The Influence of Nutritional Status of Women on Infant Mortality in Zambia

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

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I, **CHOTA E. MUTILA** declare that this dissertation; represents my work, has not previously been submitted for a degree at this or any other university and does not incorporate any published work or material from another dissertation.

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Date...

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CERTIFICATE OF APPROVAL

This dissertation of **CHOTA E. MUTILA** is approved as fulfilling part of the requirements for the award of the degree of Master of Arts in Population Studies at the University of Zambia.

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ABSTRACT

Infant mortality has declined world over, Zambia inclusive. This decline has been due to various interventions such as improvements in the medical realms (e.g. development of vaccines and immunizations) and programmes such as encouraging women to attend antenatal and postnatal care, practice of exclusive breastfeeding and nutrition programmes. Infant mortality in Zambia declined from 107 deaths per 1,000 live births in 1992, to 45 deaths per 1 000 live births in 2013-14. Despite the reduction of infant mortality, there is a gap in information on the interaction of nutritional status of women (measured using BMI) and infant mortality. The 2013-14 ZDHS had a total population of 16, 411 women. A total of 13, 457 women reported to have had children in the five years preceding the survey. The study only included all women who reported to have had children aged below 1 in the 5 years preceding the survey as they were exposed to the risk of infant mortality. A total of 727 children (aged 0 to 5) were reported to have died, however, only 554 were reported as infant deaths and were included in the analysis process. Stata software version 14 was used for analysis which included: descriptive, bivariate and multivariate analysis using binary logistic regression to produce odds ratios of an infant dying before their first birthday.

The findings at multivariate level (adjusted odds ratios) show that infants reported to be small in size at birth (AOR: 2.2) were more likely to die before their first birthday compared to those reported to be average. Infants born to mothers in the middle wealth index (AOR: 1.5) were more likely to die compared to those born to mothers in the poorest wealth index. HIV exposed infants (AOR: 1.4) were more like to die compared to those born to mothers whose HIV status was negative. Results also show that infants born to mothers in Copperbelt, Luapula, Northern and North-western provinces were more like to die during infancy (AOR: 2.1, 2.1, 2.4 and 2.4 respectively) compared to those in Lusaka. Furthermore, Infants born to mothers whose marital status was never married were less likely to die during infancy compared to those born to married mothers. Results also showed that having an unimproved toilet (AOR: 0.70) reduced the likelihood of infant dying before reaching age 1 when compared to those in households with no toilet facility at all.

In conclusion the findings from this study show that the nutritional status of women is Zambia did not have an influence on the likelihood of a child dying before their first birthday.

The study had one major limitation; the ZDHS collects current information on key variables such as nutritional status of women (Body Mass Index) that were required for analysis. For the children, detailed information is captured for most recent births. This made it a challenge to link mother's nutritional status to the infant deaths. In addition, the cross-sectional nature of ZDHS data does not enable the determination of causality between the variables but only allows determining association.

DEDICATION

I dedicate this dissertation to my grandparents Mr. and Mrs. Sebastian and Evelyn Mutila and, Professor and Mrs. Nevelyn and Margaret Willombe

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LIST OF ACRONYMS

AIDS	Acquired Immune Deficiency Syndrome
AOR	Adjusted Odds Ratio
BMI	Body Mass Index
CI	Confidence Interval
CSO	Central Statistical Office
DHS	Demographic and Health Survey
EPI	Expanded Programme on Immunization
HIV	Human Immune-deficiency Virus
IMCI	Integrated Management of Childhood Illnesses
IMR	Infant Mortality Rate
LBW	Low Birth Weight
MDG	Millennium Development Goal
MNCH	Maternal and Newborn Child Health
MoH	Ministry of Health
NCDs	Non-communicable Diseases
NFNSP	National Food and Nutrition Strategic Plan
NNMR	Neonatal Mortality Rate
PMTCT	Prevention of Mother-to-Child Transmission
PNNMR	Post Neonatal Mortality Rate
SDG	Sustainable Development Goals
SSA	Sub-Saharan Africa
SUN	Scale Up Nutrition
TB	Tuberculosis
WHO	World Health Organisation
UN	United Nations
UNDP	United Nations Development Programme

UNICEF	United Nations Children's Fund
WB	World Bank
ZDHS	Zambia Demographic and Health Survey

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CHAPTER ONE: INTRODUCTION

1.1 Background

Adult and child mortality have declined in many parts of the world due to tremendous development in all spheres of the global village, particularly the advancement in the medical sphere with regard to research and development. Furthermore, much evidence has been witnessed in the 21st century with the development of drugs and vaccines for prevention of a variety of disease and many life threatening conditions. More specifically, vaccines that target childhood diseases such as Haemophilus Influenza type B, Dipheria, Hepatitis type A and B, measles and whooping cough have contributed to reduction in childhood mortality. The global under-5 mortality rate has fallen from 90·6 deaths per 1000 livebirths to 42·5 in 2015. During the same period, the annual number of under-5 deaths worldwide dropped from 12·7 million to 5·9 million (You, 2015)

Further, world over, efforts have been made through the United Nations (UN) Millennium Development Goals (MDGs) and other in-county development initiatives to reduce mortality; especially maternal and child mortality. The UN Millennium Summit of 2000 set eight MDGs as part of the efforts aimed at improving the socioeconomic and wellbeing of the people and to reduce mortality. One of the pronounced MDGs was goal number four which focused on reducing child mortality and one of its targets was reducing under-five mortality rates by two-thirds from the 1990 levels by the year 2015 (UN Report, 2010: 26).The target for Zambia, in line with MDG 4 was to reduce under-five mortality rate from 119 in 2009 to 63 in 2015 (SNDP, 2011: 89). It is within this specific MDG target that the aspect of reducing infant mortality is part. This is because infant mortality has been identified and still remains a very key factor in the evaluation of the health sector performance of any country. Zambia has also reaffirmed commitment to the improved health by implementing health project and activities that promote the achievement of the UN Sustainable Development Goals number (SDG) 3[1]. SDG 3 seeks to ensure health and well-being for all, at every stage of life. The Goal addresses all major health priorities, including reproductive, maternal and child health; communicable, non-communicable and environmental

[1] https://unstats.un.org/sdgs/files/report/2016/secretary-general-sdg-report-2016--EN.pdf

diseases; universal health coverage; and access to safe, effective, quality and affordable medicines and vaccines. It also calls for more research and development, increased health financing, and strengthened capacity of all countries in health risk reduction and management (UNSTATS, 2016)

Infant Mortality is defined as the probability of dying between birth and the first birthday (ZDHS 2013-14: p109).Over the years, progress has been made in Sub-Saharan African (SSA) countries to reduce infant deaths despite falling behind other regions in the world (UNICEF 2014: 9). Table 1 depicts the decline in infant mortality rates over the years the ZDHS has been implemented, from 107 infant deaths in 1992 to 45 infant deaths in 2013-14.

Table 1:1 Trend in Infant Mortality in Zambia

Year	NNMR	PNNMR	IMR
1992	43	64	107
1996	35	74	109
2001-2	37	58	95
2007	34	36	70
2013-14	24	21	45

Source: ZDHS, 1992 to 2013-14

Mortality is affected by many factors that include socio-economic, bio-demographic and environmental factors. These factors work through the mother and consequently determine the survival of the infant. Among these factors, nutrition of women is very important in the survival of infants since they solely depend on nothing but breast milk. Therefore, woman's nutritional status during and after pregnancy is critical for the survival of an infant. The nutritional status of women was assessed using height measurement and body mass index (BMI). The WHO defines BMI a measure for indicating nutritional status in adults. It is defined as a person's weight in kilograms divided by the square of the person's height in metres (kg/m2). The WHO[2] classifies BMI into four categories as follows: BMI less than 18.5 indicates being underweight; BMI of between 18.5 and 24.9 indicates being normal weight; BMI between 25.0 and 29.9 indicates being overweight; and BMI of at least 30 indicates being obese.

[2] https://www.euro.who.int/en/health-topics/disease-prevention/nutrition/a-healthy-lifestyle/body-mass-index-bmi

The most nutritionally vulnerable women are those with additional nutritional stress of pregnancy and lactation. Too often women do not see the need for, or cannot afford, additional and high quality diets and micronutrient supplements during these periods, and few are encouraged to eat differently by their spouses and other influential family members. Frequently, the results are poor nutritional status that threatens not only the health of a woman but also safe birth for a baby (NFNSP 2011: 6).

Women's nutritional status is driven by various factors that lead to women being undernourished or over nourished. In SSA, for example, due to high levels of poverty, most women may lack the necessary micronutrients needed for proper child development and survival. In addition, maternal and child nutrition in the region depends on the education and income of their families; on the availability of adequate health facilities; or the food self-sufficiency of the communities and countries they live in. An article by Lindsay (2012) shows that pregnant women in countries of Sub-Saharan Africa (SSA) are at risk of poor nutritional status and adverse outcomes as a result of poverty, food insecurity, sub-optimal healthcare facilities, frequent infections and frequent pregnancies.

Adewusi (2018) found that child mortality is particularly high among mothers without formal education and relatively lower among those with other levels of education although factors such as family size, religious affiliation, wealth index and sex of household head had strong influence on these women. He further shows that relationship that subsists between maternal education and child mortality cannot be fully understood without examining certain background variables such as family, economic and religious factors among others.

Zambia has also experienced a decline in infant over the years as shown in Table 1. Some of the reasons for the decline have been attributed to improvements in the availability of qualified/professional medical personnel in health centers. This has been facilitated by training and recruitment of more health personnel to reduce the doctor-to-patient ratio as well as to increase the number of women receiving pre and post-natal care from skilled health personnel. The Government of Zambia in recent years embarked on increasing access to health facilities countrywide by strategizing the construction of 650 health posts and equipping these facilities with necessary equipment for quality medical service provision. Other programmes include immunization of under-5 children through child health week programme conducted once or twice every year in all parts of the country to provide vitamins and other vaccines to children.

Since nutritional status of women is important for the survival of children, there have been interventions in Zambia targeted towards improving maternal health. These programmes have included: strengthening community involvement in Maternal and Newborn Child Health (MNCH) and nutrition services and mainstreaming nutrition in other key health sector interventions, such as maternal and adolescent health, HIV/AIDS care, TB and non-communicable diseases (NCDs). These programmes are aimed at encouraging women to attend antenatal and postnatal care, practice exclusive breastfeeding and adopting appropriate nutritional practices. In addition, the Prevention of Mother-to-Child Transmission (PMTCT) of HIV programme has also made progress by ensuring that women who are HIV positive have reduced risk of transmitting HIV to their newly born babies (ZDHS 2013-14: 179).

1.2 Problem Statement

The Government of Zambia through the National Food and Nutrition Strategic Plan (NFNSP) for period 2011 to 2015 developed strategies that aimed at improving nutritional outcomes for both women and children. The strategic direction focused on: “expansion and enhancing integration of high impact maternal and child nutrition interventions focusing on the First 1000 Most Critical Days” (NFNSP 2011: 18), and “develop a cost funding strategy seeking resources from multiple sectors, and substantial funds from international sources committed to Scale Up Nutrition (SUN)”. There has been a decline in under nutrition for women; from 15 percent to 10 percent in year 2001 to the year 2014 (ZDHS 2013-14: 177) this gives an indication of improved nutritional status of women in Zambia.

In addition to the NFNSP there has been increased financial support to the health sector that resulted in increased health staff and health facilities. This has also been coupled with a number of government interventions to accelerate this reduction have included the Expanded Programme on Immunization (EPI) and the Integrated Management of Childhood Illnesses (IMCI) programme (MoH NHSP 2011:13). Other interventions are the scale up of the infant and young child feeding practices, including promotion of breastfeeding and complementary feeding after six months. The strategies and innervation resulted in the reduction of infant mortality rates and improvement in nutritional status of women. In particular, the 2013-14 ZDHS shows that infant mortality rate has declined from 107 deaths per 1,000 live births in 1992, to 45 deaths per 1 000 live births in 2013-14 (ZDHS 2013-14: 112).

However, there is still a knowledge gap between the nutritional status of women and to the observed decline in infant mortality in Zambia. Therefore, this study aimed at determining whether improvements in nutritional status of women have contributed to reduction in infant mortality in Zambia.

1.3 Rationale of the Study

Understanding the level of infant mortality helps to determine a country's social and economic development as well as the health status of a population. Infant mortality is also a crude indicator of community health status, availability and quality of health services, and medical technology. Additionally, infant mortality is viewed as a key indicator not only of child health and nutrition that indicate the effectiveness of child survival interventions. For example the 2013-14 ZDHS shows that infant mortality has declined over the years the ZDHS has been implemented. This means it's pivotal to understand the factors (socioeconomic and demographic) that influence the increase or decrease of infant mortality. In particular, this study aimed at understanding and providing knowledge on the relationship between nutritional status of women in infant mortality in Zambia. Filling the knowledge gap would also strengthen maternal and child health programmes meant to accelerate the reduction of infant mortality further.

1.4 Research Objectives and Question

1.5 General Objective

To investigate the influence of women's nutritional status on infant mortality in Zambia.

1.6 Specific Objectives

i. To determine the relationship between nutritional status of women and the reduction of infant mortality in Zambia.
ii. To determine the relationship of socio-economic and demographic, and infant mortality in Zambia.
iii. To determine the relationship of environment factors and infant mortality in Zambia.
iv. To determine the relationship of biological factors and infant mortality in Zambia.

1.7 Research Questions

i. To what extent has women's nutritional status contributed to the decline in infant mortality in Zambia?

CHAPTER TWO: LITERATURE REVIEW, THEORETICAL AND CONCEPTUAL FRAMEWORK

2.1 Literature Review

2.1.1 Biological factors

Child Size at birth (Birth weight)

A child's weight at birth is the most important determinant of mortality and morbidity in the neonatal period and may have an influence on health in adult. A study by O'Leary (2017) examined a sample of first born children from Africa, Asia and Latin America and found that numbers of infant deaths per 1000 live births were 30.5 overall and 22.4, 48.6, 160.0 and 402.0 among infants born weighing at least 2.50, 2.00–2.49, 1.50–1.99 and less than 1.50 kg, respectively. Mortality declined with age but was consistently higher for low-birthweight infants than for non-low-birthweight infants. The likelihood of death increased with lower birth weight ($P < 0.0001$). After adjusting for all potential confounders, infants born weighing 2.00–2.49, 1.50–1.99 and less than 1.50 kg were about two times more likely to die in their first year of life than non-low-birth-weight infants. Although higher mortality with lower birth weight was seen in each time period, the magnitude of the association declined over time. For example, compared with non-low-birth-weight infants, infants born weighing less than 1.50 kg had about 48 times the mortality rate in the neonatal period but only eight times in late infancy. The corresponding ratios were similar for infants born weighing 1.50–1.99 kg in the neonatal period and 1.61 in the late infant period – and, to a lesser extent, for the infants born weighing 2.00–2.49 kg – 2.29 and 1.60, respectively. O'Leary also found that the effect of birth weight on mortality did not vary by either distance to the nearest health facility or socioeconomic status.

Similarly Lukonga (2015) examined factors associated with neonatal mortality in the general population using the 2007 ZDHS. The results showed that the odds of dying were significantly higher for infants with low birth weight compared to infants born with normal weight, (aOR=2.58, 95%CI 1.02-6.49). Over weight born babies showed increased odds of dying (aOR 3.21, 95%CI 1.36-7.59). Compared to infants born from Mothers with no education, infants born from mothers with higher education were associated with increased odds of dying (aOR 3.55, CI 95%, 1.26-9.94).

Results from the 2013-14 ZDHS have shown that infant mortality was higher among described as “small/very small” by mothers compared with those described as being “average or larger” (65 and 18 deaths per 1,000 live births, respectively). (2013-14 ZDHS: 114)

Sex and birth order

Negera (2013) used a synthetic cohort life table from the 2000, 2005 and 2011 Ethiopian Demographic and Health Survey to examine levels and trends of childhood mortality and a Cox Regression is applied to assess the associations of child, mother and household characteristics with infant and under-five mortality. The results show that sex of the child is one of the predictors of infant mortality among child characteristics. Male children are at greater risk of dying before reaching their first birthday, by 14 per cent, than female children. The results also show higher prevalence of infant and under-five mortality for the lower and higher birth order children, and lower prevalence for the middle birth order children.

Zhao et al 2017 explore gender differences in infant mortality and neonatal morbidity in mixed-gender twin pairs. Data were obtained from the US National Center for Health Statistics Linked Birth-Infant Death Cohort. A total of 108,038 pairs of mixed-gender twins were included in this analysis. Among the mixed-gender twins, no significant difference in the odds of fetal mortality between male twins (1.05%) and female co-twins (1.04%). However, male twins were at increased odds of neonatal mortality (adjusted OR 1.59; 95% CI 1.37, 1.85) and overall infant mortality (adjusted OR 1.43; 95% CI 1.27, 1.61) relative to their female co-twins. Congenital abnormalities (adjusted OR 1.38; 95% CI 1.27, 1.50) were identified significantly more frequently in male than female twins. Moreover, increased odds of having low 5-minute Apgar score (<7) (adjusted OR 1.15; 95% CI 1.05, 1.26), assistant ventilation >30 minutes (adjusted OR 1.31; 95% CI 1.17, 1.47), and respiratory distress syndrome (adjusted OR 1.45; 95% CI 1.26, 1.66) were identified in male twins relative to their female counterparts. The results of our study indicated that in mixed-gender twin pairs, the odds of infant mortality and neonatal morbidity were higher in male twins than their female co-twins.

Results in the 2013-14 ZDHS show that infant mortality was higher among male infants compared to female infants, there is higher infant mortality among infants in the first and 7th birth orders when compared to those in the 2nd to 6th birth orders.

2.1.2 Maternal Factors

Maternal Age

Pregnancy during teenage is a significant problem globally, with the highest incidence rates occurring in developing nations. While early childbearing has often been regarded as a social issue, there is evidence that young maternal age may be linked to adverse pregnancy outcomes including low birth weight (LBW), preterm birth, intrauterine growth restriction, stillbirth, neonatal mortality (Chen et al., 2007). Other studies have shown relationship between birth orders, birth interval, maternal age and neonatal mortality. Overall, these studies found that delaying the age at first birth may be a valuable strategy to promote and improve neonatal health and survival. Moreover, birth order, birth interval, mother's partner co-residence and sex of the neonate appeared as important markers for neonatal survival.

A study conducted by Ghosh and Bharati (2009) examined the rates of infant and child mortality and associated demographic and socioeconomic factors in 2 socioeconomically vulnerable populations, comprising 195 Munda and 334 Poundrakshatriya women having similar access to health care facilities in a peri-urban region of Kolkata city. Higher infant mortality rate (IMR) was noted in the older and younger Munda women, in contrast to lower IMR in younger Pod women. Child mortality rate was lower in younger women in both the ethnic groups.

Using longitudinal health and demographic data in Tanzania, a study by Selemani et al (2014) examined the effect mother's age and other related factors on neonatal survival associated with birth order. The study established that new-borns for teenage mothers (13–19 years) had higher neonatal mortality rate as compared with those born to older mothers (20 to 34 years) and (35 to 49 years), (46 per 1,000 live births, 28 and 31 per 1,000 live births respectively).

Maternal Education

A research conducted in the United States by Gage (2013) to determine whether the observed decline in infant mortality with socioeconomic level, operationalized as maternal education), is due to its "indirect" effect (operating through birth weight) and/or to its "direct" effect (independent of birth weight). The data used are the 2001 U.S. national African American, Mexican American, and European American birth cohorts by sex. The analysis explored the birth outcomes of infants undergoing normal and compromised fetal development separately by using covariate density defined mixture of logistic regressions. Among normal births, mean birth weight increases significantly (by 27-108 g) with higher maternal education. Mortality declines significantly (by a factor of 0.40-0.96) through the direct effect of education. The indirect effect of education among normal births is small but significant in three cohorts. Furthermore, the indirect effect of maternal education tends to increase mortality despite improved birth weight. Among compromised births, education has small and inconsistent effects on birth weight and infant mortality. Overall, our results are consistent with the view that the decrease in infant death by socioeconomic level is not mediated by improved birth weight. Interventions targeting birth weight may not result in lower infant mortality.

Nutritional Status of Women (measure by Body Mass Index-BMI)

A study on women's and children's status in Ethiopia found that malnutrition is one of the most serious problems affecting children and their mothers. Furthermore, it was also evident that undernourished mothers face greater risks during pregnancy and childbirth, and their children may set off on a weaker developmental path, both physically and mentally. In addition, undernourished children had lower resistance to infection and more likely to die from common childhood ailments such as diarrheal diseases and respiratory infections compared to children born from mothers with adequate nutrition (Infant & Young Child Nutrition Project, 2011).

Results from a study in Sweden by Lindam (2016) found that infants of obese women (BMI ≥30) had a more than doubled risk of infant death (OR=2.41, 95% CI: 1.83, 3.16) compared with infants of normal-weight women. Most infant deaths occurred during the neonatal period, and the association between maternal BMI and risk of neonatal mortality was similar to that in the analyses of BMI and infant mortality. Compared with infants of normal-weight mothers, the adjusted risk of neonatal mortality was higher in infants of obese mothers.

Chen et al (2009 studied maternal obesity (defined as pre-pregnancy body mass index [BMI] ≥30 kg/m2) and it's associated with increased risk of neonatal death. Its association with infant death, post neonatal death, and cause-specific infant death is less well-characterized. They studied the association between maternal obesity and the risk of infant death by using 1988 US National Maternal and Infant Health Survey data. A case-control analysis of 4265 infant deaths and 7293 controls was conducted using SUDAAN software. Self-reported pre-pregnancy BMI and weight gain were used in the primary analysis, whereas weight variables in medical records were used in a subset of 4308 women. Their results showed that compared with normal weight women (pre-pregnancy BMI = 18.5–24.9 kg/m2) who gained 0.30 to 0.44 kg/wk during pregnancy, obese women had increased risk of neonatal death and overall infant death. For obese women who had weight gain during pregnancy of <0.15, 0.15 to 0.29, 0.30 to 0.44, and ≥0.45 kg/wk, the adjusted odds ratios of infant death were 1.75 (95% confidence interval = 1.28–2.39), 1.42 (1.07–1.89), 1.59 (1.00–2.51), and 2.87 (1.98–4.16), respectively. Non-obese women with very low weight gain during pregnancy also had a higher risk of infant death. The subset with weight information from medical records had similar results for recorded pre-pregnancy BMI and weight gain. Maternal obesity was associated with neonatal death from pregnancy complications or disorders relating to short gestation and unspecified low birth weight.

Marital Status

Balayla conducted a study in 2011 to evaluate the association between maternal marital status and the risk of fetal and infant death, including sudden infant death syndrome (SIDS). The study was conducted through a population-based cohort study using the Centers for Disease Control and Prevention's Linked Birth-Infant Death and Fetal Death data on all births in the United States between 1995 and 2004. Marital status was obtained from the birth certificate. The adjusted effect of marital status on the risk of fetal and infant mortalities was estimated using unconditional logistic regression analysis. The cohort consisted of 40,529,306 births, of which 37,461,715 met study criteria. Results show that there were 130,353 stillbirths (3.5/1,000 births) and 140,175 infant deaths (3.8/1,000 births), of which 24,066 were due to SIDS (0.6/1,000 births). Rates of non-marital births increased from 31.3% to 35.4% over the study period. As compared with births from married women, births from unmarried women were at an increased risk of stillbirths (relative rise [RR], 1.24; 95% confidence interval [CI], 1.21-1.26), total infant deaths (RR, 1.45; 95% CI, 1.42-1.47), and SIDS (RR, 1.70; 95% CI, 1.63-1.78). Among unmarried women, those at a higher risk of fetal and infant death were women under 15 or over 40 years of age, African-American women, and those who received no prenatal care. Non-marital childbearing seems to be associated with an increased risk of fetal and infant death, including SIDS. Promoting access to care and targeting unmarried mothers-to-be with the goal of educating, increasing awareness, and providing resources for proper obstetrical and maternal care may be of great benefit to their pregnancies.

Type of residence

Adewuyi (2017) analyzed the 2013 Nigeria demographic and health survey (NDHS), using complex samples statistics. A multivariable logistic regression analysis was computed to explore the adjusted relationship and identify risk factors for infant mortality. Results showed that in rural and urban Nigeria, IMRs were 70 and 49 deaths per 1000 live births, respectively. Risk factors in rural residence were past maternal marital union (adjusted odds ratio (AOR): 1.625, $p = 0.020$), small birth size (AOR: 1.550, $p < 0.001$), birth interval < 24 months (AOR: 2.057, $p < 0.001$), residence in North-East (AOR: 1.346, $p = 0.038$) and North-West (AOR: 1.653, $p < 0.001$) regions, and cesarean delivery (AOR: 2.922, $p = 0.001$). Risk factors in urban residence were poor wealth index (AOR: 2.292, $p < 0.001$), small birth size (AOR: 2.276, $p < 0.001$), male gender (AOR: 1.416, $p = 0.022$), birth interval < 24 months (AOR: 1.605, $p = 0.002$), maternal obesity (AOR: 1.641, $p = 0.008$), and cesarean delivery (AOR: 1.947, $p = 0.032$). Adewuyi concluded that infants in rural residence had higher rates of mortality than their urban counterparts and disparities in risk factors exist between the residences.

The 2015 UNICEF report on maternal and newborn health care in Zimbabwe showed that in rural areas, 69 percent of women made at least 4 antenatal care (ANC) visits compared to 72 percent in urban areas. Coverage of skilled attendance at birth is 71 percent in rural areas, compared to 93 percent in urban areas. 71 percent of newborns in rural areas receive postnatal care (PNC) within 2 days after birth, compared to 80 percent in urban areas.

HIV exposure

Kurewa (2010) studied a total of 1045 mother and singleton infant pairs, 474 HIV-positive and 571 HIV-negative mothers, delivered 469 and 569 live infants, respectively. Differences in mortality were at 6 weeks and 4 months, RR (95% CI) 9.71 (1.22 to 77.32) and 21.84 (2.93 to 162.98), respectively. Overall, 9-month mortality rates were 150 and 47 per 1000 person-years for infants born to HIV-positive and HIV-negative mothers, respectively. Proportional hazard ratio of mortality for children born to HIV-positive mothers was 3.21 (1.91 to 5.38) when compared with that for children born to HIV-negative mothers. The conclusion from the study was that maternal HIV exposure was associated with higher mortality in the first 4 months of life. Infant's HIV status was the strongest predictor of infant mortality. There is a need to screen infants for HIV from delivery and throughout breastfeeding.

2.1.3 Environmental Factors

Kembo (2009) analyzed the Zimbabwe Demographic and Health Data and observed that household amenities, namely piped drinking water and improved toilet facilities. In the presence of maternal and socioeconomic variables the odds of dying for infants born to mothers in households with access to piped drinking water are reduced by 12 percent relative to infants born to mothers in households without access to piped drinking water. In the presence of maternal and socio-economic variables, infants born to mothers in households with access to improved toilet facilities are associated with a 38 percent lower risk of dying in infancy compared to those born to mothers in households without access to such facilities. We further observe that although the odds ratios for piped drinking water and flush toilet are in the expected direction they are both not statistically significant.

A study by Geruso and Spears (2017) found that that Indian Muslims practice open defecation at significantly lower rates than Indian Hindus, implying that the neighbors of Muslims are on average exposed to better sanitation environments. Tests of the mechanisms linking open defecation to infant death, including contamination of food and water and acute malnutrition due to intestinal disease, lend support to this interpretation. More broadly, their study provides insights into the public goods aspect of sanitation. Understanding this public goods component is important for policy interventions motivated by the efficiency concern that private demand is below the social optimum. Results from study suggest that many infants die each year due to poor sanitation in their localities. In the context of India, a back-of-the-envelope calculation within the range of variation supported by the data suggests that reducing mean open defecation by 10 percentage points (one quarter of a standard deviation across localities) would reduce IMR by 6 deaths per thousand, or about 8% of the mean mortality rate. With an estimated 26 million children born in India each year which equates to 156,000 deaths annually.

Social Economic Factors

A study by Kanmiki (2014) examined the influence of particular social, economic and demographic characteristics of mothers on under-five mortality in rural northern Ghana. Results showed that several factors are implicated in under-five mortality. The bivariate analysis shows that variables such as mother's age, level of education, marital status, place of residence, occupation, religion, autonomy, contraceptive use, national health insurance enrollment status, polygamous union and socio economic status were significantly associated with experience of under-five death in this largely rural setting. Controlling for the confounding effects of the various factors, mother's age, level of education, marital status and polygamy, were found to have significant robust association with childhood mortality. Both multivariate and bivariate analysis indicate that children born to older mothers (35 years and above) were more at risk of under-five death compared to younger mothers (20 years of age). Level of mothers' education emerged as a strong predictor of under-five mortality in both bivariate and multivariate analysis after controlling for other variables. Results also showed that children born to mothers in marital unions were less likely to die. Marriage is also believed to confer advantages such as pooling of resources to either patronize good health services or provide adequate care with respect to providing good nutrition to infants and children.

The above literature shows how different factors influence mortality in different parts of the world. The literature has shown that mother's education and age are inversely related to infant mortality in that mothers with no education and those mothers who are young have a high probability of their children dying during infancy. The results also show that poor sanitation increases the probability of infant death. Furthermore, the literature has shown that interaction with environment especially poor sanitation increase probability of infant mortality.

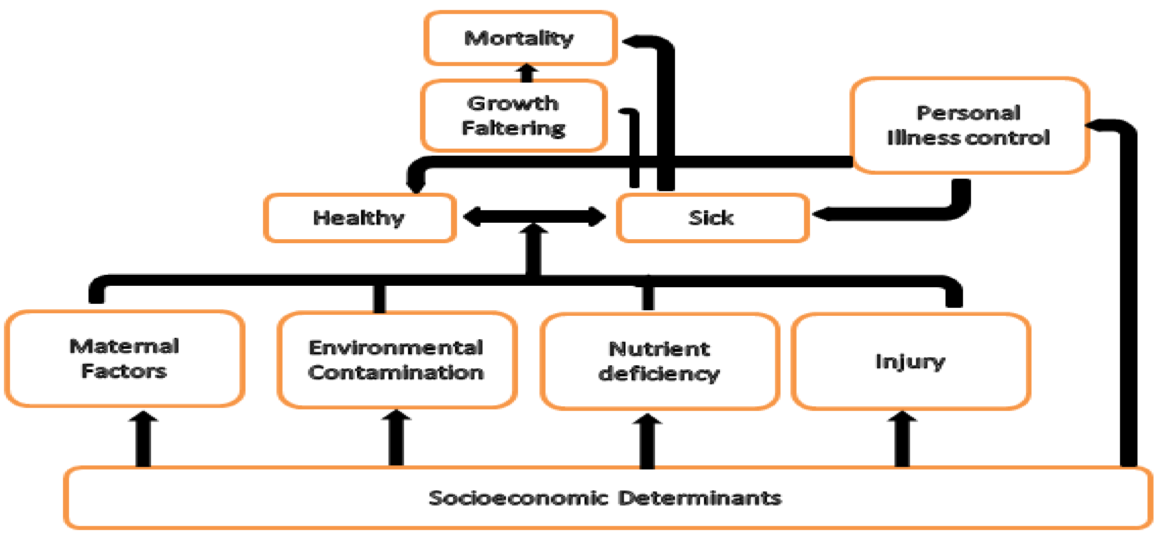
However, the literature does not provide information on how it affects the survival of children during infancy, particularly on how nutritional status of women (BMI) interacts with different social-economic and demographic factors to influence infant mortality using retrospective data such as the ZDHS.

2.2 Theoretical Review

Mosley and Chen Framework of Child Survival in Developing Countries (1984)

The study adopted concepts from the Mosley and Chen Framework of Child Survival in Developing countries to investigate the influence of the nutritional status of women on infant mortality in Zambia. The framework is presented and explained below.

Figure 2:1 Mosley and Chen Framework of Child Survival in Developing Countries



Source: Mosley, W.H., and Chen, L.C. (1984)

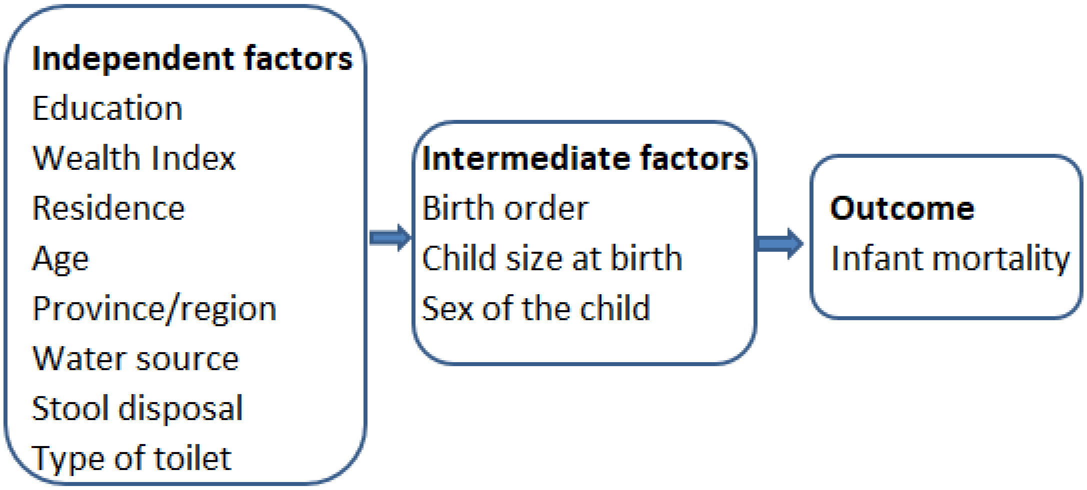
Mosley and Chen (1984) in their explanation of the determinants of child health viewed child morbidity and mortality as being influenced by an interaction of what they termed as the five proximate determinants of child morbidity and mortality.

The proximate determinants included in this framework are maternal factors, which look at a woman's age, birth interval and parity. Another determinant is environmental contamination which reflects the various routes of spread of diseases may be measured by levels of potential exposure to disease can be approximated and scaled by using a series of simple physical indexes that are known to be strongly correlated with child mortality. For example water contamination will be scaled up by source of supply (such as ditch, pond and piped water).Injury involves the operation of intermediate variables and is measured by the incidence of recent injuries on the child. Nutrient deficiency of specific nutrients in the diet can be assessed by less precise measures such as recall history of the diet of the mother.

2.3 Conceptual Framework

Using the concept from the Mosley and Chen framework, the following conceptual framework was developed for this study.

Figure 2:2 Conceptual framework on factors influencing infant mortality in Zambia



The conceptual framework in figure 2 shows the interaction of different variables that influence infant mortality in Zambia.

Socioeconomic factors have an influence on the nutritional status of women, which then influences infant mortality. Infants born to mothers in the poor wealth quintile are more likely to die during infancy compared to those born to mothers in the middle and rich wealth quintiles. Mothers in the rich wealth quintile are likely to have access to required micro nutrients and minerals and better health services (specialized private hospitals) during after pregnancy. Infants born to mother with tertiary level education are less like likely to die during infancy compared to mothers with no education. This is because mothers with tertiary level education are more likely to make informed decisions that favor the balanced nutritional requirements when feeding the infants and also seek modern medicine practices regarding the health of the infants.

Infants born to thin mothers have a higher chance of dying during infancy especially during the early neonatal days compared to those born to mothers with normal BMI; this is mainly due complications during birth. Exposure to HIV comes with risks of many comorbidities that may lead to death especially in the absence of life saving anti-retroviral drugs. Many infants have survived infancy as result of ARVs however, mortality is always higher in comparison to those that are not exposed. Mothers from household with improved source (piped water, protected well, etc.) of drinking water are more likely to have a lower risk of infant death compared to those mothers with unimproved source (spring, river, ditch, etc.) of drinking. Mothers from household with access to a toilet facility were less likely to experience infant deaths compared to mothers from households with no toilet facility.

Infants born to young mothers are highly likely to die during infancy compared to those born to older mothers. This is because they may lack experience on how to care for the infant. Furthermore, the framework shows that infants born to mothers in urban areas are less likely to die during infancy compared to those born to mothers in rural areas. This is mainly due to easy access to health facilities and diverse nutritional options in urban areas compared to rural areas. Infants born in the first birth order are more likely to die compared to those of the second and third birth order as mortality starts to increase with an increase in birth order. The high risk of infant deaths among the first order births is mostly attributed to the young age of the mother, complications during birth and mother inexperience in caring for the child while increased mortality in high order births is attributed to the fact that women who have had more pregnancies may experience complications during pregnancy and birth of the child. Male children were more likely to die before celebrating their first birthday as well as those born to formerly married mothers and those reported to be small in size at birth.

CHAPTER THREE: STUDY METHODOLOGY

This chapter provides a description of the research design, sources and quality of data, population definition, sample size, inclusion and exclusion criteria. Furthermore, the steps taken in the data analysis process, including variable description, bivariate and multivariate logistic regression analysis and finally the steps taken in model building. It is important to note that the 2013-14 ZDHS employed a cross sectional study design meaning that data was collected at particular point for the five years preceding the survey.

3.1. Research Design

The study used an analytical study design in carrying out the investigation. This is because the study endeavored to establish the relationship between nutritional status of women and the reduction of infant mortality in Zambia. The study design was employed because the study aimed at assessing the relationship of nutritional status of women status to infant mortality in Zambia taking into account other confounding factors.

3.2. Data Source and Quality

The study used the 2013-14 ZDHS children's dataset. The ZDHS applies a cross-sectional research design as it collects information on a population at a particular point in time. This is because the ZDHS is a nationally representative survey that collects comprehensive information on fertility, infant and child mortality, family planning and other health related issues such as breastfeeding, antenatal care, and children's immunization and childhood diseases. Therefore, the study utilized the 2013-14 ZDHS children's datasets as they provide data on women who had children that died as infants and other data that is relevant for answering the research objectives and question.

In terms of quality assurance, the ZDHS conforms to the international DHS program standard of performing and ensuring consistency checks. Thus, it accounts for both internal and external validity making it worthwhile for use in data analysis.

3.3. Population Definition

3.3.1. Description of Target Population and Sample

The target population for the study was all women of the reproductive age group (15-49 years). The ZDHS samples are nationally representative samples of women who are in the reproductive age group and, therefore, provide estimates of data on infant mortality and the factors that might be influencing it. The sample women who reported to have had a child within the 5 years of reference for the survey. The unit of analysis in the sample was all women who reported having a child that died before the age of 1 irrespective of their nutritional status.

3.3.2. Sample Inclusion and Exclusion Criteria

The sample was further refined to include women who only reported to have had children in the 5 years preceding the survey. Women without children were not included as the unit of analysis in infant mortality, as they did not have any child who was at risk of dying as an infant. Therefore, the study only included women whose children were at risk of dying as infants and the children born within 5 years preceding the survey.

3.3.3. Study Sample Size

The 2013-14 ZDHS had a total population of 16, 411 women. A total of 13, 457 women reported to have had children in the five years preceding the survey. The study only included all women who reported to have had children aged below 1 in the 5 years preceding the survey as they were exposed to the risk of infant mortality. A total of 727 children (aged 0 to 5) were reported to have died, however, only 554 were reported as infant deaths and were included in the analysis process.

3.4. Data Analysis

The study used Stata statistical software version 14 to perform analysis on the variables of interest. Data cleaning and coding was done to ensure that variables are coded according to the definitions of the researcher.

Before any analysis was conducted, the data was weighted to ensure that it was representative of the population strata and results can be generalized to the entire population. The weighting process enabled generalization of each observation made in the sample to represent 1000,000 observations in the general population. This was achieved through the setting the 2013-14 ZDHS for weighted analysis in Stata with commands:

1. gen sampwt=v005/1000000
2. svyset v021 [pweight = sampwt], strata (v022)

The analysis included descriptive, bivariate and multivariate using binary logistic regression to determine the relationship and influence of different variables on infant mortality in Zambia.

The analysis was done in three steps; the first step focused on descriptive analysis to describe the characteristics of the study population. The second step of analysis focused on bivariate using chi-square test of significance and simple binary logistic regression, this was done to determine significance and the odds ratio of infant mortality with each of the independent variables. The last stage focused on multivariate binary logistic regression. This was done to determine the odds ratio of infant mortality as determined by nutritional status of women while controlling for other predictors. The multivariate regression model was developed using the stepwise method. The results from the analysis process were presented using tables.

3.4.1. Description of Variables

This section describes how variables were created and used in the process of analysis. The dependent variable child_alive_dead was created recoding variable “b7” which is age at death in months and combining it with variable “b5” which is child alive. Child_alive_dead had two values coded as “0” for the children who survived infancy and “1” for those who died during infancy. This enabled using “0” as a reference category when the binary logistic analysis was performed. The main independent variable mother’s nutritional status was measured using BMI. This was a recode of variable “v445” into three categories; “thin”, “normal” and “obese”. The categorization is based on WHO[3], however, for purposes of analysis categories in the 2013-14 ZDHS were used. The BMI ranges were as follow:

1. Normal BMI: 18.5-24.9
2. Thin BMI: <18.5

[3] https://www.euro.who.int/en/health-topics/disease-prevention/nutrition/a-healthy-lifestyle/body-mass-index-bmi

3. Obese BMI: ≥25

The “normal” category was treated as a reference category when performing regression analysis.

The variable birth order was coded into four categories; 1st birth order, 2-3, 4-6 and 7+ birth orders. The 1st birth orders were treated as reference category in the regression analysis. Female children were treated as a reference category for the sex variable.

Variable m18 was recoded to child size. This was done by collapsing the category of very large and large into large, the smaller than average and small were collapsed into small and average was taken as average. The three “small”, “average” and “large” were used in the analysis to enable presenting the data on child size at birth as it is presented in the 2013-14 ZDHS. The average size at birth category was treated as a reference category in regression analysis. The province variables covered all the 10 provinces in Zambia with Lusaka province used as reference category. Lusaka province was treated as reference category because it more health facilities, with good infrastructure and health staff dotted around the province (both private and government owned) in comparison to any other province.

The education variable was recoded into four categories: no education, primary education, secondary education and tertiary education; the no education category was treated as a reference category. The residence variable covering all urban and rural areas used urban areas as a reference category. Mother’s marital status was categorized into three categories: never married, married and formerly married; “never married” was treated as the reference category. Wealth index was categorized into five categories: “poorest”, “poorer”, “rich”, “middle”, “richer” and “richest; the “poorest” category served as the reference category. The HIV status of categorized as either negative or positive. The negative HIV test result was used as a reference category.

The water source variable was created by recoding variable V113 into two main categories of sources of drinking water: “improved source” and “unimproved source”. The category “improved source” was treated as reference category. The variable toilet facility was created by recording variable V116 into three main categories: “improved toilet”, “unimproved toilet” and “no toilet facility”. The category “improved toilet” was treated as reference category. Improved Toilet facility included flush/pour flush to piped sewer system, Flush/pour flush to septic tank, Flush/pour flush to pit latrine, Ventilated improved pit (VIP) latrine, Pit latrine with slab. Non-improved Toilet facility included: Flush/pour flush not to sewer/septic, tank/pit latrine, Pit latrine without slab/open pit, hanging toilet/hanging latrine. No toilet facility included: No facility/bush/field

3.4.2. Definition of Variables

Table 3.1: Variables and Operational Definitions

Variable name and type	Question/Definition	Responses	Scale
Infant Death **(Dependent Variable)**	The risk of death during infancy defined as any age below one year (0-11 months). The respondent was asked if the child is alive or dead.	1. Yes 0. No	Nominal
Nutritional status of women (Body Mass Index) **(Independent Variable)**	The BMI is derived from recoding the body mass index of the mothers according the World Health Organization standards according to the three broad categories: Normal, Thin and Overweight/obese (adopted from ZDHS).	0. Normal 1. Thin 2. Overweight/Obese	Interval
Age **(Independent Variable)**	How old were you on your last birthday?	15, 16….49 years	Interval
Education **(Independent Variable)**	What is the highest level you have attended?	0. No education 1. Primary 2. Secondary 3. Higher	Ordinal
HIV Status **(Independent Variable)**	Testing Positive or Negative for HIV	0. Negative 1. Positive	Norminal
Marital Status **(Independent Variable)**	The state of never/been married	0. Never married 1. Married 2. Formally married	Nominal
Wealth index **(Independent Variable)**	Economic status (capability to provide sufficiently the basics and or luxuries)	3. Poorer 4. Poor 5. Middle 6. Richer 7. Richest	Ordinal
Region/Province **(Independent Variable)**	Place were the residence of the woman is found at the time of the ZDHS.	0. Lusaka 1. Central 2. Copperbelt 3. N-Western 4. Southern 5. Western 6. Luapula 7. Muchinga 8. Northern 9. Eastern	Nominal
Sex **(Independent Variable)**		0. Male 1. Female	Nominal
Birth-order **(Independent Variable)**	The order a child is born in.	$1^{st,}$ 2^{nd}, 3^{rd} ……7^{th}	Ordinal
Source of water **(Independent Variable)**	The origin of drinking water for the household.	0. Improved 1. Unimproved	Nominal
Type of toilet facility **(Independent Variable)**	Presence and type of toilet used to dispose human waste	0. Improved 1. Unimproved 2. No toilet	Nominal
Residence **(Independent Variable)**	The place of mother's residence at the time of the ZDHS.	0. Urban 1. Rural	Nominal
Child Size **(Independent Variable)**	Size of the child at birth	0. Normal 1. Small 2. large	Nominal
Disposal of child's stool **(Independent Variable)**	Method of stool disposal	0. Safe 1. Unsafe	Nominal

3.4.3. Binary Logistic Regression

Binary logistic model was used in this study because the dependent variable infant mortality is two outcome variable. It's either a child died or survived beyond age 1. The dependent variable: child_alive_dead has a binary value of "0" if the infant survived beyond age 1 and a value "1" if the infant died before age 1. Binary logistic regression was used to estimate the odds or probability of occurrence of infant mortality for those children below 1 year of age. The odds were also adjusted for other confounders to give a more realistic outcome where there are various variables influencing the dependent variables. Further, it was used because only the dependent variable is required to be dichotomous. The general logistic regression model is given by:

$$\text{logistic (P)}^{4} = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + \ldots.+b_nX_n$$

In this regression, the odds were determined by getting the natural log of the probability. This can be portrayed as;

$$\log\left(\frac{p}{1-p}\right) = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + \ldots.+b_nX_n.$$

Odds Ratios (OR) were used for interpretation and these are calculated as:

$$p = \frac{e^{\beta o+\beta 1X1+\beta 2X2+\cdots+\beta nXn}}{1 + e^{\beta o+\beta 1X1+\beta 2X2+\cdots+\beta nXn}}$$

P is a dichotomous dependent variable with values 0 (Didn't die as an infant) or 1 (Died as an infant)
b_0... b_n: - is the coefficient of the independent variables.
X_1...X_n: - denote the independent variables, for example age of the mother, education level, etc.
e=Exponential Value

Assumptions for a Logistic regression[5]:

1. Adequate sample size (too few participants for too many predictors is bad!);
2. Absence of multicollinearity
3. No outliers

[4] http://analyzerlab.com/logistic-regression/
[5] https://www.statisticssolutions.com/binary-logistic-regression/

Interpretation of Odds Ratios (OR) is as follows:

1. An OR above 1indicate that the chance of dying before age one increased
2. An OR less than 1 indicate that the chance of dying before age one reduced
3. An OR equal to 1 indicate that there is no effect from factors being investigated.

3.4.4. Model Building

The regression model building ensured that the key independent variable (women's nutritional status) was always included in the equation. This was done to ensure that the adjusted odds ratio where taking into account the possible confounders. The first model only included the main independent variable nutritional status of women (BMI)) and the dependent variable child_alive_dead). The rest of the models included an addition of one more independent variable (confounders). The following models were built:

1. $logistic\ (child\_alive\_dead) = \beta 0 + \beta 1 Mother's\ Nutrition\ (BMI)$

This model was used to estimate the odds of infant deaths based on the nutritional status (BMI) of the mother.

2. $logistic\ (child\_alive\_dead) = \beta 0 + \beta 1 Mother's\ Nutrition\ (BMI) + \beta 2 Child\ Size\ at\ Birth + \beta 3 Sex\ of\ the\ chid$

This model was used to estimate the odds of infant deaths based on the biological characteristics of a child (child size and sex). The model also included nutritional status (BMI) of the mother as the key predictor in the study.

3. $logistic\ (child\_alive\_dead) = \beta 0 + \beta 1 Mother's\ Nutrition\ (BMI) + \beta 2 Mother's\ age + \beta 3 Marital\ Status + \beta 4 Mother's\ Education + \beta 5 Wealth\ index + \beta 6 Residence + \beta 7 Region + \beta 8 Birth\ order + \beta 9 HIV\ status$

   This model was used to estimate the odds of infant deaths based on the mothers' characteristics (Nutrition, Age, Marital status, Education, Wealth Index, Residence, Region, HIV status and Birth order).
4. $logistic\ (child\_alive\_dead) = \beta 0 + \beta 1 Mother's\ Nutrition\ (BMI) + \beta 2 Type\ of\ toilet\ facility + \beta Source\ of\ drinking\ water + \beta 3 Disposal\ of\ youngest\ child's\ stool$

This model was used to estimate the odds of infant deaths based on the environmental factors (Sanitation [Water source and toilet facility] and disposal of child stool). The model also included nutritional status (BMI) of the mother as the key predictor in the study.

5. $logistic\ (child\_alive\_dead) = \beta 0 + \beta 1 Mother's\ Nutrition\ (BMI) + \beta 2 Child\ Size\ at\ Birth + \beta 3 Sex\ of\ the\ chid + \ + \ \beta 4 Birth\ Order + \ \beta 5 Mother's\ age + \beta 6 Marital\ Status + \ \ \beta 7 Mother's\ Education + \ \beta 8 Wealth\ index + \ \beta 9 Residence + \beta 10 Region + \ \beta 11 Type\ of\ toilet\ facility + \beta 12 Source\ of\ drinking\ water + \beta 13 Disposal\ of\ youngest\ child's\ stool$

This model was used to estimate the odds of infant deaths based on all factors: biological, maternal and environment. This was done to present a more realistic picture of how different factors may act together in influencing survivorship beyond age 1 of the infants.

3.5. Limitations of the Study

i. The 2013-14ZDHS collected information based on current measures especially for maternal characteristics such as BMI, education etc. For the children, detailed information is captured for most recent births. This made it a challenge to link mother's nutritional status to the infant deaths because information is collected in retrospect and may be affected by recall bias.
ii. The ZDHS data was collected to give a picture of the country's demographic and health status; this differs from the purpose of this research which aimed at bridging the knowledge gap.
iii. The cross-sectional nature of ZDHS data does not enable the determination of causality between the variables but only allows determining association.

3.6. Ethical Consideration

The 2013-14 ZDHS Children's dataset was requested through following the steps provided by the Demographic and Health Surveys (DHS) Program at https://www.dhsprogram.com/. Approval was granted for the dataset to be downloaded. This study did not review any participant information in conducting any analysis.

CHAPTER FOUR: STUDY FINDINGS

This section presents the findings of the study in terms of univariate frequencies, Chi-square test of significance, bivariate and multivariate binary logistic regression analysis. The study aimed at investigating the influence of nutritional status of women on infant mortality in Zambia.

4.1 Background characteristics of the study population

Univariate analysis was conducted to provide information on the description of the study population. The results are weighted prior to analysis and are a combination of demographic, environmental and socio-economic characteristics of the mother and child in relation to infant mortality. Results in table 4.1 show that 4.2 percent of children died before reaching age 1 and 95.8 percent survived beyond age 1.

Results show that 82.5 percent of the women who reported having an infant were married and 56.2 percent had attained primary school education. Twenty four percent of the women who reported to have had an infant were in the poorest wealth index, 14.7 percent of the women were from Lusaka, and 65.8 percent were had residency in rural areas.

Results show that 86.1 percent of the mothers used safe methods of stool disposal and 60.3 percent of the mothers came from households with access to improved water sources. Results also show that 40.6 percent of mothers came from households with an unimproved toilet facility and 19.1 percent of households had no toilet.

Results show that of all children in the sample, 51.0 percent of the children were reported to be male and 49.0 percent were reported to be female by their mothers. Furthermore, 57.8 percent of children were reported to have been of average size at birth and 11.3 percent were of small size at birth. Results on child's birth order show that 33.3 percent of the mothers reported their children being born in the 2^{nd}-3^{rd} birth order and 14.6 percent were reported to have been born in 7+ birth order. Table 4 also shows that 46.7 percent of the mothers were in the age group 25-34 and 22.3 percent were in the age group 35-49. Results on HIV status of the mother indicate that 12 percent of the mothers were positive and 88 percent were negative. Most women in the study had a normal body mass index (70.6 percent) and few were underweight (8.3 percent).

Table 4:1 Background characteristics of the study population

Variable	Weighted count	Percent
Infant Mortality		
Survived Infancy	12,703	95.8
Died in Infancy	550	4.2
Marital Status		
Married	10926	82.5
Never married	984	7.4
Formerly married	1342	10.1
Maternal Education		
No education	1460	11.0
Primary	7438	56.2
Secondary	3883	29.3
Higher/tertiary	458	3.5
Wealth Index		
Poorest	3179	24.0
Poorer	3050	23.0
Middle	2726	20.6
Richer	2344	17.7
Richest	1956	14.8
Province		
Lusaka	1952	14.7
Central	1287	9.7
Copperbelt	1697	12.8
Eastern	1721	13.0
Luapula	1181	8.9
Muchinga	809	6.1
Northern	1259	9.5
Northwestern	666	5.0
Southern	1833	13.8
Western	848	6.4
Residence		
Urban	4532	34.2
Rural	8720	65.8
Disposal of youngest child Stool		
Safe methods	10407	86.1
Unsafe Methods	1684	13.9
Water Source		
Improved	7747	60.3
Unimproved	5092	39.7
Type of Toilet		
Improved	5204	40.3
Unimproved	5236	40.6
No toilet	2464	19.1
Sex of the Child		
Female	6489	49.0
Male	6763	51.0

Variable	Weighted count	Percent
Child size at birth		
Average	7530	57.8
Large	4025	30.9
Small	1462	11.3
Birth Order		
1st	2825	21.3
2-3	4413	33.3
4-6	4083	30.8
7+	1931	14.6
Maternal Age		
15-24	4115	31.0
25-34	6183	46.7
35-49	2954	22.3
HIV Status		
Positive	1504	12
Negative	11067	88
Nutritional status of women (BMI)		
Normal	9360	70.6
Underweight	1095	8.3
Obese	2798	21.1

Source: Calculated using the 2013-14 ZDHS dataset

4.2 Bivariate Analysis: Chi-square test of significance

This section presents results from bivariate analysis using Chi-square test of significance, which aimed to establish the relationships between the infant mortality, and maternal, child and socio-demographic-economic factors respectively.

Results in table 4.2 show that there were more infant deaths (8.4%) among infants whose size at birth was reported to be small compared to those whose size at birth was reported to be large (3.4%). There were more infant deaths among children born in the first order compared to those born the seventh order (4.2%). Results also show that more male children (4.7%) died as infants compared to female children (3.6%). Women aged 15-24 reported more infant deaths (4.9%) compared to those in the age group 35-49 (4.1%). There is a statistically significant relationship between the sex of the child, child size at birth, birth order, maternal age and death of a child before reaching age one. The results further show that there were 4.8 percent of infant deaths reported from households with an improved toilet facility compared 3.4 percent reported from households that used an unimproved toilet facility. This observation in the results presents above are statistically significant given that $P<0.05$ at 95 % confidence interval Results on mothers nutritional status (BMI), marital status, maternal education, wealth index, province, residence, stool disposal and water source were not statistical significant.

Table 4:2 Bivariate analysis Chi-square test of significance

Variable	Survived Infancy %	Died in infancy %	Df	X^2	P-value
Sex of the Child			**1**	**10.4774**	**0.0072**
Female	96.4 (6257)	3.6 (232)			
Male	95.3 (6445)	4.7 (318)			
Child size at birth			**2**	**86.4820**	**0.0000**
Average	96.6 (7273)	3.4 (256)			
Large	96.6 (3890)	3.4 (135)			
Small	91.6 (1339)	8.4 (123)			
Birth Order			**3**	**28.1243**	**0.0005**
1st	94.2 (2660)	5.8 (164)			
2-3	96.2 (4245)	3.8 (168)			
4-5	96.7 (3947)	3.3 (134)			
7+	95.8 (1849)	4.2 (81)			
Maternal Age			**2**	**9.5548**	**0.0499**
15-24	95.1 (3913)	4.9 (201)			
25-34	96.3 (5956)	3.7 (226)			
35-49	95.9 (2832)	4.1 (121)			
Nutritional status of women (BMI)			**2**	**0.3908**	**0.8893**
Normal	95.8 (8967)	4.2 (393)			
Underweight	96.2 (1053)	3.8 (41)			
Obese	95.1 (2682)	4.1 (115)			
Marital Status			**2**	**0.9477**	**0.7034**
Married	95.9 (10479)	4.1 (446)			
never married	95.8 (943)	4.2 (41)			
Formerly married	95.3 (1280)	4.7 (62)			
HIV status			**1**	**17**	**0.0000**
Positive	93.0 (1399)	7 (107)			
Negative	96.3 (10653)	3.7 (413)			
Maternal Education			**3**	**1.5325**	**0.7541**
No education	95.7 (1398)	4.3 (62)			
Primary	95.9 (7135)	4.1 (303)			
Secondary	95.7 (3715)	4.3 (168)			
Higher	96.8 (443)	3.2 (14)			
Wealth Index			**4**	**8.4235**	**0.2589**
Poorer	95.9 (3047)	4.1 (131)			
Poor	95.9 (2924)	4.1 (125)			
Middle	96.2 (2621)	3.8 (103)			
Richer	94.8 (2223)	5.2 (120)			
Richest	96.4 (1885)	3.6 (69)			
Province			**9**	**17.6302**	**0.2937**
Lusaka	96.0 (1873)	4.0 (78)			
Central	96.8 (1246)	3.2 (41)			
Copperbelt	95.9 (1628)	4.1 (68)			
Eastern	94.2 (1621)	5.8 (99)			
Luapula	95.4 (1126)	4.6 (54)			

Variable	Survived Infancy %	Died in infancy %	Df	X^2	P-value
Muchinga	96.1 (777)	3.9 (31)			
Northern	95.8 (1206)	4.2 (52)			
Southern	96.1 (1761)	3.9 (71)			
Western	96.5 (818)	3.5 (29)			

Residence			**1**	**0.5145**	**0.5973**
Urban	95.7 (4336)	4.3 (196)			
Disposal of youngest child stool			**1**	**0.3469**	**0.5957**
Safe Methods	97.3 (10125)	2.7 (281)			
Unsafe Methods	97.5 (1642)	2.5 (41)			
Water Source			**1**	**1.6263**	**0.3114**
Improved	95.7 (7413)	4.3 (333)			
Unimproved	96.1 (4896)	3.9 (196)			
Type of Toilet			**2**	**12.5563**	**0.0209**
Improved	95.2 (4954)	4.8 (249)			
Unimproved	95.6 (5056)	3.4 (179)			
No toilet	95.9 (2362)	4.1 (101)			

Source: Calculated using the 2013-14 ZDHS dataset

4.3 Unadjusted Odds: Binary Logistic Regression

This section presents results of Binary logistic regression analysis of infant mortality by mother's BMI, age, education level, province, HIV status, wealth index, marital status, child's sex, birth order and size at birth.

The results in table 4.3 show infants whose size at birth was small were 2.4 times more likely to die before reaching age 1 (CI: 2.001-3.111, P<0.05 at 95%CI) when compared to infants who were average sized at birth. Infants born to mothers whose HIV status is positive were 2 times more like to die before reaching age 1 when compared to those born to mothers whose HIV status was negative (CI: 1.709-2.623, P<0.05 at 95%CI). Results also show that infants born to mothers from rural residential areas were less likely to die before reaching age 1 (OR: 0.827, CI: 0.695-0.983, P<0.05 at 95%CI) compared to those born to mothers in urban residential areas. Infants born to mothers in the age group 25-34 had a reduced likelihood of dying before age one (AOR: 0.729, CI: 0.601-0.885, P<0.05 at 95%CI) when compared to those born to mothers in the age group 15-24.

Infant whose mothers reside in Eastern province were 1.6 times more likely to die before reaching age 1 when compare to those whose mothers reside in Lusaka province (CI 1.119-2.359, P<0.05 at 95%). Infants born the second birth order and above had reduced likelihood of dying before age 1 (OR: 0.66, 060 and 0.76) when compared to those born in the first order. Male infants were 1.2 times more likely to die during infancy compared with female infants (CI: 1.037-1.461, P<0.05 at 95% CI). Furthermore, results show that children born to mothers in households with an unimproved toilet facility (AOR: 0.754 CI: 0.624-0.912) were less likely to die before reaching age 1 when compared to those born to mothers in households with no toilet facility. Results on nutritional status of women (BMI), marital status, education and wealth index were not statistically significant

Table 4:3 Unadjusted Odds: Simple binary logistic regression

Variable	Unadjusted Odds Ratio	P-Value	95% Confidence Interval	
Body Mass Index (BMI)				
Normal (RC)	1.000			
Underweight	0.908	0.561	0.656	1.256
Obese	0.986	0.897	0.795	1.222
Child Size				
Average (RC)	1.000			
Large	0.978	0.802	0.784	1.206
Small	2.496	0.000	2.001	3.111
Marital status				
Married (RC)	1.000			
Never married	0.960	0.800	0.702	1.313
Formerly married	1.555	0.287	0.885	1.508
Education level				
No education	1.000			
Primary	0.943	0.679	0.714	1.245
Secondary	1.069	0.655	0.797	1.434
Higher	0.807	0.454	0.461	1.412
HIV status				
Negative	1.000			
Positive	2.118	0.000	1.709	2.623
Wealth index				
Poorest	1.000			
Poorer	0.983	0.898	0.762	1.268
Middle	1.109	0.414	0.864	1.425
Richer	1.307	0.043	1.008	1.695
Richest	0.909	0.553	0.664	1.244
Residence				
Urban	1.000			
Rural	0.827	0.031	0.695	0.983
Mother's age				
15-24	1.000			
25-34	0.729	0.001	0.601	0.885
35-49	0.820	0.092	0.652	1.033
Region				
Lusaka	1.000			
Central	0.821	0.401	0.518	1.300
Copperbelt	1.176	0.452	0.770	1.794
Eastern	1.624	0.011	1.119	2.359
Luapula	1.340	0.139	0.909	1.974
Muchinga	1.067	0.763	0.698	1.631
Northern	1.308	0.177	0.885	1.932
North-western	1.065	0.764	0.704	1.612
Southern	1.160	0.466	0.777	1.732
Western	0.909	0.686	0.576	1.435

Variable	Unadjusted Odds Ratio	P-Value	95% Confidence Interval	
Birth order				
1st	1.000			
2-3	0.669	0.000	0.535	0.836
4-6	0.609	0.000	0.483	0.767
7+	0.763	0.051	0.582	1.001
Sex of child				
Female	1.000			
Male	1.231	0.017	1.037	1.461
Type of toilet facility				
No toilet facility	1.000			
Unimproved toilet facility	0.754	0.004	0.624	0.912
No toilet facility Improved toilet facility	0.836	0.164	0.650	1.075
Type of water source				
Improved source	1.000			
Unimproved source	0.933	0.445	0.781	1.114

Source: Calculated using the 2013-14 ZDHS dataset

4.4 Adjusted Odds Ratios: Multivariate results-Independent Models

This section presents results of multivariate analysis of infant mortality by biological, maternal and environmental factors. Results in table 4.4 show the adjusted odds of infant mortality after accounting for variations in the independent variables.

Model 2 results show that infants whose size at birth was reported to be small were 2.5 times more likely die before reaching age 1 when compared to those whose size was reported to be average. The results also show that male infants were 1.2 times more like die before reaching age 1 when compared to female infants. Model 3 results show that infants born to mothers in Eastern, Luapula, and Northern provinces were more likely to die before reaching age 1 when compared to those born to mothers in Lusaka (AOR: 1.7, 1.6, and 1.5 respectively). Infants born in birth orders 2-3 and 4-6 were less likely to die before reaching age 1 (AOR: 0.65 and 0.60 respectively) when compared to those born in the 1st birth order. The results also show that infants born to mothers whose HIV status was positive were 2.2 times more likely to die during infancy when compared to those born to mothers whose status was negative.

Table 4:4 Models: Adjusted Odds Ratio of Infant Mortality

Variable	Adjusted Odds Ratio	P-value	95% Confidence Interval	
		Model 1		
Body Mass Index				
Normal **(RC)**				
Underweight	0.908	0.561	0.656	1.256
Obese	0.985	0.897	0.795	1.222
		Model 2		
Body Mass Index				
Normal **(RC)**				
Underweight	0.918	0.615	0.660	1.278
Obese	0.980	0.864	0.782	1.228
Child size				
Average				
Large	0.963	0.734	0.77	1.195
Small	2.517	0.000	2.018	3.139
Sex of Child				
Female (RC)				
Male	1.282	0.00	1.073	1.532

Source: Calculated using the 2013-14 ZDHS dataset

Variable	Adjusted Odds Ratio	P-value	95% Confidence Interval	
		Model 3		
Body Mass Index				
Normal (RC)				
Underweight	0.943	0.740	0.678	1.317
Obese	1.023	0.848	0.808	1.295
Mothers' Age				
15-24 (RC)				
25-34	0.843	0.216	0.645	1.103
35-49	0.911	0.642	0.617	1.346
Mothers' Marital Status				
Married (RC)				
Never married	0.734	0.088	0.515	1.046
Formerly married	1.015	0.915	0.765	1.346
Highest level of Education				
No Education (RC)				
Primary	0.857	0.293	0.643	1.142
Secondary	0.857	0.369	0.613	1.199
Higher	0.759	0.433	0.381	1.511
Wealth Index				
Poorest (RC)				
Poorer	0.996	0.978	0.762	1.302
Middle	1.047	0.753	0.784	1.397
Richer	1.098	0.602	0.772	1.562
Richest	0.792	0.325	0.498	1.259
Region				
Lusaka (RC)				
Central	0.910	0.702	0.562	1.473
Copperbelt	1.185	0.453	0.760	1.847
Eastern	1.793	0.004	1.200	2.678
Luapula	1.603	0.027	1.054	2.439
Muchinga	1.251	0.328	0.798	1.962
Northern	1.518	0.052	0.996	2.314
Northwestern	1.274	0.281	0.820	1.980
Southern	1.270	0.271	0.829	1.947
Western	0.953	0.853	0.577	1.573
Residence				
Urban (RC)				
Rural	0.811	0.090	0.636	1.033
Birth Order				
1st (RC)				
2-3	0.658	0.002	0.504	0.859
4-6	0.605	0.004	0.428	0.855
7+	0.796	0.321	0.508	1.248
HIV Status				
Negative (RC)				
Positive	2.216	0.000	1.765	2.780

Variable	Adjusted Odds Ratio	P-value	95% Confidence Interval	
		Model 4		
Body Mass Index				
Normal (RC)				
Underweight	0.875	0.541	0.572	1.339
Obese	0.871	0.357	0.650	1.167
Type of Toilet Facility				
No toilet facility (RC)				
Unimproved toilet facility	0.892	0.374	0.694	1.146
Improved toilet facility	0915	0.621	0.645	1.298
Water Source				
Improved toilet facility (RC)				
Unimproved toilet facility	0.892	0.338	0.886	1.417
Disposal of Stool				
Safe methods (RC)				
Unsafe methods	0.891	0.501	0.638	1.244

Source: Calculated using the 2013-14 ZDHS dataset

Adjusted Odds Ratio: Multivariate Analysis Combined model with all socioeconomic-demographic, environmental, child and maternal factors

The combined model shows how all factors interact to influence infant mortality. Results indicate the adjusted odds ratios for infant mortality. Infants whose size at birth was reported to be small were 2.2 times (CI: 1.638-3.019, P<0.05 at 95%CI) more likely to die during infancy when compared to those of average size. Infants whose mother's marital status was never married were less likely to die during infancy (AOR 0.262, CI: 0.130-0.530, P<0.05 at 95%CI) when compared to those born to mothers whose marital status was married. Mothers in the middle wealth quintile had infants who were 1.5 (CI: 1.053-2.315, P<0.05 at 95%CI) times more likely to die during infancy when compared to those in the poorest wealth quintile.

The results also show that infants in Copperbelt, Luapula, Northern and North-western provinces were more likely to die during infancy (AOR: 2.1, 2.1, 2.4 and 2.4 respectively) when compared to those in Lusaka province. Infants whose mother's HIV status was positive were 1.4 times (CI: 1.021-2.048, P<0.05 at 95%CI) more like to die before reaching age 1 when compared to those in whose mother's HIV status was negative. Furthermore, results also show that infants in households with an unimproved toilet facility were less likely to die during infancy (AOR: 0.706, CI: 0.525-0.948, P<0.05 at 95%CI) when compared to those in households with no toilet facility.

Variable	Adjusted Odds ratio	P-value	Confidence Interval	
Body mass index				
Normal (RC)				
Underweight	0.959	0.853	0.612	1.502
Obese	0.931	0.673	0.667	1.299
Child size				
Average (RC)				
Large	0.904	0.510	0.669	1.221
Small	2.224	0.000	1.638	3.019
Child's sex				
Female (RC)				
Male	1.227	0.094	0.966	1.559
Mother's age				
15-19 (RC)				
25-34	0.887	0.515	0.619	1.272
35-49	0.760	0.313	0.446	1.295
Marital status				
Married (RC)				
Never married	0.262	0.000	0.130	0.530
Formerly married	1.010	0.961	0.682	1.496
Mothers education				
No education (RC)				
Primary	0.775	0.173	0.537	1.118
Secondary	0.745	0.189	0.480	1.156
Higher	0.540	0.246	0.190	1.529
Wealth index				
Poorest (RC)				
Poorer	1.347	0.106	0.939	1.932
Middle	1.561	0.027	1.053	2.315
Richer	1.346	0.256	0.806	2.247
Richest	0.911	0.794	0.454	1.830
Residence				
Urban (RC)				
Rural	1.041	0.811	0.748	1.448
Province				
Lusaka (RC)				
Central	1.327	0.423	0.664	2.649
Copperbelt	2.129	0.023	1.109	4.086
Eastern	1.836	0.062	0.970	3.475
Luapula	2.183	0.016	1.153	4.132
Muchinga	1.731	0.109	0.884	3.388
Northern	2.421	0.007	1.274	4.601
Northwestern	2.441	0.008	1.264	4.711
Southern	1.344	0.400	0.675	2.679
Western	1.440	0.342	0.679	3.058

Birth order				
1st (RC)				
2-3	0.720	0.078	0.499	1.037
4-6	0.685	0.110	0.430	1.089
7+	0.838	0.566	0.457	1.534
HIV status				
Negative (RC)				
Positive	1.446	0.038	1.021	2.048
Toilet facility				
No toilet (RC)				
Unimproved toilet facility	0.706	0.021	0.525	0.948
Improved toilet facility	0.859	0.488	0.560	1.319
Water source				
Improved source (RC)				
Unimproved source	0.975	0.859	0.741	1.284
Disposal of stool				
Safe methods (RC)				
Unsafe	1.008	0.963	0.708	1.435

Source: Calculated using the 2013-14 ZDHS dataset

4.5 Measures of goodness of fit

Measures of goodness of fit for each independent model were conducted using the Hosmer-Lemeshow criteria. The following is a summary of the fitness estimation for each model.

Table 4:5 Hosmer-Lemeshow

Model	Df	Hosmer-Lemeshow Chi2	P>Chi2
1	0	0	
2	6	7	0.302
3	8	7	0.537
4	7	8	0.313
5	8	9	0.268

Based on the Hosmer-Lemeshow chi-squared values, degrees of freedom and p-values, the models show no evidence of lack of fit.

Measures of fit for binary logistic regression on infant mortality were conducted using the Akaike criterion (AIC) and Bayesian Information Criterion (BIC)[6]. The choice of the final model adopted in this study was done by comparing the AIC and BIC of the models.

Table 4:6 Akaike criterion (AIC) and Bayesian Information Criterion (BIC)

Model	Df	AIC	BIC
1	3	4614	4636
2	6	4300	4345
3	28	4337	4546
4	7	2990	3042
5	35	2611	2868

Model 5 was chosen as the best fit model on account having the lowest AIC and BIC value in comparison to other models.

[6] https://www.stata.com/manuals13/restatic.pdf

CHAPTER FIVE: DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Summary of findings

Infant mortality rates have declined world over, Zambia inclusive. This decline has been due to various interventions such as improvements in the medical realms (e.g. development of vaccines and immunizations) and programmes such as encouraging women to attend antenatal and postnatal care, practice of exclusive breastfeeding and nutrition programmes among others. The 2013-14 ZDHS shows that infant mortality rate has declined from 107 deaths per 1,000 live births in 1992, to 45 deaths per 1,000 live births in 2013-14. The study aimed at investigating the influence of women's nutritional status (measured by BMI) on infant mortality rate in Zambia. It also aimed at answering the research question: To what extent has women's nutritional status contributed to the decline in infant mortality in Zambia? Findings from the study show that women's nutritional status did not influence infant mortality in any way. The results also show women's nutritional status did not contribute to the decline in the infant mortality in Zambia on account that all observations between women's nutritional status and infant mortality were due to chance.

5.1.1 Discussion

5.1.2 Objective: To determine the relationship between nutritional status of women and the reduction of infant mortality in Zambia.

Findings of the study at bivariate and multivariate logistic level (adjusted odds for all factors) show that BMI did not accounted for reduction in infant mortality in Zambia. The observations were due chance owing to that fact that reported BMI could not be accurately ties to the birth and death of the infants. The BMI was computed at the time of survey data collection while information on birth and death of the infants was collected retrospectively. This study differed on methodologies applied by the Infant and Young Children project in Ethiopia and Lindam who studied the association between maternal BMI and the risk of infant deaths. The two studies followed and tracked BMI for the mothers during pregnancy and when the children were born. This is very different from the ZDHS whose design is cross-sectional. A longitudinal approach makes possible to link changes in BMI to infant death without having to encounter any recall bias.

5.1.3 Objective: To determine the relationship of socio-economic and demographic, and infant mortality in Zambia.

The study found that children whose birth size was small were significantly more likely to die during infancy compared to those reported to be average. Low birth weight infants are more likely to die during infancy than normal birth weight babies because they are more prone to birth asphyxia, trauma, and do not adapt well to extra uterine life and are very susceptible to hypothermia and infection. The findings on size at birth agree with findings by O'Leary who studied first born infants and found that odds of death were significantly higher among low birth weight infants. The notable difference is that the study included all infants regardless of being a first born or not while O'Leary only focused on first born infants. Lukonga also adds that the small sized infants die due the level of maternal education. In regards to birth order, the study found higher neonatal mortality rates among second birth order as compared with first birth order (38 vs 28 per 1000 live births, respectively). The results also showed that short birth intervals compared with long birth intervals were associated with an increased neonatal mortality rate in second births (47 and 29 per 1000 live birth respectively). The findings also reflect the variable interactions in the conceptual framework.

Children born in the 2nd to 3rd and 4th to 6th orders have been found to be significantly less likely to die during infancy compared with children born in the 1st order. This finding is similar to what Negera found in Ethiopia. This could be mainly because the mothers have had more time to understand and learn the nutritional, health and environmental requirements for the infants to be safe and health when compared to first time mothers who are often too young. The results on the child's sex are similar to what Negera found. Male infants had increased odds of dying before their first birthday when compared to female infants. The results also agree with the conceptual framework in that infants born in the first birth orders, male infant and small size at birth had a higher likelihood of dying before reaching age 1. The results on sex, child size and birth order are consistent with the 2013-14 ZDHS (ZDHS 2013-14: 114) and the study conceptual framework.

5.1.4 Objective: To determine the relationship of socio-economic and demographic and infant mortality in Zambia

Exposure to HIV especially for infants is challenging. In the era of eliminating HIV transmission, many infants born to HIV mothers are at risk of infection especially when health guidelines are not adhered to. Results from the study show that infant born to HIV Positive mothers had increased odds of dying in comparison to those whose mothers were negative. This could be because the infants are immune compromised and this makes very susceptible to different illnesses and disease that eventually result in death. Kurewa (2010) found similar results among HIV exposed infants.

In terms of region, the results show that children born to mothers in Eastern, Luapula and Northern provinces were more likely to die during infancy than those in Lusaka. The observed results could be due to the lack of robust health services in comparison to Lusaka. The other reason could be that there are more mothers in the rich and richest wealth index in Lusaka compared to other provinces as evidence by the high population in the province. This entails better access to health services and variety of foods required for infant growth.

5.1.5 Objective: To determine the relationship of environment factors and infant mortality in Zambia.

The results showed that infants from households with an unimproved toilet were more likely to survive infancy compared to those with no toilet facility. This is because an unimproved toilet facility is likely to prevent contamination of surrounding especially water sources which may lead to diarrhea and infant deaths. Having a forma toilet improved or otherwise promotes good sanitation that not only protects the child but the family as well. The results from the study are in line with results from Kembo (2009) and Geruso (2017).

5.2 Conclusion

The study aimed at investigating the influence of women's nutritional status on infant mortality in Zambia using the 2013-14 ZDHS. In line with the objectives of the study, it is clear that sex of the child, size of the child at birth, province, birth order and mothers HIV status are seen to significantly relate to infant mortality. The findings in the variables are in line with the data presented in the 2013-14 ZDHS and what other scholars have found. The findings also reveal that there is no relationship or association between the infant mortality reported in the 2013-14 ZDHS and the nutritional status of women. This is due the nature of measurement of the BMI which is used as proxy for nutritional status of women. BMI information was only collected at survey implementation time unlike the health and mortality data that was collected in retrospect. The study also shown the usefulness of the Mosley and Chen model in explaining factors that influence infant mortality.

5.3 Recommendations

The following are the recommendations based on the findings from this study.

- There is need to conduct further investigation on the relationship of the mother's nutritional status and infant mortality in Zambia using a longitudinal study. This would enrich already existing DHS data from the Zambian perspective.

- Health facilities should also track and record pregnancy and post pregnancy BMI in effort to enhance service provision especially to mothers whose children are born small

- There should be investments made in programs and activities that will encourage establishment of good sanitation in communities such safe and secure toilets (Latrines and flushable toilets)

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