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Household Characteristics and Child Health Nexus.

An economic investigation of the link between household socioeconomic characteristics and the health of children under the age five in Zimbabwe.

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Dissertation submitted in partial fulfilment of the requirements of the Master of Science Degree in Economics.

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Declaration of Authorship

I, Eltone Mabodo, declare that the work presented in this dissertation entitled:

"Household Characteristics and Child Health Nexus: An economic investigation of the link between household socioeconomic characteristics and the health of children under the age of five in Zimbabwe.",

is my own and has not been published or submitted for assessment, in part or in full, in any previous application for a degree. Where other authors' information has been used, it has been indicated by way of citations, acknowledgements, or both.

EMabodo	23 June 2020
Signature	Date

Eltone Mabodo (R115526R)

Dedication

To Eltone Jnr. You have the whole world ahead of you.

Acknowledgement

Writing this dissertation has proved to be an interesting journey, yet at the same time, academically challenging and enlightening adventure. There is no way this piece was going to come together the way it did without the contribution and help of many individuals. To this regard, I would like to express my deepest gratitude to those who have immensely contributed to this work.

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May the Lord's grace and peace be upon you good people!!!!!

Abstract

This study was carried out with the main aim of finding ways of improving the health of children under the age of five in Zimbabwe. Under-five mortality and undernutrition were the two health indicators used in this study. The study used cross-sectional data collected during the 2015 Zimbabwe Demographic and Health Survey, with permission granted by the ICF International. Data analysis was carried out using Stata® 15. Two separate regression models were estimated, one for the determinants of undernutrition and the other for the determinants of child survival. For the determinants of undernutrition, an ordered logistic regression model was estimated and for child survival, survival analysis was carried out using the Cox Proportional Hazards Model.

On the causes of undernutrition, the study find factors such as short birth interval, being a male child, maternal education below tertiary level, premature birth, urban residence and being born to a mother following the apostolic sect religious doctrine contributing to poor nutrition stock of the children. On the other hand, factors such as safe drinking water, single births, improved toilet facility and clean cooking power all contributing to the child having good nutrition stock. In addition, survival analysis has revealed factors such as maternal alcohol consumption, healthcare services accessibility, improved toilet facility, maternal age, premature birth, single birth and religious doctrine as the contributing factors increasing the probability of the child dying before their fifth birthday.

Hence the study advocates that targeting these variables, that is, maternal characteristics (alcohol consumption, age and education), household characteristics (urban residence, cooking fuel and apostolic sect religious doctrine followers), child specific characteristics (male child, premature births, single births and children with shorter birth interval) and water, sanitation and health variables (improving toilet facilities, providing safe drinking water and enhancing the accessibility of healthcare services) will improve the health of children under the age of five in Zimbabwe.

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List of Acronyms

AIDS	Acquired Immune Deficiency Syndrome
DHS	Demographic and Health Survey
FNC	Food and Nutrition Council
GoZ	Government of Zimbabwe
HIV	Human Immunodeficiency Virus
MDGs	Millennium Development Goals
MoHCC	Ministry of Health and Child Care
SARA	Service Availability and Readiness Assessment
SDGs	Sustainable Development Goals
SSA	Sub-Sahara Africa
UNICEF	United Nations Children's Fund
UNIGME	United Nations Inter-Agency Group for Child Mortality Estimation
WASH	Water, Sanitation and Hygiene
WAZ	Weight-for-Age Z score
WHO	World Health Organization
ZDHS	Zimbabwe Demographic and Health Survey

Chapter One

Introduction and Background

1.0 Introduction

The future social, demographic, political, environmental, and economic potential of any community or country rests on the hands of the kids of today. This means the health and quality of the future economy are to some extent reflected by the "quality" and health of children of today. One can easily argue that to build a strong future economy we must start by taking care of the children. More so, together with women and the disabled, children are considered the most vulnerable members of the community (World Bank, 2006). Hence the health of children reflects not only the "quality" of children themselves but also the current "quality" of the entire community (Becker & Barro, 1986; Becker, 1993; Charmarbagwala, et al., 2012; de Onis, et al., 2004; Development Initiatives, 2018). Yet the health of children under five years, particularly in developing countries, has been negatively affected by high mortality risks and undernutrition problems (Development Initiatives, 2018; UNICEF, 2019; World Bank, 2006).

At an individual level, a person is predicted to have a better life ahead of them if they survive earlier years of their life well-nourished and healthy (Rabbani & Qayyum, 2015; Caulfield, et al., 2004; Frongillo & Pelletier, 2003; UNICEF Zimbabwe, 2016). At a macro level, a healthy child is an asset to any country, as they represent strong future human capital. Coupled with the fact that every human being (children included) has a moral right to a healthy life[1], improvement in the health of children and the reduction of their mortality rate becomes not only an economic duty but also a moral duty for policymakers (Grantham-McGregor, et al., 2007; Becker, 1993).

Globally, it is estimated that millions of children under five years of age die, mostly from preventable causes such as pneumonia, diarrhea, and malaria (United Nations Inter-agency Group for Child Mortality Estimation (UNIGME), 2017). In many developing countries, undernutrition alone accounts for around 45% of these deaths, while unsafe water, sanitation, and hygiene are also significant contributing factors (Development Initiatives, 2018). With the

1 In Zimbabwe, this is enshrined in Section 76 of the Constitution of Zimbabwe.

introduction of the Sustainable Development Goals (SDGs)[2] in 2015 and the UN Decade of Action on Nutrition (2016-2025) goals, the health of children under the age of five also become a good measure of the track of the progress towards the attainment of these goals, since most of these are centered on the above-mentioned problems. This is reflected by the link between SDG 2 target for child malnutrition[3] and SDG 3 target for child mortality[4] and the rest of the SDGs.

Given the strong link between the health of the children, individual cognitive development and community prosperity highlighted above, it becomes important to have a deeper understanding of why a child is likely to have good health in their early years of life. These early years are also very sensitive, delicate, and future-shaping years of every human being.

1.1 Key Definitions

There are various ways of assessing the healthiness of children. We begin by defining some child health indicators which are key and relevant to this research.

a. Under-five Mortality

This refers to the probability of a child dying before their fifth birthday. This comprises the risk of dying within one month of birth (neonatal mortality) and the probability or risk of dying within one year of birth (infant mortality) (Development Initiatives, 2018). It is measured as the number of deaths per 1000 live births.

b. Undernutrition

Undernutrition refers to a lack of proper nutrition, caused by not having enough food, not eating enough food containing substances necessary for growth and health, and other direct and indirect causes (Development Initiatives, 2018). This is a major problem in developing countries, and in children under five, it can be assessed by stunting and wasting (Development Initiatives, 2018; Food and Nutrition Council, 2018; UNICEF, 2019).

- Stunting is defined as length or height-for-age z-score more than 2 standard deviations below the median of the World Health Organization (WHO) child growth standards.

2 The successor to the Millennium Development Goals (MDGs).

3 **SDG 2. End hunger, achieve food security, and improved nutrition and promote sustainable agriculture.** Target 2.2 aims to end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age by 2030.

4 **SDG 3. Ensure healthy lives and promote wellbeing for all at all ages.** Target 3.2 aims to end preventable deaths of new-borns and children under 5 years of age by 2030

Recent evidence has shown that it is becoming increasingly clear that children who are stunted are more likely to become wasted (Development Initiatives, 2018; Food and Nutrition Council, 2018).

- Wasting is defined as weight-for-length or height z-score more than 2 standard deviations below the median of the WHO child growth standards. It is becoming increasingly clear that children who are wasted are more likely to become stunted (United Nations Children's Fund., 2015; Development Initiatives, 2018).

1.2 Background of the Study

1.2.1 Under-five Malnutrition in Zimbabwe

On the global level, children under five years of age face multiple nutrition burdens, that is, 150.8 million (22.2%) are stunted, 50.5 million (7.5%) is wasted and 38.3 million (5.6%) are overweight (Development Initiatives, 2018). Meanwhile, the 2018 Global Nutrition Report has also reported that 20 million babies are born with a low birth weight each year. These problems continue to exist despite global efforts to end them (Development Initiatives, 2018; UNICEF, 2019).

Bringing these issues home, whilst stunting prevalence has declined from 33% in 2010 to 26% in 2018, it remains above the acceptable global threshold of 20% (Food and Nutrition Council, 2018; Zimbabwe National Statistics Agency & ICF International, 2016; Development Initiatives, 2018). Furthermore, 35 districts are above the national average of 26% while 14 districts are in the high prevalence category according to the World Health Organization (WHO) classifications (30-39%). Hence, stunting reduction programs need to be scaled up to accelerate the attainment of the Malabo declaration target of 20% or less by 2025 across all the country's districts (Zimbabwe National Statistics Agency & ICF International, 2016; Development Initiatives, 2018). On the other hand, the current prevalence of wasting (2.5%) is within the acceptable WHO cut off values for public health action. However, some districts have prevalence above the national average. These include districts in Matabeleland South and Manicaland provinces.

The current national prevalence of underweight is 8.8% and remains acceptable based on the WHO threshold of below 10%. It is also lower than the combined Southern Africa region figure of 12.7%. However, it is worth pointing out that evidence from the 2015 Zimbabwe Demographic and Health Survey (ZDHS) showed that 14 districts are in the medium prevalence of 10-19% (Zimbabwe National Statistics Agency & ICF International, 2016). The

Government of Zimbabwe needs to focus on interventions that reduce and maintain underweight rates below global thresholds in all the country's districts (Zimbabwe National Statistics Agency & ICF International, 2016).

Table 1.1 Triple Burden of Malnutrition in Zimbabwe.

REGION/ COUNTRY	Stunting (%)	Wasting (%)	Underweight (%)
Zimbabwe (2018)	26.2	2.5	8.8
Southern Africa (2019)	29.0	3.3	12.7
Global Targets	< 20	< 5	< 10

Source: 2018 ZNNS, 2018 Global Nutrition Report and UNICEF, WHO, World Bank 2019.

Stunting generally tends to increase with a child's age, with data from the 2015 ZDHS showing that it increased from 13 percent in children age 6-8 months to a peak of 39 percent of children age 24-35 months, before declining to 18 percent of children age 48-59 months (Zimbabwe National Statistics Agency & ICF International, 2016). Additionally, stunting varies with gender, with boys having a higher proportion of stunting than girls (30 percent versus 24 percent). Evidence from the 2015 Zimbabwe Demographic and Health Survey shows that all the three measurements of undernutrition (i.e. stunting and wasting) are higher in rural areas than in urban areas, whereas the proportion of overweight children is higher in urban areas than rural areas (Development Initiatives, 2018; Food and Nutrition Council, 2018; Zimbabwe National Statistics Agency & ICF International, 2016).

The survey also finds that the prevalence of stunting is highest among children whose mothers have no education (45 percent) and lowest among children whose mothers have more than secondary education (9 percent) (Food and Nutrition Council, 2018; Zimbabwe National Statistics Agency & ICF International, 2016). In contrast, the prevalence of overweight is lowest among children whose mothers have no education (3 percent) and highest among those whose mothers have more than secondary education (9 percent) (Zimbabwe National Statistics Agency & ICF International, 2016).

1.2.2 Under-five mortality in Zimbabwe.

According to the 2015 ZDHS, under-five mortality increased from 1988 (71 deaths per 1,000 live births) to 1999 (102 deaths per 1000 live births) and then declined such that the rate in 2015 (69 deaths per 1,000 live births) was just slightly lower than the 1988 rate (Zimbabwe National Statistics Agency & ICF International, 2016). More so, these statistics vary significantly based on geography. Under-five mortality is higher in rural areas than in urban areas (92 deaths per 1,000 live births versus 60 deaths per 1,000 live births) (Zimbabwe National Statistics Agency & ICF International, 2016). The table below compares Zimbabwe with some selected parts of the world.

Table 1.2 Under-Five Mortality Trends, Zimbabwe vs the World (deaths per 1,000 live births)

UNICEF Region	1985	1990	1995	2000	2005	2010	2015
Zimbabwe	**71**	**80**	**77**	**105**	**82**	**84**	**69**
Europe and Central Asia	37	31	27	21	16	12	10
Latin America and Caribbean	68	55	43	33	25	24	18
Middle East and North Africa	86	65	53	42	34	27	23
Sub-Sahara Africa	**188**	**180**	**172**	**153**	**125**	**101**	**85**
World	**102**	**93**	**87**	**76**	**63**	**51**	**42**

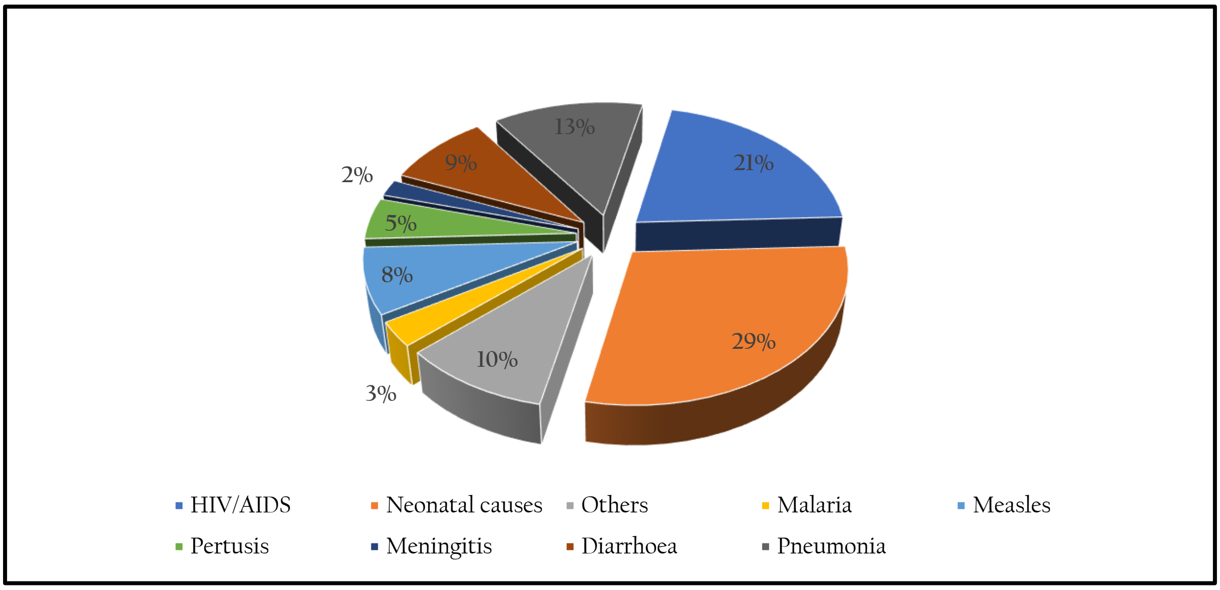
Source: UNICEF (2019) and ZDHS 2015.

From the above table, Zimbabwe has been performing well as far as under-five mortality is concerned compared to the whole region of Sub-Sahara Africa (SSA) combined. For example, in 1985 the under-five mortality rate was 71 deaths per 1000 live births in Zimbabwe. This figure was more than two and a half times better compared to the combined SSA figure of 188 deaths per 1000 live births. However, from the above, we also note that mortality was always on a downward trajectory for the SSA region, whilst for Zimbabwe in some periods it was increasing and decreasing in some periods. This possibly indicates a shift in policies, affecting the economic environment. However, when compared to other developed regions of the world, then we realize that the task at hand is enormous.

Comparison of rates of under-five mortality within the country's borders showed that it varies depending on different socioeconomic, maternal, and geographic locations variables. Provincially, under-five mortality ranges from a low of 50 deaths per 1,000 live births in Bulawayo to a high of 112 deaths per 1,000 live births in Manicaland. The 2015 ZDHS also noted that there is a significant disparity in under-five mortality between the rural and urban populations. Under-five mortality was higher in rural areas than in urban areas (92 deaths per 1,000 live births versus 60 deaths per 1,000 live births) (Zimbabwe National Statistics Agency & ICF International, 2016).

The major causes of these deaths nationally include malaria, HIV/AIDS, meningitis, diarrhea, and many more. Evidence from the 2015 Zimbabwe Demographic and Health Survey (ZDHS) show that the highest cause of under-five mortality in Zimbabwe is neonatal causes, which account for 29% of those deaths. This is followed by HIV/AIDS which accounts for 21%. The least contributor is meningitis, which accounts for 2% (see the pie chart below). It is important to note these are preventable diseases that the United Nations' Sustainable Development Goals seek to end by 2030. Figure 1:1 below summarizes this information.

Figure 1:1 Major Causes of Under-Five Mortality in Zimbabwe



Source: ZDHS, 2015

The 2015 ZDHS also shows that there are significant disparities of under-five mortality among different levels of maternal education. For the period of 10 years before the 2015 ZDHS, the under-five mortality rate was 106 deaths per 1000 live births for mothers with only primary level of education, 73 deaths per 1000 live births for mothers who have attained secondary education and the figure was 26 deaths per 1000 live births for mothers with an education level higher than secondary level (Zimbabwe National Statistics Agency & ICF International, 2016).

Besides, evidence from the 2015 ZDHS showed that under-five mortality generally decreases with household wealth, from 102 deaths per 1,000 live births in the lowest wealth quintile to 52 deaths per 1,000 live births in the highest wealth quintile (Zimbabwe National Statistics Agency & ICF International, 2016). The explanation here may be the fact that more wealth will ensure a relatively more childcare quality expenditure for each child (the quality aspect here is assumed to be nutritional products and healthcare provision products and services), both at prenatal and postnatal stages. If this is the case, then it will be in line with the predictions of the Quality-Quantity theory (Becker & Barro, 1986; Becker & Lewis, 1973), the Proximate determinants framework of Mosley and Chen (Mosley & Chen, 1984) and the UNICEF child nutrition and child survival framework (United Nations Children's Fund., 2015; World Bank, 2006), all of which are going to be discussed in detail later in chapter two of this research.

1.2.3 Zimbabwe Health Sector Overview and Performance

The provision of healthcare in Zimbabwe is enshrined in the country's 2013 constitution (Section 76 to be specific) and falls under the jurisdiction of the Ministry of Health and Child Care (MoHCC). Currently, MoHCC is guided by the National Health Strategy, covering the period from 2016 to 2020. The 2016-2020 National Health Strategy builds on the 2009-2013 strategy and its extension in 2014-15 by addressing existing gaps and, more importantly, seeks to sustain the gains achieved thus far through a comprehensive response to the burden of disease and strengthening of the health system to deliver quality health services to all Zimbabweans (MoHCC, 2016).

The sector has faced many challenges over the years. Some of the notable challenges in the sector include the fact 22% of girls between the ages of fifteen and nineteen are married (Zimbabwe National Statistics Agency & ICF International, 2016). More so, the level of government funding of US$25 per capita is still low compared to the WHO recommendation of US$86 per capita. However, despite these challenges, some significant achievements have been registered. Some of these notable achievements include the reduction of maternal mortality from over 1000 per 100 000 live births to 614 per 100 000 live births, increase in the percentage of pregnant women accessing antenatal care from 65% in 2009 to 76% in 2015 and also the reduction of under-five mortality rate from 102 per 1000 live births in 1999 to 69 per 1000 live births in 2015 (Zimbabwe National Statistics Agency & ICF International, 2016).

Government allocations to the MoHCC over the years have not been consistent, albeit the fact that they have been on an upward trend in US$ terms. For example, budget allocations rose from US$ 381 million in 2013 to US$ 474 million in 2018 (UNICEF, 2019). However, as a percentage of total government expenditure, health expenditure has been on a downward trend. More so, Zimbabwe is still lagging as far as global and regional health budget allocations commitments are concerned. For example, the health expenditure to total expenditure of 8.25% was far lower than the Abuja target of 15%.

Table 1.3 Government Allocation to the Ministry of Health and Child Care

Expenditure	2013	2014	2015	2016	2017	2018
Health Budget Allocation (US$ millions)	381	337	329	331	282	474
Health Expenditure to Total Expenditure (%)	9.9	8.2	6.6	8.27	6.88	8.25
Health Expenditure to GDP (%)	2.9	2.5	2.4	2.34	1.94	2.44

Source: UNICEF 2018

Health sector performance and preparedness can be measured using different methods which include inpatient bed density, health facility density, and maternity bed density. The 2015 Zimbabwe Service Availability and Readiness Assessment (SARA), provided a summary of these measurements. These are shown in Table 1.4 overleaf. Inpatient Bed Density is an indicator of inpatient service availability per 10 000 people. Zimbabwe has a national inpatient bed density of 18 per 10 000 people, which is double the WHO Africa Region of 9 beds per 10 000 people. However, this is below the national target of 25 and among the ten provinces of the country, only Bulawayo Metropolitan province has a density above both the current national level and the target (41 beds per 10 000 people).

Facility density measures outpatient services available per 10 000 people. Evidence from the 2015 SARA showed that at the national level this density is 1.1 health facilities per 10 000 people, which is below the target of 2 health facilities per 10 000 people. Facility density across the country's provinces ranges from less than 1 health facility per 10 000 population in Harare and Bulawayo provinces to 1.7 health facilities per 10 000 people in Manicaland and Matabeleland. However, there is a possibility of undercounting of hospitals in Harare and Bulawayo provinces due to the availability of private facilities which were not included in the survey (MoHCC, 2015).

Table 1.4 Selected Health Sector Performance Indicators

Province	Inpatient Bed Density (per 10 000 people)	Health Facility Density (per10 000 people)	Maternity Beds density (per 1000 pregnant women)
Harare	13	0.2	6
Bulawayo	41	0.4	13
Manicaland	16	1.7	9
Midlands	19	1.2	11
Masvingo	21	1.2	9
Mash Central	12	1.2	7
Mash East	17	1.5	10
Mash West	13	1.1	7
Mat/land North	21	1.6	11
Mat/land South	23	1.7	15
National (Current Level)	**18**	**1.1**	**8**
Target	**25**	**2**	**10**

Source: Zimbabwe Service Availability and Readiness Assessment Report, 2015

Of the included assessment measurements, maternity beds density, which measures the availability of maternal services is probably the most relevant to this study. It measures the inpatient beds that are used by pregnant mothers during pregnancy and after delivery, although for this survey delivery beds were not included. The national figure of 8 beds per 1000 pregnant women is slightly below the national target of 10 beds per 1 000 pregnant women. It is also worth noting that five provinces matched or exceeded the SARA target of 10 beds per 1 000 pregnant women, with Matabeleland South province leading with 15 maternity beds per 1 000 pregnant women.

1.3 Research Problem

One of the major goals of every government, with the help of development partners and non-governmental organizations, is to ensure good health to all its citizens at all age groups. There is a consensus, however, that the first five years of every individual are the most crucial (in terms of human, physical and cognitive development), and yet also the most delicate (health-wise). Better performance in school, better individual productivity, increased life expectancy, and better overall life satisfaction are all positively linked to better health in the first five years of life (Becker & Barro, 1986; Development Initiatives, 2018; Food and Nutrition Council, 2018; MoHCC, 2016; United Nations Children's Fund., 2015; World Bank, 2006; Becker, 1993; Becker & Lewis, 1973). Yet when it comes to the health of children under five years in Zimbabwe, long-standing problems of undernutrition and high mortality risks have refused to go away despite increased efforts by the government and its development partners to eradicate them.

With an under-five mortality rate of 69 deaths per 1000 live births, Zimbabwe has one of the highest under-five mortality rates in the world (MoHCC, 2016; UNICEF, 2019; Zimbabwe National Statistics Agency & ICF International, 2016). This figure is also above the 2030 target of at most 25 deaths per 1000 live births. It is estimated that around 45% of deaths of children below the age of five are linked to undernutrition related diseases (United Nations Inter-agency Group for Child Mortality Estimation (UNIGME), 2017; UNICEF, 2019; Development Initiatives, 2018). Undernutrition also impacts negatively on the child's development thereby compromising the immune system, increasing susceptibility to diseases, and restricting the attainment of human potential (Food and Nutrition Council, 2018; United Nations Children's Fund., 2015). Yet the country has 26.2% of the kids under five years suffering from undernutrition (Zimbabwe National Statistics Agency & ICF International, 2016). Not only is this figure among the highest in the world, but it is also above the UN global target of less than 20% (Development Initiatives, 2018).

1.4 Research Objectives

Two separate research objectives with the main purpose of finding ways of improving the health of children under the age of five in Zimbabwe are of interest. Specific objectives include:

- To identify the factors which causes undernutrition in children under the age of five years in Zimbabwe.
- To identify the factors which causes under-five mortality in Zimbabwe.

1.5 Research Questions

Questions to be answered by this research are:

- What are the factors causing undernutrition in children under the age of five years in Zimbabwe?
- What are the factors affecting the mortality of children under the age of five in Zimbabwe?

1.6 Study Hypotheses

The hypotheses which this research seeks to test include:

- Family demographics, socioeconomic factors, geographical location, and sanitation conditions (*source of drinking water and toilet facility)* have an impact on child undernutrition and under-five mortality.
- Child-specific and maternal factors (*child's birth order, preceding birth interval, maternal age, maternal education, child's sex, type of birth*), have an impact on child undernutrition and under-five mortality.

1.7 Significance and Justification of the Study.

Zimbabwe has failed to meet MDG 4[5]. Whether or not we are going to meet SDG 2 and SDG 3 is still up in the air. Of course, some considerable achievements have been noted, however, the task at hand remains enormous. Hence knowing the causal relationship between child health and various socioeconomic variables will help in the formulation of good policies, moving the nation closer to achieving the above goals. Furthermore, in addition to studies that were done on the topic by other researchers, this research aims to advance the little empirical evidence available.

The importance of children cannot be emphasized enough, from being the future generations, future leaders as well as being future human capital. Yet they are also among the most vulnerable groups of the community, most vulnerable to malnutrition induced diseases and deaths. Hence, it becomes imperative for this country (or any other developing nation for that matter), to understand the risk factors underlying child survival and undernutrition (Charmarbagwala, et al., 2012; United Nations Children's Fund., 2015). More so, the Zimbabwe National Nutrition Survey (ZNNS) 2018 has noted that *"While the findings provide an overview of the nutrition situation, there is a need for further interrogation to establish causal relationships"*. Hence this research is necessary to find the causal relationships mentioned above to inform policymakers on which variables to target.

1.8 Organisation of the Rest of the Study

In the next chapter, both the theoretical and empirical literature reviews are presented. Chapter three gives a detailed outline of the methods and procedures used while chapter four presents

5 Reduce child mortality.

the results and the interpretation of the estimation results. Lastly, chapter five summarizes, concludes, and outlines the policy recommendations and suggestions for further studies.

Chapter Two

Literature Review

2.0 Introduction

This chapter reviews the theoretical and empirical literature on child health, with under-five mortality and undernutrition as child health indicators. This enables us to develop a conceptual framework for empirical model specification, which will be used to answer the research questions developed in chapter one. The first section of the chapter presents the theoretical models of child health. The empirical section reviews empirical findings on the factors that affect both child mortality as well as child undernutrition, as found in previous studies. The review of both the theoretical and empirical literature will also help to identify variables and methodology to be used in modeling the factors affecting the health of children under the age of five.

2.1 Theoretical Literature Review

Economic analysis of child health is empirically linked to classical household models, healthcare demand and provision models, nutrition provision models, and fertility models, where a household's utility is maximized subject to some resource constraints. Application of these models is ultimately related to choices made in respect of some investment decisions, which also explain trade-offs between the number of children and the ability to raise them qualitatively (Becker & Barro, 1986; Becker, 1965; Becker, 1993; Becker & Lewis, 1973).

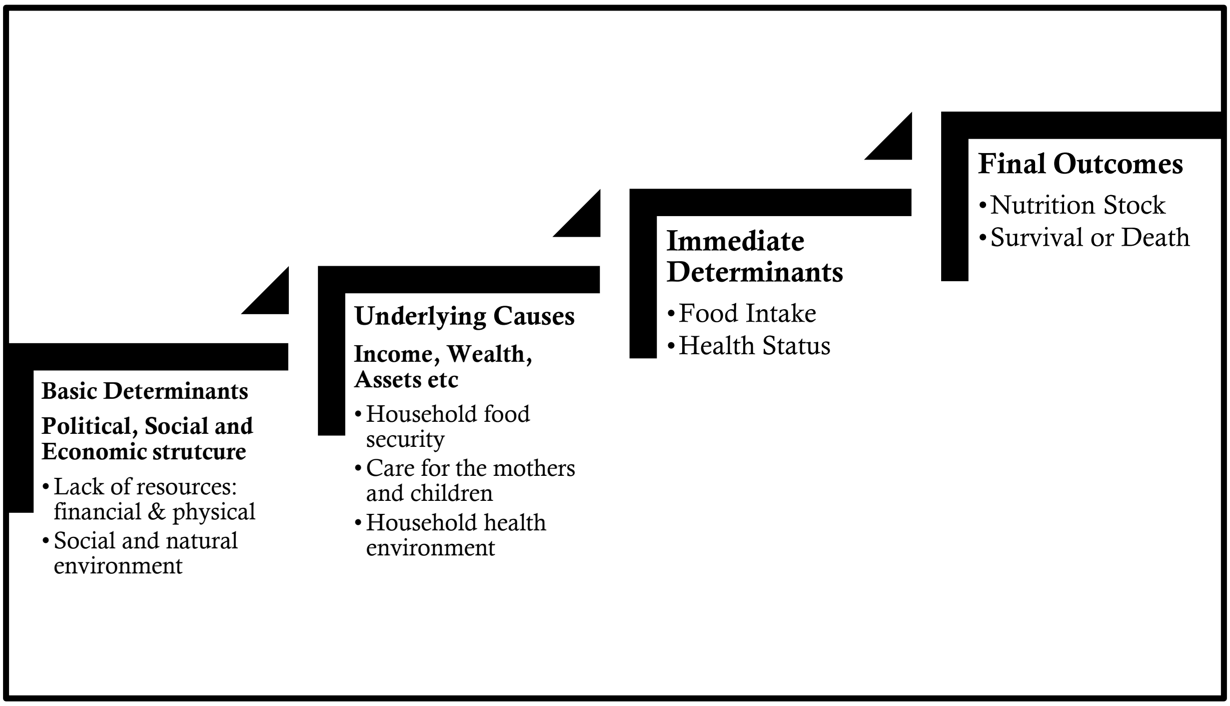
Major cited theories in this regard include the United Nations Children's Fund (UNICEF) Framework, Mosley-Chen Framework, The Quantity-Quality theory, and the Grossman model.

The UNICEF Framework

The UNICEF framework is one of the widely used frameworks to study the determinants of child health. The framework incorporates both socioeconomic and biological determinants and encompasses causes at both macro and micro levels. In this framework, there is a sequence of events that will determine the health of the child. At the bottom of this sequence are basic determinants and these affect underlying determinants. Underlying determinants in turn will affect immediate determinants and it is these immediate determinants that will eventually impact the health of the child (Scrimshaw, et al., 1968; United Nations Children's Fund., 2015;

Smith & Haddad, 1999). The sequence of events in this framework is shown in Figure 2:1 below.

Figure 2:1 UNICEF Conceptual Framework



Source: UNICEF 1998, 2015. Modified by the author to suite the study.

a. Basic Determinants

These are recognized at the country or community level. They include the potential resources available to a country or community which are limited by the natural environment, access to technology, and quality of human resources. Political, economic, cultural, and social factors affect the utilization of these potential resources and how they are translated into resources for food security, care, and healthy environments and services. These social, economic, and political factors can have long term influence on child health, increasing the risk of mortality and undernutrition (World Bank, 2006).

b. Underlying Determinants

These manifests themselves at the household level and they include food security, adequate care for the child and the childcare giver, and proper health environment, including access to health services. Food security is achieved when an individual has enough food for an active and healthy life. Resources necessary for achieving food security include food stock, income for food purchases, among others. More so, no child can grow without the nurturing of another individual being. In this framework, the child-caregiver is assumed to be the mother. Therefore, the framework advocates for the care of both the child and the mother.

Health environment and services is also another underlying determinant and rest on the availability of safe water, sanitation, and healthcare services. Anchoring all these underlying determinants is poverty. A person is in poverty if they cannot afford basic needs. The effects of poverty on child health are pervasive. Poor families are unable to achieve food security, have inadequate resources for childcare, and are unable to afford healthcare products and services (Scrimshaw, et al., 1968).

c. Immediate Determinants

These manifest themselves at the individual human being level. They include dietary intake (for example, nutrients consumption) and health status. A child with inadequate dietary intake is more susceptible to diseases. In turn, diseases depress appetite, inhibit the absorption of nutrients in foods, and competes for the child's energy, leading to more child health problems. Dietary intake must also be adequate in quantity and quality, for the child’s body to be able to absorb the nutrients (Scrimshaw, et al., 1968; United Nations Children’s Fund., 2015; World Bank, 2006).

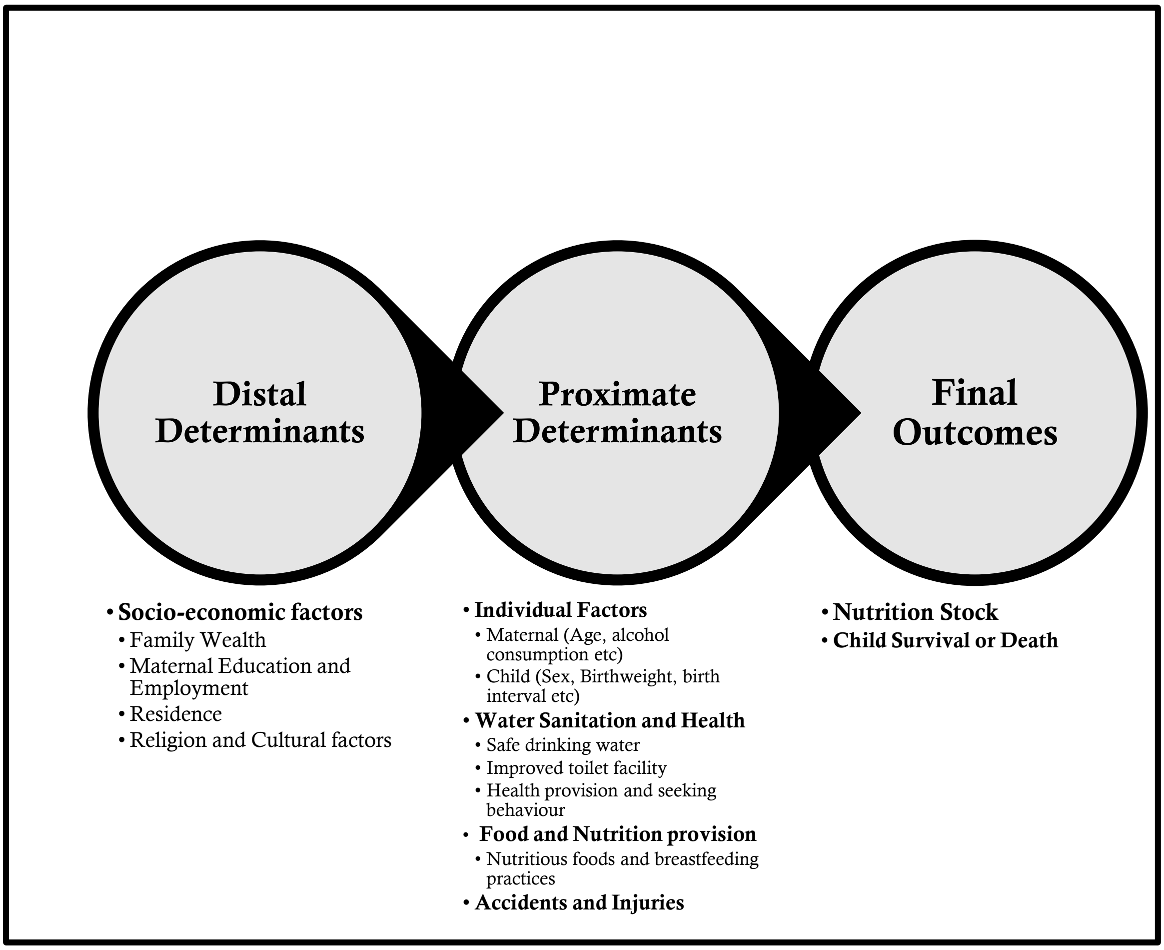
The Mosley-Chen Framework (Proximate Determinants Model)

This model came out of the acknowledgment that most disciplines (especially social scientists and medical scientists) have tried to solve the problem of child health differently, leading to different policy recommendations. The model incorporates both the biological and social variables and integrates research methods employed by medical and social scientists to model the problem of child health (Mosley & Chen, 1984). It is based on the premise that all social and economic determinants of child health necessarily operate through a common set of biological mechanisms or proximate determinants to affect the health of the child.

Traditionally, social science research on child health has focused on the association between socioeconomic status and health patterns in populations. Particularly, correlations between health and socioeconomic characteristics were used to generate inferences about mortality determinants. For instance, income and maternal education are the two most used socioeconomic variables (Mosley & Chen, 1984). Up until this theory, specific medical causes of deterioration in health were generally not addressed by social scientists, and the mechanisms by which socioeconomic determinants operate to produce the observed health remained largely unexplained. On the other hand, medical research focuses primarily on the biological process of diseases and less frequently on child health *per se*. Medical scientists attribute deterioration in health to specific disease processes such as infections as well as malnutrition, using information obtained from deaths reports or clinical case studies. It is out of this gap that the Proximate Determinants Model was born.

Firstly, Mosley and Chen defined the distal determinants of both child health outcomes. These distal determinants include only socioeconomic variables which are family wealth, maternal education, and employment, rural or urban residence, and religion and cultural factors. They are called distal determinants because they do not determine child health. They however affect the proximate determinants, which in turn affect the outcome variables of interest. This sequence of events is shown in Figure 2:2 below.

Figure 2:2 Modified Mosley-Chen Framework



Source: Adopted from Mosley and Chen, 1984. Modified to suite the study

According to this theory, proximate determinants are the ones that ultimately causes death or undernutrition. These proximate determinants include individual factors that are maternal specific (age, alcohol consumption, health status, among others) and child-specific (sex, birth weight, birth interval). The maternal factors affect their child caregiving practices as well as initial health stock to the child. For example, alcohol consumption by the mother negatively affects the child during pregnancy and lactation. This leaves the child with very low health stock, compromising the child's body ability to absorb nutrients. This will eventually lead to poor nutrition stock or even the death of the child. As for the child-specific factors, these are the initial natural biological endowments which the child gets at birth. The better these initial biological endowments (better birth weight and longer birth interval, for example), the less likely that the child will have health problems. The better also the child's body will be able to absorb nutrients and therefore the better the child's nutrition stock.

Another category of these proximate determinants includes the health environment which the child is living in and the healthcare-seeking behavior by the child's parents or caregivers. For example, safe drinking water, improved toilet facility, and the accessibility of healthcare services. These health environment factors minimize the possibility of diseases of the child. For example, safe drinking water and improved toilet facilities reduce the probability of a child getting diseases such as diarrhea and cholera. These diseases affect the child's immune system, leading to a reduced ability of the body to absorb nutrients. This will ultimately lead to reduced nutrition stock in the child's body or in the worst-case scenario, this will lead to death. On the other hand, the accessibility of health services will minimize disease outbreaks or reduce sick days.

Food taken by the child is also another category of the proximate determinants. These include nutritional food availability as well as good breastfeeding practices. There is no way a child's body can absorb nutrients whilst getting food without nutrients themselves. The food is given to the child must have good nutrients and these nutrients must be in good amounts to enable the child to grow well. Breastfeeding is also essential for the child when the child is not able to eat. As a result, good breastfeeding practices and intake of nutritional food by the child is predicted to reduce the probability of the child dying before they reach their fifth birthday. These also are predicted to maximize the amount of nutritional stock in the child's body.

Besides the above well-defined proximate determinants, death can occur due to accidents and injuries. However, in real life, it is difficult to model these since they are unpredictable events (Mosley & Chen, 1984).

The Quality-Quantity Theory (Becker-Lewis Model)

This is a theory of the trade-off that a household face between the quality and the number of children. The Quality-Quantity theory of Becker and Lewis (1973) predicts that the decisions on child quality and quantity are closely related than those of any two goods or services chosen at random, because of a special non-linearity in the budget constraint. In the model, the shadow price of child quality depends on the number of children a household has. The shadow price of the number of children also depends on the desired child quality by the parents (Becker, 1974; Becker & Barro, 1986; Doepke, 2015; Becker & Lewis, 1973).

Formally, households maximize utility, which is a function of the number of children (that is, the quantity), the quality of the children, and a composite good (Becker & Barro, 1986; Becker, 1974; Doepke, 2015; Becker & Lewis, 1973). The main argument in this model is that even though child quality and the number of children enter separately in the household utility function, they are still closely connected through the household's budget constraint. Child quality is modeled as goods and services spend on each child, including (but not limited to) education, nutritional foods, and healthcare. This implies that if child quality increases (more spending per child), increasing quantity (more children) becomes more expensive (Becker & Barro, 1986; Doepke, 2015). Conversely, if quantity increases, increasing quality also becomes more costly, since expenditure will be spread on many children.

Becker and Tomes (1976) extended the original model by allowing child quality to depend not just on parental inputs, but also on initial endowments, which can take the form of inherited ability, public investments in children, and other factors (Doepke, 2015; Becker & Tomes, 1976). One consequence of the presence of endowments is that the income elasticity of child quality tends to be higher at low-income levels since for low-income parents the endowment represents a larger portion of total child quality (Becker & Barro, 1986; Becker, 1993; Doepke, 2015). Becker and Tomes (1976) showed that this feature can generate a U-shaped connection between income and fertility, even if the income elasticities for child quantity and total child quality are equal and constant (Doepke, 2015; Becker & Tomes, 1976).

The predictions of this model in the context of child health, are that if the household gets more utility from the number of kids they have, they are likely to suffer more child health problems compared to the household which focuses more on the quality of kids. This is because all other things being equal, relative childcare expenditure per child is relatively high for the household with fewer kids compared to the household with many children. Healthcare expenditure will be spread on a wider number of children. On the other hand, if more utility is enjoyed from "quality" children compared to the number of children, then health problems are going to be few for this household. This is because relative expenditure on the quality of each kid in this household is higher compared to that of a similar kid in a household in which there are many children, *ceteris paribus*.

Grossman Model (1972)

One of the most cited models in the health economics literature is the Grossman Model of 1972. Grossman defines health broadly to include longevity and illness free days each year which is demanded and produced by consumers (Zweifel, 2012; Grossman, 1972; Grossman, 1999). In this model, health is treated as a durable capital stock (Grossman, 1972; Grossman, 1999). Developing this model Grossman argued that such a model is important for two main reasons. Firstly, the level of health stock influences the amount and the level of productivity supplied to the economy. Secondly, people do not demand health services per se, but they demand good health and medical and healthcare services are pathways to that good health (Jacobson, 1999).

In the model, the individual maximizes his or her utility. The utility function is made up of health stock now, $\mathbf{H_t}$, and a composite good, $\mathbf{Z_t}$. The health stock at a given point in time produces "health days" at that particular time. This health stock allows for the use of good health, which is the consumption commodity, and it also allows time to be spent on other market and non-market activities, that is, investment commodity. In the model, individuals are viewed as maximizing utility subject to two constraints, time constraint, and income constraint. The time constraint states that in each period time is allocated between consumption, investment, or the generation of wages. An increase in sick days leaves less time for these activities. The income constraint reflects the opportunity cost of time spends consuming or investing in the health stock rather than earning wages on the labor market. It is assumed that individuals are born with a certain level of health stock, which depreciates with age at a given rate, $\boldsymbol{\delta}$. Formally, the utility function and the health function will take the form:

$$\mathbf{U_t = U(H_t, Z_t)}$$

$$\mathbf{H_t = I_t - \delta_{t-1} H_{t-1}}$$

Death will occur at time, t, if $\mathbf{H_t < H_{min}}$ where $\mathbf{H_{min}}$ is the minimum level of health stock necessary to keep the individual alive.

One of the major extensions of the Grossman model which may be relevant to this research was done by (Jacobson, 1999) in the 1999 paper. In this extension, the Grossman model was extended to include parents as child health producers. In this extension, it was shown that if wealth constraint is binding, that is in poor families, the value of the child's health is higher compared to rich families and families where the wealth constraint is not binding have zero marginal utility child health (Jacobson, 1999). More so, a child born to parents who are unhealthy can be expected to have lower health compared to a child with healthy parents. The argument was that resources must be spent on increasing health investment for unhealthy parents so that the marginal condition will be fulfilled. The model also showed that even parents who are not altruistic towards the children will also invest in the health of the child since child health status affects family income.

The overall predictions of this model on child health are that once a child is born, continuous investments need to be taken on the healthcare of the child. If that is not the case, the initial health endowment which the child has been born with will depreciate leading to undernutrition problems, and in the worst-case scenario, the child will eventually die. Whilst we are still on this point, it is worth noting that the actual level of health which will cause death is not known to the researcher. We will observe that this threshold has been crossed going in the negative direction when death occurs.

2.2 Empirical Literature Review

2.2.1 Determinants of Under-Five Mortality

Studies about mortality on kids are very diverse in terms of methodology, region, data used as well as the theoretical backgrounds upon which the empirical models were built. Most studies, however, have made use of the readily available Demographic and Health Survey data (Ejaz, et al., 2019; Rabbani & Qayyum, 2015; Kembo & Van Ginneken, 2009; Zerai, 1997; Oyekale, 2014). On the methodology side, some have used logistic regression model (Ejaz, et al., 2019; Rabbani & Qayyum, 2015) whilst others have used the probit model (Oyekale, 2014) and others have also used the more sophisticated survival analysis models (Kembo & Van Ginneken, 2009; Zerai, 1997).

Zerai (1996) examined socio-economic and demographic variables in a multi-level framework to determine conditions influencing infant survival in Zimbabwe. He employed Cox regression analysis to the 1988 ZDHS data to study socioeconomic determinants of infant mortality. The unique finding of this research was that women's average educational levels in their community exert a greater influence on infant survival than the individual maternal educational level. This result supports assertions that child survival is strongly impacted by mass education (Kembo & Van Ginneken, 2009; Cleland & Van Ginneken, 1988). However, the author did not show the differential impact of the independent variables on infant and child mortality.

Building on from the research by Zerai (1996), Kembo and Van Ginneken (2009) tried to find the differential impact of independent variables on both infant and child mortality. Their research paper seeks to fill the gap in the existing literature on childhood mortality, by analyzing how child and infant mortality are differently impacted by the variables, particularly for Zimbabwe. They employed the multivariate Proportional Hazards Regression Models on the 2005-06 Zimbabwe Demographic and Health Survey data. They found out that determinants of child mortality were different in relative importance from those of infant mortality. The infant mortality risk associated with multiple births was 2.08 times higher relative to singleton births ($p < 0.001$) (Kembo & Van Ginneken, 2009). A unique result from this research was that they found out that socioeconomic variables did not have a distinct impact on infant mortality. However, they did have an impact on child mortality.

Bicego (1990) applied a three-step procedure using proportional hazards regression to estimate trends and determinants of childhood mortality in Haiti. He used the data from the 1987 Mortality, Morbidity, and Services Utilization Survey (EMMUS) in Haiti. Maternal education and low age at birth were found to have marked effects on neonatal survivorship but little effect thereafter (Bicego, 1990; Kembo & Van Ginneken, 2009). Indices that reflect community-level access to child health services were shown to be important especially during childhood.

Manda (1999) used data from the 1992 DHS in Malawi to study the relationship between infant and child mortality and birth interval, maternal age at birth and, birth order, with and without controlling for other relevant explanatory variables. He also investigated the direct and indirect (through its relationship with birth intervals) effects of breastfeeding on childhood mortality. The study employed proportional hazards models. The results show that birth interval and maternal age effects are largely limited to the period of infancy (Manda, 1999). As the child grows older, the influence of social and economic variables on the mortality risk is enhanced, and the relationship between bio demographic variables and mortality risk is strengthened. The study further shows that breastfeeding status does not significantly alter the effects of preceding birth interval length on mortality risk but does partially diminish the succeeding birth interval effect.

Mutunga (2007) examined the factors associated with under-five mortality in Kenya, using the proportional hazard rate model. Focusing on household environmental characteristics, the study suggested that drinking water sources, sanitation facilities, and sources of cooking fuels are important determinants of child mortality (Mutunga, 2007). Also, bio-demographic factors as well as socioeconomic factors were important and significant variables.

In Ethiopia, Oyekale (2014) used a two-stage least square probit model on the 2011 Ethiopian Demographic and Health Survey data to explain the factors affecting child survival. His results show that the age of household head, urban residence, drinking of alcohol, and smoking significantly reduces the probability of child survival. On the other hand, education, male household leadership, age at first birth reduce the probability of child survival. The conclusion was that efforts at reducing maternal fertility by promoting education of female children will go a long way in reducing child mortality in Ethiopia (Oyekale, 2014). Using the same data, Dejene and Girma (2013) used the Cox proportional hazards model to analyze the risk factors on child survival. Wealth and education were found to reduce the hazard rate. They also find out that the hazard ratio was higher for boys compared to girls. Maternal age, short birth interval, and twin births were identified risk factors for increased under-five mortality (Dejene & Girma, 2013).

Mekonnen et al. (2013) used pooled cross-section data from 3 DHS surveys to examine the determinants of neonatal mortality in Ethiopia. The results of the multivariate analysis using the Cox Proportional Hazard model suggest that bio-demographic determinants such as child sex, maternal age, and birth interval are the significant variables which is consistent with the previous two pieces of research mentioned above. Other factors such as tetanus injection, season, and mother's education are also important determinants (Mekonnen, et al., 2013).

Using 86 Demographic and Health Survey data collected from 56 developing countries between the periods from 1986 to 1998, Rutstein (2000) investigated the factors related to the trends of infant mortality in developing countries in the 1990s. Employing the Ordinary Least Square (OLS) method, the researcher found out that fertility behavior factors such as childbirth rank, childbirth interval, and maternal age at birth are associated with the change in infant mortality in this period. Also, behavioral factors such as health prevention care and treatment for diarrhea, as well as good nutritional intake practices are related to the decline of infant mortality. On the other hand, poor household hygiene such as surface water source and dirt floor related to an increase in infant mortality (Rutstein, 2000). Some socioeconomic variables were also found to be important to the change in infant mortality in developing countries, and these include access to electricity and maternal education.

2.2.2 Determinants of Undernutrition

This subsection outlines the empirical literature for the studies which were done to try to find the factors which affect malnutrition in children under the age of five in different parts of the world, particularly in developing countries. This literature varies again in terms of the data used and methodologies used.

Makoka (2013) studied the impact of maternal education on child nutrition in three different countries which are Malawi, Tanzania, and Zimbabwe. The author used Demographic Health Surveys data, 2010 for Malawi, 2009-10 for Tanzania, and 2005-06 for Zimbabwe. Logistic regression was employed to assess the determinants of the three measures of malnutrition (i.e., stunting, wasting, and underweight), placing focus on maternal education. He found out that in the three countries, the three measures of malnutrition significantly decrease with increased levels of maternal education. After controlling for other factors, maternal education reduces the odds of all three measures of child malnutrition in all the three countries (Makoka, 2013). The threshold level of maternal education above which it significantly improves child stunting and underweight were 9 years in Malawi and 11 years in Zimbabwe and Tanzania. The author advocated for more educational incentives for women, since the current free primary education being offered in the three countries may not be sufficient to address child malnutrition (Makoka, 2013).

Poda *et al* (2017) studied the factors associated with under five malnutrition in Burkina Faso using the 2010 DHS data of that country. Both multivariate and bivariate methods were used for analysis. Child sex, age, size at birth, child morbidity, mother's education and body mass index and household wealth index were significantly associated with undernutrition among children under 5 years in Burkina Faso (Poda, et al., 2017). In addition to the improvement of household wealth index, more health and nutritional education for mothers should be implemented by the government to improve health and nutritional status of children under 5 years in Burkina Faso (Poda, et al., 2017). This research concurred with the one done by Makoka (2013) on the issue of maternal education and malnutrition in children under the age of five, even though the studies were done in different countries and used different methodologies.

Furthermore, Sondai et al (2017) carried out a research on the same topic for in the community of Yemoh Town in the city of Bo, Southern Sierra Leone. The researchers collected primary data and used primary descriptive statistics to analyze the data. The population comprised all under-five children and their lactating mothers or caregivers, a sample of 100 under-five children and 100 lactating mothers selected from the Yemoh town community. The study revealed that 48 percent of the sampled under-five malnourished children and out of this percentage, 55 percent were females (Sondai, et al., 2017). The findings revealed that the demographic factor associated with under-five children in Yemoh town community in Bo city is age distribution of the mother at birth. The socioeconomic factors include of education of the mother, number of meals taken by the child per 24 hours, breastfeeding practices, household's employment status, alcohol intake by respondent mother/ caregiver, and parent's marital status. Also, the health-related factors are antenatal clinic consultation (ANC), immunization status, vitamin A supplementation, and institution where child was delivered. In the end they recommended that increasing household food security and reinforcing educational intervention could contribute to the reduction in the prevalence of malnutrition of under-five children in the communities.

In addition, a number of researches were also carried out using the logistic regression model in several parts of the world (Sazedur, et al., 2017; Gowranga, et al., 2018; Mishra, et al., 2014; Adhikari, et al., 2019; Talukder, 2017). In Bangladesh, the results from the research by Talukder (2017) strongly highlighted the necessity of increasing maternal education level, improving the maternal nutritional status, and increasing facilities providing antenatal care service to achieve better nutrition status among under-five children. The research from Nepal by Adhikari et al. (2019) reveals that household wealth status, age of child, size of child at time of birth, and child anemia comprised the common determinants of stunting in all three surveys in Nepal (Adhikari, et al., 2019). Study findings underscore the need for effective implementation of evidence-based nutrition interventions in health and non-health sectors to reduce the high rates of child stunting in Nepal. The same results were found in India by Mishra et al. (2014). For children suffering from acute malnutrition, maternal nutritional status was the most dominant factor followed by child's age, maternal education, wealth index, type of tribe and size of child at birth (Mishra, et al., 2014).

2.2.3 Literature Gap

There is diverse literature on how to improve the health of children, as discussed above. Most empirical research used only one health indicator, either under-five mortality or nutrition but not both, even when the data available could have allowed such analysis to be carried out given that almost all studies used the Demographic and Health Survey data. This research will take a step further and include nutrition as a health indicator in addition to under-five mortality. More so, this research will try and solve this problem specifically for Zimbabwe, given that they are very few researches which were done on this topic in this country. It is against the above-mentioned twin problems, the gap in the literature identified, and the mixed body of empirical results that this research is being carried out, with the view that in the end long-lasting solutions to these twin problems can be found not only for Zimbabwe but for the rest of the world too.

2.3 Conclusion

This chapter clearly explores both the theoretical and empirical literature that is related to the causes of child mortality and undernutrition. These laid the foundation to the theoretical framework of how different socioeconomic and demographic variables may influence both mortality and undernutrition. The next chapter will build on these theoretical and empirical literature reviews and build a conceptual framework to be estimated and the methods to be used.

Chapter Three

Research Methodology

3.0 Introduction

This study seeks to investigate the socioeconomic determinants of the health of children in Zimbabwe using household data from the 2015 Zimbabwe Demographic and Health Survey. Under-five mortality and undernutrition are used as health indicators of interest. This chapter outline the methods and procedures that were employed to answer the questions asked in Chapter One of this research. The chapter also outlines the data sources, variables used as well as the specification of the models estimated. The theoretical framework will be presented first, followed by empirical models. The chapter also defines and justifies variables used in the study.

3.1 Data Sources

The study used a highly reliable data set, the Zimbabwe Demographic and Health Survey (ZDHS) of 2015. The 2015 ZDHS presents the major findings of a nationally representative survey and for the research questions to be answered in this research, a total of 6 132 children who were born in the period between 2010 and 2015 were included. However, not all children who were included in this survey are used in the study since some of them do not have the complete set of variables relevant to this study. This ZDHS is the sixth comprehensive survey conducted in Zimbabwe as part of the Demographic and Health Surveys (DHS) program.

3.2 Theoretical Conceptual Framework

Using the theoretical literature and empirical literature reviews presented in the previous chapter, the study first develops the economic theoretical framework for the estimation of models to answer the research questions developed in Chapter One. The framework is based on the household production framework developed by Becker in 1965 and further developed by several authors (Barnett, 1977; Chernichovsky & Zangwill, 1988; Rosenzweig & Schultz, 1983). The study assumes a simple household which is made up of the parents (father and mother) and their children. Since the research questions to be answered pertain to children under the age of five years, the research exclusively assumes that the family has no kids older than five, or if they did, they do not care much about them as they do to those who are under five. This household is seeking to maximize household welfare function, **W**, which is made up of the utility functions of each household member. Equation 3:1 below will be the household welfare function.

$$\mathbf{W(U^{m}, U^{f}, U^{i}_{ch}),\ \forall_{i} = 1, \dots, n;} \qquad \textbf{3:1}$$

where $\mathbf{U^{m}}$ is the mother's utility function, $\mathbf{U^{f}}$ is the father's utility function and $\mathbf{U^{i}_{ch}}$ represent the ith child's utility function.

The parents in this household are assumed to derive utility from the consumption of the composite good, **X**, as well as the quality of children. Borrowing from (Becker, 1993), parents are assumed to be altruistic towards their children. Since we are analyzing the quality of children who are under five, we assume that the quality aspect of these kids which their parents are much worried about includes only health stock and nutrition stock.[6] Then the parents' utility functions will take the form:

$$\mathbf{U^{j}_{p} = U[X^{j}_{p}; U^{i}_{ch}(NS^{i}_{ch}, HS^{i}_{ch})]; j = m, f\ ; i = 1, \dots, n} \qquad \textbf{3:2(i)}$$

$$\mathbf{\partial U^{j}_{p} / \partial U^{i}_{ch} > 0} \qquad \textbf{3:2(ii)}$$

where $\mathbf{X^{j}_{p}}$ is the quantity of the composite good consumed by the jth parent, $\mathbf{NS^{i}_{ch}}$ and $\mathbf{HS^{i}_{ch}}$ are the nutrition stock and health stock of the ith child respectively.$\mathbf{U^{i}_{ch}(NS^{i}_{ch}, HS^{i}_{ch})}$ is the individual child's utility function and represents the overall child "quality" aspect which the parents "consume" to maximize their utility. The utility function of each child enters the utility function of the parent to signify the idea that the parents also derive their utility from the utility of their children. This will help explain the amounts spend on both health and nutrition provision products and services of the children.[7] The children however derive their utility from their health stock and nutrition stock, and these are the quality aspects which their parents care about. For the condition of altruism to be satisfied then the derivative of the parent's utility function with the respect to the child's utility function (that is the marginal utility with respect to child quality) should be positive and equation **3:2(ii)** should hold.

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6 We could have added education in that bracket but ignored it since it is not relevant to this research. More so, we are analyzing children who have not yet gone to school so adding education in the bracket of child quality is not relevant here.

7 Children are not employed and have no income, so these expenses are paid for by their parents' income.

Following (Smith & Haddad, 1999), nutrition stock is viewed as a household provisioning process with inputs of food, non-food commodities and services, and care. More so, borrowing from the UNICEF Framework and the Mosley-Chen Framework discussed in chapter two, the factors which affect health stock (and eventually mortality) and nutrition stock of the children are the same. Hence the nutrition stock provisioning and health stock provisioning functions for the i^{th} child are as follows:

$$\mathbf{NS^i_{ch}, HS^i_{ch} = f(F^i, C^i, NF^i;\ \omega^i, \xi_{HEnv}, \xi_{Food}, \xi_{NEnv}), i = 1, \dots, n} \qquad \mathbf{3:3}$$

where $\mathbf{C^i}$ is the care received by the i^{th} child, $\mathbf{F^i}$ represent the food consumed and $\mathbf{NF^i}$ represent the non-food commodities and services purchased for caregiving purposes such as medicine and other healthcare services. The variable ω^i saves as the physiological initial endowment of the child, that is, his or her inborn healthiness. This variable is assumed to be depreciating as predicted by Grossman (1972) and death of the child will occur once this variable depreciates below a certain threshold without any investment in it (Grossman, 1972; Grossman, 1999). The variable $\boldsymbol{\xi_{HEnv}}$ represent the household health environment, including availability of safe water, sanitation, and health services by the household. The variable $\boldsymbol{\xi_{Food}}$ represent the availability of food in the household. Finally, $\boldsymbol{\xi_{NEnv}}$ represents community's natural environment characteristics such as agricultural climatic conditions, for food production.

The child cannot grow well without the care of another individual. The child caregiver is assumed to be the mother, hence most of the parental features likely to affect child caregiving are going to be derived from the mother, that is, maternal characteristics. The mother's caregiving decision making process is assumed to be governed by the Equation 3.4 below:

$$\mathbf{C^i = C\left(T^i_{m,c}, MC_c;\ \zeta_C\right)\ i = 1, \dots, n} \qquad \mathbf{3:4}$$

In Equation 3:4, $\mathbf{T^i_{m,c}}$ represent the time allocated by the mother to the caregiving of the i^{th} child, $\mathbf{MC_c}$ represent maternal characteristics which affects her child caregiving practices and these include maternal education, maternal nutrition status, maternal employment, maternal age, maternal alcohol consumption etc. The variable $\boldsymbol{\zeta_C}$ represents household religious and cultural factors affecting caregiving practices

The optimization problem therefore becomes the maximization of **Equation 3:1** subject to **Equations 3:2-3:4** along with the household's income and time constraints. This leads to reduced form equations for the i^{th} child's nutritional stock and health stock at any point in their life, shown in Equation 3:5(i) and 3:5(ii) below.

$$\mathbf{NS_{ch}^{i^*}, HS_{ch}^{i^*} = f(\,\omega^i, MC_c, \xi_{HEnv}, \xi_{Food}, \xi_{NEnv}\,, \zeta_C, \delta);\ i = 1, \dots, n} \qquad \textbf{3:5(i)}$$

$$\mathbf{HS_{ch}^{i^*} \geq \phi_{ch}^{i}} \qquad \textbf{3:5(ii)}$$

Where $\boldsymbol{\delta}$ is the household's real income and $\boldsymbol{\phi_{ch}^{i}}$ is the minimum level of health stock that is necessary to keep the child alive. It is important to point out that this minimum level of health stock is not known by the researcher. However, the death of the child will signify that health stock has declined beyond this level. For the child to be alive, equation 3:5(ii) should hold, and if it does not hold then the child is dead. These equations represent household and individual behavior and have been used to guide in the selection of variables that are important determinants of child health. These include child's initial health endowment ($\boldsymbol{\omega^i}$), health environment ($\boldsymbol{\xi_{HEnv}}$), food availability ($\boldsymbol{\xi_{Food}}$), community's natural endowments ($\boldsymbol{\xi_{NEnv}}$), religious and cultural norms affecting caregiving ($\boldsymbol{\zeta_C}$), maternal characteristics, ($\mathbf{MC_c}$), (age, employment, marital status, nutrition status etc.) and household's real income,$\boldsymbol{\delta}$. Equations 3:5(i) and 3:5(ii) will be used to answer both research questions of this study.

3.3 Empirical Analysis

The subject of child health has been extensively studied in various parts of the world. While these studies have followed almost similar conceptual frameworks, they have employed different statistical models in trying to address the problem of child health. This section will discuss the empirical methods which the researcher is going to use.

3.3.1 Empirical model for the causes of under-five mortality

Under-five mortality was used here as a health indicator variable, borrowing from the Grossman model (1972) and the argument was that deterioration in health will ultimately lead to death (Grossman, 1972). Under-five mortality was viewed as an event failure, therefore a hazard. To this regard, survival analysis was used to answer this research question and the Cox Proportional Hazards Model was used.

The Cox Proportional Hazards Model or any survival analysis model is more useful than the logistic model under the following scenarios:

- The dependent variable or the response is the waiting time until the occurrence of the event, which in our case is the death of a child before they reach their fifth birthday.
- Observations are censored in the sense that for some units the event of interest has not happen yet when the data was collected and analyzed, i.e. the child is still alive when the data was collected.

- There are predictors or explanatory variable we wish to detect their effect on the waiting time.

The model analyses the time to event of a unit, while at the same time it explores the effects of different independent variables on the probability of survival. The dependent variable is a combination of a continuous variable (how long did the observation remained in the sample) and a categorical variable (whether the event occurred or not).

Cox Proportional Hazards Model Specification

A large family of models introduced by Cox (1972) focuses directly on the hazard function. The simplest member of the family is the proportional hazards model, where the hazard at time t for an individual with covariates X_i (not including a constant), $\boldsymbol{\lambda_i(t|X_i, \beta)}$, is assumed to be:

$$\boldsymbol{\lambda_i(t|X_i, \beta) = \lambda_0(t)\exp\,(X_i'\beta)} \qquad \textbf{3:6}$$

In the right hand side of the model, $\boldsymbol{\lambda_0(t)}$ is a baseline hazard function that describes the risk for individuals with $\boldsymbol{X_i = 0}$, who serve as a reference cell or pivot, and **exp** $(\boldsymbol{X_i'\beta})$ is the relative risk, a proportionate increase or reduction in the risk of dying, associated with the set of explanatory variables, $\boldsymbol{X_i}$, which were outlined in **Equation 3:5(i)**. This increase or reduction in risk is assumed to be the same at all durations, **t**, that is the proportional hazards assumption.

The regression coefficients$(\boldsymbol{\beta_i})$, for $\boldsymbol{i = 1, \ldots, k}$ gives the expected change in the hazard ratio or probability of survival in relation to changes in these explanatory variables. To estimate the coefficients $\boldsymbol{\beta_i}$ or effects of each factor in a multiple regression model, Cox (1972) proposed a partial likelihood function based on a conditional probability of failure. Using this model, probability of a child dying was viewed as an event failure, therefore a hazard.

3.3.2 Empirical model for the causes of undernutrition

We will develop an ordered logistic regression model to answer this question. This model is suitable for our research on this question because the dependent variable (i.e., nutrition stock) is a categorical variable and is ordered from one up to three. One represents severe undernutrition, two representing moderate undernutrition and three representing good or acceptable nutrition stock. This model is also known as the proportional odds model because the odds ratio of the event is independent of the category j. The odds ratio is assumed to be constant for all categories.

Our dependent variable is nutrition status, Y, then in an ordered logit model Y is the observed variable. Y is in turn a function of another variable,$\boldsymbol{Y^*}$, that is not measured which is called a latent variable. This latent variable is unmeasured and continuous, and its values determine what the values of the ordinal variable, Y^*, will be. The ordinal variable $\mathbf{Y}^*$ has three threshold points. In our case, Weight-for-Age Z (WAZ) score will be the continuous variable. From this score, a child will be considered to suffer from severe undernutrition if his or her WAZ score is below -301. The child is considered to suffer from moderate undernutrition if their WAZ score is between -300 and -201. The child will be considered to have good or acceptable nutrition stock if their WAZ score is greater than -201.

Model Specification

Given the above description, the ordered logistic regression model will be specified as:

$$\boldsymbol{y_i^* = x_i'\beta + \mu_i} \begin{cases} \boldsymbol{y_i^* = 1 \; if \; waz_i \leq -301 \Rightarrow \; severe \; undernutrition}; \\ \boldsymbol{y_i^* = 2 \; if \; -300 \leq waz_i \leq -201 \Rightarrow moderate \; undernutrition}; \\ \boldsymbol{y_i^* = 3 \; if \; waz_i \geq \; -200 \Rightarrow no \; undernutrition} \end{cases} \quad \mathbf{3{:}7}$$

Where y_i^* is the nutrition status of child *i*, x_i' is the vector of socio-economic factors likely to affect the nutritional status of child *i* as defined by equation **3:5(i)**. β is the vector of coefficients to be estimated. μ_i is the error term, assumed to be normally distributed. From the equation above, the probability that the child's nutritional status is likely to be any of the above categories will be given by the equation below:

$$\text{Logit}(\textstyle\sum_{i=1}^{3} p_i) \equiv \log \frac{\sum_{i=1}^{3} p_i}{1\text{-}\sum_{i=1}^{3} p_i} = \alpha_i + x_i'\beta \quad \mathbf{3.8}$$

Where $\sum_{i=1}^{3} p_i = 1$, with p_i being the probability that the child's nutritional status will be in category *i*. For example, p_1 will be the probability that the nutritional status of the child will be categorized as severe undernutrition. α_i will be the predicted cut-off points of the nutritional status categories.

3.4 Models Diagnostic Tests

Model diagnostic tests which were carried out in this research are grouped into two. These two categories are the pre-estimation tests and the post-estimation tests. There was only one pre-estimation test carried out, which is the multicollinearity test. On the other hand, post-estimation tests include model specification test, model goodness of fit test, parallel regression assumption test (for the ordered logistic regression model) and the proportional hazards assumption test (for the Cox Proportional Hazards model).

3.4.1 Pre-estimation Tests

As highlighted above, there was only one pre-estimation test carried out which is the multicollinearity test. Multicollinearity is a situation where there exists a perfect or exact linear relationship between independent variables in a regression model. The correlation matrix was utilized to check for multicollinearity. The rule of thumb says if the absolute correlation coefficient between any two explanatory variables is 0.8 or above, the variables will be correlated. Multicollinearity poses problems in regression models such that the confidence intervals will be much wider. This may lead to the quick acceptance of the null hypothesis. In addition, multicollinearity affects the t-values associated with the coefficients to be statistically insignificant. Multicollinearity can be solved by dropping one of the highly correlated variables from the model.

3.4.2 Post-estimation Tests

Three post-estimation tests were carried out, and these include model specification test, parallel regression assumption test (for the ordered logistic regression model) and the proportional hazards assumption test (for the Cox Proportional Hazards Model).

a. Models Specification Test

A Link test was carried out to see if the models estimated were correctly specified. If our model really is specified correctly, then according to this test, if we were to regress the dependent variable on the prediction and the prediction squared, the prediction squared would have no explanatory power, that is, it should have a p-value greater than the acceptable levels of significances (0.1, 0.05 and 0.01).

b. Parallel Regression Assumption Test

Ordered Logistic model is also known as the proportional odds model. This is because the odds ratios of all the categories involved are assumed to be proportional. This assumption is also known as the parallel regression assumption. In this study, the Brant test will be used to test whether this assumption hold or not. Under this test, a significant test statistic provides evidence that the parallel regression assumption was violated.

c. Proportional Hazards Assumption Test

When estimating the Cox Proportional Hazard model, the critical assumption which is made is that the hazard ratio remains constant over time. Although the risk of the event happening may vary over time, the variations over time must be the same for all covariates. In this study, this test will be carried out using the *estat phtest* command in Stata.

3.5 Variable Selection, Justification and Measurement

3.5.1 Dependent Variables

Nutrition Stock or Nutrition Status (NS)

This is the dependent variable for the ordered logit model which seek to answer the question of factors affecting undernutrition. In this study stunting is used to measure nutrition stock since children who are stunted are also likely to suffer from weighting and wasting. More so, stunting is the biggest problem in the country compared to the other two problems. It will be categorical and ordered from 1 to 3, i.e. severe undernutrition (=1), moderate undernutrition (=2) and good nutrition status (=3). Several researchers have used this method of measuring nutrition stock (Gowranga, et al., 2018; Talukder, 2017; Rajaretnam & Hallad, 2000; Rayhan & Khan, 2006; Das, et al., 2008). It is also in line with WHO standards (Development Initiatives, 2018).

Child Hazard Rate

For answering the question of factors affecting under five mortality (that is the second research question), survival analysis is going to be used following a couple of other researchers who have used it (Bicego, 1990; Dejene & Girma, 2013; Kembo & Van Ginneken, 2009; Zerai, 1997). The dependent variable in this case will be a hazard rate, which refers to the chances of making a transition from the current state at each instant conditioned on survival up to that point (Lartey, et al., 2016). It will be a combination of a time variable (which will be the age of the child in months at the time of the survey) and a binary outcome variable indicating whether a child is dead (=1) or is still alive (=0).

3.5.2 Explanatory Variables

Wealth Index

The household wealth index is a socioeconomic index constructed as an indicator of the level of wealth that is consistent with expenditure and income measures. In the DHS the index is based on data from household ownership of assets and consumer goods such as source of drinking water, type of toilet facilities, type of fuel, ownership of various durable goods, and other characteristics relating to socioeconomic status of the household. Each household was then assigned a score for each asset and the scores were summed for each household (Zimbabwe National Statistics Agency & ICF International, 2016). For this analysis, the researcher grouped the wealth index into three categories by the researcher i.e. poor (=1), middle (=2), and rich (=3). As predicted by the theories outlined in chapter two, we expect richer households to record fewer child health problems compared to the poor ones.

Maternal Education

This refers to the highest level of education attained by the maternal mother of the child under study. From the dataset for ZDHS this variable was already categorized into four categories namely no education, primary education, secondary education, and tertiary education. For this study however, the variable was recoded to a dummy with 1 representing lower levels of education attainment (no education, primary education and secondary) whilst 0 represents higher level of education (tertiary).This study hypothesized that the higher a mother goes in terms of education, the more likely they can have more resources, both in terms of financial and knowledge for caregiving purposes (Food and Nutrition Council, 2018; UNICEF, 2019). Hence less child health problems are expected for children born to mothers with tertiary level education

Maternal Nutritional Status

Good health of the child starts even before birth. Poor maternal nutrition affects the child while in the womb and during childbirth (UNICEF, 2019). Hence the importance of maternal nutrition status in this research as an explanatory variable. Body Mass Index (BMI) was used to measure this variable. Maternal BMI was computed as weight in kilograms divided by the square of height in meters. BMI cut-offs were based on the recommended international cut-offs, i.e. underweight was defined as BMI<18.5 kg/m^2, normal body weight was defined as BMI 18.5– 24.9 kg/ m^2, overweight and obesity was defined as BMI > 25.0kg/m^2. A dummy variable was then coded, with 1 representing underweight and 0 representing normal and overweight. We expect mothers with a normal and or overweight body weight to report fewer cases of child health problems compared to mothers who are underweight.

Maternal Age

Biologically, there are certain years in the woman's age where there is an increased probability that a woman will get pregnant. Maternal fertility increases from the period of first menstrual period and reaches a peak in the mid to early 30s. Thereafter, from the mid-30s, it starts depreciating and it is during this period that can lead to child health complications during pregnancy. These complications may negatively affect the health of the child, during pregnancy leading to the child experiencing difficult first five years of their life (World Bank, 2006). The variable was coded as a dummy, with 1 representing maternal age of above 35 years and 0 representing otherwise.

Maternal Employment Status

This refers to whether the mother of the child is employed (=1) or not (=0). Maternal employment can lead to increased financial resources to the family, leading to increased child quality product and services spending. This is likely to reduce the risk of death to the child as well as reducing malnutrition problems. However, on the other hand this leaves less time for childcare purposes, thereby compromising the health of the child (Becker, 1993). As a result, it is unclear what effect this variable can have on child health. It will depend on which effect is more powerful than the other. If the financial resources effect is stronger, then we should observe less health problems for children born to employed mothers. However, if the childcare time effect is stronger, then we should observe more health problems to children born to employed mothers.

Maternal Alcohol Consumption

This variable was coded as a dummy, with 1 representing that the mother consume alcohol and 0 representing otherwise. Alcohol consumption by the mother may be harmful to a child during pregnancy. This may lead to complications to the child (Development Initiatives, 2018; Mosley & Chen, 1984). These complications may increase the risk of child dying before they reach their fifth birthday. They may also negatively affect the child's digestive system, leading to poor nutrients absorption by the child's body. This will negatively affect the child's nutrition status. Hence, we expect children born to mothers who drink alcohol to have more health problems compared to children born to mothers who do not drink alcohol.

Premature Birth

This is another variable which was included to capture the initial health endowment which the child was born with. According to the World Health Organization (WHO), a child is prematurely born if their birth weight is below 2500 grams (Zimbabwe National Statistics Agency & ICF International, 2016). Hence the variable was coded as a dummy, with 1 representing that a child was delivered prematurely (that is birth weight below 2500 grams) and 0 representing otherwise. The priori expectation is that a child who was born prematurely will have tough first years of their life, leading to increased health problems.

Single Births

Refers to whether the child was delivered in singleton (=1) or otherwise (=0). This speaks to competition on initial health endowments among children during pregnancy. We expect children who are born in singleton to have no competition on resources during pregnancy, hence less child health problems. On the other hand, we expect a child who was delivered as part of multiple births at once to have more resources competition during pregnancy, leading to problems such as low birth weight. These in turn may increase health problems and may cause death (Becker & Tomes, 1976; Becker & Lewis, 1973).

Child's Sex

Sex refers to the gender of the child under study and it is a dummy variable categorized as male (=1) or female (=0). This variable speaks to the genetic variability between the girl child and the boy child. With the survey data reporting more male children deaths compared to female ones, a priori expectations were that male children were expected to show more health problems compared to female children.

Cooking Fuel

This refers to the type of cooking fuel used which is either solid fuel (=0) or clean fuel (=1). This speaks to how the food is prepared, leading to the quality of nutrients which are eventually taken in (United Nations Children's Fund., 2015). This also speaks to financial resources availability to each household, given that in Zimbabwe clean energy is expensive compared to solid energy. People almost always do not need to pay to get solid fuel, especially firewood which is the dominant solid fuel in the country. It is unclear whether solid fuels prepare food better compared to clean fuels or vice versa. What is clear is that households which uses clean energy for food preparation are likely to have more financial resources compared to those using solid fuel. Hence, we may observe households using clean energy to report less child health problems compared to those using solid fuel.

Residence

This refers to the place in which the child resides. It is categorized as urban (=1) or rural (=0). The fundamental differences in the socio-economic set up between rural and urban makes this variable important in determining the health of children in these areas. Poverty levels are relatively high in rural compared to urban, and as such a priori expectation is that there are high cases of both undernutrition and mortality in rural areas, where residents are disadvantaged in terms of their socioeconomic standing as well as their accessibility to health services.

Source of Drinking Water

Refers to the source of drinking water used by the household. It was put in two categories in accordance with the guidance of the DHS Program. These categories are improved water source (=1) and unimproved water source (=0). According to the DHS Program Statistics guidance manual improved water source include piped, borehole, protected well, protected spring, rainwater, and bottled water. On the other hand unimproved water facilities include unprotected well, unprotected spring, surface water, small cart, tanker truck and other (Croft, et al., 2018). Priori expectations are that children whose households use unimproved water would experience more death and malnutrition problems compared to those that used improved source of water.

Preceding Birth Interval

This refers to the space between one child and the previous one. The standard WHO recommendation for this space is 33 months, which include 24 months since the last child was born plus a mature pregnancy (9 months) (Development Initiatives, 2018; UNICEF, 2019). The variable was coded as a dummy, with short birth interval (=1) and long birth interval (=0). A priori expectation of the study is that infants that are given care for a shorter period by their mothers before another sibling is born would have less chances of surviving compared to those who are sparsely distributed. Thus, birth interval was expected to be negatively related to both child mortality and malnutrition.

Religious Background

This refers to the type of religious doctrine which the household members of the family to which the child was born. This speaks to the beliefs and norms which the parents have about raising children. For this research, this variable was a dummy, with 1 representing those mothers who follow the apostolic sect doctrine and 0 representing otherwise.

Toilet Facility

The physical environment in which mothers live and their children grow up in is important in determining their health. In that case sanitation too, and the type of toilet facility used is an important part of sanitation and hygiene. Toilet facility was measured as either an improved source (=1) or an unimproved source (=0), based on the DHS classification method. We expect families using improved source to report good health for their children compared to those with an unimproved source.

Healthcare Services Accessibility

This variable will be there to measure the accessibility of healthcare services to the child. Health insurance was used as a proxy for this variable. The variable is a dummy, with 1 representing those mothers who indicated that the child is covered by some form of healthcare insurance and 0 representing those who are not. We expect households with healthcare insurance to have fewer health problems for their children compared to those who are not (Adhikari, et al., 2019).

Antenatal Visits

This is a continuous variable representing the number of antenatal clinic visits which the mother has made during pregnancy. This speaks to the healthcare services seeking behavior of the mother during pregnancy, which may be an important factor determining child health after delivery (Zimbabwe National Statistics Agency & ICF International, 2016). We expect mothers who have made more of these trips to record fewer child health challenges compared to those who have made fewer antenatal clinic visits.

3.6 Conclusion

This chapter outlined the methodology that will be used to answer the research questions designed in chapter one and the data to be used. This chapter also briefly evaluate the model specifications together with the tests to be carried out. Furthermore, definition and justification of variables was conducted.

Chapter Four

Estimation, Presentation, and Interpretation of Results

4.0 Introduction

This chapter gives a detailed analysis of the findings of the study. Using model specifications and methods elaborated in the previous chapter, the chapter estimates factors that influence under-five mortality as well as undernutrition in Zimbabwe. Descriptive analysis of the dependent and explanatory variables is done first. Thereafter, econometric analysis is carried out using the Cox proportional hazards model for estimating mortality risk factors in under-five children in Zimbabwe. For the causes of undernutrition in under-five children, an ordered logistic regression is used. It is worth pointing out that the DHS Program employs a two-stage cluster sampling method. This is considered in the analysis since not doing so will lead to biased results because of standard errors being inflated. This is a big problem, particularly for regression analysis, where standard errors and p-values will be reported.

4.1 Descriptive Statistics Analysis

The nature of the research questions which this research is trying to answer is such that it will require different types of data for the dependent variables in each model. We first discuss the descriptive statistics of the dependent variables, followed by the continuous explanatory variables and then categorical explanatory variables.

In the 2015 ZDHS, a total of 6, 132 children were included as the sample. However, not all variables which are relevant to this study were recorded for every child. For example, the anthropometric measurements for the child nutrition stock for the deceased children were not recorded since it is impossible to record those statistics if the child is not available. More so, some information on certain variables were not recorded simply because either the child or the mother refused to give such information even though the child was included in the sample. As a result, the sample size was trimmed down to 2,812 for the nutrition problem model and 3,608 for the child survival model.

Descriptive Statistics for the Dependent Variables

The dependent variable in the model to assess the causes of undernutrition is an ordinal variable with three categories. In this research, the study used stunting only to measure nutrition stock (or nutrition status) since children who are stunted are also likely to suffer wasting and underweight problems (Development Initiatives, 2018). More so, stunting is the biggest problem in the country compared to other ways of measuring malnutrition. The results from the 2015 ZDHS are shown in Table 4.1 below.

Table 4.1 Nutrition Status (Stock) of children under five, stratified by residence

Nutrition Status (Stock)	Rural (%)	Urban (%)	National (%)	National (Frequency)
Severe Undernutrition	09	07	08	225
Moderate Undernutrition	19	15	18	506
Good Nutrition	72	78	74	2,081
Total	**100**	**100**	**100**	**2,812**

Source: Author's Calculations from the 2015 ZDHS Data

From the table above, at the national level, 8% of children whose mothers were interviewed are seen to be suffering from severe undernutrition. This translates to a total of 417 children. More so, 18% of the children whose mothers were interviewed have been categorized as suffering from moderate undernutrition. However, 74% of the children whose mother was interviewed have been categorized as having good nutrition stock. When stratified by residence, the table shows 9% of rural children suffer from severe undernutrition whilst the figure is 7% for urban children. The same stratification also shows that 19% of rural children suffer from moderate undernutrition compared to 15% in urban areas. More so, 78% of urban children had good nutrition stock compared to 72% in rural areas.

Descriptive statistics for survival Data

Children were tracked for a period of 60 months from their birthday, with the minimum entry being zero months and the maximum being 59 months. This means that there was no delayed entry in the survival data used for analysis. The minimum final entry was one month, the mean being 29.23 months. The total time at risk was 92,756 months. If we divide the number of failures (deaths) that by the total time at risk, we get the incidence rate, which is 0.1%. This summary is provided by Table 4.2 overleaf.

Table 4.2 Descriptive Statistics for Child Survival Data

Category	Total	Statistics per Child			
		Mean	Min	Median	Max
No of subjects and records	3,608	1	1	1	1
Entry time (final)		29.23	1	29	59
Time at risk	92,756	29.23	1	1	1
Failures (Deaths)	**47**	**0.03**	**0**	**1**	**1**

Source: Author's Calculations using the 2015 ZDHS Data

Descriptive Statistics for Explanatory Variables

Explanatory variables used in this research are grouped into continuous and categorical variables. There was only one continuous variable used in this study, which is antenatal care clinic visits during pregnancy by the mother. The table below shows the descriptive statistics for the single continuous variable used.

Table 4.3 Antenatal Care Visits, stratified by residence

Variable	Rural		Urban		National	
	Mean	SE	Mean	SE	Mean	SE
ANC visits	4.91	0.08	5.52	0.11	5.11	0.06

Source: Author's Calculations using the 2015 ZDHS Data

The national average antenatal care visits during maternal pregnancy were 5.11, which is approximately 5 visits. Stratifying this variable by the type of residence (rural or urban), the table above shows that in rural areas on average mothers have visited a health facility for around 5 times. However, mothers who reside in urban areas had approximately 6 antenatal care visits, which exhibits an additional 1 visit compared to their rural counterparts. The variability in these statistics is higher in urban areas as indicated by the standard error of 0.11 compared to 0.08 in the rural areas.

Categorical Variables

In addition to the continuous variable used above, the research also used categorical variables. These include maternal education, maternal age, maternal BMI, maternal alcohol consumption, child's sex, whether the child was delivered or not, whether the child was delivered prematurely or not, the birth interval between the child and the previous one, type of cooking fuel, type of toilet facility, health insurance, drinking water, and the religious doctrine followed by the household. Table 4.4 overleaf shows descriptive statistics for these categorical variables.

Table 4.4 Categorical Variables, stratified by residence.

Categorical Variable	Category	Rural (%)	Urban (%)	National (%)	National (Frequency)
Religion:	Apostolic	64	32	54	2,086
	Other	36	68	46	1,777
Drinking Water:	Safe	11	18	14	541
	Unsafe	89	82	86	3,322
H/care Insurance:	Yes	02	21	08	309
	No	98	79	92	3,554
Toilet Facility:	Improved	44	95	60	2,318
	Unimproved	56	05	40	1,545
Cooking Fuel:	Clean	05	68	25	966
	Unclean	95	32	75	2,897
Premature Birth:	Yes	09	10	09	348
	No	91	90	91	3,515
Birth Interval:	Long	69	74	70	2,704
	Shorter	31	26	30	1,159
Single Birth:	Yes	97	95	96	3,708
	No	03	05	04	155
Child's Sex:	Male	50	48	49	1,893
	Female	50	52	51	1,970
Mat. Employment:	Yes	36	55	42	1,622
	No	64	45	58	2,241
Mat. A/Consumption:	Yes	06	16	09	348
	No	94	84	91	3,515
Maternal Age:	35+ years	07	05	07	270
	35- years	93	95	93	3,593
Maternal BMI:	Undernourished	05	02	04	155
	Normal & Over	95	98	96	3,708
Maternal Education:	Tertiary	02	13	05	193
	Sec or less	98	87	95	3,670

Source: Author's Calculations using the 2015 ZDHS Data

One of the categorical variables included in the study is the religious doctrine followed by household members. The table shows that at the national level, 54% of households follow the apostolic sect religious doctrine whilst the remainder follows other doctrines. When stratified by residence, the table also shows that 64% of the rural households follow the apostolic sect doctrine compared to just 32% in the urban areas. At the national level, only 14% of the households have access to safe drinking water whilst 86% do not. When stratified by residence, the table below shows that 11% of rural residents have access to safe drinking water compared to 18% of urban residence.

The table also shows that at the national level, only 8% of the households have health insurance whilst 92% do not have. When stratified by residence, a mere 2% of households in rural areas have health insurance whilst the figure is 21% for urban households. From the table above, at the national level, 5% of the interviewed mothers have indicated that they have achieved a tertiary level of education. Stratifying this variable by rural or urban residence, the table above shows that only 2% of the interviewed mothers who reside in rural areas have achieved a tertiary level of education. This is less than the same figure for mothers who reside in urban areas, which indicate that 13% of them have achieved a tertiary level of education.

Table 4.4 also shows that 5% of the interviewed mothers who reside in the rural areas suffer from undernutrition compared to only 2% of the mothers who reside in the urban areas. The national statistic for this variable is 4%. In rural areas, 7% of the mothers have delivered their child whilst they were at least 35 years old. However, in the urban areas, only 5% of the mothers who were interviewed have delivered the child whilst they were at least 35 years. On the other hand, 95% of the interviewed mothers who reside in the urban areas delivered their baby (or babies) whilst they were younger than 35 years. At national level, 9% of the interviewed mothers have indicated that they consume alcohol whilst 91% have indicated that they do not. Stratifying this variable by residence, the table above shows that 16% of the interviewed mothers who reside in the urban areas consume alcohol whilst the remainder (84%) do not.

More so, maternal employment was is another explanatory variable used in the study. At national level, 42% of the interviewed mothers indicated that they were employed whilst 58% indicated that they were not. Stratified by residence, 36% of the interviewed mothers living in rural areas indicated that they were employed, compared to 55% of mothers living in urban areas. However, 64% of the interviewed mothers living in rural areas are unemployed whilst the figure is 45% of the interviewed mothers living in urban arears.

At a national level, for the period between 2010 and 2015, 49% of the children who were delivered between this period were males whilst 51% were females. However, in the rural areas, the figure was equal at 50% males and females. The figure for the urban areas was slightly different with 48% deliveries being males and 52% being females. Of the total child deliveries made during the period under study, 96% were single birth deliveries whilst only 4% were multiple deliveries. However, when stratified by rural or urban residence, the table below shows that 97% of deliveries in the rural areas were single deliveries whilst only 3% were multiple deliveries.

Table 4.4 also shows that at the national level, 70% of the babies were delivered with a long (recommended) preceding birth interval whilst 30% were delivered with a shorter than recommended preceding birth interval. Stratified by residence, the table above shows that 69% of the deliveries made in rural areas were made with the recommended preceding birth interval, whilst the figure was 74% for urban deliveries. Also, at the national level, 9% of the children born during the period between 2010 and 2015 were born prematurely whilst the remaining 91% were born maturely. This national figure is the same as that of the children born in rural areas. However, the figures slightly differ for urban areas, where 10% of the children living in urban areas were born prematurely.

At the national level, 25% of the interviewed mothers indicated that they use clean energy for food preparation purposes whilst the remaining 75% indicated that they use solid fuels for food preparation purposes. Stratified by residence, the table also showed that only 5% of the mothers in rural areas use clean energy for cooking purposes compared to 68% in the urban areas. The table above also shows that only 32% of the mothers in urban areas use solid fuels for cooking, compared to 95% of the households in rural areas. More so, the table also shows that at the national level 60% of households use an improved toilet facility whilst 40% use an unimproved toilet facility. However, when stratified by residence, the table also shows that only 44% of households in the rural areas have access to an improved toilet facility, whilst the figure is 95% for the urban dwellers. The table also shows that 56% of the households in rural areas use an unimproved toilet facility whilst the figure is 5% in urban areas.

4.2 Pre-estimation Tests

A multicollinearity test was carried out before estimating the models. The results showed that there was no problem since all the absolute pairwise correlations were below 0.8. The results are shown in Appendix A.

4.3 Regression Analysis Models

In all the models, backward stepwise regression was carried out first to determine the variables to include in the final model. This is because including so many variables will lead to loss of many degrees of freedom, compromising the quality of results. The decision was made to include only variables with a p-value of 0.25 or less. This was done without factoring in the survey characteristics. However, the final models were estimated factoring survey design technique used, that is the two-stage cluster sampling method.

4.3.1 Factors causing undernutrition in under-five children in Zimbabwe

An ordered logistic regression was carried out to determine the factors causing undernutrition in children under five years in Zimbabwe. The dependent variable was weight-for-age z-scores, grouped into three groups. These groups are severe undernutrition, moderate undernutrition, and good or acceptable nutrition stock.

Table 4.5 Causes of under-five undernutrition in Zimbabwe

Dependent Variable	Coefficient	Standard Error	P > |t|	[95% Conf. Interval]	
Birth Interval	-0.23^{**}	0.12	0.05	-0.47	0.01
Child's Sex	-0.40^{***}	0.10	0.00	-0.60	-0.19
Cooking Power	0.79^{***}	0.19	0.00	0.43	1.16
Maternal Age	-0.14	0.18	0.45	-0.49	0.22
Maternal BMI	-0.35	0.26	0.17	-0.86	0.15
Maternal Education	-1.12^{***}	0.33	0.00	-1.77	-0.46
Premature Birth	-0.66^{***}	0.16	0.00	-0.97	-0.34
Religion	-0.18	0.12	0.12	-0.41	0.05
Residence	-0.53^{***}	0.17	0.00	-0.86	-0.20
Safe Drinking Water	0.31^{**}	0.15	0.05	0.01	0.61
Single Birth	0.49^{*}	0.29	0.09	-0.08	1.07
Toilet Facility	0.26^{*}	0.13	0.06	-0.01	0.52

Significance Level: * P<0.1; ** P<0.05; *** P<0.01. Number of observations: 2,812. Population Size: 2,910. Number of strata: 19. Number of PSUs: 397. F (12, 367) = 7.68. Prob > F = 0.00

Source: Author's calculations using the 2015 ZDHS Data

Coefficients estimated from an ordered logistic model only give the direction of change given that they are statistically significant, i.e. if the sign is negative then a positive change in the explanatory variable will be associated with a reduction of the probability of being in the higher category (in this case good nutrition stock). For example, from Table 4.5 above, we can only conclude that shorter birth interval, being male, maternal education of less than tertiary level, premature birth, and urban residence all reduce the probability that the child will have good nutrition stock since these variables are carrying negative signs. To see the absolute change in probabilities of being in respective categories, marginal effects have been calculated and are going to be used in interpretation instead of the coefficients. But model diagnostic tests must be carried out first.

Model Diagnostic Tests

The diagnostic tests carried out for the model estimated above include goodness of fit test, model specification test, and the parallel regression assumption test.

a. **Goodness of fit test**

The classical way of measuring the goodness of fit of any model, that is the adjusted R squared, does not work for the ordered logistic model estimated above. The best way to estimate how good is our model as far as the predictive power is concerned is using the estimated probabilities and compare those with the frequencies or proportions of being in the respective categories using the raw data. Hence, after the model was estimated, the *mfx predict outcome* command in Stata was used to estimate the probabilities of being in any of the three categories and they were compared with the proportions from the raw data.

Table 4.6 Ordered Logistic Model Goodness of Fit

Nutrition Status (Stock)	Raw data Proportion	Predicted Probabilities	Estimated Proportion
Severe Undernutrition	8	6	7
Moderate Undernutrition	18	17	17
Good/Acceptable Nutrition	74	77	76

Source: Author's Calculations using the 2015 ZDHS

From the table above we can conclude that our model performs well as far as predicting power is concerned, since there are little differences between the predicted probabilities, estimated mean, and the frequencies from the original data set. For example, the raw data proportion of children considered suffering from severe undernutrition in 8%, whilst the fitted model estimated that 7% of the children suffers from severe undernutrition. Marginal effects predict this figure to be 6%. For the children suffering from moderate undernutrition, raw data showed that 18% suffering from moderate undernutrition whilst the model estimated that 17% of the children suffering from moderate undernutrition. Marginal effects predicted this figure to be 17% as well. The model also predicted that 76% of the children have good nutrition stock whilst the actual proportion from raw data was 74%. Hence, we may conclude that our model fit well, since there are little differences between the actual proportion from raw data and the proportions predicted by the model.

b. Model Specification Test

A link test was carried out to see if the fitted model was correctly specified. The results are presented in Table 4.7 below. According to this test, a model is correctly specified if the squared estimate (the variable _hatsq in the table below) is insignificant, that is if its p-value is greater than the required level of significance.

Table 4.7 Ordered Logistic Model Specification Test-Link Test.

Nutrition Status	Coefficient	Standard Error	P > |t|
_hat	0.94	0.21	0.00
_hatsq	-0.04	0.11	0.73

Source: Author Calculations using the 2015 ZDHS Data

From the table above, the coefficient of the squared estimate (_hatsq) has a p-value of 0.73. This is greater than the acceptable level of significances (0.10, 0.05, and 0.01). Hence, we may conclude that _hatsq is insignificant, and the model was correctly specified.

c. Parallel Regression Assumption Test

Ordered Logistic model is also known as the proportional odds model. This is because the odds ratios of all the categories involved are assumed to be proportional. This assumption is also known as the parallel regression assumption. With the model fitted using survey data, Stata does not allow this test to be carried out. Trying to run the command for this test (*brant* command) in Stata gives back an error saying the command is not supported for survey set data. However, the model was estimated without the *svy* command and the results showed that the assumption was not violated. The results are shown in Appendix H.

Marginal Effects

Marginal effects results are presented in Table 4.8 overleaf. For a continuous explanatory variable, marginal effects measure the change in the probability of being in respective categories as the explanatory variable changes. For a categorical explanatory variable, marginal effects compare the probability of being in respective categories of the dependent variable between the categories of the explanatory variable.

Table 4.8 Ordered Logistic Regression Model Marginal Effects.

Dependent Variable	Severe Undernutrition	Moderate Undernutrition	Good/Acceptable Nutrition	P > |t|
Birth Interval	0.01	0.03	-0.04	0.07
Child's Sex	0.02	0.05	-0.07	0.00
Cooking Power	-0.04	-0.09	0.12	0.00
Drinking Water	-0.01	-0.04	0.05	0.03
Maternal Age	0.01	0.02	-0.02	0.47
Maternal BMI	0.02	0.05	-0.07	0.23
Maternal Education	0.04	0.10	-0.15	0.00
Premature Birth	0.05	0.09	-0.13	0.00
Religion	0.01	0.02	-0.03	0.12
Residence	0.03	0.07	-0.10	0.00
Single Birth	-0.03	-0.06	0.10	0.16
Toilet Facility	-0.02	-0.03	0.05	0.06

Source: Author's Calculations using the 2015 ZDHS Data

Interpretation of Marginal Effects

The space between the children (preceding birth interval) was found to be a factor influencing the nutritional stock of the child. Children who were born with a short birth interval (less than 33 months), were found to be 1% more likely to suffer from severe undernutrition compared to children who were born with the recommended birth interval (33 months or more). They were also found to be 3% more likely to suffer from moderate undernutrition. However, children with a short birth interval were also found to be 4% less likely to be in good or acceptable nutrition status category. In short, a long birth interval improves the nutrition stock of the child whilst a short birth interval worsens it. This is true at a 1% level of significance.

The gender of the child was also found to be a significant determinant of the child's nutritional status. Compared to female kids, boys under the age of five are 2% more likely to suffer from severe undernutrition. Boys are also 5% more likely to suffer from moderate undernutrition. However, in comparison with girls of the same age, boys under the age of five years are 7% less likely to have a good nutrition stock. In short, the evidence from the 2015 ZDHS showed that boys under the age of five are more likely to suffer undernutrition problems compared to girls of the same age. This is true at a 1% level of significance. Poda *et al* (2017) also find similar results, for the study carried out in Burkina Faso.

The type of fuel used for cooking food was also found to influence the nutritional status of the kids. Compared to children whose food is prepared using solid fuel, children whose food is prepared using clean fuel are 4% less likely to suffer from severe undernutrition. They are also 9% less likely to suffer from moderate undernutrition. However, they are 12% more likely to have good nutritional stock. In short, clean fuels prepare food better compared to solid fuels. This is true at a 1% level of significance.

Safe drinking water was also found to reduce undernutrition problems. Compared to children born to a household without access to safe drinking water, children born to a household with access to safe drinking water were found to be 2% less likely to suffer from severe undernutrition. They were also found to be 4% less likely to suffer from moderate undernutrition. However, being born to a household with access to safe drinking water will increase the probability of the child having good or acceptable nutrition stock by 5%. In short, safe drinking water reduce undernutrition problems to children under the age of five in Zimbabwe. This was found to be true at a 5% level of significance.

Maternal education was found to be one of the factors determining the nutrition stock of the children under five years old in Zimbabwe. Being born to a mother who achieved only a secondary level or less will increase the probability that the child will suffer from severe undernutrition by 4%. This will also increase the probability that the child will suffer from moderate undernutrition by 10%. However, this will reduce the probability that the child will have a good nutrition stock by 15%. In short, the research found that as the mother achieved tertiary education, the problems of undernutrition will be reduced, and the child born to this mother will be likely to have a good nutrition stock. In his study in three countries (Zimbabwe, Malawi, and Tanzania), Makoka (2013) also find similar results.

More so, consistent with the results found by Das *et al* (2008), children who were delivered prematurely were also found to have more undernutrition problems compared to children born maturely. Compared to children who were born maturely, premature births were found to be 5% more likely to suffer from severe undernutrition. They were also found to be 9% more likely to suffer from moderate undernutrition. However, compared to children who were born maturely, children who were born prematurely were 13% less likely to have acceptable or good nutrition stock. This assertion is true at a 1% level of significance.

Improvement in the household toilet facility was also found to reduce undernutrition problems in children under the age of five in Zimbabwe. Compared to children who live in a household which uses unimproved toilet facility, children born to a household which uses improved toilet facility were found to be 2% less likely to suffer from severe undernutrition. They were also found to be 3% less likely to suffer from moderate undernutrition. On the other hand, given that a child is born to a family that uses an improved toilet facility, that child is 5% more likely to have good or acceptable nutrition stock. This was found to be true at a 10% level of significance. The same results were found by Talukder (2017) in Bangladesh.

In contradiction with the research priori expectations, children living in urban areas were found to be 3% more likely to suffer from severe undernutrition. They were also found to be 7% more likely to suffer from moderate undernutrition. However, children living in urban are 10% less likely to be in good nutrition stock compared to children living in rural areas. These statements are true at a 1% level of significance.

4.3.2 Factors affecting under-five mortality in Zimbabwe

A backward stepwise regression was carried out first (with only variables with a p-value less than 0.25 retained in the final model). Table 4.9 below shows the results of the Cox Proportional Hazard Model.

Table 4.9 Cox Proportional Hazards Model for Under-Five mortality

Variable	Haz Ratio	Standard Error	P >|t|	[95% Conf. Interval]	
Alcohol Consumption	2.10**	0.81	0.05	0.99	4.47
Antenatal Visits	1.08	0.07	0.20	0.96	1.22
Healthcare Accessibility	0.17**	0.13	0.02	0.04	0.78
Improved Toilet Facility	0.47**	0.16	0.03	0.24	0.93
Maternal Age	2.75***	1.13	0.01	1.23	6.15
Maternal BMI	1.91	0.99	0.21	0.69	5.29
Premature Birth	2.30**	0.83	0.02	1.14	4.66
Religious Background	2.28***	0.76	0.01	1.19	4.38
Single Births	0.22***	0.09	0.00	0.10	0.50

Significance Level: * P<0.1; ** P<0.05; *** P<0.01. Number of observations: 3,863. Population Size: 3,888. Number of strata: 19. Number of PSUs: 399. F (9, 372) = 5.90. Prob > F = 0.00

Source: Author's Calculations using the 2015 ZDHS Data

Before the interpretations of the hazard ratios is done, model diagnostic tests must be carried out. These include proportional hazards assumption test and the model specification test.

Model Diagnostic Tests

a. Proportional Hazards Assumption Test

When estimating the Cox Proportional Hazard model, the critical assumption which is made is that the hazard ratio remains constant over time. Although the risk of the event happening may vary over time, the variations overtime must be the same for all covariates. However, Stata does not support this test to be carried out with survey set data. Running the *estat phtest* command echoed an error saying the command was not allowed. However, the same model was estimated without the *svy* command and then a global test was carried out to see whether this assumption was violated, and the results are presented in Table 4.10 below.

Table 4.10 Proportional Hazards Assumption Global Test

Chi-squared	Degrees of Freedom	Prob > Chi-square
11.99	9	0.21

Source: Author's Calculations after the Cox Proportional Hazards Model estimation

The null hypothesis in this test is that the hazard ratios are not proportional or that the proportional hazards assumption was violated. The conclusion from the table above is that since p-value (0.21) is greater than acceptable levels of significance (0.1, 0.05, and 0.01) we may reject the null hypothesis at all acceptable levels of significance (0.1, 0.05 and 0.01) and conclude that the proportional hazard assumption has not been violated.

b. Model Specification Test

The Link Test was carried out to see if the model was correctly specified. Under this test, the null hypothesis will be that the model is not misspecified and the alternative will be that the model is misspecified. The results are shown in Table 4.11 below.

Table 4.11 Cox Model Specification Test-Link Test

_t	**Coefficient**	**Standard Error**	**P > |t|**
_hat	0.99	0.14	0.00
_hatsq	0.03	0.06	0.66

Source: Author's Calculations using the 2015 ZDHS Data

The results show that the model was correctly specified since _hatsq is not significant at acceptable levels of significance, that is, 0.10, 0.05, and 0.01.

Interpretation of the Hazard Ratios

For a categorical explanatory variable, hazard ratios measure how high is the risk of the child dying before their fifth birthday in one group of children compared to the other. For example, how high is the risk of dying for boys compared to girls or how high the risk of dying for rural children compared to urban children. For a continuous explanatory variable, hazard ratios measures how the risk of child dying before their fifth birthday increase or decrease as the explanatory variable increase or decrease.

Compared to children born to mothers who do not drink alcohol, children born to mothers who drink alcohol are 2.10 times likely to die before they reach their fifth birthday. This means that the hazard rate is higher for children born to alcohol-consuming mothers compared to those born to non-alcohol consuming mothers. This is in line with the priori expectations of this research and is true at a 10% level of significance.

Healthcare accessibility was also found to reduce the hazard of dying before the age of five. Children born to families who found it easy to access healthcare services were found to be 0.17 times likely to die before they reach their fifth birthday compared to children born to families who find it hard to access healthcare services. In other words, children born to families who find it hard to access healthcare services were found to be 5.88 times likely to experience death before they reach their fifth birthday compared to children born to families who find it easy to access healthcare services. This is in line with the research priori expectations and is statistically true at a 5% level of significance.

Type of toilet facility in which the household in which the child is residing also has an impact on mortality. Children born to a household which uses an improved toilet facility are 0.47 times likely to die before they reach their fifth birthday compared to children born to a household using an unimproved toilet facility. In other words, children born to a household that uses an unimproved toilet facility are 2.13 times likely to die before they reach their fifth birthday compared to children born to a household using an improved toilet facility. Again, this is in line with the research's priori expectation and is true at a 5% level of significance.

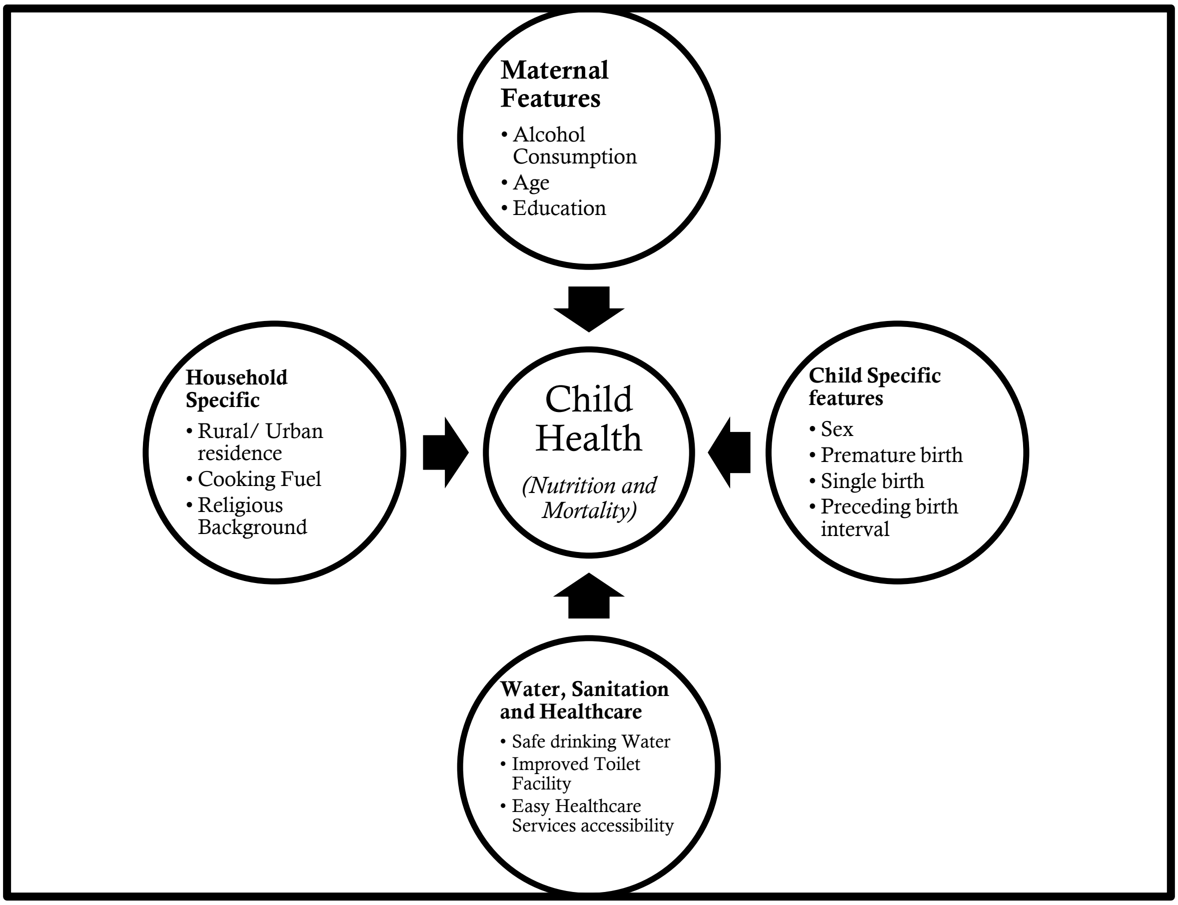
When it comes to the age of the mother at delivery, children born to mothers who are older than 35 years were found to be at a higher risk of dying before their fifth birthday compared to children born to mothers who are less than 35 years. Children born to mothers who are at least 35 years are 2.75 times likely to die before they reach their fifth birthday compared to children born to mothers less than 35 years old. This is in line with the priori expectation of the research and is true at a 5% level of significance. Some researchers also find similar results (Cleland & Van Ginneken, 1988; Dejene & Girma, 2013) More so, children born to mothers who follow the apostolic sect religious doctrine were found to be 2.28 times likely to die before they reach their fifth birthday compared to children born to mothers who do not follow the apostolic sect religious doctrine. This was found to be statistically significant at 1% level of significance.

Compared to mature births, premature births are 2.30 times likely to die before they reach five years old. This is true at a 5% level of significance and it is also in line with the research's priori expectations. Compared to multiple births, single births are at a lower risk of dying before they reach their fifth birthday. Single births are 0.22 times likely to experience death before they reach 5 years old compared to multiple births. In other words, multiple births are 4.55 times likely to die before they reach five years old compared to single births. The risk of dying is low for single births compared to multiple births. Kembo and Van Ginneken (2009) also find similar results, only that their hazard ratio was smaller than what we found here (i.e. 2.08) This is true at a 1% level of significance.

4.4 Household Characteristics and Child Health nexus

Figure 4:1 overleaf summarizes the household characteristics and child health nexus in Zimbabwe, as found in this research. The research has concurred with most of the predictions of theories reviewed in chapter two, particularly the Mosley-Chen framework and the UNICEF framework. The research has found that in some there are certain variables which affect both under-five mortality and undernutrition, whilst others affect only one of these child health indicators. For example, premature birth, improved toilet facility, and single births to all significantly affect under-five mortality and undernutrition. Policy recommendations in the next chapter will be focusing on the above factors. If we are to reduce mortality and undernutrition problems in children under the age of five in Zimbabwe, resources should be channeled towards these high-risk areas.

Figure 4:1 Household characteristics and child health nexus in Zimbabwe



Source: From the Author, based on the results of the study

4.5 Conclusion

This chapter gave an empirical analysis to answer the study questions developed in chapter one of this research. Descriptive statistics and regression analysis methods were used in this regard. There was evidence that good household health conditions, health facilities, religion, maternal education, maternal age, type of cooking fuel, preceding birth interval, and premature births have a significant impact on either child mortality or child nutrition stock or both. The following chapter will provide a summary of the whole study and some policy recommendations, based entirely on the results found in this chapter.

Chapter Five

Summary, Conclusions and Policy Recommendations

5.0 Introduction

This chapter provides a summary and conclusions to the study as well as providing policy recommendations, guided by the research findings discussed in the previous chapter. More so, this chapter will also suggest areas of further study on the topic of child health. The chapter will also outline some limitations of the study.

5.1 Summary and Conclusions

The study was carried out to find ways to improve the health of children under the age of five in Zimbabwe, specifically look at the causes of mortality and undernutrition in this sub-population. For the causes of undernutrition, the research finds factors such as maternal education, improved toilet facility, premature births, safe drinking water, multiple births, cooking fuel, longer birth interval, sex of the child, to significantly determine the nutrition status of children. An ordered logistic regression was used in this regard with the measure of nutrition stock being stunting, which was categorized into three categories, that is severe undernutrition, moderate undernutrition, and good or acceptable nutrition stock. Survival analysis was carried out to try and find the risk factors affecting child mortality in Zimbabwe. The research found factors such as maternal alcohol consumption, premature birth, religious doctrine followed by household members, healthcare services accessibility, improvement in toilet facility used by the household, maternal age, and single birth to significantly contribute to the risk of the child dying before they reach their fifth birthday.

5.2 Policy Implications and Recommendations

Improving the health of children under the age of five is important to any economy, with benefits likely to come in the long term. Factors contributing to the health of children under the age of five were identified and put into four groups. These four groups are maternal characteristics, child-specific characteristics, household-specific characteristics, and the health environment. Targeting these will go a long way in improving the health of children under the age of five in Zimbabwe.

a. Maternal Characteristics

Given the research findings highlighted in the previous chapter about maternal characteristics, the researcher, therefore, recommends that the government should subsidize education to the girl child, particularly in the rural areas given that only 2% of rural mothers have achieved tertiary education compared to 13% in urban areas so that they will achieve higher levels of education. More so, the government can specifically target children born to women who are 35 years or older by giving them special treatment compared to those born to mothers who are less than 35 years. Policies that will reduce alcohol consumption by mothers, at least during pregnancy and lactation periods, will also go a long way in improving the health of children under the age of five. Strong focus can be put in urban areas where descriptive statistics have shown that 16% of mothers consume alcohol, compared to rural areas where 6% of mothers consume alcohol.

b. Child Specific Features

When it comes to child-specific characteristics, the research found out that boys, premature deliveries, multiple births, and a shorter preceding birth interval all compromise the quality of the child. Concentrating the limited resources which the government has to these high-risk areas will help improve the health of children in Zimbabwe. For example, the government can initiate a program to offer supplementary food to mothers with boys, children who were prematurely delivered, children with short preceding birth interval, and to mothers who had multiple deliveries at once. This will go a long way in improving the health of children. More so, taking good care of the mothers during pregnancy will also help, especially in the case of premature deliveries. On the issue of shorter preceding birth interval, the government and non-governmental organizations can scale up efforts on family planning education and the distribution of such medication so that the space between the children will be long.

c. Household Specific Features

The research found that being an urban resident, born to a household that follows the apostolic sect religious doctrine and born to a household that uses solid fuels for cooking will all compromise the health of the child. In the short term, the government can offer subsidies to the urban mothers, and apostolic sect mothers. In the long term, making clean energy accessible to all, particularly in the rural areas where the descriptive statistics have shown that only 5% have access to clean energy, will also help improve the health of the children.

d. Water, Sanitation, and Healthcare

On the issue of healthcare services accessibility, the government can offer universal healthcare insurance for the children below the age of five. The government can especially target rural children in this regard, given that only 2% of rural children have healthcare insurance, compared to 21% of urban children. This will make health services accessible to this subpopulation and will improve the health of the children. When it comes to improvement in the toilet facility, in the meantime the government can use its resources to target rural areas given that only 44% of rural households have access to improved toilet facilities, compared to 95% of urban households.

5.3 Limitations of the study and suggestions of areas of further Study

The study was only focused on the health of the children for the period between 2010 and 2015. In the future, it will be good to focus on the long-term trend and maybe analyze how the problems have been changing over time. More so, given that Zimbabwe is an agriculture-based society, it would be important to see how the two child health problems examined fared in the different agricultural ecological regions of the country since this speaks to the type and quality of the food available. However, the available data did not allow for this kind of analysis to happen.

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Appendices

Appendix A: Multicollinearity Test

```
. correlate educ01 bmi01 mage2 religion3 childsex res hv237 alcohol birthint premature single power sanitation visi
> ts h_insurance
(obs=2,717)
```

	educ01	bmi01	mage2	religi~3	childsex	res	hv237	alcohol	birthint	premat~e	single
educ01	1.0000										
bmi01	0.0292	1.0000									
mage2	0.0077	0.0149	1.0000								
religion3	0.2119	0.0159	-0.0165	1.0000							
childsex	0.0025	-0.0184	-0.0026	0.0309	1.0000						
res	-0.2173	-0.0761	-0.0324	-0.2864	-0.0321	1.0000					
hv237	-0.0733	0.0106	-0.0175	-0.0136	-0.0029	0.0139	1.0000				
alcohol	-0.0793	-0.0315	-0.0326	-0.1235	0.0404	0.1384	0.0007	1.0000			
birthint	0.0085	0.0211	-0.0773	0.0457	-0.0198	0.0140	0.0197	0.0215	1.0000		
premature	0.0078	0.0207	0.0073	-0.0149	-0.0473	0.0429	0.0280	0.0069	-0.0185	1.0000	
single	-0.0026	0.0163	-0.0069	0.0202	0.0236	-0.0153	-0.0169	0.0180	0.0024	-0.2224	1.0000
power	-0.2823	-0.0714	-0.0316	-0.2860	-0.0532	0.6561	0.0367	0.1379	-0.0062	0.0303	-0.0146
sanitation	-0.1780	-0.0326	0.0048	-0.1860	-0.0065	0.4813	0.0677	0.0867	-0.0427	-0.0170	0.0031
visits	-0.1693	-0.0180	0.0361	-0.1109	0.0127	0.0575	0.0586	0.0285	-0.0945	-0.0036	0.0190
h_insurance	-0.4639	-0.0447	0.0120	-0.2361	-0.0125	0.2926	0.0637	0.0925	-0.0438	-0.0116	-0.0225

	power	sanita~n	visits	h_insu~e
power	1.0000			
sanitation	0.4253	1.0000		
visits	0.1161	0.0797	1.0000	
h_insurance	0.3886	0.2124	0.1856	1.0000

Appendix B: Cox Prportional Hazards Model

```
. svy linearized: stcox  bmi01 mage2 religion3 alcohol premature single sanitation visits h_insurance
(running stcox on estimation sample)

Survey: Cox regression

Number of strata   =        19                Number of obs     =      3,863
Number of PSUs     =       399                Population size   = 3,888.6555
                                              Subpop. no. obs   =      3,608
                                              Subpop. size      = 3,613.4735
                                              Design df         =        380
                                              F(   9,    372)   =       5.90
                                              Prob > F          =     0.0000
```

_t	Haz. Ratio	Linearized Std. Err.	t	P>|t|	[95% Conf.	Interval]
bmi01	1.908503	.9903219	1.25	0.214	.6880079	5.294104
mage2	2.749174	1.126267	2.47	0.014	1.228492	6.152222
religion3	2.278952	.7572107	2.48	0.014	1.185794	4.379871
alcohol	2.098988	.8067946	1.93	0.054	.9857924	4.469247
premature	2.303296	.8254125	2.33	0.020	1.138511	4.659746
single	.2180819	.092139	-3.60	0.000	.0950255	.5004941
sanitation	.4691062	.163689	-2.17	0.031	.2362139	.9316159
visits	1.079529	.0647708	1.28	0.203	.9593999	1.214699
h_insurance	.1719172	.1321569	-2.29	0.023	.0379219	.7793797

Appendix C: Link test for the Cox Proportional Hazards Model

```
. linktest
(running stcox on estimation sample)

Survey: Cox regression

Number of strata   =        19              Number of obs     =      3,863
Number of PSUs     =       399              Population size   = 3,888.6555
                                            Subpop. no. obs   =      3,608
                                            Subpop. size      = 3,613.4735
                                            Design df         =        380
                                            F(   2,    379)   =      28.54
                                            Prob > F          =     0.0000
```

_t	Coef.	Linearized Std. Err.	t	P>|t|	[95% Conf.	Interval]
_hat	.9929045	.1374089	7.23	0.000	.7227276	1.263081
_hatsq	.0263188	.0592243	0.44	0.657	-.0901296	.1427672

Appendix D: Proportinal Hazards Assumption Test

```
. estat phtest

      Test of proportional-hazards assumption

      Time:  Time
```

	chi2	df	Prob>chi2
global test	11.12	9	0.2673

Appendix E: Ordered Logistic Model

```
. svy linearized: ologit haz educ01 bmi01 mage2 religion3 single childsex res hv237 birthint premature power sanita
> tion
(running ologit on estimation sample)

Survey: Ordered logistic regression

Number of strata   =        19                Number of obs     =      2,812
Number of PSUs     =       397                Population size   =  2,910.211
                                              Design df         =        378
                                              F(  12,    367)   =       7.68
                                              Prob > F          =     0.0000
```

haz	Coef.	Linearized Std. Err.	t	P>|t|	[95% Conf.	Interval]
educ01	-1.115953	.3339815	-3.34	0.001	-1.772647	-.4592583
bmi01	-.3539262	.2573685	-1.38	0.170	-.8599794	.152127
mage2	-.1355184	.1794178	-0.76	0.451	-.4883004	.2172637
religion3	-.1813707	.1165971	-1.56	0.121	-.4106308	.0478894
single	.4923361	.2932628	1.68	0.094	-.0842946	1.068967
childsex	-.3966852	.1042605	-3.80	0.000	-.6016884	-.1916819
res	-.5302296	.1687749	-3.14	0.002	-.8620849	-.1983743
hv237	.3067942	.1539998	1.99	0.047	.0039906	.6095979
birthint	-.2337619	.1196583	-1.95	0.051	-.4690412	.0015174
premature	-.6582571	.1604404	-4.10	0.000	-.9737246	-.3427897
power	.7936587	.1861972	4.26	0.000	.4275467	1.159771
sanitation	.256335	.1332448	1.92	0.055	-.0056588	.5183288
/cut1	-3.541021	.4376211			-4.401498	-2.680544
/cut2	-1.998059	.4360021			-2.855353	-1.140766

Appendix F: Ordered Logistic Model Link Test

```
. linktest
(running ologit on estimation sample)

Survey: Ordered logistic regression

Number of strata   =        19                Number of obs     =      2,812
Number of PSUs     =       397                Population size   =  2,910.211
                                              Design df         =        378
                                              F(   2,    377)   =      45.78
                                              Prob > F          =     0.0000
```

haz	Coef.	Linearized Std. Err.	t	P>|t|	[95% Conf.	Interval]
_hat	.9382721	.2089943	4.49	0.000	.5273351	1.349209
_hatsq	-.0378053	.1080023	-0.35	0.727	-.2501659	.1745554
/cut1	-3.526525	.148966			-3.819431	-3.233619
/cut2	-1.982755	.1194755			-2.217675	-1.747836

Appendix G: Marginal Effects

```
. mfx, predict(outcome(1))

Marginal effects after svy:ologit
      y  = Pr(haz==1) (predict, outcome(1))
         =  .05888753
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
educ01*	.0414159	.00783	5.29	0.000	.026073	.056759	.936343
bmi01*	.022729	.01893	1.20	0.230	-.014381	.059839	.033195
mage2*	.0078939	.01098	0.72	0.472	-.013618	.029405	.086122
religi~3*	.0100346	.00644	1.56	0.119	-.00259	.022659	.516229
single*	-.033426	.02371	-1.41	0.159	-.079902	.01305	.960601
childsex*	.0222359	.0061	3.65	0.000	.010283	.034189	.479881
res*	.0319029	.01098	2.91	0.004	.010392	.053414	.33936
hv237*	-.01547	.00715	-2.16	0.031	-.029491	-.001449	.143299
birthint*	.0136417	.00744	1.83	0.067	-.000931	.028215	.255835
premat~e*	.0467664	.01456	3.21	0.001	.018221	.075311	.082245
power*	-.0376547	.00719	-5.24	0.000	-.051747	-.023562	.254219
sanita~n*	-.0146098	.00784	-1.86	0.062	-.029968	.000748	.616199

(*) dy/dx is for discrete change of dummy variable from 0 to 1

```
. mfx, predict(outcome(2))

Marginal effects after svy:ologit
      y  = Pr(haz==2) (predict, outcome(2))
         =  .16756155
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
educ01*	.1043668	.02287	4.56	0.000	.059537	.149196	.936343
bmi01*	.0447485	.03397	1.32	0.188	-.021831	.111328	.033195
mage2*	.0165694	.02239	0.74	0.459	-.027323	.060462	.086122
religi~3*	.0216827	.0139	1.56	0.119	-.005555	.04892	.516229
single*	-.0631216	.03991	-1.58	0.114	-.141351	.015108	.960601
childsex*	.0475287	.01258	3.78	0.000	.022869	.072188	.479881
res*	.0651671	.02122	3.07	0.002	.02357	.106764	.33936
hv237*	-.0350462	.0166	-2.11	0.035	-.067586	-.002507	.143299
birthint*	.0285727	.01503	1.90	0.057	-.000892	.058038	.255835
premat~e*	.0849194	.02167	3.92	0.000	.042452	.127387	.082245
power*	-.0866782	.01854	-4.67	0.000	-.123021	-.050335	.254219
sanita~n*	-.0310143	.01624	-1.91	0.056	-.062854	.000825	.616199

(*) dy/dx is for discrete change of dummy variable from 0 to 1

```
. mfx, predict(outcome(3))

Marginal effects after svy:ologit
      y  = Pr(haz==3) (predict, outcome(3))
         =  .77355091
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.	]	X
educ01*	-.1457828	.03	-4.86	0.000	-.204584	-.086981	.936343
bmi01*	-.0674776	.05281	-1.28	0.201	-.17099	.036035	.033195
mage2*	-.0244633	.03335	-0.73	0.463	-.089831	.040905	.086122
religi~3*	-.0317174	.02029	-1.56	0.118	-.07148	.008045	.516229
single*	.0965477	.06348	1.52	0.128	-.027862	.220958	.960601
childsex*	-.0697646	.01841	-3.79	0.000	-.105849	-.03368	.479881
res*	-.09707	.03189	-3.04	0.002	-.159582	-.034558	.33936
hv237*	.0505163	.02365	2.14	0.033	.00417	.096863	.143299
birthint*	-.0422145	.02239	-1.89	0.059	-.086091	.001662	.255835
premat~e*	-.1316859	.03571	-3.69	0.000	-.201681	-.061691	.082245
power*	.1243329	.02514	4.95	0.000	.075068	.173598	.254219
sanita~n*	.0456242	.02399	1.90	0.057	-.001398	.092646	.616199

(*) dy/dx is for discrete change of dummy variable from 0 to 1

Appendix H: Parallel Regression Assumption Test

```
. brant

Brant test of parallel regression assumption
```

	chi2	p>chi2	df
All	11.86	0.457	12
educ01	0.45	0.504	1
bmi01	0.42	0.519	1
mage2	0.63	0.429	1
religion3	0.56	0.454	1
single	1.31	0.253	1
childsex	0.19	0.661	1
res	0.05	0.820	1
hv237	2.13	0.144	1
birthint	1.60	0.206	1
premature	0.32	0.569	1
power	1.70	0.192	1
sanitation	0.05	0.817	1

```
A significant test statistic provides evidence that the parallel
regression assumption has been violated.
```

"The steadfast love of the Lord never ceases; His mercies never come to an end; they are new every morning; great is Your faithfulness. 'The Lord is my portion,' says my soul, 'therefore, I will hope in Him.'"

-Lamentations 3: 22-24