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Determinants of Low Birth Weight in a Population-Based Sample of Zimbabwe

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Walden University
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Abstract

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MPH, University of Liverpool, 2012

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Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Public Health

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Abstract

Low birth weight (LBW) is a major public health concern globally. Despite its negative social and economic impact on the family and community at large, it has remained relatively unexplored at population level in Zimbabwe. The purpose of the study was to establish determinants of LBW using data from the 2015 Zimbabwe Demographic and Health Survey. The socioecological model was the conceptual framework for the study. A secondary analysis was conducted on 4,227 mother-infant dyads. Independent variables were duration of pregnancy, number of births within the past 5-year period, exposure to mass media, type of fuel used for cooking in the household, and intimate partner violence. Covariates were maternal age at delivery, place of residence, anemia, marital status, education, wealth index, ever terminated pregnancy, infant sex, and alcohol consumption. For parsimony, statistical significance was set at $p < 0.05$ at the 95% confidence interval (CI). Multivariable logistic regression analysis showed that mild maternal anemia (adjusted odds ratio [aOR] 1.83 CI 1.17-2.87 $p = 0.01$), moderate to severe anemia (aOR 1.80 CI 1.01-3.19 $p = 0.05$), and being a female neonate (aOR 1.48 CI 1.17-2.87 $p = 0.008$) had higher odds for LBW. Pregnancy duration of 8 months (aOR 0.01 CI 0.003-0.039 $p < 0.001$) and of 9 months (aOR 0.12 CI 0.04-0.33 $p = 0.001$) had lower odds for LBW. Birth of 2 infants within a 5-year period (aOR 2.40 CI 1.24-4.66 $p = 0.01$) was associated with LBW. Implications for positive social change include coming up with a health policy on the management of anemia during pregnancy and health promotion messages to promote optimal birth spacing, including strategies that reduce chances for preterm deliveries.

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Dedication

I wish to dedicate this dissertation to my wife Sibongile and children, Tafadzwa, Tadiwanashe, and Lisa. Without your support and encouragement, this academic accomplishment would have remained a dream. Your consistent words of love and encouragement is what kept me trudging along. I also extend my dedication to my late and present brothers and sisters who always provided words of wisdom and support each time I sat down for my studies. You may not all be present today, but your laugher and humour is what kept inspiring me as I burnt candles all night.

I also would like to thank Fungai, my nephew, who kept my other errands moving while studies held me up. You played a great part and without your role, this dissertation would have taken even longer to complete. We worked in the garden and did the plumbing for the whole house together, yet on numerous occasions, you kept reminding me that it’s time up to go back to the reading room.

Finally, I dedicate this dissertation to all children of the African continent who are struggling to go to school, either due to sickness, long distance they have to walk, some barefooted, or the failure by their guardians to raise school fees. Your voices carry hope and determination, and it is my hope that this dissertation will inspire you and make a positive social change in your lives.

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I am deeply indebted to my chairperson, Dr. James Rohrer, who assisted me throughout the dissertation process. I fumbled in many ways during the early stages but his rapid response and timely feedback, even during odd hours, was just extraordinary. I am truly amazed by the energy and the quality of the guidance he provided. I also extend my gratitude to my committee member, Dr. Mehdi Agha, for playing a pivotal role in shaping my research methodology and data analysis. The questions he raised during the oral defense provided me with a new world of thinking when I thought I was now a grandmaster. I truly value your guidance.

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Chapter 1: Introduction to the Study

Introduction

Zimbabwe is a low-income country located in Southern Africa. It borders with Zambia to the north and with South Africa to the south. To the east and west, it borders with Mozambique and Botswana respectively. Statistics from the Zimbabwe Demographic and Health Survey (ZDHS) for 2010-2011 showed that low birth weight (LBW) was 9.5% (Zimbabwe National Statistics Agency [ZimStat], 2012) and remained the same in the 2015 ZDHS. With over half a million live births occurring annually in Zimbabwe, the cumulative number of infants born with LBW and the downstream negative social and economic consequences can be alarming in future.

At global level, one strategy towards improving birth outcomes was by the World Health Organization (WHO, 2014) Resolution 65.6. The policy brief outlined six global nutrition targets and proposed countries to aim for a 30% reduction in LBW by 2025 when compared with the 2012 baseline. However, real progress towards attaining the goal will require more than declarations alone, even when backed by blueprints. Currently, Zimbabwe does not have a clear strategy on what to focus on, nor are there specific monitoring and evaluation mechanisms to measure progress towards the attainment of the global goal. Thus, understanding determinants of LBW will allow the country to take appropriate interventions in the best interest of the population.

Underlying determinants of LBW revolve around social, environmental, individual, and gynecological aspects (Madden, 2014; U.S. Department of Health and Human Services, 2011). As geography and socioeconomic circumstances differ across countries, this can lead to a disjuncture in areas of the research to focus on. Besides, most of the research on LBW has been clinic based and leaned toward biomedical, yet proponents of the public health perspective have argued that improvements in social determinants of health also improve the health of the population (Commission on Social Determinants of Health, 2008; Wilkinson & Marmot, 2003). Understanding key drivers of LBW at the population level, as was my intention with this study, is one of the important steps towards identifying amenable maternal factors to target and improve pregnancy outcomes. Within the past two decades, the socioeconomic and demographic characteristics of the country transitioned significantly following years of socioeconomic collapse (Nyazema, 2010). Tapping the collective knowledge on such a shift uniquely provides insights that health promotion programs could rely on to improve the health status of future generations. The potential positive social change implication for this study is that, once amenable maternal factors have been identified at population level, health programs may be designed to target and modify those factors. In the long run, such interventions may result in, among others, reduced suffering to the family as a whole.

This chapter provides a broad overview of LBW. I discuss the background and the problem statement of the study. The hypotheses and the conceptual framework underpinning the study are also discussed. The chapter concludes by highlighting the potential positive change to health policy in Zimbabwe.

Background

LBW is a global public health challenge. A number of authors have noted its strong association with infant morbidity and mortality (Castro, Leite, Almeida, &

Guinsburg, 2014; Kader & Perera, 2014; Mathews & MacDorman, 2013). Of the deliveries worldwide, the WHO (2015) estimated that 15% to 20% were LBW and represented over 20 million births annually. Developing countries accounted for 96.5% of the LBW (WHO, 2015). The WHO further noted that prevalence of LBW varies across regions and ranges between 6% and 28%, with East Asia recording the highest proportion. In the United States, of the 3,932,181 live births registered in 2013, close to 8.0% weighed less than 2,500g (Centers for Disease Control and Prevention [CDC], 2015). In Wales in the United Kingdom, the prevalence of LBW in the population was 6.9% (Organisation for Economic Co-operation and Development, 2012) while latest population-based data from African countries such as Zambia and Zimbabwe showed prevalence rates of 9.2% (Central Statistical Office, 2014) and 9.5% (ZimStat, 2015) respectively. The proportion of LBW therefore varies across regions and cuts across communities, including even the most egalitarian societies.

LBW is defined as a live birth weight of less than 2,500g, irrespective of the gestational age of the infant (WHO, 1992). It is also a predictor of the child's physical, emotional, and psychological growth later in life. Epidemiological studies showed that LBW babies were 20 times as likely to die as normal weight babies (Kramer, 1987; McCormick, 1985; United Nations International Children's Emergency Fund [UNICEF], 2014). The 2010 National Vital Statistics Reports for the United States showed that mortality rate among LBW infants was 24 times higher than for normal birth weight infants (Mathews & MacDorman, 2013). The same report also showed that, together with short gestational age, LBW was a second leading cause for infant mortality.

Children born with LBW are not only prone to mortality but have shown increased risk of cognitive and poor school performance as their normal birth weight peers (Mulder, Pitchford, & Marlow, 2011; Pritchard et al., 2009). In Oman, Islam and ElSayed (2015) observed school performance 2 to 6 times poorer than normal birth weight peers. The effects of LBW are therefore not only immediate through life events such as morbidity and mortality at young age, but also present adversely later in adulthood.

The consequences of LBW can be far reaching with severe impact on quality of life later on. Barker (1997) hypothesized that limited supply of nutrients during early stages of fetal development can permanently change the physiology and metabolism of the infant, thereby marking the origins of related chronic disorders in later life. Some studies (Barker, 2004; Negrato & Gomes, 2013; Silverwood et al., 2013; Walter, Ehlenbach, Hotchkin, Chien, & Koepsell, 2009) also showed that LBW increased the risk for non-communicable diseases such as respiratory illness, coronary heart disease, and diabetes, which all have long-term deleterious consequences in adulthood. However, these findings contrasted with other recent findings (Gomes et al., 2013; Haas, Liepold, & Schwandt, 2015) where the association was not established.

Managing infants with LBW can be costly. A longitudinal study in the United States found that, over 15 years of life, underweight babies cost treasury between $5.5 to $6 billion more than normal birth weight children (Lewit, Baker, & Corman, 1995). Over the same duration, other studies found the cost for managing neonates born at different birth weights to be $19,000 for infants weighting 1,750g to 1,999g, $4,300 for 2,250g to

2,499g infants, and $1,000 for those weighting at least 3,000g (Gilbert, Nesbitt, & Danielsen, 2003). The costs were even above $100,000 for infants weighting less than 1,000g. In Italy, Cavallo et al. (2015) found that hospital cost for a very LBW infant was €20,502 compared with €907 for the full-term infant, and the respective societal costs during the first 18 months of life were €58,098 and €24,209. The above studies suggested that LBW can have both direct and indirect economic impact on a family and the society at large.

An important motivating factor for undertaking this study was that, apart from economic impact that comes with managing the condition, LBW brings social suffering that goes beyond the individual sufferer to also includes the family and social networks as well. Despite all the cited knowledge on the deleterious consequences of LBW, leading determinants of LBW from a population-based perspective are not known in Zimbabwe. This disjuncture has resulted in knowledge gaps across a cascade of maternal services on the specific determinants to target and modify. The study was therefore necessary for maternal and neonatal health programs that could be enhanced to reduce societal costs associated with LBW.

Problem Statement

In 2008, Zimbabwe experienced a wave of socioeconomic and political meltdown that left a number of systems paralyzed. This paralysis raised a number of important questions that still remain unanswered, such as whether changes in the socioeconomic and demographic structures resulted in poor birth outcomes as reflected by LBW. The problem here is that, while several studies have established determinants of LBW (Asp et al., 2014; Class et al., 2017; Kaur, Upadhyay, Srivastava, Srivastava, & Pandey, 2014; Miranda, Edwards, Chang, & Auten, 2013), current researchers still do not know the specific determinants in the context of Zimbabwean population. Further, researchers do not know the levels and extent of the magnitude of effect each determinant has on LBW. Such a dearth in knowledge presents challenges to health delivery systems as the same methods of health care delivery continue to be offered yet do not optimally respond to population needs. Additionally, the known determinants are considered at the same level of impact, yet analysis has not shown that their magnitudes are different. Rose (2001) argued that public health interventions should shun away from focusing on change in individual risk profiles for a particular health problem, but rather focus on altering conditions that lead to the distribution of risk in the population. Failure to come up with population-based strategies at the very early stage of life may affect funding for other public health interventions as limited resources may be channeled towards managing the consequences of LBW, yet a condition that could have been averted even before birth. Besides, Zimbabwe is a signatory to the United Nations and milestones towards the goal of the WHO (2014) remain unmeasured.

Additionally, at 9.5%, the prevalence of LBW is disproportionately high for the country. With close to half a million infants born annually, the number of LBW can be alarming for a country with an already deteriorating health care system. LBW brings social challenges to the family, as the theory of social suffering suggests (Kleinman, 2010). In addition, the consequences of LBW are not only evident through poor cognitive development or prenatal morbidity and mortality but also adversely present later in life through chronic conditions such as diabetes and high blood pressure (Barker, 1997; Larroque, Bertrais, Czernichow, & Leger, 2001; Luyckx & Brenner, 2005; Risnes et al., 2011). The economic burden of managing such chronic conditions may weigh heavily on government as provision of health care in Zimbabwe is predominantly through public funding. Alderman and Behrman (2006) observed that reducing the incidence of LBW brings economic gains to a country in the long run, including improved quality of life.

Purpose of the Study

The purpose of this quantitative study was to establish determinants of LBW using population-based data. Results of the study would feed into health promotion programs to improve delivery outcomes. The socioecological model was the conceptual framework for the study. Mother-infant dyads from the 2015 ZDHS data were analyzed with duration of pregnancy, number of births within a 5-year period, exposure to mass media, type of fuel used for cooking in the household, and intimate partner violence (IPV) as independent variables. Covariates for the study were maternal age at delivery, place of residence, maternal anemia, marital status, education, wealth index, ever terminated pregnancy, infant sex, and alcohol consumption. Infant birth weight was the dependent variable.

Research Questions and Hypotheses

The overall research aimed at identifying determinants of LBW. Seven research questions were formulated. The specific research questions, null hypothesis (H_0), and the alternative hypothesis (H_a) were stated as follows:

Research Question 1: Is duration of pregnancy, defined as the time lapse in months from conception to date of delivery of an infant, associated with LBW?

$H_0$1: There is no association between duration of pregnancy and LBW.

H_a1: There is an association between duration of pregnancy and LBW.

Research Question 2: Is the number of children born within a 5-year interval, defined as number of reported births in a 5-year period, associated with LBW?

$H_0$2: There is no association between number of children born within a 5-year interval and LBW.

H_a2: There is an association between number of children born within a 5-year interval and LBW.

Research Question 3: Is TV watching at least once a week associated with LBW?

$H_0$3: There is no association between watching TV and LBW.

H_a3: There is an association between watching TV and LBW.

Research Question 4: Is listening to radio at least once a week associated with LBW?

$H_0$4: There is no association between radio listening and LBW.

H_a4: There is an association between radio listening and LBW.

Research Question 5: Is reading a magazine at least once a week associated with LBW?

$H_0$5: There is no association between reading a magazine and LBW.

H_a5: There is an association between reading a magazine and LBW.

Research Question 6: Is type of fuel used for cooking, defined as the form of energy used for cooking in the home, associated with LBW?

$H_0$6: There is no association between type of fuel used for cooking and LBW.

H_a6: There is an association between type of fuel used for cooking and LBW.

Research Question 7: Is IPV, defined as fear for the husband/partner associated with LBW?

$H_0$7: There is no association between IPV and LBW.

H_a7: There is an association between IPV and LBW.

Conceptual Framework for the Study

The study was grounded on the socioecological model (Figure 1), also referred to as the ecological model. The model draws its tenets from the interaction of several factors in a wider society, an institution that forms "the basic foundation of a society" (Frieden, 2010, p. 592). In Zimbabwe, to the best of current knowledge, no research exists that has used the socioecological model to establish determinants of LBW at population level.

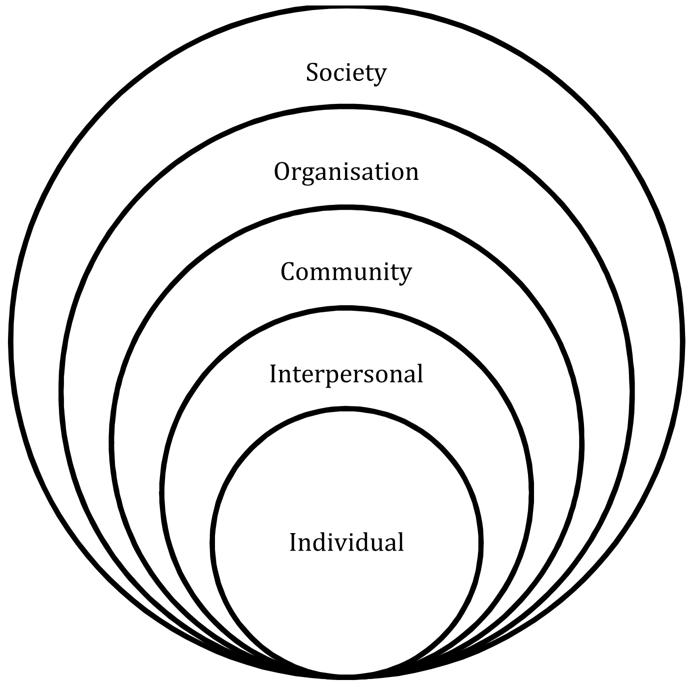

Figure 1. Socioecological model. Adapted from "Social ecological model: A framework for prevention," by Centres for Disease Control and Prevention, 2018

The framework posits that an individual and the environment interact within distinct social domains. Derived from the original model by Bronfenbrenner (1979), the model focuses at the individual, interpersonal, community, organizational, and society level. Each of these social domains is intricately linked to all other factors within the environment where the individual lives. Distal and proximal factors are responsible for shaping how an individual grows, develops, and lives in the society. The model finds relevancy in this present study for there is no one key risk factor responsible for LBW. The innermost oval represents the infant, whose weight prior to birth is entirely dependent on maternal circumstances. It is at this level when maternal level factors are impacting on the pregnancy. Targeting amenable maternal factors at this very early stage could help to reduce the risk of LBW.

The applicability of the socioecological model spans back in time in several domains, including in health. Goodman, Wandersman, Chinman, Imm, and Morrissey (1996) used the ecological model to evaluate a community-based intervention aimed at preventing alcohol, tobacco, and substance use in South Carolina and surrounding communities of Columbia Metropolitan in the United States. Also in the United States, DiClemente, Salazar, Crosby, and Rosenthal (2005) used the model to gain insights about the prevention of sexually transmitted infections (STIs) among adolescents. In Canada, Willows, Hanley, and Delormier (2012) used the ecological model to identify risk factors associated with obesity among Aborigine children. The study found that modifying sociodemographic risk factors, such as education and income, went a long way towards ameliorating food insecurity linked to obesity. Recently, Baral, Logie, Grosso, Wirtz, and Beyrer (2013) discussed how the model could be used to visualize multilevel domains of HIV infection risks. In the United States, Scott et al. (2015) used the model on the HPTN 061 cohort data to explore factors associated with bacterial STIs among Black men who had sex with other man. The CDC (2015a) also used the model in colorectal cancer prevention.

The rationale for using the socioecological model in this present study is that interaction of the behavioral and socioeconomic risk factors within the environment the woman lives is complex to an extent that some of the known determinants affecting infants' birth weight are beyond the woman's immediate control. Clearly, they are part of a complex interplay involving the psychosocial, socioeconomic, and biological factors that are not isolated events in women's lives. In the present study, I have argued that exploring the socioeconomic and physical space in which the pregnancy is conceived could provide potential avenues to target and intervene. In line with the population approach, the contextual conditions facilitating LBW in a population are shaped by maternal circumstances. Therefore, population-health interventions could equally attempt to modify maternal level factors and alter the distribution of LBW in the population.

Nature of the Study

This was a cross-sectional study design with quantitative data derived from the 2015 ZDHS. Cross-sectional study designs are observational in nature with data collected at some point in time used to explore plausible relationships between exposure and outcomes (Carlson & Morrison, 2009). The present study did not establish temporal relationships between exposure and outcome but did provide cross-sectional analysis of the determinants of LBW. Quantitative methods were the strategy of enquiry. Lincoln and Guba (1985) contended that quantitative methods are “value-free” and thus render their objectivity, replicability, and generalizability in the general settings.

The overall approach to data collection and tools used in the ZDHS has been explained elsewhere (ZimStat, 2014). Suffice to say that a stratified, two-stage cluster design was used with enumeration areas (EAs) forming the first sampling units. In all, 406 EAs comprising 169 and 237 EAs for the urban and rural areas respectively were established. The second stage of sampling involved identifying households where consenting adults were interviewed. From the dataset, maternal-infant data formed the unit of the analysis.

Independent variables used in the study were duration of pregnancy, number of children born in the past 5 years preceding the survey, exposure to mass media, type of fuel used for cooking in the household, and IPV. Covariates were maternal age at delivery, marital status, place of residence, education level, wealth index, alcohol consumption, maternal anemia, ever terminated pregnancy, and infant sex. The selection of these variables and setting them out as independent and as covariates was based on the review of other past studies. Infant birth weight was the dependent variable and dichotomized as <2,500g and ≥2,500g.

The approach to data collection, cleaning, and management was clearly explained in the ZDHS (ZimStat, 2015), however to note that the survey allowed for sampling of individuals in households using digital data collection devices. The questionnaire for women allowed for the collection of background characteristics, birth history and childhood mortality, knowledge and use of family planning methods, antenatal, delivery, and postnatal care, marriage and sexual activity, and domestic violence among others. Additionally, the questionnaire collected data on infant health outcomes that included birth weight. Multivariable logistic regression analysis was applied on the data to explore the relationship between the independent variable and the dependent variable while controlling for covariates.

Definitions

Duration of pregnancy: Number of months elapsed from conception to birth, also referred to as the gestation period.

Determinants of health: Social and economic conditions that influence the health of people and communities, including the environment where individuals are born, grow, live, and work (Commission on Social Determinants of Health, 2008).

Exposure to media: Access to reading a newspaper, listening to the radio, or watching television during the week. The information is indicative of the extent to which Zimbabwean women regularly expose themselves to current affairs including information on health-related topics.

Intimate partner violence (IPV): A behavior within an intimate relationship that is bound to result in physical, sexual, or psychological harm to the other partner or spouse (CDC, 2015c).

Socioecological model: A theory-based framework for understanding the complex interplay and interactive effects of personal and environmental factors that determine behaviors and for identifying behavioral and organizational leverage points and intermediaries for health promotion within organizations (CDC, 2018).

Wealth index: A standardized population score based on the number and kinds of consumer goods they own (Howe, Hargreaves, & Huttly, 2008). It is measured using a wide range of assets that include television to a bicycle or a car, including housing characteristics such as source of drinking water, toilet facilities, and flooring materials.

Type of fuel used for cooking in the household: The main form of energy used when cooking in the house such as wood, electricity, liquefied petroleum gas (LPG), and cow dung among others.

Assumptions

Four key assumptions underpinned the study. First, the sensitivity of instruments used to weigh infants at birth was assumed to be the same across all health facilities in the country. Second, as individuals from households either agreed, declined, or were unavailable at the household during the time of the survey, it was assumed that characteristics of all individuals, hence birth outcomes regardless of participation in the study, were randomly distributed. Third, the socioeconomic situation of the mother, as presented during data collection, was assumed to be the same as at the entire duration of the pregnancy through to delivery. For example, if at the time of the survey the mother was using firewood or LPG as fuel for cooking in the household, the study assumed that the same form of energy was also used during the lifetime of the pregnancy. Fourth, it was assumed that maternal health status such as anemia at the time of the survey was the same throughout the life time of the pregnancy. Fifth, the underlying influence of covariates was additive, each additional covariate contributing the same additional risk it would independently. These assumptions are necessary considering that data collection was cross-sectional and can only give a snapshot of the relationship between the exposure and the outcome in the presence of other mediating factors.

Scope and Delimitations

The focus of the study was to establish the relationship between maternal sociodemographic and environmental characteristics and infant birth weight from a population-based dataset and to explore how this relationship was mediated by some covariates. Women aged between 15 and 49 years with a history of live delivery were included in the study. As per the study design, women who lived in institutionalized settings such as army barracks, hospitals, police camps, or boarding schools were excluded. Although relevant to some sections of the study, the biomedical model (Bilton et al., 2002) and the behavioral model (Oliver, 1983) could not be used given the type of relationship I intended to explore in the present study. External validity is a critical challenge in research when results from a sample of data are inferred into the whole population. The fact that ZDHS data were used and approximate very closely to a census, the results may be generalizable.

Limitations

The study gave a snapshot of events that occurred at some point in time prior to data collection. Accuracy in responses such as experience of IPV or exposure to mass media during pregnancy could be of concern considering that the survey collected historical data; possibilities for recall bias (Drews & Greenland, 1990; Raphael, 1987) existed. Without the physical child health card shown, recall bias also extended to instances when the mother read out infant birth weight to data collectors. On the other hand, in cases were infant health records were physically shared with data collectors, potential for selection bias existed. That is, a different infant health record might have been shown, particularly in cases where the mother gave birth to more than two children during the 5-year period. I, however, believe that both the selection and the recall biases were minimal in line with the influence of common good as well as the study approach that comes with the ZDHS.

The study approach gave no evidence of a temporal relationship between exposure and outcome; that is, whether exposure occurred before or during the period covered by the pregnancy. It is therefore a limitation to entirely infer causality between independent variables and LBW. Further, the survey did not collect obstetrics data; had such data been included in the regression model, a relatively robust research finding could have been established. The study did not consider preexisting maternal medical health conditions such as diabetes mellitus, anemia, or hypertension. Some studies showed that the presence of gestational diabetes mellitus (Yi et al., 2013) or maternal stress (Nkansah-amankra, Luchok, Hussey, Watkins, & Liu, 2010) were predisposing factors for LBW. This study only used maternal data, yet research increasingly has shown that paternal factors also affect an infant's birth weight (Metgud, Naik, & Mallapur, 2012).

Significance

Gluckman, Hanson, and Mitchell (2010) pointed out that " when we see potential risk from that angle, we should resolve to use our developmental perspective to devise interventions in time to help the next generation" (p. 3). In line with that thinking, the implication for positive social change that comes with this study includes the use of empirical evidence to help providers of health care services to develop rudimentary checklists that categorize and place pregnant women into risk profiles on the basis of some ecological characteristics. Such profiling has a potential to help health care service providers to design targeted interventions that improve long-term quality of life at reduced health care costs. The research findings may stimulate policy dialogue and advocate for a reorganized approach to health service delivery with the aim to improve birth outcomes. That is, beyond placing emphasis on the biology of the pregnant woman when she presents for antenatal, service delivery models could be tailor-made and be responsive to geographical location, individual circumstances, and health care needs. Currently the country does not have a policy framework on how LBW could be addressed from the sociological perspective.

In his theory of social change, Thomas Kuhn argued that people often continue to use unworkable paradigms until new ones become commonly accepted (Restivo, 1983). A dramatic change from past orientations is therefore needed. Although Kuhn's theory focused on the individual, it also finds relevancy in health service delivery systems where for a long time some systems have remained rigid and bureaucratic, yet, despite no meaningful improvements in health outcomes, they continue to be used. Similarly, the health delivery model for Zimbabwe has barely changed despite its deteriorating standards. Instead, greater emphasis is still placed on the biomedical approach at the expense of the public health approach that intervenes at the population level. Understanding maternal socioeconomic and environment situation in which the pregnancy grows is therefore an essential first step of intervening if pregnancy outcomes at population level are to improve.

Summary

Chapter 1 of the study began with an introduction and background to LBW, a birth outcome that globally has a significant impact on infant morbidity and mortality. The chapter presented the problem statement, noting that, at population level, there is paucity of knowledge on determinants of LBW in Zimbabwe. The purpose of the study, research questions, and hypotheses were also presented. The socioecological model was introduced as the conceptual framework for the study. The nature of the study, definition of terms, assumptions, delimitations, and limitations were also explained. Finally, the significance of the study was presented, highlighting the potential to influencing health policy in Zimbabwe.

Chapter 2 will present the literature review for the study. It draws the study into the context of other existing bodies of knowledge. The chapter concludes by presenting a summary of main themes as well as the knowledge gap.

Chapter 2: Literature Review

Introduction

LBW remains a public health challenge and its determinants at population level are less explored in Zimbabwe. The overall purpose of the study was to establish the relationship between the independent variables (duration of pregnancy, number of births within a 5-year period, exposure to mass media, type of fuel used for cooking in the household, and IPV) and the dependent variable (birth weight), to test how this relationship was mediated by some covariates (maternal age at delivery, marital status, place of residence, education level, wealth index, alcohol consumption, maternal anemia, ever terminated pregnancy, and infant sex). Epidemiological analyses regard infant weight at birth as a factor strongly associated with mortality risk during the first year (Gaiva, Fujimori, & Sato, 2014; Xu, Kochanek, Murphy, Xu, & Tejada-Vera, 2010). Its association with developmental milestones in childhood has been noted (Gluckman et al., 2010). While the link between birth weight and health outcomes may not be causal, their distribution provides an estimate of the origins of human health and disease.

There is a growing body of evidence that has suggested social determinants of health and health outcomes are linked (Commission on the Social Determinants of Health, 2008; Elgar, 2010; Gehlert et al., 2008; Wilkinson & Marmot, 2003). Three models of global health exist, and each presents different ways of looking at health. The biomedical model postulates that health is the absence of disease or disorders (Bilton et al., 2002); the behavioral model sees health as a product of making healthy lifestyle choices (Oliver, 1983); while the socioenvironmental model (socioecological model) views health as an interactive product of social, economic, and environmental determinants (Wilkinson & Marmot, 2003; Wilkinson & Pickett, 2010). There is no contradiction among the models, suffice to say that each model acknowledges that social and natural sciences have different worldviews of looking at health problems. Notwithstanding, the approach to providing recommendations on the appropriate public health interventions therefore depends on the health model used for the study. For this dissertation, I used the socioecological model to establish determinants of LBW in a population-based sample of Zimbabwe.

Chapter 2 of this study provides literature review. In this chapter, I outline the search strategy used. I then focus on the overview of LBW, as well as on the epidemiology of LBW in Zimbabwe. Finally, I provide a review of literature, specifically looking at studies that explored factors associated with LBW. I also present a table summarizing key studies from the reviewed literature. In concluding this chapter, I highlight a research gap this study was designed to focus on so as to contribute to the existing body of knowledge.

Literature Search Strategy

The review of literature focused on maternal socioeconomic and environmental factors and how they impact on LBW. The search strategy was applied to PLoS ONE, CINAHL, ProQuest Nursing & Allied Health Source, Global Health Database, and EBSCO at Walden University. The search engines included Pub Med, ProQuest, MEDLINE, Elsevier, and Google Scholar. Key words used to search for the articles were *socioecological model, health determinants, LBW, ecological model, socioeconomic* *status, infant mortality, intimate partner violence, spouse abuse, infant morbidity*, *ambient environmental exposure, gestation age, anemia, interpregnancy interval,* and *pregnancy.* Either singly or in combination, these key words were used to search for the most relevant and recent articles on LBW. In limited circumstances, however, articles older than 5 years were included. This was primarily done to get a broader historical perspective about LBW.

The Conceptual Framework

The socioecological model underpinned the conceptual framework for the study. The framework is drawn from the original model by Bronfenbrenner (1979), who acknowledged that the social world is made up of interrelated micro-, meso-, exor-, and macrosystems (Figure 2). In his model, Bronfenbrenner described the microsystem as "a pattern of activities, roles, and interpersonal relations experienced by the developing person in a given setting with particular physical and material characteristics" (p. 22). In a reproductive health intervention, the microsystem could infer to dyadic existing between the mother and the infant. The infant develops and grows in the womb where growth is determined by maternal circumstances. Maternal nutrition and access to support services during and after pregnancy have been known to improve chances for better infant development and growth (Leung et al., 2016). Thus, interventions at this level of the system can only happen to the mother and ensure that the infant is delivered healthy.

Bronfenbrenner (1979) inferred the mesosystem as a sociophysical environment in which the developing person actively participates. For this study, I viewed a pregnant woman as an entity that interacts with family members, friends, and other peers who provide social support in many ways. Social support increases self-esteem and provides individuals with practical resources to improve their well-being. Studies have shown that higher circulating levels of cortisol, epinephrine, and norepinephrine are present among people who are socially isolated (Seeman & McEwen, 1996; Uchino, Cacioppo, & Kiecolt-Glaser, 1996) and can impact on their well-being. As the theory of social suffering (Renault, 2009) may suggest, social isolation not only brings misery to the mother but, at times, extends to family and the entire social network. A well natured environment for the pregnant woman will most likely result in improved birth outcomes.

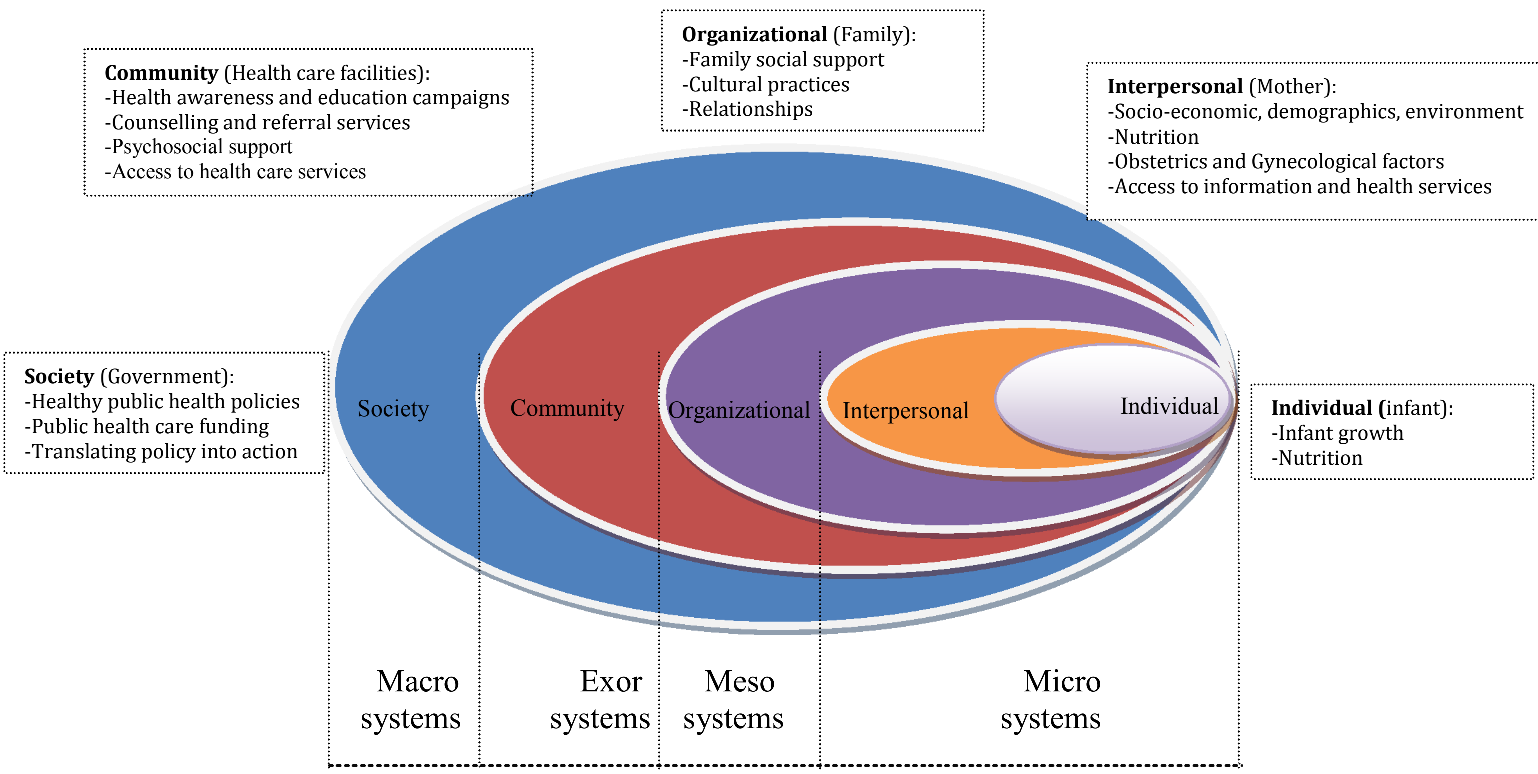

Figure 2. A framework for exploring determinants of LBW

The exosystem, as Bronfenbrenner (1979) further described, is a "one or more settings that do not involve the developing person as an active participant, but in which events occur that affect, or are affected by, what happens in the setting containing the developing person" (p. 25). These are distal factors such as the environment in which the pregnant woman lives. Sociocultural norms and values, religion, social cohesion, and network structures all can play a role on the development of the pregnancy. The developmental origins of health and disease posit that environmental factors acting early during fetal development have profound effect on the infant later in life (Gluckman et al., 2010). Epidemiological studies through epigenetic processes have provided evidence on how biological mechanisms are interlinked with environmental factors and do explain how individuals become susceptible to chronic conditions (Gluckman, Hanson, Cooper, & Thornburg, 2008). At the exosystem, on one hand, the community can be a source to promote better health while on the other may also bring about stigma. For example, community antiretroviral refill groups have been known to provide evidence of adherence and retention (Decroo et al., 2017; Rasschaert, Telfer, Lessitala et al., 2014) for people living with HIV. On the other hand, the community can be a source of stigma as reported elsewhere among people with mental illnesses (Gonzales et al., 2018). Thus, health promotion activities implemented at community level may bring awareness to the community in a way that encourages pregnant women to adapt behaviors that could result in improved delivery outcomes.

Finally, the macrosystem describes the interactions of the individual with the broader society. At this level are maternal and child health care policies and interventions that ensure key factors related to individuals and their environments are targeted and modified. For example, a systematic review of the literature by Elder et al. (2010)

showed that alcohol tax policy was an effective intervention towards reducing excessive alcohol consumption and other related harms. In another study using population-based data from the Behavioral Risk Factor Surveillance System (1985–2002) as well as the U.S. Natality Detailed Files, Zhang (2010) found out that a 1-cent increase in alcohol taxes decreased the prevalence of LBW by 0.1 to 2 percentage points. In Zimbabwe, user-fees at clinics/hospitals have been identified as one of the factors that drive away pregnant women from attending antenatal care services.

While the socioecological model is a useful conceptual framework for this study, WHO (2002) conceded however that delineation between micro-, meso-, exor-, and macrosystems is not obvious; one of the systems typically influences the other. Notwithstanding, the framework provided a starting point for this study given the complex underlying relationship between the developing person and their environment.

Epidemiology of LBW in Zimbabwe

Zimbabwe is divided into 10 administrative geographic provinces. Weighted data for the 2005-2006, 2010-2011, and 2015 ZDHS (Table 1) show an unclear pattern of trends of LBW amongst the three surveys. However, whereas the Multiple Indicator Cluster Survey (MICS) for 2014 (Zimstat, 2014) showed an overall prevalence of 10.1%, weighted data from the ZDHS showed fairly high rates at around 9.5%. The latest ZDHS data for 2015 showed that the prevalence of LBW varied across provinces and ranged from 7.0% in Masvingo to 10.6% in Mashonaland Central. Except for Harare, Manicaland, Matabeleland North, and Matabeleland South, intersurvey results from the

ZDHS showed that between 2010 and 2015, the proportion of infants with LBW was on the increase with the heaviest burden on Mashonaland Central.

Table 1

Percent Distribution of Reported LBW by Province and by type of Survey conducted in Zimbabwe

Province	2005-2006 ZDHS	2010-2011 ZDHS	2015 ZDHS	2014 MICS
Bulawayo	14.2	7.7	10.5	10.8
Harare	11.3	14.0	9.9	8.9
Manicaland	9.0	9.7	9.7	11.0
Mashonaland Central	10.3	8.2	10.6	9.0
Mashonaland East	6.5	7.1	9.9	9.5
Mashonaland West	7.9	9.2	9.7	10.4
Masvingo	8.2	6.7	7.0	9.4
Matabeleland North	9.5	10.9	9.3	11.0
Matabeleland South	5.8	10.3	8.8	12.4
Midlands	10.8	7.8	9.5	8.6
Overall	9.6	9.5	9.5	10.1

Subanalysis of the 2005-2006 survey showed that the prevalence rates for LBW in urban and in rural areas were 10.4% and 9.0% respectively. The same observation, albeit widening, was evident in the 2010-2011 survey where the prevalence rates in urban and rural areas were 11.2% and 8.4% respectively. The 2015 ZDHS data also showed that 10.0% of the urban and 9.1% of the rural infants were LBW. It is evident therefore that the epidemiology of LBW vary across geographical regions as well as place of resident, with the greatest burden being in urban areas.

Literature Review Related to LBW

The causes for LBW vary across individuals. They range from heredity to maternal health condition and dietary habits during pregnancy. Studies have documented that infants born with intrauterine growth restriction have low weight at birth (Olusanya, 2010). A baby gains additional weight in the later part of pregnancy, therefore when born prematurely there are increased odds for low weight at birth. Some suggested underlying causes include lifestyle or genetic factors. Lifestyle factors such as tobacco smoking (Krstev, Marinković, Simić, Kocev, & Bondy, 2013; Mohlman & Levy, 2016; Rijken et al., 2014), alcohol consumption (Miyake, Tanaka, Okubo, Sasaki, & Arakawa, 2014; Witt, Mandell, Wisk et al., 2016), or poor dietary intake lacking micronutrients with iron (Muthayya, 2009) have higher chances for giving birth to underweight infants. The environment plays a role too, particularly when the mother is exposed to air pollutions. Elevated concentrations of inhaled toxic substances such as carbon monoxide, sulfur, and nitrogen can reduce the amount of oxygen circulating in the body leading to intrauterine growth retardation and risk of LBW (Naz, Page, & Agho, 2015).

The literature below presents studies that have explored factors associated with LBW. The studies are broadly organized under four themes: demographics, socioeconomic, environmental, and health indicator markers. The selection of these indicators was guided by what others studies have explored, however maintaining them to a minimum based on what was available in the ZDHS dataset.

Demographic Characteristics

Place of residence. The neighborhood where people live sometimes define and shape who they are. This goes on to describe their social networks, peers, income, education, and occupation. In most studies, place of residence, either rural or urban, has been used as a proxy for the socioeconomic status of the individual. In the case for Zimbabwe, with the advent of industrialization, coupled with push and pull factors created, a fine line may exist between urban and rural. Notwithstanding, some research have shown that urban and rural populations have different health status (Kent, McClure, Zaitchik, & M Gohlke, 2014) primarily due to differences in inequalities across the social spectrum. In Ghana, LBW was associated with rural dwelling (Kayode et al., 2014). Wilkinson and Pickett (2010) hypothesized the theory of social gradient of health which posits that health inequalities run down the social class such that those in the lowest rung have worst health outcomes as measured by morbidity and mortality. Communities that experience steep social gradient experience worst health outcomes. The rural-urban disparities in health-related quality of life are presented in a Polish study of postmenopausal women (Kaczmarek, Pacholska-Bogalska, Kwaśniewski, Kotarski, Halerz-Nowakowska, & Goździcka-Józefiak, 2016). In the study using a sample size of 660 postmenopausal women aged 48 to 60 years, researchers found out that rural women generally had greater odds of poorer quality of life than women in urban areas (odds ratio [OR] 0.45 confidence interval [CI] 0.25-0.83 $p = 0.0099$). The rural-urban disparities may also be explored in the context of birth outcomes.

A cross-sectional study by Bhattacharjya, Das, and Ghos (2015) in a department of obstetrics and gynecology of Agartala Government Medical College, India, showed that, of the 305 mothers who delivered at the hospital, LBW was significantly higher in rural (28.6%, $p = 0.017$) than urban communities. Using binary logistic regression analysis, the same study established that place of residence (OR 2.373 CI 1.39-4.06 $p = 0.002$) was a significant determinant of birth weight. Findings from Bhattacharjya, Das, and Ghos (2015) however do contrast with observational data from the 2010-2011 ZDHS which showed higher prevalence of LBW in urban than in rural communities. Thus, the extent to which place of residence impacts on LBW, at least in the context of Zimbabwe, remains an area to also explore.

Maternal age. The age of the mother during pregnancy is a key variable to consider as it helps to determine whether the woman could be categorized as being at risk of delivering an underweight infant. Studies that explored the relationship between maternal age and LBW observed that extreme ends of maternal age at delivery tend to be associated with LBW (Goisis, Remes, Barclay, Martikainen, & Myrskylä, 2017; Kaur et al., 2014; Yi et al., 2013). In a study by Kaur et al. (2014), risks for LBW were evident among women aged less than 20 years (87.5%) and those above 30 years (78.8%). The effect of maternal age was also evident in a study in Pelotas, Brazil as well as in Avon, UK (Restrepo-Méndez et al., 2015). Jointly, the researchers conducted three birth cohort studies for 1982, 1993, and 2004. The Hosmer–Lemeshow goodness-of-fit test was applied to examine the association between maternal age and LBW. Cohorts for 1982 and 1993 showed that maternal age less than 20 and greater than 34 years were strongly associated with LBW. However, when adjusted for socioeconomic status, the relationship attenuated to the null.

In Taiwan, data from the Taiwan Birth Registry were collected for the period 1985 to 1997 (Chen, Tsai, Sung, Lee, Lu, Li, & Ko, 2010). Of the 1,185,597 live births born to mothers aged 24 years or less, 151,259 (12.8%) were born to adolescent mothers. After controlling for birth and socioeconomic characteristics, the age-specific analysis established variations in risks for LBW, with the youngest age being at increased risk. Elsewhere in India, Borah and Agarwalla (2016) conducted a community-based study to determine the risk of advanced maternal age on LBW. Data from 450 mothers were analyzed using multivariate logistic regression analysis. Findings were that mothers aged below 20 years were about 4 times as likely to give birth to LBW infants (OR 3.93 CI 2.16-6.45) as mothers aged 20 to 30 years. Also when compared with those aged above 30 years (OR 1.21 CI 0.6-2.80), the association was not significant. In their study Chen, Li, Ruan, Zou, Wang, and Zhang (2013) established that mothers aged less than 20 years were more likely to result in LBW infants than those aged at least 20 years. In Oman, aged mothers were more likely to give birth with LBW (Islam & ElSayed, 2015).

The findings from above studies do suggest that maternal age at delivery was a risk factor for LBW. The risk for LBW tended to be higher among the young and the aged. The cut off age between the different age groups however was not clearly established across studies. Restrepo-Méndez and Lawlor (2015) used the 25 to 35 years as a comparison to the <16 and to the >35 years; Borah and Agarwalla (2016) focused on

<19, 20-30, and above 30 years while Silva, Hernandez, Agranonik, and Goldani, M. (2013) used the 11-16, 17-19, 20-24, 25-29, 30-34, 35-39, 40-49 age groups.

Marital status. One of the advantages of gathering evidence from multiple sources such as systematic review is that converging evidence from independent sources may support information about a particular issue. Sha, Zao, and Ali (2011) conducted a systematic review and meta-analysis of the relationship between marital status and LBW. Using different search engines that included CINHAL, Medline, and Embase, the researchers reviewed 21 studies that compared LBW among the married and the unmarried. Findings were that unmarried mothers had increased odds (OR 1.46 CI 1.25-1.71) of LBW as married mothers. A study by Oladeinde, Oladeinde, Omoregie, and Onifade (2015) in Nigeria also noted an association between marital status and LBW (OR 2.139 CI 1.174-3.898 $p = 0.015$), with the unmarried at increased odds for LBW. The results were in contrast with findings from an earlier retrospective case-control analysis of 3,463 women who delivered at Edith Wolfson Medical Center Holon, Israel (Lurie, Zalmanovitch, Golan, & Sadan, 2010). In Malaysia, 242 young Malaysian women participated in a study that evaluated the impact of maternal marital status on birth outcomes (Mohd Zain, & Othman, 2015). Findings from the study were that at the time of delivery, unmarried women were about 4 times as likely to give birth to LBW infants as married women (OR 3.61 CI 1.98-6.57). Bird, Chandra, Bennett, and Harvey (2000) argue that it is not so much about marital status but rather the characteristics of the relationship that exists.

Based on this review, it does appear that there are mixed conclusions regarding the role of marital status on LBW. In Zimbabwe, 59.4% of the sexually reproductive female population are married (ZimStat, 2014).

Education level. The theory on the demand for health suggests that the efficiency of health production is a product of education. This goes on to argue that people who are educated are knowledgeable about the production of health services. In 1986, Wagstaff used the allocative efficiency hypothesis to explore whether education improves health knowledge. The study concluded that there are many other reasons why school impacts on health outcomes while in Malawi, low maternal education was found to be associated with LBW (Muula, Siziya, & Rudatsikira, 2011). In Greece, Tsimbos and Verropoulou (2011) conducted a nationwide study among migrants and natives to establish maternal socioeconomic and demographic determinants associated with LBW. Multinomial logistic regression analysis was performed on a sample of 103,266 women. Findings from the study were that, when compared with up to secondary level of educational attainment, the relative risk ratios for LBW among mothers with tertiary education was 0.724 ($p < 0.05$). In a community study in India, Avachat, Phalke, and Kambale (2014) conducted a cross-sectional study to analyze data from 652 randomly selected children under 5 years of age who had records of birth weight. Descriptive analysis from the study established that a significant proportion of women from lower educational status ($p < 0.01$) were associated with LBW. These trends were also evident in another cross-sectional study conducted in a rural community of Kinaye Primary Health Centre in Karnataka, India (Metgud et al., 2012). Results from the multiple logistic regression analysis revealed that women with low literacy were about 3 times (OR 3.2 CI 1.0–10.3) as likely to have LBW infants as women with tertiary education.

Silvestrin, Silva, Hirakata, Goldani, Silveira, and Goldani (2013) conducted a met-analysis to assess the relationship between maternal educational level and LBW. Of the 729 articles reviewed, nine articles met the quality for consideration in the review. The review concluded that maternal education had a 33% protective effect against LBW when compared with no education. Medium level of education showed no significant difference when compared with no education. These findings are supported by results from a meta-analysis of cohort and cross-sectional studies by Silvestrin et al. (2013). When compared with no education, the results were that high maternal education showed a 33% protective effect against LBW (OR 0.67 CI 0.51-0.88). No degree of association was established in the medium or low maternal education. From the above review, one may conclude that a plausible relationship exists between educational gradient and health outcomes. Lower educational level was significantly associated with LBW.

Socioeconomic and Psychological Characteristics

Wealth index. The social gradient of health poses that inequalities in population health status is a result of the inherent inequalities in social status of individuals in the community. According to early propositions of the hypothesis of social gradient (Wilkinson & Marmot, 2003; Wilkinson, 1996), it was argued that a link exists between socioeconomic status and health. People who are worst off in the community and are at the lowest rung of the economic ladder have poor health outcomes as measured by morbidity and mortality. Yet others argued that it is not absolute but relative income that gives rise to social gradient of health (Theodossiou & Zangelidis, 2009). Using the Blinder-Oaxaca decomposition in Ireland, Madden (2014) found that socioeconomic gradient for LBW was due to differences between being rich and poor. Yet in a separate study on 4,364 rural women in China who recently gave birth, Nwaru et al. (2011) established a weak to moderate association between wealth index and LBW. Elsewhere in the United States, Nepomnyaschy (2009) used a nationally representative dataset of 8,650 women who had given birth. The study found no evidence of the relationship between any of the socioeconomic status indicators and LBW among all races, except for the white population (OR 1.36 CI 1.01-1.84). In Sri Lanka however, low wealth index mediated the association with LBW (Anuranga, Wickramasinghe, Rannan-Eliya, Hossain, & Abeykoon, 2012). Findings from all the above studies did suggest that there are other underlying socioeconomic factors linked to LBW.

Exposure to mass media. The Zimbabwe DHS data for 2010-2011 show that exposure to mass media among women ranged between 16.7% and 49.2%. A less than 50% exposure is also evident in the 2015 DHS data. How exposure to media among pregnant women influences birth weight worth exploring is less established in Zimbabwe. The health benefits of exposure to media in general are evident in a cross-sectional study conducted by Ankomah, Adebayo, Arogundade et al. (2014) in one of the malaria-endemic zones of Nigeria. Of the 2,348 women interviewed, results did show that women who listened to radio were 1.6 times as likely to use insecticide treated nets (OR 1.56 CI 1.07-2.28 $p = 0.02$) as women who did not listen to radio. The study concluded that pregnant women who had access to mass media communication were more likely to adapt health behaviors that reduce exposure to malaria than those who never had access to media.

In a Bangladesh study by Jesmin, Chaudhuri, and Abdullah (2013) using DHS data, it was found out that a significant association existed between exposure to media and improved knowledge about HIV and AIDS ($p < 0.01$). The association was however mediated by socioeconomic characteristics. The positive impact of media exposure on health outcomes is further evident in a birth preparedness study among women in southwestern Uganda (Asp, Odberg Pettersson, et al., 2014). Univariate and multivariate logistic regression were applied on data derived from 765 women who delivered in the village. Findings from the study were that reading newspapers was associated with birth preparedness (adjusted OR [aOR] 2.2 CI 1.5-3.2). The association however was not evident among women with regular exposure to radio, newspaper, or television (aOR 1.3 CI 0.9-2.0). These contrasting findings may suggest that small bursts of information as opposed to saturated information may have an influence on health behaviors.

Nature of household drinking water. Water sources in Zimbabwe vary and include dams, unprotected wells, boreholes, and rivers. In some communities, families boil, chlorinate, or do not treat water meant for drinking. Some urban or rural settings receive portable water for domestic use. However, the extent of the safety of the water remains questionable as it may not be as per the WHO standards. Ruckart, Bove, and Maslia (2014) conducted a cross-sectional study of births that occurred between 1968 and 1985 at Camp Lejeune, North Carolina in the United States. Data from 11,896 mothers and their singletons were available for analysis. Unexposed mothers were identified as those who did not receive contaminated drinking water, else were classified as exposed. Using unconditional logistic regression, the study established no significant association between nature of drinking water and LBW.

In a community exposed to unsafe nitrate levels in drinking water, Blake (2014) found no association between type of drinking water and LBW. Elsewhere in Kaunas, Lithuania, a cohort of 4,161 pregnant women was followed between 2007 and 2009 with maternal outcomes assessed (Grazuleviciene, Nieuwenhuijsen, Vencloviene, 2011). The study found a dose-response relationship between exposure to different levels of trihalomethanes (TTMH) in drinking water and LBW. For example, for TTMH levels between 0.3545-2.4040 mg/d, exposure was associated with 2.13 folds (CI 1.17-3.87) risk for LBW. These results are also confirmed in earlier epidemiological studies (Whitaker et al., 2005).

Except for exposure to different levels of TTMH, the literature suggests no evidence of the association between quality of drinking water and LBW.

Birth spacing. Research shows that children born within short birth spacing intervals of less than 18 months are at increased risk of poor health (Dean, Lassi, Imam, & Bhutta, 2014; Kaur et al., 2014), including LBW (Partington, Steber, Blair, & Cisler, 2009). How this transcends to LBW is evident in a study by Firdous, Qureshi, Manzoor, and Pandit (2014) who conducted a cross-sectional study in Lalla Ded Hospital at the Valley of Kashmir from August 2010 to August 2011. One thousand mother-baby pair data were collected and analyzed to determine the association between birth spacing and LBW. Multiple logistic regression analysis was applied on the data. After controlling for other sociodemographic variables, the findings were that child spacing intervals of <18 months (OR 2.1 CI 1.3-3.5) and >48 months (OR 1.88 CI 1.1-3.1) significantly increased the risk for LBW. Within the context of Zimbabwe, the median birth interval is 47.1 months, and about 9% of children are born within a 24-month period (ZimStats, 2014). The findings are further confirmed in Tampa, Florida (Salihu, August, Mbah, et al., 2012) and in Sweden (Class, Rickert, Oberg et al., 2017). For example, in the Swedish study, researchers observed that short interpregnancy intervals of 0 to 5 months (aOR 1.25 99%CI 1.13-1.39) and long interpregnancy intervals of at least 60 months (aOR 1.61 99%CI 1.50-1.73) were associated with LBW. Earlier study by Ball, Pereira, Jacoby, de Klerk, and Stanley (2014) provide a different conclusion while Chen, Jhangri, Lacasse, Kumar, and Chandra, (2015) concluded that interpregnancy interval was associated with LBW.

Using Retrospective cohort study of 40,441 women, Ball et al. (2014) used matched analysis to model incidence of adverse birth outcomes. Each mother was used as a case as well as a control. Conditional and unconditional logistic regression analysis were applied on the data. Findings were that, relative to the reference category of 18 to 23 months, the unmatched analysis revealed that IPI of 0 to 5 months was associated with LBW (OR 1.26 CI 1.15-1.37) whereas with the matched analysis, IPI above 59 months was not associated with LBW (OR 1.03, 0.79-1.34). The researchers concluded by questioning the causal effect of short IPI and suggested that there could be latent variables contributing to the observed relationship as established by previous studies.

In Michigan, the United States, Bao-Ping and Le (2003) used a retrospective cohort study design to examine the relationship between IPI and LBW. Data generated between 1989 and 2000 were analyzed. The risk for LBW was found to be between 18 and 23 months after birth and increased with 0.5% for every additional month. After controlling for other risk factors, the researchers observed a J-shaped relationship. For example, among the first-second birth pairs, the aORs and CI for LBW associated with IPI at less than 6, 24 to 59, 60 to 95, and 96 to 136 months were 1.4 (CI 1.3-1.5), 1.5 (CI 1.3-1.6), 1.1 (CI 1.0-1.1) and 1.5 (CI 1.3-1.8), respectively, compared with interval of 18 to 23 months.

From the above review, it is evident that extreme birth intervals were associated with LBW. Favorable birth outcomes seem to be from mothers who were in their early 20s and 30s. Outside of these age limits, studies seem to suggest that a relative increase in birth interval also increase the odds for LBW.

Environmental Characteristics

Type of fuel used for cooking in the household. In Zimbabwe, the majority of people in rural communities use wood as a form of fuel for cooking in the household. Additionally, it is used to provide warmth during winter. With massive deforestation that has been going on in the past three decades, alternative forms of fuel such as LPG, coal, and electricity are being used. Kerosene remains another common form of energy in poorest communities. The use of these forms of fuels can impact on the environment and the quality of air particulate considering smoke fuses they produce. According to the Health People 2010 (U.S. Department of Health and Human Services, 2011), it was estimated that, worldwide, 25% of preventable illnesses were due to exposure to environmental pollution. Some studies show that environmental exposure to toxicants while pregnant can affect birth weight outcomes (Ghosh, Wilhelm, & Ritz, 2013; Miranda et al., 2013; Nascimento & Moreira, 2009). Elsewhere, Singh, Ueranantasun, and Kuning (2017) find highly polluting cooking fuels (aOR 1.49 CI 1.03-2.22) being associated with LBW infants. After adjusting for LPG as form of fuel for cooking, Min, Jie, Min et al. (2015) established evidence of an association between coal and LBW (OR 1.92 CI 1.37-2.69). The same study found increased odds for LBW among mothers who used biomass (OR 3.74 CI 2.35-5.94). Using data from the Bangladesh national survey, Khan, Nurs, Islam, Islam, and Rahman (2017) established that regardless of the solid form of fuel used, it was indoor use that in fact was associated with LBW (aOR 1.25 CI 1.10-1.43).

Evidence of the association between form of fuel and LBW was established in a cross-sectional, retrospective study by Ahern, Mullett, Mackay, and Hamilton (2011) whose study explored the association between LBW and mother's residence in a coal mining community of West Virginia in the United States. Maternal, infant, and environmental data generated from each county between 2005 and 2007 were collected and analyzed. After adjusting for covariates, dwelling in high coal mining activities had increased odds for LBW (OR 1.16 CI 1.08-1.25 $p = 0.0002$). In Ghana, Amegah, Jaakkola, Quansah, Norgbe, and Dzodzomenyo (2012) used a cross-sectional study on 592 mothers and their newborns at the Korle Bu Teaching Hospital in Accra. Data for maternal characteristics, indoor environment, and birth weight were recorded. The study found that maternal exposure to charcoal during pregnancy and burning of garbage within the home environment were associated with LBW. In India, a study conducted by Kadam, Mimansa, Chavan, and Gore (2013) found that increased exposure to wood fumes in the household was associated with LBW ($F = 3.825$, $p < 0.05$). However, Wylie, Hamer, Yeboah-Antwi et al. (2014) refute findings from Kadam et al. (2013).

Alcohol consumption. Alcohol is a social drink. Like tobacco smoking, some people consume alcohol to alleviate stress, respond to peer pressure, or to manage loneliness. Alcohol can bring a sense of adventure. Consuming alcohol sometimes brings stupor or excitement to the mind. The effects of alcohol can at times transcend to sexual violence, and other aggressive behaviors, including fetal alcohol syndrome (Truong, Reifsnider, Spitler, & Mayorga, 2013). The association between alcohol consumption and LBW were explored in Japana (Tanaka, Miyake, Miyake et al., n.d.). From a meta-analysis of 1,565 Japanese mothers with singleton pregnancies, no relationships were observed between light to moderate alcohol consumption of <1.0g/day during pregnancy (OR 0.98 CI 0.46-1.85). However, consumption of 1.0 g or more per day during pregnancy was significantly associated with an increased risk of LBW (OR 2.58 CI 1.004-5.80 $p = 0.03$ Findings from the study seem to suggest that drinking alcohol may not necessary result in LBW, but perhaps the amounts consumed (Truong, Reifsnider, Spitler, & Mayorga, 2013). These finding remarks are consistent with results from the analysis of data from the National Center for Health Statistics of the United States. Findings were that maternal binge drinking attributed to the 5,627 (CI 5,121-6,133) LBW deliveries in 2008.

Intimate partner violence. IPV is an outcome that is multifaceted and arises following a number of events. It could take the form of physical, emotional abuse, harassment, sexual violence, or psychological harm. In recognition of a gap in knowledge on the impact of IPV on LBW, Sigalla et al. (2017) conducted a prospective cohort study on 1,112 pregnant women attending antenatal care in Moshi, Tanzania. Logistic regression analysis of the data showed an association between IPV and LBW (aOR 3.2 CI 1.3-7.7). The relationship was even stronger for women who had previous history of adverse outcome (aOR 4.8 CI 1.6-14.8). The findings resonate with results from Wado, Afework, and Hindin, (2014) on a community-based prospective cohort study in rural southwestern Ethiopia. In all, 537 women were enrolled to examine the association, among others, of prenatal depression and social support on the risk of LBW. Multivariable log binomial regression was used to model the risk of LBW as a function of demographic and psychosocial factors. After adjusting for social support and other sociodemographic variables, the study found that depression during pregnancy was associated with LBW (OR 1.89 CI 1.14-3.12 $p < 0.01$).

Some substantial negative sequelae that IPV imparts on women during pregnancy are established in other studies. Demelash, Nigatu, and Gashaw (2015) used a randomized controlled trial in the District of Columbia, United States, targeting 819 African-American women who experienced IPV during pregnancy. The study observed that depression was associated with LBW. After controlling for sociodemographic and health risk factors, the multivariate logistic regression showed that the intervention group was almost twice (OR 1.71 CI 1.12-2.62) as likely to deliver infants with improved birth weights as the control group.

Elsewhere in the United States, Alhusen, Bullock, Sharps, Schminkey, Comstock, and Campbell (2014) used the Conflict Tactics Scale 2 to measure the severity of IPV among women at a perinatal clinic. Of the 194 neonates in the study, there was a higher chance for LBW (OR 4.20 CI 1.46-12.10) for infants whose mothers had a high severity of IPV during pregnancy. Similarly, using a prospective cohort study design on 1,461 pregnant women in a primary health center of Mazandaran University of Medical Sciences in the North of Iran, Abdollahi, Abhari, Delavar, and Charati (2015) observed an increased risk (OR 2.9 CI 1.92-4.40 $p < 0.001$) of LBW in women who experienced IPV as women who did not experience any partner violence. A prospective study by Bloch, Webb, Mathews, Dennis, Bennett, and Culhan (2010) on low-income urban women in PNC, Philadelphia, Pennsylvania, found that women in poor relationships were almost twice as likely to have depressive symptoms (adjusted prevalence ratio [aPR] 1.93 CI 1.65-2.25) as women in good relationship. There were more likely to have stress (aPR 1.24 CI 1.14-1.35), use drugs (aPR 1.34 CI 1.11-1.61), and smoke (aPR 1.28 CI 1.10-1.49) when compared with those in a good relationship. These results do suggest that poor partner relationship can trigger a number of poor health events. Absence of physical violence is a reflection of stable mental health hence improved birth outcomes. A review of the above studies therefore suggest that a relationship exists between IPV and LBW.

Health Indicators

Anemia. According to the WHO (2016), the leading causes for anemia are iron deficiencies in the diet. Iron is responsible for carrying oxygen to meet other complex physiologic needs of the body. Diet that provides an array of nutrients to the growth of the pregnancy therefore plays an important part during the development of the infant. Some studies indicate that anemia increases the risk for preterm delivery and delivering LBW babies (Mumbare, Maindarkar, Darade, Yenge, Tolani, & Patole, 2012; Sekhavat, Davar, & Hosseinidezoki, 2011; Kaur et al., 2014; Feresu, Harlow, & Woelk, 2015; Chen, Li, Ruan, Zou, Wang, & Zhang, 2013; Md Mizanur, Krull Abe, Md Shafiur et al., 2016). These findings nonetheless contrast with findings from other studies (Joshi, Likhar, Athavale, & Shukla, 2013; Masukume, Khashan, Kenny, Baker, & Nelson, 2015) where the association was not established.

A contrast to the above results may be explored in the context of the study design, sample sizes used, and covariates considered in the analysis. In Nigeria, Agarwal, Agarwal, Agrawal, Agrawal, and Chaudhary (2011) used a cross-sectional study design with 350 mothers delivering at a tertiary hospital institution. Results from the descriptive analysis were that a significantly higher proportion (60.5%, $p < 0.001$) of mothers who delivered LBW infants were anemic. In another cross-sectional descriptive study, Kaur et al., (2014) noted that the prevalence of LBW was significantly high among anemic mothers (28.8%, $p = 0.0069$). In India, Borah and Agarwalla (2016) found that the odds for LBW given that the mother was anemic was about twice as much (OR 1.93 CI 1.3-2.9). Using a prospective study design at Paropakar Maternity and Women's Hospital, Kathmandu in Nepal, a study by Rana, Sharma, Chand, and Malla (2011) used 491 primigravidas with full term singleton pregnancy. The study established that anemic mothers had higher odds for LBW when compared with non-anemic mothers (OR 6.80 CI 3.83-12.12 $p < 0.0001$). By contrast, in Benin, Koura, Ouedraogo, Le Port et al. (2012) conducted a prospective study of 617 mother-infant pairs to explore the association between anemia and LBW. The prevalence of anemia among the sample was 39.5%. The study found no significant association between maternal anemia and LBW (OR 1.2 CI 0.6-2.2). These findings too are confirmed in a study conducted in India (Ahankari, Myles, Dixit, Tata, & Fogarty, 2017). That is, the researcher found lower risk for LBW among mothers who were anemic (unadjusted OR 0.34 CI 0.13-0.92 $p = 0.03$).

Based on the review of the literature above, there appeared mixed findings regarding the relationship between anemia and LBW. The influence of geography may play a role in this regard. Data from the WHO (2015) showed that globally, prevalence rates of anemia differ considerably across countries.

Pregnancy termination. Some studies have explored the relationship between impact of pregnancy termination on future pregnancy outcomes, including LBW. In Finland, Männistö, Mentula, Bloigu, Gissler, Niinimäki, and Heikinheimo (2014), used data from health registries to explore birth outcomes from second versus first trimester medical termination of pregnancy (MTOP) in primigravid women. Of the 88,522 women used in the study, no significant difference in birth weight was observed in subsequent pregnancies between those with first- and second-trimester MTOP (OR 1.21 CI 0.71-2.07 $p = 0.484$). The findings contrast with results from 36 studies in a meta-analysis of

1,047,683 women. The study showed that induced termination of pregnancy or spontaneous abortion (7.3% vs 5.9%; OR 1.41 CI 1.22-1.62) was associated with LBW in future pregnancies when compared with the controls.

In a related study, Männistö, Bloigu, Mentula, Gissler, Heikinheimo, and Niinimäki (2017) used data from 19,894 pregnant women who underwent termination of pregnancy between 2000 and 2009. Only singleton deliveries were considered in the study. After adjusting for all factors, findings were that women who delivered within less than 6 months of pregnancy termination had increased odds for LBW (OR 1.35 CI 1.02-1.77). On further analysis, researcher rather established that interpregnancy period following the abortion was in fact associated with LBW in future pregnancies than the history of having aborted. In another retrospective analysis of children born in 39 hospitals drawn from 14 different provinces of China targeting 112,441 women, findings were that previous history of adverse pregnancies was associated with LBW (Chen et al., 2013).

Critique of Research Methods

The study designs varied and were mostly cohort, cross-sectional, systematic review, and case-control studies. These are summarized as follows:

- *Prospective cohort* – In Tanzania, Sigalla et al. (2017) used a prospective study design to determine the association between IPV and preterm delivery and LBW. The sample size for the study was 1,112. In India, of the eligible 303 women who were followed, only 287 (95%) provided data for analysis (Ahankari et al., 2017). In Vietnam, Hoang, Van, Gammeltoft et al., (2016) also used a prospective cohort study design on a sample of 1,276 pregnant women in Dong Anh district. Considering that the socioeconomic status of the mother may change over time, these prospective cohort studies tended to focus on outcomes that were of medical importance.

- *Retrospective cohort* – In Michigan, a sample size of 565,911 livebirth documented between 1989 and 2000 was obtained from a maternal linked registry (Bao-Ping, & Le 2003). In southern rural Ghana, Salihu, Mbah, & de Cuba (2012) used the database of health and demographic surveillance system to extract variables that included pregnancy, birth, demographic and socioeconomic indicators of 6,777 mothers who gave birth in 2011, 2012, and 2013. In their study, maternal age was categorized as <20, 20-24, 25-29, 30-34, and >35 years. The design facilitated convenience access to historical data, and has bias associated with the sampling of participants.
- *Cross sectional* – Data were generated mostly from a sample of hospital files or from electronic registries at the hospital. Some studies considered DHS data as was the case in Sri Lanka (Anuranga et al., 2012) and Ghana (Kayode et al., 2014). Studies that extracted data from electronic registries tended to have a relatively large sample size, perhaps due to the convenience associated with access to such data. For example, in Canada the sample size was 46,243 (Chen et al., 2015) while in Finland, Männistö et al. (2014) used the Finnish health registers to extract data from 88,522 women. Selection of study participants included cluster, simple random, or convenience sampling. In

most of the studies, the variables included place of residence, occupation, level of education, multiple micronutrient supplements, maternal age at birth, interpregnancy intervals, antenatal care attendance, wealth status, region, parity, and maternal employment. Hospital-based clinical studies tended to use small for gestational age, an alternative variable for duration of pregnancy. However, where population-based data were used, none of the studies considered duration of pregnancy as one of the variables to explore. Multiple logistic regression analysis was applied with OR used to infer meaning out of the data.

- *Systematic review* – The reviews used database that included PubMed, Science Direct, Cochrane, Medline, Web of Science, Scopus, Springer, Embase, and Google scholar. The final number of studies ranged from eight to 30. For example, while exploring the relationship between maternal anemia and LBW, Rahmati, Delpishe, Azami, Ahmadi, and Sayehmiri (2017) had 17 studies with a total sample size of 245,407 entered in the final meta-analysis. Systematic reviews generally take a long time to gather data and analyze.
- *Case-control study designs* – These were applied on a number of studies I reviewed. The variables considered for the analysis were prepregnancy hypertension, Body Mass Index, previous history of live birth, maternal education, eclampsia, gestational hypertension, hospitalization during pregnancy, previous preterm birth, multiple gestation, and race. Multiple logistic regression analysis was applied on the data with results reported as

OR or aOR. For example, a community hospital in Baltimore Maryland used data generated between July 2010 and June 2011 (Harvey, Strobino, Sherrod et al., 2017). The sample size for the study was 862 women with primiparity. Logistic regression analysis was used with results reported as OR and CI.

It is evident from above that the study designs varied, with different sample sizes and different sample selection methods applied. The variables used also varied but do align with those suggested in this present study. Of note however is that pregnancy duration and number of children born within a 5-year period were not considered in a single analytic model using population-based data, much in contrast with the present study. The study settings were rural and urban as well as hospitals. Table 2 shows selected studies used in the literature review.

Table 2

The Literature Review Matrix

Author, year, and source	Research question or theoretical/conceptual framework	Study design, settings, data collection period, and sample size	Sampling and analysis	Results and conclusions	Implications for practice
Salihu et al., 2012, *Journal Of Community Health*	To examine the influence of the Federal Healthy Start's interconception care services on IPI and fetal growth outcomes	Retrospective cohort, 2002-2009 with xxx participants	Records from the Central Hillsborough Healthy Start program, Multivariate logistic regression	Shortest IPI (0-5 months: AOR = 1.39, 95% CI 1.23-1.56) and longest IPI (≥60 months: AOR 1.13, CI 1.03-1.23) associated with LBW	Conception care be provided to women in the childbearing age group
Kadam, et al., 2013, Indian Journal of Community Medicine	To study the effect of exposure to various kitchen fuels on birth weight	Retrospective analysis, 6 month, 328	Hospital-based, binary logistic regression	Wood increased chances for LBW, χ^2= 12.926, $p <$ 0.01	Substitution with cleaner forms of fuel for cooking is advisable
Sigalla et al., 2017, *Plos ONE*	To determine the association between IPV exposure during pregnancy and PTB and LBW	Prospective cohort study, March 2014 to May 2015, and 1,112 women participated	Face-to-face interviews and clinic records, Logistic regression analysis	Impact of IPV on LBW was evident (aOR 3.2 CI 1.3–7.7) and even remained stronger for women who had previous history of adverse outcome (aOR 4.8 CI 1.6-14.8).	Health services to offer screening during ANC and identify elements of exposure to violence
Männistö et al., 2014, *American Journal of Obstetrics & Gynecology*	To compare risks of preterm birth, LBW, small for gestational age infants and placental complications in subsequent pregnancy after second vs. first trimester MTOP in primigravid women.	Retrospective analysis, 2000–2009, a total of 88,522 women	Collection of registry data, logistic regression	No evidence of association was noted (OR 1.21 CI 0.71-2.07 p = 0.484)	Increased counselling is required for women contemplating to undergo second-trimester TOP

(table continues)

Author, year, and source	Research question or theoretical/conceptual framework	Study design, settings, data collection period, and sample size	Sampling and analysis	Results and conclusions	Implications for practice
Md Mizanur et al., 2016, *American Journal Of Clinical Nutrition*	To estimate the pooled prevalence of anemia, the association between maternal anemia and pregnancy outcomes in low to middle income countries	A systematic review and meta-analysis, from inception to May 2015, 29 studies included in systematic review, and 26 in the meta-analysis.	Collection of studies, systematic review and meta-analysis	Significantly higher risks of LBW (RR 1.31 CI 1.13-1.51)	Low- and middle-income countries to devise mechanisms to devise mechanisms to manage anemia among pregnant women
Ko et al., 2014, *Pediatrics and Neonatology*	The effects of maternal and paternal smoking on the offspring during the different stages of pregnancy	Prospective longitudinal cohort, Taiwan national birth registration, June 2005 and July 2006, 24,200	Proportion probability to size, Multiple logistic regression analyses	At first trimester, smoking 1-10 cigarettes/day (OR 2.27 CI 1.72-2.99) smoking 11-20 cigarettes per day (OR 2.72 CI 1.53-4.85) and more than 20 per day (OR 3.12 CI 0.67-14.60)	Smoking cessation/reduction should be advised to pregnant women to reduce adverse pregnancy outcomes
Miyake et al., 2014, *BMC Pregnancy and Childbirth*	The relationships between light to moderate alcohol consumption during pregnancy and the risk of LBW, preterm birth or small-for-gestational-age	Meta-analysis, April 2007 and March 2008, 1,565	Prospective prebirth cohort study, multiple logistic regression analysis	Light (<1.0g/day (OR 0.98 CI 0.46-1.85)) to moderate (>1.0g/day (OR 1.31 CI 0.52-2.84)) alcohol consumption not associated with LBW	Women should abstain from alcohol consumption during period of pregnancy

Summary of Themes

The review of the literature provided an overview of the current state of knowledge on the determinants of LBW. The emerging trends from the literature show that LBW is a life-course condition arising from a multiplicity of factors evolving around social, environmental, individual, and gynaecogical. There is no one influencing factor, but rather several factors act in combination, a phenomenon that aligns with the foundations of the socioecological model. From the review of literature, the primary causes of LBW varied and medically include anemia (Kaur et al., 2014; Feresu, Harlow, & Woelk, 2015) and intra uterine growth retardation (Naz, Page, & Agho, 2015). Life style factors associated with LBW included alcohol consumption (Miyake et al., 2014; Tanaka et al., n.d.). Social factors were low maternal education (Avachat, Phalke, & Kambale, 2014), being young or elderly (Kaur et al., 2014; Goisis et al., 2017), and exposure to IPV (Sigalla, Mushi, Meyrowitsch et al., 2017). In addition, low wealth index (Nwaru et al., 2011), history of miscarriage (Männistö, 2014), and being a female neonate were associated with LBW. Environmental factors such as maternal exposure to air pollutants (Ghosh, Wilhelm, & Ritz, 2013; Amegah, et al., 2012) were also associated with LBW.

The most common methods of analysis were descriptive and multiple logistic regression analysis. Variables that independently were associated with LBW at the 95% CI were all entered into the multiple logistic regression model. By including several variables into a single research study, all studies remained consistent with the focus of the socioecological model which underscores the interconnectedness of multiple social determinants on health. A point of departure of our study from most of the studies reviewed however is that we used population based data to explore factors such as duration of pregnancy. In addition, our study went on to establish the odds for LBW, given the different months the pregnancies lasted.

Knowledge Gap

The reviewed literature has shown determinants of LBW, with significant geographic variability. The literature highlights an array of factors across countries, albeit limited population based data analyzed to establish determinants of LBW. In addition, prior work in the field is mostly dominated by Asian, American, or European voices, leaving a void on the context of southern Africa. In our review of the literature, a number of studies conducted in Asia showed that maternal anemia was associated with LBW, ordinarily a continent endowed with highest levels of anemia (WHO, 2015). Data from the Vitamin and Mineral Nutrition Information System show that Zimbabwe is the only country in sub-Saharan Africa with the least proportion (5.0-19.9%) of anemia among pregnant women (WHO, 2015).

In cases were population based datasets were analyzed, a yawning gap was that none of the studies used DHS data with duration of pregnancy as one of the independent variables. By exploring duration of pregnancy as one of the key determinants at population level, results from the study will increase our knowledge on the extent it impacts on birth weight. The present study used a nationally representative sample of the DHS data. Using population based data allows for generalizability of the study results.

Summary and Transition

LBW remains a public health concern with both immediate and long term deleterious health consequences. Upstream efforts that aim to identify factors, intervene and modify amenable factors at the maternal level remain acknowledgeable in public health. Chapter 2 provided a review of literature, focusing on key findings from studies that explored factors associated with LBW. Study designs included cohort, cross-sectional, case-control, and systematic reviews. Multiple logistic regression analysis predominantly featured in the studies, with data presented as OR and CI. Chapter 3 now presents the methodology for the study. It outlines the study design, the method of inquiry, sampling strategy, and the approach to data collection and analysis. The research questions and hypotheses for the study are restated.

Chapter 3: Research Method

Introduction

The purpose of the study was to establish determinants of LBW from a population-based dataset. Maternal socioeconomic, demographic, and environmental characteristics were assessed using the 2015 ZDHS data. This chapter presents the research design, methods of inquiry, sampling procedure, sample size, instrumentation, and operationalization of the constructs. Also discussed is the approach to data analysis, threats to validity, and ethical procedures. The research questions and hypotheses are restated.

Research Design and Rationale

Independent variables used in the study were duration of pregnancy, number of children born in the past 5-years preceding the survey, exposure to mass media, type of fuel used for cooking in the household, and IPV. Covariates were maternal age at delivery, marital status, place of residence, education level, wealth index, alcohol consumption, maternal anemia, ever terminated pregnancy, and infant sex. Infant birth weight was the dependent variable and dichotomized as <2,500g and ≥2,500g.

A secondary analysis of cross-sectional data generated during the 2015 ZDHS was used. Cross-sectional study designs take a snapshot of a population of interest and collect data at a certain point in time to allow for conclusions to be made about a phenomenon. The design allowed for the collection of maternal and infant data, including some covariates. The present study was quantitative, an approach that allows for the collection and analysis of numeric data to explain a phenomenon. The approach was deductive and was deep-rooted in the positivity philosophy, which views natural science as objective, reality, and value-free (Lincoln & Guba, 1985; Green & Thorogood, 2009). In this study, the focus was on establishing the association between independent variables and birth weight and on exploring how the relation was mediated by some covariates. This study design is consistent with other research conducted (Anuranga et al., 2012; Kayode et al., 2014).

Methodology

Population

The study population were mother-infant dyads. Data were collected from women in the targeted 10,534 households. Prior to the study, data collectors for the ZDHS gave participants appropriate information.

Sampling and Sampling Procedures

The ZDHS collected a sample of the national data. A stratified, two-stage cluster sampling design was used. Probability proportional to size was applied to sample a household in each stratum. Participants were then randomly selected from the 400 EAs that comprised 166 EAs in urban areas and 234 in rural areas. As per the study design, women who lived in institutionalized settings such as army barracks, hospitals, police camps, or boarding schools were excluded. The study used a secondary dataset collected through ZDHS. The recruitment, participation, and data collection procedures have been explained elsewhere (ZimStat, 2015); suffice to say that a representative sample of 11,196 households was selected. Data collection spanned from July 6, 2015 to December 20, 2015. In all, 9,955 women from 10,534 households were reached out. All questionnaires were programmed and preloaded into tablet computers to facilitate computer-assisted personal interviewing during data collection. Data for birth weight was recorded using the metric scale (in grams). During data collection, birth weight was confirmed by way of a documented evidence on the child health card or verbally from the mother. The DHS data were weighted prior to analysis to reflect population representativeness. Figure 3 shows the stages of how the final dataset for analysis was arrived at. Of the 9,955 original participants in the dataset, birth weight was not documented on 580 of the infants. Two of the participants had missing data on LBW, 24 participants did not know about birth weight, while data from 5,122 of the adult women were excluded. For example, parts of the women's questionnaire followed a skipping pattern rendering some responses inapplicable to women who never gave birth in the past 5-year period prior to the survey. In my study, 4,227 records were available for analysis.

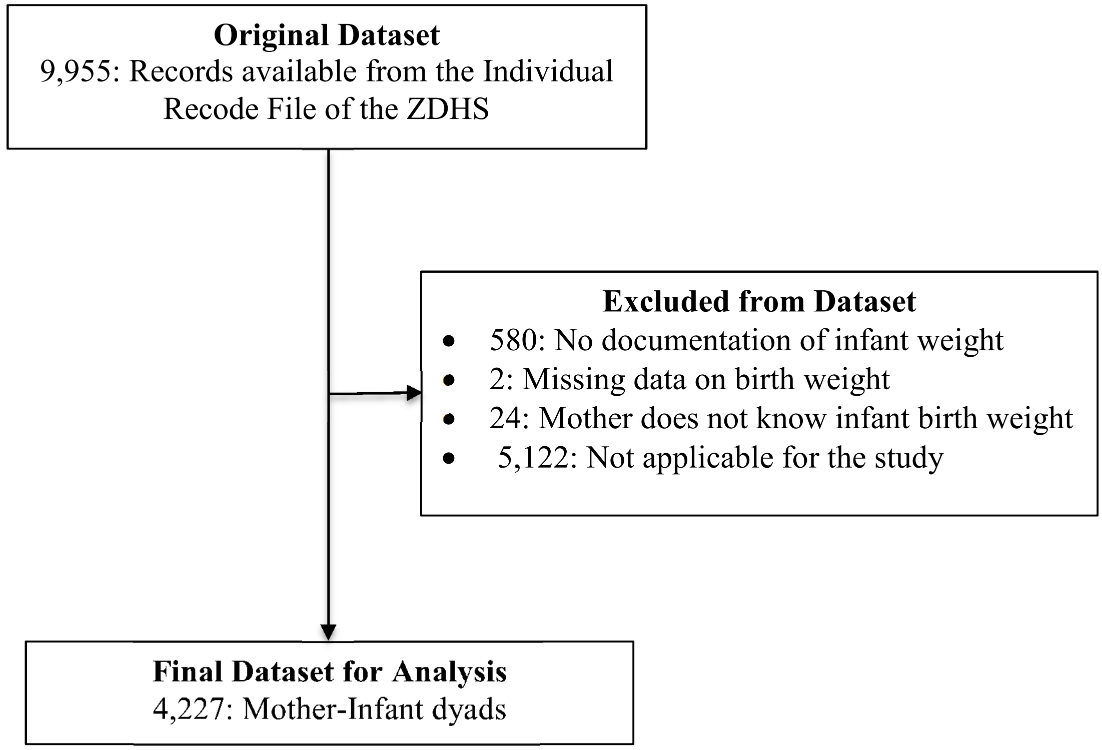

Figure 3. Flow chart of the data management process.

Instrumentation and Operationalization

Validated questionnaires per the protocol for undertaking a ZDHS were used. Data generated using the women's questionnaire were recoded into and individual recode file, which was then used to select specific variables for the study. Of significant to note is that the women's questionnaire contains both maternal and infant data.

Understanding the level of measurement for each of the variables helps to select the most appropriate statistical method to use when analyzing the data. The scales of measurement of data were nominal, ordinal, and continuous. Variables that are measured on an ordinal scale take on intrinsic ordering whereas on a nominal scale the variables are categorical and mutually exclusive. Data measured on a continuous scale allow for the use of advanced statistical analysis. Table 3 shows the variables and their levels of measurement.

Table 3

Variable and Level of Measurement

Variable	Level of measurement
Maternal age at delivery	Ordinal
Duration of pregnancy	
Number of children born during the 5-year period	
Wealth index	
Education level	
Maternal anemia	
Watching TV	
Listening to radio	
Reading paper-based publications	
Marital status	Nominal
Place of residence	
Electricity in household	
Own TV	
Own radio	
Type of fuel used for cooking	
Ever terminated pregnancy	
Infant sex	
IPV	
Consume alcohol	
Source of water	
Province	
LBW	

Independent variables. All independent variables for the study were categorical.

Duration of pregnancy, also referred to as the gestation period, was classified as an ordinal variable made up of 6, 7, 8, 9 and 10 months.

Number of children born within a 5-year period was an ordinal variable consisting of 1, 2 and 3+ children born in the 5-year period.

Exposure to mass media was measured on an ordinary scale and referred to the number of times the women watched TV, listened to radio, or the number of times the women read any paper-based publication during the week. The responses for each of the levels of exposures were 0 referring to never, 1 referring to once, and 2+ being at least twice during the week.

Type of fuel used for cooking in the household was on a nominal scale to indicate the type of fuel used in the household.

IPV was derived from whether the woman was afraid of husband/partner. It was measured on a nominal scale with three responses as never, most of the time, and always.

Covariates. Forthofer, Lee, and Hernandez (2007) observed that a covariate is a secondary variable that can affect the relationship between the independent and the dependent variable. It can influence the independent variable or can have a direct relationship with the dependent variable. At the covariates for the study were categorical measured on and ordinal or nominal scale. For example, maternal age at birth was an ordinal variable consisting of <18, 18 to 39, and >40, while marital status—referring to married, never in union, living together, divorced, widowed or no longer in partnership/separated—was nominal

Dependent variable. Birth weight was the dependent variable. It was operationalized as a dichotomy, reflecting infant birth weight below or at least above 2,500g. As a combined construct, LBW also included infants who had very LBW.

Data Analysis Plan

The CDC (2013) recommended that an analysis plan be developed prior to data analysis so that all relevant variables are considered in the analytic framework. The data analysis plan provides a detailed description of processes that are going to be undertaken to answer a research question. In this study, the analysis plan brought together the research question and the hypotheses into an analytic framework in line with the aim of the study. Study variables were set up to appropriate levels of measurement.

The IBM Statistical Package for the Social Sciences (IBM SPSS version 21.0) was used for analysis. Data analysis codes (Appendix A) were developed to assist with the interpretation of the coded variables. Below are the main research questions and the hypotheses restated:

Research Question 1: Is duration of pregnancy, defined as the time lapse in months from conception to date of delivery of an infant, associated with LBW?

$H_0 1$: There is no association between duration of pregnancy and LBW.

$H_a 1$: There is an association between duration of pregnancy and LBW.

Research Question 2: Is the number of children born within a 5-year interval, defined as number of reported births in a 5-year period, associated with LBW?

$H_0 2$: There is no association between number of children born within a 5-year interval and LBW.

H_a2: There is an association between number of children born within a 5-year interval and LBW.

Research Question 3: Is watching TV at least once a week associated with LBW?

H_03: There is no association between watching TV and LBW.

H_a3: There is an association between watching TV and LBW.

Research Question 4: Is listening to radio at least once a week associated with LBW?

H_04: There is no association between radio listening and LBW.

H_a4: There is an association between radio listening and LBW.

Research Question 5: Is reading a magazine at least once a week associated with LBW?

H_05: There is no association between reading a magazine and LBW.

H_a5: There is an association between reading a magazine and LBW.

Research Question 6: Is type of fuel used for cooking, defined as the form of energy used for cooking in the home, associated with LBW?

H_06: There is no association between type of fuel used for cooking and LBW.

H_a6: There is an association between type of fuel used for cooking and LBW.

Research Question 7: Is IPV, defined as fear for the husband/partner associated with LBW?

H_07: There is no association between IPV and LBW.

H_a7: There is an association between IPV and LBW.

The approach to data analysis was in three parts: first, descriptive analysis was conducted. Birth weight, which was measured on a continuous scale, was recoded to a categorical variable, <2,500g and >2,500g. For categorical variables, frequency distributions were established. Second, the bivariate analysis used the Pearson's chi-square test of association to explore the relationship between each of the covariates with LBW. Variables that were significant at $p < 0.05$ were retained for the binary logistic regression analysis. Third, all independent variables and covariates that were significant at $p < 0.05$ were entered into the binary logistic regression analysis. The aOR of the association between independent and dependent variables, controlling for covariates, were computed at the 95%CI. For parsimony, only variables at $p < 0.05$ level of significance were retained in the analysis.

Threats to Validity

Threats to both internal and external validity of the study existed. Trochim (2006) noted that whereas internal validity refers to how the cause-effect relationship can be attributed to the manipulation of the independent variable, external validity is concerned with the extent to which results from the study are generalizable to other study settings and populations. Often, birth weight is recorded by medical personnel on the child health card. The sensitivity of the measuring scales can affect the results considering that sensitivity of instruments used to measure birth weight across health facilities may vary. In addition, maternal characteristics such as age, levels of anemia, and gestation period are variables collected by medical personnel while infant sex is directly observed upon birth. Accordingly, these are considered as reliable. In contrast, self-reported variables, such as the number of completed months the pregnancy lasted, alcohol consumption, type of fuel for cooking, number of children born in the past 5 years preceding the survey, marital status, and education level may not be as accurate considering that they were self-reported and participants often want to be socially desirable. Notwithstanding, there is no reason to suspect that such understatement would impact on the study.

The study used population-based data derived from a multistage cluster sampling with female participants randomly selected to participate in the study. Such a sampling approach improves the external validity of the study, hence allowing for generalization of study results to the population where data were drawn from.

Ethical Procedures

The study is based on an analysis of a secondary dataset derived from a population-based ZDHS dataset for Zimbabwe. Access to the data was through a formal request to The DHS Program on their website. A dataset in SPSS format was downloaded for the purpose of the study. In the case of Zimbabwe, eight different SPSS datasets were available, each focusing on a particular group of respondents. The Walden University's Institutional Review Board approval number for this study was 07-22-15-0332155. Thus, other than the Walden University Institutional Review Board approval, no additional ethical approvals were required.

Summary

Chapter 3 of this dissertation discussed the methodology of the study, noting that the design was cross-sectional. The sample size for the study comprised of 4,227 mother-infant dyads. The independent variables, covariates, and the dependent variable were discussed, including the approach to data analysis. Multivariable logistic regression was the analytic approach considered for the final model of the study. Ethical procedures were acknowledged, noting that data were derived from the ZDHS, whose study protocol went through local and international ethics boards. At this point, I will move on to Chapter 4 of the study which presents the study results.

Chapter 4: Results

Introduction

The purpose of this quantitative study was to establish determinants of LBW. A secondary analysis was conducted using population data derived from the 2015 ZDHS. The socioecological model underpinned the conceptual framework for the study. Seven research questions and their respective hypotheses were stated as follows:

Research Question 1: Is duration of pregnancy, defined as the time lapse in months from conception to date of delivery of an infant, associated with LBW?

$H_0$1: There is no association between duration of pregnancy and LBW.

H_a1: There is an association between duration of pregnancy and LBW.

Research Question 2: Is the number of children born within a 5-year interval, defined as number of reported births in a 5-year period, associated with LBW?

$H_0$2: There is no association between number of children born within a 5-year interval and LBW.

H_a2: There is an association between number of children born within a 5-year interval and LBW.

Research Question 3: Is TV watching at least once a week associated with LBW?

$H_0$3: There is no association between watching TV and LBW.

H_a3: There is an association between watching TV and LBW.

Research Question 4: Is listening to radio at least once a week associated with LBW?

$H_0$4: There is no association between radio listening and LBW.

H_a4: There is an association between radio listening and LBW.

Research Question 5: Is reading a magazine at least once a week associated with LBW?

H_05: There is no association between reading a magazine and LBW.

H_a5: There is an association between reading a magazine and LBW.

Research Question 6: Is type of fuel used for cooking, defined as the form of energy used for cooking in the home, associated with LBW?

H_06: There is no association between type of fuel used for cooking and LBW.

H_a6: There is an association between type of fuel used for cooking and LBW.

Research Question 7: Is IPV, defined as fear for the husband/partner associated with LBW?

H_07: There is no association between IPV and LBW.

H_a7: There is an association between IPV and LBW.

This chapter includes presentation of the results of the study. It is organized into four parts: the first part provides a preview of the data collection while the second part provides descriptive statistics of respondents. The third section includes discussion of the exploratory analysis used to test the hypotheses of the study. The fourth part gives a summary of the entire chapter.

Sociodemographic and Economic Characteristics

I have presented data from 4,227 mother-infant dyads. There were 2,125 (50.3%) female and 2,102 (49.7%) male infants in the study. The minimum and maximum birth weights were 500.0g and 8,000.0g respectively. Of the 376 infants with LBW, 57.4% (*n*

= 216) were female neonates. The majority of female neonates had lower birth weight than males (10.2% versus 7.6%). The unweighted proportion of LBW was 8.9%. Figure 4 shows the spread of infant weight at birth, depicting a normal distribution. For the purpose of analysis, infant's weight at birth was dichotomized to <2,500g and ≥2,500g.

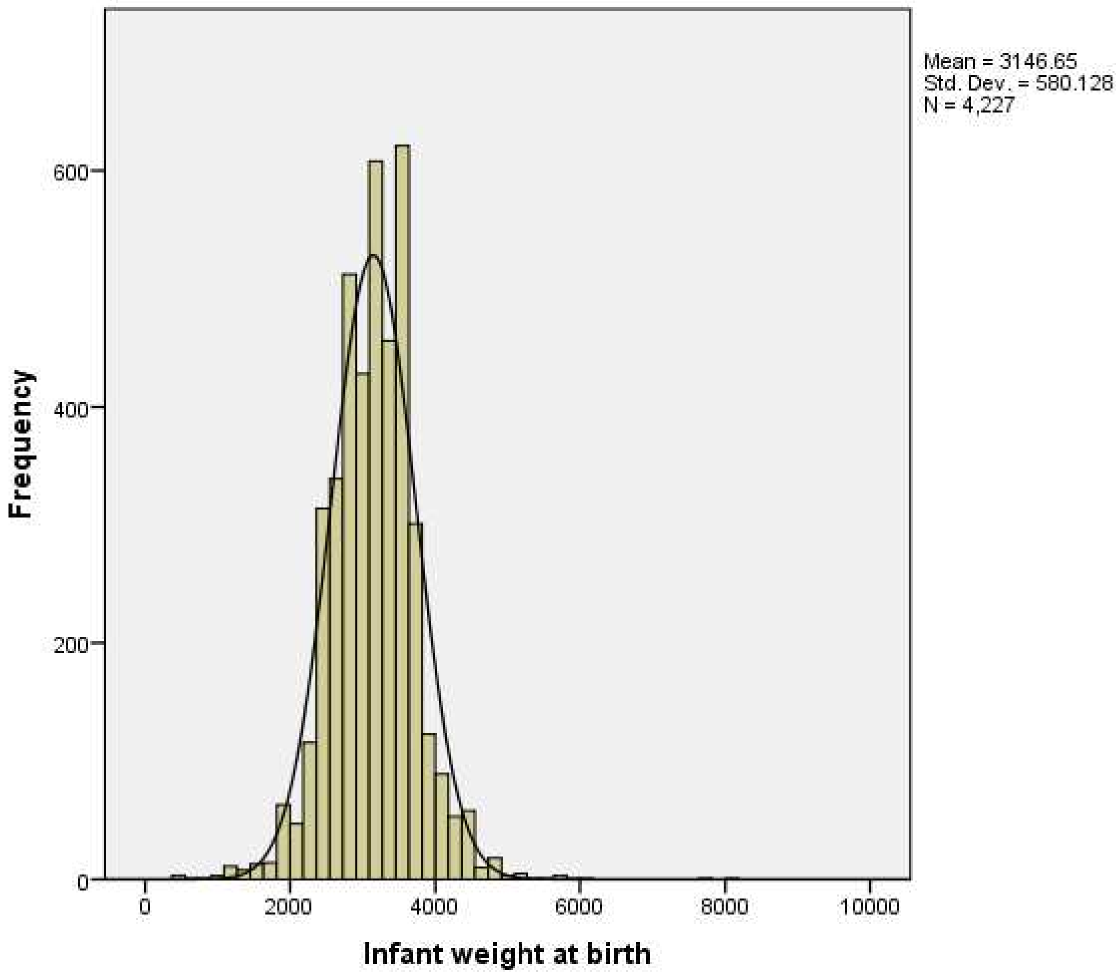

Figure 4. Weight of infants at birth.

Of the 4,227 female respondents (Table 4), 91.6% were aged 18 to 39 years. Slightly more than two fifths (*n* = 1,832, 43.3%) were from urban areas while the majority (*n* = 2,395, 56.7%) were from rural areas. Harare, an urban setting, contributed the most respondents (*n* = 534, 12.6%) while Bulawayo, another urban city, had the lowest number of respondents (*n* = 350, 8.3%). Slightly more than three quarters (*n* = 3,347, 79.2%) of the mothers were married while close to two thirds (*n* = 2,825, 66.8%) had a secondary level of education. The proportion of the combined wealth index for the poor and the poorest was 31.9% (*n* = 1,347). About three quarters (*n* = 3,018, 74.9%) of the mothers were nonanemic. Television (TV) was the most common form of media available in the household. Despite the availability of such media in the house, most of the mothers neither listened to the radio (*n* = 1,857, 43.9%) during the week nor watched TV (*n* = 2,279, 53.9%). Additionally, the majority of mothers (*n* = 2,400, 56.8%) did not read any paper-based publication during any week. Most pregnancy durations were 9 months (*n* = 4,027, 95.3%) while only a few lasted between 6 and 7 months (*n* = 47, 1.1%). Slightly more than three quarters (*n* = 3,245) of mothers gave birth to one child during the 5-year period while only 1.9% (*n* = 78) gave birth to at least three children during the period.

Table 4

Maternal Socioeconomic and Demographic Characteristics (N = 4,227)

Variable	n	%
Age at delivery		
<18	232	5.5
18-39	3,873	91.6
40+	122	2.9
Marital Status		
Never in Union	271	6.4
Married	3,347	79.2
Living with partner	157	3.7
Widowed	68	1.6
Divorced	191	4.5
No longer in partnership/separated	193	4.6
Area of residence		
Urban	1,832	43.3
Rural	2,395	56.7
Education level		
No education	30	0.7
Primary	1,074	25.4
Secondary	2,825	66.8
Higher	298	7.0
Wealth Index		
Poorest	679	16.1
Poor	668	15.8
Middle	648	15.3
Rich	1,210	28.6
Richest	1,022	24.2
Ever terminated pregnancy		
No	3,714	87.9
Yes	513	12.1

(table continues)

Variable	n	%
Duration of pregnancy (months)		
6/7	47	1.1
8	71	1.7
9	4,027	95.3
10	82	1.9
Number of births in past 5 years		
1	3,245	76.8
2	904	21.4
3+	78	1.8
Anemic		
Not anemic	3,018	74.9
Mild	803	19.9
Moderate-severe	207	5.2
Have electricity in household		
No	2,412	59.7
Yes	1,625	40.3
Frequency of reading paper-based publication		
0	2,400	56.8
1	1,182	28.0
2	645	15.3
Have radio in household		
No	2,170	53.8
Yes	1,867	46.2
Frequency of listening to radio		
0	1,857	43.9
1	871	20.6
2	1,499	35.5
Have TV in household		
No	2,141	53.0
Yes	1,896	47.0

(table continues)

Variable	n	%
Frequency of watching TV		
0	2,279	53.9
1	548	13.0
2	1,400	33.1
Province		
Bulawayo	350	8.3
Harare	534	12.6
Manicaland	424	10.0
Masvingo	429	10.1
Mashonaland Central	464	11.0
Mashonaland East	370	8.8
Mashonaland West	421	10.0
Matabeleland North	378	8.9
Matabeleland South	377	8.9
Midlands	480	11.4

Socioenvironmental Characteristics

Table 5 shows the distribution of maternal socioenvironmental characteristics. Wood (n = 2,466, 61.1%) was the most common form of fuel used for cooking in the household, followed by electricity (n = 1,266, 31.4%), kerosene (3.6%) and LPG (3.1%). Most mothers (n = 1,057, 26.2%) used borehole water in the household. There were 223 (6.9%) mothers who indicated fear of their husband/partner.

Table 5

Maternal Socioenvironmental Characteristics (N = 4,227)

Variable	n	%
Fuel for cooking		
Electricity	1,266	31.4
LPG	126	3.1
Kerosene	143	3.6
Wood	2,466	61.1
All other±	34	0.8
Source of water		
Piped into dwelling	801	19.9
Piped into ward	530	13.2
Public taps	62	1.5
Public standalone	231	5.7
Borehole	1,057	26.2
Protected well	598	14.8
Unprotected well	351	8.7
Protected spring	44	1.1
Unprotected spring	94	2.3
River/dam	231	5.7
All other*	35	0.9
Afraid of husband/partner		
Never afraid	2,409	74.8
Most of the time	223	6.9
Sometimes afraid	588	18.3
Drink alcohol		
No	3744	88.6
Yes	483	11.4

± Natural gas, biogas, coal lignite, charcoal, shrubs/grass, animal dung
* Rain water, tanker truck, bottled water

Two-Way Test of Association Between Covariates and Birth Weight

I categorized maternal age at delivery as <18, 18 to 39, and $\geq$40 years in line with analysis from the reviewed literature. Pearson's chi-square test of association was applied on the data to test for the relationship between covariates and birth weight (Table 6). Infant sex ($\chi^2 = 8.50$, $df = 1$, $p = 0.004$) was statistically significant. A direct relationship was evident between anemia and LBW ($\chi^2 = 8.18$, $df = 2$, $p = 0.02$) where a decrease in anemia was associated with a decrease in the proportion of LBW. Additionally, except for the presence of electricity in the household ($p = 0.03$), the rest of the variables were not statistically significant. The analysis was not adjusted for any other factors.

Table 6

Two-Way Tests of the Association Between Covariates and Birth Weight (N = 4,227)

Variable	Birth weight <2,500g (*n* = 376) Count (%)	Birth weight ≥2,500g (*n* = 3,851) Count (%)	χ^2	*df*	*p*-value
Age at delivery			4.35	2	0.11
<18	23(9.9)	209(90.1)			
18-39	336(8.7)	3,537(91.3)			
40+	17(13.9)	105(86.1)			
Marital Status			7.85	5	0.16
Never in Union	30(11.1)	241(88.9)			
Married	281(8.4)	3,066(91.6)			
Living with partner	20(12.7)	137(87.3)			
Widowed	5(7.4)	63(92.6)			
Divorced	17(8.9)	174(91.1)			
No longer in partnership	23(11.9)	170(88.1)			
Area of residence			2.69	1	0.10
Urban	178(9.7)	1,654(90.3)			
Rural	198(8.3)	2,197(91.7)			
Education level			2.89	3	0.41
No education	4(13.3)	26(86.7)			
Primary	104(9.7)	970(90.3)			
Secondary	247(8.7)	2,578(91.3)			
Higher	21(7.0)	277(93.0)			
Wealth Index			4.32	4	0.37
Poorest	62(9.1)	617(90.9)			
Poor	52(7.8)	616(92.2)			
Middle	49(7.6)	599(92.4)			
Rich	121(10.0)	1,089(90.0)			
Richest	92(9.0)	930(91.0)			

(table continues)

Variable	Birth weight <2,500g (*n* = 376) Count (%)	Birth weight ≥2,500g (*n* = 3,851) Count (%)	χ^2	*df*	*p*-value
Infant sex			8.50	1	0.004*
Male	160(7.6)	1,942(92.4)			
Female	216(10.2)	1,909(89.8)			
Radio			0.41	1	0.52
Yes	163(8.7)	1704(91.3)			
No	209(9.3)	1968(90.7)			
TV			1.11	1	0.29
Yes	181(9.5)	1715(90.5)			
No	184(8.6)	1957(91.4)			
Ever terminated pregnancy			0.01	1	0.92
No	331(8.9)	3383(91.1)			
Yes	45(8.8)	468(91.2)			
Electricity			4.56	1	0.03*
No	199(8.3)	2,213(91.7)			
Yes	166(10.2)	1,459(89.8)			
Anemic			8.18	2	0.02*
No anemic	249(8.3)	2,769(91.7)			
Mild	80(10.0)	723(90.0)			
Moderate-severe	28(13.5)	179(86.5)			
Take alcohol			0.12	1	0.73
No	331(8.8)	3,413(91.2)			
Yes	45(9.3)	438(90.7)			

(table continues)

Variable	Birth weight <2,500g (*n* = 376) Count (%)	Birth weight ≥2,500g (*n* = 3,851) Count (%)	χ^2	*df*	*p*-value
Province			5.84	9	0.75
Bulawayo	33(9.4)	317(90.6)			
Harare	49(9.2)	485(90.8)			
Manicaland	36(8.5)	388(91.5)			
Masvingo	27(6.3)	402(93.7)			
Mashonaland Central	46(9.9)	418(90.1)			
Mashonaland East	38(10.3)	332(89.7)			
Mashonaland West	34(8.1)	387(91.9)			
Matabeleland North	36(9.5)	342(90.5)			
Matabeleland South	34(9.0)	343(91.0)			
Midlands	43(9.0)	437(91.0)			
Source of drinking water			16.16	10	0.09
Piped into dwelling	75(9.4)	726(90.6)			
Piped into yard	56(10.6)	474(89.4)			
Public Taps	4(6.5)	58(93.5)			
Public Stand Alone	27(11.7)	204(88.3)			
Borehole	104(9.8)	953(90.2)			
Protected Wall	48(8.0)	550(92.0)			
Unprotected Wall	18(5.1)	333(94.9)			
Protected Spring	2(4.5)	42(95.5)			
Unprotected Spring	11(11.7)	83(88.3)			
River Dam	18(7.8)	213(92.2)			
All other	1(2.9)	34(97.1)			

*Statistically significant at $p < 0.05$

There were six mothers who had pregnancy duration of 6 months and the number had to be added up with those with a pregnancy duration of 7 months. The variable was coded as 6/7. A chi-square test of association was performed to determine whether a relationship exists between independent variables and the dependent variable (Table 7). The highest proportions of infants weighting <2,500g were born at 6/7 months (87.2%) and at 8 months (43.7%) respectively. From the bivariate analysis, the following variables were independently associated with LBW: frequency of watching TV (p = 0.42), frequency of listening to radio (p = 0.82), frequency of reading a paper-based publication (p = 0.43), IPV (p = 0.34), and type of fuel used for cooking in the household (p = 0.73). There was a direct relationship between number of births in the past 5 years and the proportion of LBW. That is, as the number of births increased so did the proportion of LBW. The number of births in a 5-year period ($\chi^2 = 18.74$, $df = 2$, $p = 0.001$) was significantly associated with LBW. On the other, an inverse relationship existed between duration of pregnancy and LBW and was statistically significant ($\chi^2 = 473.36$, $df = 3$, $p < 0.001$).

Table 7

Two-Way Tests of the Association Between Independent Variables and Birth Weight (N = 4,227)

Variable	Birth weight <2,500g (n = 376) Count (%)	Birth weight ≥2,500g (n = 3,851) Count (%)	χ^2	*df*	*p*-value
Duration of pregnancy (months)			473.36	3	< 0.001*
6/7	41(87.2)	6(12.8)			
8	31(43.7)	40(56.3)			
9	299(7.4)	3,728(92.6)			
10	5(6.1)	77(93.9)			
Number of births in past 5 years			18.74	2	< 0.001*
1	269(8.3)	2,976(91.7)			
2	90(10.0)	814(90.0)			
3+	17(21.8)	61(78.2)			
Frequency of watching TV			1.75	2	0.42
0	191(8.4)	2,088(91.6)			
1	50(9.1)	498(90.9)			
2	135(9.6)	1,265(90.4)			
Frequency of listening to radio			0.39	2	0.82
0	170(9.2)	1,687(90.8)			
1	78(9.0)	793(91.0)			
2	128(8.5)	1,371(91.5)			
Frequency of reading magazine			1.71	2	0.43
0	209(8.7)	2,191(91.3)			
1	101(8.5)	1,081(91.5)			
2	66(10.2)	579(89.8)			
IPV			2.15	2	0.34
Never afraid	208(8.6)	2,201(91.4)			
Most of the time afraid	25(11.2)	198(88.8)			
Sometimes afraid	47(8.0)	541(92.0)			
Fuel for cooking			1.28	4	0.87
Electricity	122(9.6)	1,144(90.4)			
LPG	10(7.9)	116(92.1)			
Kerosene	13(9.1)	130(90.9)			
Wood	216(8.8)	2,250(91.2)			
All other	4(11.8)	30(88.2)			

*Statistically significant at $p < 0.05$

Multivariable Logistic Regression Analysis

The use of logistic analysis showed the net effects of socioeconomic and demographic characteristics on predicting infant birth weight. All variable that were significant in the bivariate analysis at $p < 0.05$ were entered into the multivariable logistic regression model to test for the association with birth weight.

A test of the model against a constant only model was statistically significant ($\chi^2 = 240.10$, $df = 9$, $p < 0.001$), indicating that independent variables reliably distinguished between low and normal birth weight. Nagelkerke's R^2 was 0.133, indicating that only 13.3% of the variation between the independent and the dependent variables was explained by the model while the rest was unaccounted for. The Hosmer and Lemeshow's goodness-of-fit test statistic tested for the hypothesis that the observed data were significantly different from the predicted values. The results were non-significant ($\chi^2 = 9.78$, $df = 7$, $p = 0.20$) suggesting that the model was a good fit to predict LBW.

When compared with non-anemic, mothers with mild anemia (aOR 1.83 CI 1.17-2.87 $p = 0.008$) and with moderate to severe anemia (aOR 1.80 CI 1.01-3.19 $p = 0.05$) had higher odds for giving birth to LBW. Female neonates had higher odds (aOR 1.48 CI 1.17-1.88 $p = 0.001$) for LBW when compared with male neonates. Table 8 shows aOR, CI, and p-value for the adjusted model. The adjusted model shows lower odds for LBW at pregnancy duration of 8 months (aOR 0.01 CI 0.003-0.039 $p < 0.001$) when compared with pregnancy duration of 7 months. The association was also statistically significant when compared with pregnancy duration of 9 months (aOR 0.12 CI 0.04-0.33 $p = 0.001$). No association was observed when compared with pregnancy duration of 10 months (aOR 1.00 CI 0.40-2.51 $p = 0.99$). Giving birth to two children within a 5-year period showed a twofold increase for LBW (aOR 2.40 CI 1.24-4.66 $p = 0.01$) when compared with giving birth to one child within the same time interval. A weak association was however evident when number of births were at least three (aOR 1.98 CI 0.99-3.96 $p = 0.05$) during the same time interval. The association between female neonate and LBW was statistically significant in the bivariate analysis (aOR 1.73, CI 1.11-1.70 $p = 0.004$).

Table 8

Multivariable Logistic Regression Analysis Showing the aOR and CI of the Association Between Independent Variables and LBW (N = 4,227)

Characteristics	B	S.E.	Wald	*df*	Exp(B)	95%CI of Exp(B)	*p*-value
Duration of pregnancy (months)							
6/7 (ref)					1.0	1.0	1.0
8	-4.57	0.67	46.70	1	0.01	0.003-0.039	<0.001*
9	-2.15	0.53	16.18	1	0.12	0.04-0.33	<0.001*
10	0.001	0.47	0.00	1	1.00	0.40-2.51	0.998
Number of births in past 5yrs							
1 (ref)					1.0	1.0	1.0
2	0.88	0.34	6.71	1	2.40	1.24-4.66	0.01*
3+	0.69	0.35	3.77	1	1.98	0.99-3.96	0.05
Anemia							
Not anemic (ref)					1.0	1.0	1.0
Mild	0.61	0.23	7.00	1	1.83	1.17-2.87	0.008*
Moderate-severe	0.43	0.25	2.95	1	1.80	1.01-3.19	0.05
Electricity							
No (ref)					1.0	1.0	1.0
Yes	0.13	0.12	1.14	1	1.14	0.90-1.45	0.29
Infant sex							
Male					1.0	1.0	1.0
Female	0.39	0.12	10.33	1	1.48	1.17-1.88	0.001*

Ref - indicates reference category

Summary

The study raised seven research questions in an attempt to establish the relationship between each of the independent variables with infant birth weight. The first research question intended to establish the relationship between duration of pregnancy and LBW, controlling for the covariates. The results indicate that pregnancy duration was associated with LBW. Infants born at 7 months tended to weigh less when compared with those born at 8, 9, or 10 months. In light of the findings, I rejected the null hypothesis and concluded that pregnancy duration was associated with LBW.

The second research question aimed at establishing the relationship between number of births within the 5-year period preceding the survey and infant birth weight, controlling for the covariates. The results show that number of births in a 5-year period was associated with LBW. That is, mothers who had two or more births in a 5-year period had higher odds of giving birth to infants with LBW than mothers who had one birth in the same period. In line with the study hypothesis, I rejected the null hypothesis and concluded that there was a significant association between number of children born within a 5-year interval and LBW.

The third, fourth and fifth research questions focused on the relationship between exposure to mass media in the form of watching TV, radio, or reading some publications during the week and infant birth weight, controlling for the covariates. The findings were that exposure to mass media in the form of watching TV, listening to radio, or reading a paper-based publication was independently associated with LBW. Based on the findings, I failed to reject the null hypothesis and concluded that there was no significant association between exposure to mass media and LBW.

The sixth research question aimed at establishing the relationship between exposure to IPV and infant birth weight, controlling for the covariates. The study established no significant association between IPV and birth weight. In view of the findings, I failed to reject the null hypothesis and concluded that IPV was not a predictor for LBW.

The seventh research question explored the relationship between type of fuel used for cooking in the household and infant birth weight, controlling for the covariates. Findings were that type of fuel used in the household was not significantly associated with birth weight. Thus, I failed to reject the null hypothesis and concluded that type of fuel used for cooking in the household is independently associated with LBW.

Among the covariates, anemia was inversely associated with birth weight. Male neonates had lower odds for LBW as female neonates. Presence of electricity in the household was associated with LBW. Province, alcohol intake, wealth index, education level, marital status, age at delivery, residence, and source of drinking water were not associated with LWB. Chapter 5 of the study presents interpretations of the findings, limitations of the study, recommendations, implications for future studies, and conclusions.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The disproportionately high prevalence of LBW in the Zimbabwe population remains a cause for concern. There are social and economic costs attached to managing infants born with birth weight of <2,500g. Establishing maternal level factors associated with LBW provides a starting point to identify amenable factors to target and modify to improve birth outcomes. Zimbabwe is a signatory to the UN Conventions, and this study provides one of the areas to intervene as the country progresses toward the global goal of reducing LBW by 30% by 2025 (WHO, 2014). A key strength that came with this approach was that use of mother-infant dyad as the unit of analysis.

The purpose of this quantitative study was to establish determinants of LBW using data from mother-infant dyads who participated in the ZDHS. In recognition of the multidimensional nature of health, the socioecological model, which integrates aspects of the social, economic, and environmental measures, was used. Seven research questions were formulated. A secondary dataset from the 2015 ZDHS was extracted from The DHS Program and analyzed. Independent variables for the study were duration of pregnancy, number of children born within a 5-year interval, watching TV at least once per week, listening to radio at least once per week, reading paper-based publications at least once per week, IPV, and type of fuel used for cooking in the household. Covariates for the study were maternal age at delivery, place of residence, maternal anemia, marital status, education, wealth index, ever terminated pregnancy, infant sex, and alcohol consumption. LBW was the dependent variable. Multivariable logistic regression analysis was applied on the data to test for the relationship between independent variables and the dependent variable, controlling for covariates that were significant in the bivariate analysis.

Using population data, findings from the study provide empirical evidence of the relationship between maternal factors and LBW, a knowledge gap that, until now, has existed in Zimbabwe. Results of the study indicated that watching TV at least once per week, listening to radio at least once per week, reading paper-based publications at least once per week, IPV, type of fuel used for cooking in the household, maternal age at delivery, place of residence, marital status, education, wealth index, ever terminated pregnancy, and alcohol consumption were not associated with LBW. My study findings differ from other studies conducted elsewhere where a relationship between some of the above variables and LBW was established. Absence of a significant relationship could be explained by small numbers in each of the constructs of the variables in the dataset I used. For example, by 2013, Zimbabwe had the highest literacy rate in Africa at 96% (Southern African Development Community, 2013). Evidently, the occurrence of low education level in the general population could have had less effect to warrant a significant association with LBW. Zimbabwe suffered unprecedented socioeconomic turmoil that saw close to 3 million of its population migrating to other countries as economic refugees (Kairiza, 2012). The socioeconomic and demographic structure of the country was severely impacted. The social hierarchy was distorted to an extent that the middle class was nonexistent. Social services were neglected while provision of basic sanitation was inadequate. The media was politically polarized to an extent that people could hardly watch TV, listen to the only national censured radio broadcast, or buy any local newspapers. These were just but a few events that perhaps render any of these factors less significantly associated with LBW.

Findings from the study showed that duration of pregnancy, number of children born within a 5-year period, anemia, and infant sex were associated with LBW. Number of children born within a certain time interval and maternal anemia are factors that can be altered. With adequate antenatal care and constant monitoring while pregnant, duration of pregnancy is a modifiable factor, too. The WHO (2016) recommended four to eight antenatal visits during the lifetime of a pregnancy for the mother can be provided with appropriate monitoring and care to reduce adverse birth outcomes. Provision of multiple micronutrient supplements rich in iron has been known to reduce levels of anemia (WHO, 2017). However, being a female neonate is both biological and inherent, a factor that is nonmodifiable. In the next sections, I present the interpretation of the findings, limitations of the study, recommendations, implications for future studies, and conclusions.

Interpretation of Findings

Using population-based data, the current study identified modifiable maternal factors that were significantly associated with LBW. The greatest proportions of underweight infants were born at 7 and at 8 months of gestation. While it can be explained that at 7 or 8 months the infant is still growing, hence yet to fully gain weight, the association perhaps is better explained using the mythologic, numerologic, and astrologic etiologies (Diels & Kranz, 1968; Kuhn, 1965). The medical discourse attributed to Hippocratic corpus hypothesized that infants born at about 8 months' gestations have limited chances of survival as infants born at 9 months or older (Resiss & Ash, 1988). Explanations put forward were that at 7 months the fetus enters the nutritional environment and receives nourishment support from the mother while at 8 months, the fetus enters the sickening stage that lasts at least 40 days. In line with the discourse, it is at these time periods when the fetus enters and exists the nutritional environment, possibly explaining the relationship with LBW. In other literature, the folate depletion hypothesis (Eijsden, Kotkaki, & Carter, 2008) has been put forward to explain the relation.

The present study established that mothers who had two or more infants within a 5-year period had higher odds of giving birth to LBW infants than mothers who had one birth during the same time interval. These findings suggest that pregnancies spread apart enable maternal recovery and, in turn, facilitate optimal fetal development. My findings resonate with results from elsewhere, where short and long interpregnancy intervals were linked to adverse pregnancy outcomes, including LBW (Chen et al., 2015; Cofer et al., 2016; Demelash, Motbainor, Nigatu, Gashaw, & Melese, 2015; Mahande & Obure, 2016; Wendt, Gibbs, Peters, & Hogue, 2012). Short birth intervals give rise to maternal depletion syndrome (Winkvist, Rasmussen, & Habicht, 1992), a hypothesis that posits that short pregnancy intervals do not give enough time for a woman to recover micro- and macronutrients necessary to sustain the next pregnancy. The physiology of the woman needs time to develop postdelivery and is mainly achieved between 18 and 48 months (Firdous et al., 2014).

Both the bivariate and multivariable analysis showed a significant association between infant sex and LBW. Female neonates tended to weigh less at birth when compared with male neonates. The results were similar to findings in other settings (Feresu et al., 2015; Muchemi, Echoka, & Makokha, 2015). For example, a trend analysis of the Canadian vital statistics for the period 2000 to 2013 showed that female neonates consistently weighted less than male neonates (Statistics Canada, 2016). The significance of the findings is that, where the sex of the infants has been established during pregnancy, clinicians can actively encourage mothers with female neonates to watch their diet and attend all antenatal care sessions as advised.

Consistent with studies from other countries (Borah & Agarwalla, 2016; Yi, Han, & Ohrr, 2013), the bivariate and multivariable analysis showed that maternal anemia was significantly associated with LBW. In the present study, the majority of women were from rural areas, a community that is often characterized by poverty and poor diet. Iron deficiency is reported as the most common cause for anemia during pregnancy (Abdullahi, Gasim, Saeed, Imam, & Adam, 2014; Lawrence, 2010) and routine multiple micronutrient supplements is often prescribed. The higher risks of giving birth to LBW neonates by mothers who are anemic reflects the positive role a diet rich in iron plays during the period covered by the pregnancy.

The study found no significant association between exposure to mass media and birth weight. Neither was the association established with IPV nor with type of fuel used in the household for cooking. In this regard, these study results did contrast with other research findings (Balakrishnan et al., 2013; Khan et al., 2017). Biologically, solid cooking fuel contains a range of pollutants such as carbon monoxide, sulfur, nitrogen and benzene formaldehyde, 1,3-butadiene (Mishra, Retherford, & Smith, 2005). When inhaled, these toxicants can reduce the amount of oxygen circulating in the body leading, among other things, to intrauterine growth retardation and risk of LBW (Naz, Page, & Agho, 2015).

No significant association was observed with IPV, contrasting with a recent prospective cohort study from Tanzania that reported that women who experienced physical IPV had increased risk for LBW (Sigalla et al., 2017). My findings contrasted too with evidence from a South African birth cohort of 263 mother-infant dyads (Koen, Wyatt, Williams et al., 2014). Lack of association in the present study could be attributed to differences in study designs and populations used. Whereas this study was a secondary analysis of cross-sectional data not necessarily collected to establish causality, several other studies I reviewed used prospective cohort study designs. In some instances, the studies were clinic based and gave researchers the additional impetus to collect data on almost all relevant variables related to mother and the child.

Limitations of the Study

Despite the weighting of the ZDHS data, some groups might have been underrepresented in the sample and this could have biased the results. At analysis level, I was therefore not able to apply the sample weights given that some characteristics of the dataset such as weighting scheme or intra-cluster correlation were unavailable.

A methodological limitation of using the ZDHS data was that the survey is not designed to collect data in a format and form that clearly allows for exploring maternal exposure and birth outcome. By nature of its design, the ZDHS was cross-sectional hence an inherent limit to establish causal relationship, as in any cross-sectional studies. Additionally, some of the birth weights are self-reported, particularly in cases where mothers have no access to the child delivery record at the time of the survey. The later limitation was evident during data collection where it was reported that only 55.6% of the infants with a recorded birth weight had delivery records shown to data collectors, while for the remainder the reliance was on maternal recall. In most retrospective study designs, recall bias exists and at times is due to participants who want to be socially desirable. Further, the MICS for Zimbabwe showed that the proportion of institutional deliveries was 79.6% of whom only 83.0% of infants born were weighed at birth (ZimStat, 2014). This limits the extent to which these results can be generalized.

An additional limitation of the study was that during pregnancy, women might have had an existing underlying health condition that increased chances for giving birth to underweight neonates. For example, prolonged inflammatory illness may result in disturbances in iron metabolism (Doig, 2012), and as my results showed, maternal anemia was an independent risk factor for LBW. A further limitation of this present study was lack of information on maternal nutritional habits during pregnancy. The role of nutrition on improving fetal development has been acknowledged in other studies (Wrottesley, Lamper, & Pisa, 2016). Further, the survey did not include questions to measure obstetrics and gynecology variables of the respondents, which are possible confounders to LBW. Notwithstanding, the ZDHS approximates very closely to a census and uses simple random sampling to select participants. This, I believe, increases the external validity of the present study.

Recommendations for Further Action

The present study looked at data for the 2015 ZDHS only. To generate trends and have a better understanding of the nature of determinants across time periods, a similar analysis needs to be done with previous and future ZDHS data. The results may be used to plan for better maternal service provision.

Despite a deteriorating and underfunded health care system, Zimbabwe has made considerable progress towards provision of maternal and child health care services. Still, there lacks in-depth understanding of underlying structural factors linked to determinants of LBW. The current study established that LBW was significantly associated with duration of pregnancy of 7 months. The biomedical approach would suggest genetics or obstetrics factors partly at play, while the proponents of the social perspective would argue that modifying the social environment in which the mother lives is an important step to take. Thus, future population-based studies could consider embedding a prospective cohort studies, much in line with The Framingham Heart Study (2018), to identify structural determinants that render some pregnant mothers susceptible to giving birth to underweight neonates. In the same vein, future ZDHS to consider collecting specific population-based data that help to explore underlying factors linked to LBW. Other studies could explore why female neonates are susceptible to being born with below average birth weight.

Another key finding of the study was that giving birth to more than two children within a 5-year period increased the risk for LBW. Appropriate interpregnancy interval gives the physiology of the mother enough time to recover, hence improved outcomes. There are social benefits to encouraging mothers to move towards optimal birth spacing. In this regard, researchers could consider coming up with econometric studies that explore societal benefits associated with optimal birth spacing.

The ZDHS is conducted every 5 years and comes along with insights on secular trends in the socioeconomic status of people, including demographic shifts of the country. Shifts in socioeconomic status and the general demography of the country are a consequence of the macroeconomic policy of a country. In Greece, Kana, Correia, Peleteiro, Severo, and Barros (2017) found that the 2007-2008 global financial crisis had an impact on birth weight. The same observation was noted in Iceland (Eiríksdóttir, Ásgeirsdóttir, Bjarnadóttir et al., 2013). Future research studies could focus on exploring the impact of socioeconomic and demographic shifts on maternal outcomes, including birth weight. Understanding such a relationship will guide the country to come up with policies that act in the best interest of the mothers against adverse impact of the induced economic shift.

Given the small numbers of LBW, no attempt was made to explore data on whether an associated existed between regional categories and LBW. Future studies to consider large sample sizes so that urban and rural dynamics can be explored in greater detail and depth.

The extent to which the trends of OR for LBW varied with duration of pregnancy was less clear, perhaps due to the small sample sizes in each of the constructs. The ideal expectation would have been an inverse relationship such that long pregnancy durations show lower OR for LBW. However, such a relationship was not evident in my study results. Future studies to consider regression analysis with large sample sizes under each of the constructs. The same regression analysis to also extend to a large dataset when exploring the relationship between number of births in a 5-year period and LBW.

Implications for Positive Social Change

LBW is a global health challenge that calls for concerted efforts from all who have an opportunity to contribute and make a positive difference. In 2015, the MOHCC came up with the National Health Strategy for 2016-2020. The overarching theme of the strategy was to ensure equity and quality in health, and that no one is left behind. Sadly, issues related to infant birth weight are silent in the strategy. Findings from the present study therefore have several implications for positive social change, transcending from health care service delivery to health promotion and policy formulation.

At individual, family and social networks level, the role of family planning needs to be openly discussed as it can be the starting point to jointly proffer sustained solutions towards optimal birth spacing. The importance of managing anemia levels through appropriate nutritious foods can be discussed at local and community level. Health promotion messages therefore need to filter down into communities to enable women to make healthy choice that results in improved birth outcomes. The deleterious effect of short inter-pregnancy interval on pregnancy outcome needs to be emphasized at every platform where women gather, including at antenatal care clinics.

In line with Geoffrey Rose's 1985 paper, *Sick individuals and sick populations* (Rose, 2001), conditions that lead to the distribution of risk in the population need to be identified. This may be possible if future ZDHS designs consider adding a few specific variables that enable sub analysis of causal factors linked to LBW. A key recommendation for practice at policy level is that health care service providers may use findings of this study to develop screening tools that categorize and place pregnant women into risk-profiles based on certain maternal characteristics. On the basis of such categorization, appropriate interventions that address conditions leading to short gestation periods, short pregnancy intervals, and elevated anemia can be targeted and modified.

Conclusions

In the context for Zimbabwe, this study has contributed to the understanding of maternal determinants associated with infant birth weight at population level. No prior research of this magnitude had ever been conducted, yet a country endowed with many populations-based datasets spanning back to many several years. Zimbabwe is a signatory to the UN, and to the best of current knowledge, no systems currently exist to specifically monitor progress being made towards attaining the goal of reducing the prevalence of LBW by 30% by 2025. Findings from this study therefore provide a starting point towards amenable factors to modify and allow the country to progress towards the UN target. The research findings also provide cues to health service providers on maternal determinants to concentrate health promotion messages on.

In general, the health delivery system for Zimbabwe needs to strengthen community awareness on optimal birth spacing, the importance of early booking for antenatal care, including the role of diet rich in iron to reduce levels of anemia. Further studies are needed to address if the effect of the socioeconomic and demographic shocks impact on LBW. Health is all about choices. However, improving maternal lifestyle choices requires that programs provide health education, increase access, and quality of care, while at the same time addressing socioeconomic disparities that continue to indirectly contribute to the incidence of LBW. Providing health promotion messages into communities and to women when they attend antennal care service can be a platform to discuss future pregnancies and ensure women do space them optimally. In the meantime, consideration for a surveillance system is called for so that potential determinants for LBW are actively monitored.

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Appendix A: Codes used During Analysis

Variable	Level of measurement	Code
Age at delivery	Ordinal	
<18		0
18-39		1
40+		2
Marital Status	Nominal	
Never in Union		1
Married		2
Living with partner		3
Widowed		4
Divorced		5
No longer in partnership/separated		6
Area of residence	Nominal	
Urban		0
Rural		1
Education level	Ordinal	
No education		1
Primary		2
Secondary		3
Higher		4
Wealth Index	Ordinal	
Poorest		1
Poor		2
Middle		3
Rich		4
Richest		5
Ever terminated pregnancy	Nominal	
No		0
Yes		1
Duration of pregnancy (months)	Ordinal	
6/7		0
8		1
9		2
10		3
Number of births in past 5 years	Ordinal	
1		0
2		1
3+		2
Anemic	Ordinal	
Not anemic		0
Mild		1
Moderate-severe		2
Have electricity in household	Nominal	
No		0
Yes		1
Frequency of reading paper-based publication	Ordinal	
0		1
1		2
2		3
Have radio in household	Nominal	

No		0
Yes		1
Frequency of listening to radio	Ordinal	
0		1
1		2
2		3
Have TV in household	Nominal	
No		0
Yes		1
Frequency of watching TV	Ordinal	
0		1
1		2
2		3
Province	Nominal	
Bulawayo		1
Harare		2
Manicaland		3
Masvingo		4
Mashonaland Central		5
Mashonaland East		6
Mashonaland West		7
Matabeleland North		8
Matabeleland South		9
Midlands		10
Fuel for cooking	Nominal	
Electricity		1
LPG		2
Kerosene		3
Wood		4
All other$^{\pm}$		5
Source of water	Nominal	
Piped into dwelling		1
Piped into ward		2
Public taps		3
Public standalone		4
Borehole		5
Protected well		6
Unprotected well		7
Protected spring		8
Unprotected spring		9
River/dam		10
All other*		11
Afraid of husband/partner	Nominal	
Never afraid		0
Most of the time		1
Sometimes afraid		2
Drink alcohol	Nominal	
No		0
Yes		1