	0.46	0.255	0.117-1.768
Region			
Middle (Ref)	1		
High	2.39**	0.025	1.117-5.131
Low	1.56	0.237	0.747-3.241
Residence			
Urban	1		
Rural	2.80**	0.03	1.105-7.097
Wealth_index			
Poor	1		
Middle	1.77	0.168	0.786-3.982
Rich	1.67	0.403	0.501-5.574
Number of antenatal visits			
Less than 4 (Ref)			
Equal/greater than 4	0.52**	0.045	0.273-0.987
Parity			
Less than 2 (Ref)			
2-4'	0.76	0.567	0.293-1.961
5+	0.67	0.527	0.188-2.357

Source: 2018 ZDHS datafile author's computations

***** p<0.01, ** p<0.05, * p<0.1**

4.8: Adjusted Odds Ratios (aORs) of the association between LBW and selected explanatory factors

Eight factors were taken to the multivariate logistic regression model using a stepwise forward model building strategy. All variables which had a p-value less than 0.1 were included in the model. These include, maternal HIV status, marital status, ANC visits, parity (CEB), maternal age, employment status, maternal education, and sex of child. Birth order was excluded from the multivariate logistic regression because of collinearity with parity (CEB).

Table 4.8 shows the adjusted multivariate logistic regression model of the association between LBW and selected background characteristics. The results show that in model I HIV positive mothers were 32 per cent more likely to give birth to LBW infants compared HIV negative mothers, however, the association was not statistically significant (aOR= 1.32, 95%C.I.= 0.952-1.828).

In model 2, maternal age at birth, maternal level of education, marital status and employment status were added to the analysis. This model indicates increased odds of LBW among infants born to HIV positive mothers compared to HIV negative mothers and there was a significant association between HIV positive mothers and LBW (aOR= 1.50, 90%C.I.= 1.064-2.102). Regarding marital status, on the risk of bearing LBW infants, the results show that the odds of bearing LBW infants among women who were married or living with partner were significantly lower when compared to women who had never been in a union (aOR = 0.70, 95 % CI = 0.506-0.982).

Mothers with secondary education were 43 per cent less likely to bear LBW infants when compared to those with no education and the association was statistically significant (aOR = 0.57, 95 % CI = 0.375-0.881) holding other variables constant.

The results in model 3 after introducing parity, number of ANC visits and sex of child show that HIV positive mothers were associated with significantly higher odds (aOR = 1.48, 95 % CI = 1.054-2.801) of giving birth to LBW infants compared to their HIV negative counterparts. Further, women with secondary education were 45 per cent less likely to give birth to LBW infants when compared to those with no education and the association was statistically significant (AOR = 0.55, 95 % CI = 0.354-0.846).

Furthermore, women who attended ANC 4 or more times were 21 per cent less likely to give birth to LBW infants (aOR= 0.79, 95%C.I.= 0.625-0.987) compared to women who attended less than 4 times and the association was statistically significant. Female infants were significantly associated with higher odds of LBW (aOR= 1.42, 95%C.I.= 1.125-1.783) compared to male infants.

Table 4.8: Adjusted Odds Ratios (aORs) of the association between LBW and selected explanatory factors

	Model 1			Model 2			Model 3		
	AORs	P-value	[95% Co Interval	AORs	P-value	[95% Conf. Interval	AORs	P-value	[95% Conf. Interva
HIV Status									
HIV negative(Ref)	1			1			1		
HIV positive	1.32*	0.096	0.952-1.828	1.50**	0.02	1.064-2.102	1.48**	0.024	1.054-2.081
Mother's age at birth									
Less than 20 (Ref)				1			1		
20-29				0.81	0.163	0.595-1.091	0.85	0.376	0.606-1.209
30-49				0.63	0.011	0.446-0.899	0.75	0.224	0.475-1.192
Marital status									
Never in Union (Ref)				1			1		
Married/Living with Partner				0.70**	0.039	0.506-0.982	0.72	0.059	0.511-1.013
Widowed/Divorced/No longer living with partner				0.68	0.14	0.414-1.132	0.69	0.162	0.410-1.160
Highest educational level									
No education (Ref)				1			1		
Primary				0.8	0.251	0.528-1.182	0.79	0.249	0.526-1.182
Secondary/Higher				0.57**	0.011	0.375-0.881	0.55***	0.007	0.354-0.846
Respondent currently working									
No (Ref)				1			1		
Yes				0.84	0.124	0.682-1.047	0.86	0.165	0.693-1.065
Parity (CEB)									
less than 2 (Ref)							1		
2-4'							0.93	0.669	0.671-1.291
5+							0.62	0.3	0.485-1.251
Number of antenatal visits									
less than 4 (Ref)							1		
equal/greater than 4							0.79**	0.038	0.625-0.987
Sex of child									
Male (Ref)							1		
Female							1.42***	0.003	1.125-1.783

Source: 2018 ZDHS datafile author's computations

***** p<0.01, ** p<0.05, * p<0.1**

The final multivariate logistic regression consisted of maternal HIV status, maternal age at birth, marital status, maternal education, employment status, number of ANC visits and sex of child and their influence LBW.

Table 4.9 shows the final model of multivariate logistic regression analysis between LBW and selected background characteristics and the results show that HIV positive women were 39 per cent more likely to give birth to LBW infants compared to HIV negative women and the association was statistically significant (aOR= 1.39, 95%C.I.= 0.999-1.957). Women who were married or living with a partner and those that were divorced or widowed were associated with significantly lower odds of bearing LBW infants compared to those who had never been in a union respectively (aOR= 0.58, 95%C.I.= 0.442-0.774) and (aOR= 0.54, 95%C.I.= 0.341-0.879).

Regarding maternal level of education women with secondary education were 47 per cent less likely to give birth to LBW infants when compared to those with no education and the association was statistically significant (aOR = 0.53, 95 % CI = 0.401-0.928).

The results of a multivariate logistic analysis also indicate that women who attended ANC 4 or more times were 23 per cent less likely to give birth to LBW infants (aOR= 0.77, 95%C. I 0.611-0.962) compared to women who attended less than 4 times and the association was statistically significant. Female infants were significantly associated with increased odds of being LBW compared to male infants (aOR= 1.41, 95%C.I.= 1.118-1.769)

Table 4.9: Adjusted Odds Ratios (aORs) of the association between LBW and selected explanatory factors

	AORs	P-value	[95% Conf. Interval]
HIV Status			
HIV negative (Ref)			
HIV positive	1.39**	0.05	0.999-1.957
Marital status			
Never in Union (Ref)			
Married/Living with Partner	0.58**	0.000	0.442-0.774
Widowed/Divorced/No longer living with partner	0.54**	0.013	0.341-0.879
Highest educational level			
No education (Ref)			
Primary	0.83	0.374	0.558-1.246
Secondary/Higher	0.53***	0.021	0.401-0.928
Number of antenatal visits			
less than 4 (Ref)			
equal/greater than 4	0.77**	0.022	0.611-0.962
Sex of child			
Male (Ref)			
Female	1.41***	0.004	1.118-1.769

Source: 2018 ZDHS datafile author's computations
***** p<0.01, ** p<0.05, * p<0.1**

CHAPTER 5: DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Discussion

This section discusses the findings of the study based on the analysis conducted and provides the conclusion and recommendations in line with the study findings.

All around the world, birth weight has been recognized as one of the most important determinants of future chances of infant survival and healthy growth, free from morbidities and mortalities (Ekubagewargies et al., 2019). This study examined the association between Maternal HIV status and LBW and found that maternal HIV status, marital status, maternal level of education, number of ANC visits and sex of an infant are significantly associated with LBW.

Levels of LBW by maternal HIV status, demographic, and socio-economic characteristics

The study has established that HIV positive mothers are at a high risk of adverse birth outcomes and need extra care and attention during pregnancy as well as at childbirth to prevent vertical transmission of HIV from mother to child and avert any effects that maybe caused by the infection, to reduce the occurrence of LBW among infants.

The study results show that 14.2 per cent of all women were HIV positive in Zambia and 9.6 per cent of infants born to HIV positive mothers were born with LBW compared 7.4 per cent of infants born to HIV negative mothers. Since women in the reproductive age group are shouldering a disproportionate burden of HIV, there is still a relatively high risk that birth weight of infants, regardless of their HIV status may be negatively affected because HIV exposure directly or indirectly in utero, intrapartum, and during breastfeeding may confer risks to children, such as LBW even in the absence of vertical transmission (Ramokolo et al., 2017).

In addition, the results show that women who had never been in a union (10.8 per cent) gave birth to LBW infants compared to 7.2 per cent of those who were divorced, widowed, or no longer living with partner. Similarly, a study by Usynina in 2017, found that single women and those that were cohabiting were 84 and 90 per cent more likely to bear LBW infants. (Usynina et al., 2017)

In terms of LBW by number of ANC visits, 9.1 per cent of women who had attended ANC less than 4 times had significantly given birth to LBW infants compared to 7.7 per cent of those who had attended more than 4 times. A study by Tshotetsi et al., 2019 found similar results that women who had attended ANC less than 4 times had given birth to a higher percentage of LBW infants, this could be because increase in ANC visits can reduce the risk of adverse birth outcomes, of which without adequate ANC attendance these risk factors may remain undetected (Tshotetsi et al., 2019). Nearly 8 per cent of female infants were significantly born with LBW compared to 6.5 per cent of male infants. Likewise a study conducted in the United States of America among infants who were born to HIV infected women found that a larger proportion of female infants were born with LBW (Schulte et al., 2007).

The influence of maternal HIV status, demographic, and socio-economic characteristics on LBW in Zambia

The results in this study reveal that more infants with LBW were born to mothers who are HIV positive compared to HIV negative mothers. While the crude analysis did not find an association between HIV positive mothers and LBW, the adjusted analysis highlighted a statistically significant influence. When adjusted for other covariates, the odds of having a LBW infant were significantly higher among HIV positive mothers compared to HIV negative mothers. The results are in line with a study conducted in North West Ethiopia where it was found that, in a multi variate analysis the odds of being born with LBW for infants who were delivered from HIV uninfected mothers were significantly reduced compared to their infected counterparts (Ekubagewargies et al., 2019). Similar results were also observed in Zambia where women who were diagnosed HIV positive were also found to have 99 per cent higher risk of having LBW infants (Smid M et al., 2015)..

This may be because HIV is an immune altering condition, meaning that patients are prone to different diseases as well as undernutrition, which is a known risk factor for LBW (Feresu SA, et al., 2015) Thereby, predisposing HIV infected women to giving birth to LBW infants.

On the other hand, according to studies conducted by Agbor et al., (2018) and Wedi et al., (2016) on LBW, positive maternal HIV status had no influence on LBW. It may, therefore, be right to assume that the results observed in these studies may be due to HIV infection interacting with other confounders such as maternal age, maternal education, employment status, marital status and parity, hence reducing the effect that HIV may confer to the weight of the baby (Tshotetsi et al., 2019b).

The study also found that there was a significant reduction in the odds of delivering LBW infants among mothers who attended ANC 4 or more times at both bivariate and multi variate levels of analysis. These findings are not just unique to this study; a research done in India on the impact of maternal HIV infection on pregnancy and birth outcomes found that ANC was very important, as mothers who had not received any care prior to delivery were at an increased risk of bearing LBW infants (Patil et al., 2011). Similarly, a study conducted by Mvunta et al in 2019 in Tanzania among women tested for HIV found that ANC attendance was a strong predictor of LBW and the risk was higher among women with inadequate ANC. This could be explained by other factors such as, preeclampsia and other complications which are common in women with inadequate ANC attendance (Mvunta et al., 2019). In this study, women who attended 4 or more ANC visits had a reduced risk of giving birth to LBW infants. Therefore, ANC needs to be encouraged, especially in poor socio-economic settings because it has been established that, the number of ANC visits can influence the birth weight of an infant. Furthermore, during ANC visits, potential risk factors are screened for, and preventive interventions to avoid LBW and other poor birth outcomes are often implemented. These risk factors may remain undiagnosed if women do not attend ANC during pregnancy (Tshotetsi et al., 2019b).

In contrast, a study conducted in Zambia on the risk of recurrent LBW among women in Lusaka, found opposing results: that there was no statistically significant association between ANC attendance and LBW (Smid M et al., 2015). The possible reason could be the differences in the methodologies employed. Smid M et al., (2015) used the Zambia Electronic Perinatal Record System (ZEPRS) to review pregnancy outcomes while Mvunta et al (2019) employed a registry-based approach.

Interestingly, neonatal sex is a very important risk factor identified by this study as it was highly associated with LBW at all levels of analysis. The results from the study indicate that female infants were significantly more likely to be born with LBW when compared to their male counterparts. These findings coincide with a study conducted in Kenya among HIV exposed uninfected infants which found that the delivery of a female infant was a significant correlate of LBW (Slyker et al., 2014). However, conflicting findings were reported in Zimbabwe where female babies were less likely to be born with LBW (Feresu SA, et al., 2015). In addition, a study in Cameroon among women whose HIV status was known also found no significant association between a female neonate and LBW (Agbor et al., 2018). It may therefore be difficult to speculate the possible explanation for the differences in results because being female is a non-modifiable factor as it is biological and inherent.

Regarding maternal education, it was observed that the chances of having LBW infants reduces with an increase in level of education. Mothers who attended secondary or higher education were significantly less likely to give birth to LBW infants compared to mothers with no education. This could be attributed to the fact that attaining high education can delay childbearing and make a woman physically and mentally ready to bear children, which may ultimately improve the birth outcomes. Furthermore, education enables mothers to be employed and have a source of income which can help them access quality health care services and better nutrition, since it is assumed that each additional year of schooling is associated with increased income (Turčín and Stávko, 2012). Similar findings were observed in a study on the prevalence and risk factors of LBW in the South East of Iran, where it was established that women with no education had increased chances of delivering LBW infants and that having no education was identified as a significant factor associated with LBW (Momeni et al., 2017). In the same vein, another study conducted among HEU infants and HUU infants concluded significant differences between mothers with lower levels of education and secondary or higher levels of education. Among births that were exposed to HIV through their mothers, very LBW deliveries were associated with lower levels of education (Kamala et al., 2018).

With regards to marital status, the study findings show that, mothers who were married and divorced or widowed had significantly reduced odds of giving birth to LBW infants when compared to those who had never been in a union. These findings are supported by a study conducted among HEU infants and infected mothers in Kenya where it was observed that women who were married and were infected with HIV were less likely to bear LBW babies. Both bivariate and multivariate analysis of the study found a significant association between marital status and birth weight of a neonate. Being married was found to be protective against LBW and those who had never been in a union had increased odds of delivering infants with LBW (Slyker et al., 2014). This could be due to the support and care married women tend to receive from their partners and may result in having better nutrition and, as such, the likelihood of giving birth to LBW infants may be reduced significantly.

To add more value to the study, a sub-population analysis was conducted on the effect of socio-demographic and economic characteristics of HIV positive women on LBW. The study findings indicate that women who were from regions with high prevalence of HIV infection (Lusaka and Copperbelt), those in the middle wealth index and those who lived in rural areas had a significantly higher likelihood of bearing LBW infants. A possible explanation could be that most of these women are immunocompromised due to the HIV infection and the likelihood of experiencing adverse birth outcomes like LBW is high.

It is, however, surprising that women in the middle wealth index despite HIV infection were more likely to bear LBW infants compared to those in the poorest wealth index. This is because Muula, et al., (2011) noted opposing findings that non-poor women were less likely to deliver LBW babies than poor women, although this was not consistently statistically significant, even in this study.

The study findings further reaffirm Magadi, et al., (2004) theoretical framework that maternal health care factors like number of ANC visits and biological factors like sex of child directly influence the birth weight of infants. The study has also shown that marital status may influence birth weight through the intermediate factors, but may, at the same time, have a direct influence on the birth weight, which is in line with the Magadi's theoretical framework. Contrary to the conceptual framework, the study found that maternal HIV status and level of education are not independently associated with LBW but only when adjusted for other factors. It has therefore, been established that, there is a statistically significant association between maternal HIV status and LBW, making the research hypothesis which states that there is an association between maternal HIV status and LBW true and valid.

5.2 Conclusion

Birth weight in any population indicates the quality of healthcare and availability of nutrition to expecting mothers, and it is a useful benchmark for assessing the quality of prenatal care (Gebremedhin et al., 2015). This study has examined the association between maternal HIV status and LBW using data obtained from the 2018 ZDHS.

The study established the levels of LBW by maternal HIV status, demographic and socio-economic characteristics and was able ascertain the socio-economic and demographic factors associated with LBW and these include marital status, maternal education, ANC visits and sex of child at birth.

Study findings have shown that being HIV positive among women was a risk factor associated with a higher chance of giving birth to LBW infants. Furthermore, the results have indicated that, the likelihood of bearing a LBW infant among women who are married and those with secondary or higher education was significantly reduced. On the other hand, among HIV positive women, residing in a region with high HIV prevalence (Lusaka and the Copperbelt) was a significant risk factor associated with LBW.

Despite universal ANC attendance in Zambia, LBW continues to be a significant public health problem and has multiple factors associated with it. The study findings have revealed that ANC attendance of 4 or more times reduces the likelihood of giving birth to LBW infants. Therefore, there is need for a more holistic and multipronged approach to ensure that expectant mothers have adequate ANC visits recommended by WHO, to improve their birth outcomes.

The study also observed that female infants were more likely to be born with LBW when compared to male infants. However, it is still relatively unclear on the possible explanation for this outcome because being female is inherently biological and non-modifiable.

Lastly, to answer the research question based on the study findings, there is an association between maternal HIV status and LBW.

5.3 Recommendations

Based on the study findings, the following recommendations have been proposed.

i. The study found that women with secondary or higher levels of education were less likely to deliver LBW infants. This calls for the government to promote and strengthen girl child education and ensure that women attain at least secondary level of education, to effectively minimize the likelihood of giving birth to LBW infants.

ii. The study found that the likelihood of giving birth to LBW infants among women with at least 4 ANC visits was reduced. Therefore, health facilities through the Ministry of Health, need to adopt a high-risk approach which implies better health care services to all ANC subjects, with special attention to those who are found to be at high risk. Thus, early registration of pregnancy should be promoted to detect the presence of any high-risk factors at the earliest and the importance of regular ANC visits should be underscored and explained to pregnant women, as a way of ensuring that women attend the recommended number of ANC visits and reduce the risk of LBW.

iii. For future research, it would be necessary to examine the effects of seasonal variations on birth weight outcomes, especially in low-income countries like Zambia where food is usually in abundance during specific seasons. Since availability of food is seasonal, nutritional status of mothers may in one way or another be affected and may consequently have an impact on the birth weight outcomes of infants.

iv. It would also be necessary for future research to investigate the extent to which the apparent health advantages of religious affiliation among adults might be attributed to health advantages in early life, especially those related to healthy birth weight even in the absence of cigarette use, poor nutrition, and alcohol use.

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APPENDICES

Appendix 1: Goodness-of-fit test for logistic model on birth weight

Goodness-of-fit test for logistic model for birth weight
F (9,513) = 0.44
Prob > F = 0.9143

Appendix 2: Letter of authorization

ICF

Feb 19, 2020

Ronald Mungoni
University of Zambia
Zambia
Phone: 0978525912
Email: ronaldmungoni7@gmail.com
Request Date: 02/19/2020

Dear Ronald Mungoni:

This is to confirm that you are approved to use the following Survey Datasets for your registered research paper titled: "Maternal HIV status and Low Birth Weight":

Zambia

To access the datasets, please login at: https://www.dhsprogram.com/data/dataset_admin/login_main.cfm. The user name is the registered email address, and the password is the one selected during registration.

The IRB-approved procedures for DHS public-use datasets do not in any way allow respondents, households, or sample communities to be identified. There are no names of individuals or household addresses in the data files. The geographic identifiers only go down to the regional level (where regions are typically very large geographical areas encompassing several states/provinces). Each enumeration area (Primary Sampling Unit) has a PSU number in the data file, but the PSU numbers do not have any labels to indicate their names or locations. In surveys that collect GIS coordinates in the field, the coordinates are only for the enumeration area (EA) as a whole, and not for individual households, and the measured coordinates are randomly displaced within a large geographic area so that specific enumeration areas cannot be identified.

The DHS Data may be used only for the purpose of statistical reporting and analysis, and only for your registered research. To use the data for another purpose, a new research project must be registered. All DHS data should be treated as confidential, and no effort should be made to identify any household or individual respondent interviewed in the survey. Please reference the complete terms of use at: https://dhsprogram.com/Data/terms-of-use.cfm.

The data must not be passed on to other researchers without the written consent of DHS. However, if you have coresearchers registered in your account for this research paper, you are authorized to share the data with them. All data users are required to submit an electronic copy (pdf) of any reports/publications resulting from using the DHS data files to: references@dhsprogram.com.

Sincerely,

Bridgette Wellington

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