ANALYSIS OF FERTILITY AND ITS EFFECTS ON HEALTH AMONG MOTHERS AND CHILDREN IN TANZANIA

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DECLARATION

This thesis is my original work and has not been presented for the award of a degree in any other university.

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To my wife Ndaya, my daughter Dora and my mother Helena for their support, encouragement and patience.

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ABBREVIATIONS AND ACRONYMS

2SLS:	Two-Stage Least Square
CEB:	Children Ever Born
CFA:	Control Function Approach
CMR:	Child Mortality Rate
DHS:	Demographic and Health Survey
HAZ:	Height-for-Age-Z score
IV:	Instrumental Variable
IVProbit:	Instrumental Variable Probit
MDG:	Millennium Development Goals
MMR:	Maternal Mortality Rate
NBS:	National Bureau of Statistics
OLS:	Ordinary Least Square
SDG:	Sustainable Development Goals
TFR:	Total Fertility Rate
UNDP:	United Nations Development Program
UNICEF:	United Nations Children Fund
WAZ:	Weight-for Age-Z score
WHO:	World Health Organization
WHZ:	Weight-for-height-Z score
ZIP:	Zero Inflated Poisson

OPERATIONAL DEFINITION OF TERMS

Child Health: This refers the physical, mental, emotional, mental and social well-being of children from infancy through adolescences.

Under-Five Mortality Rate: This is the likelihood of a death occurring between birth and the age of exactly five years expressed per 1,000 live births.

Fertility rate: The average number of children that would be born to a woman over her lifetime.

Maternal health status: Refers to the health of the woman during pregnancy, at the time of delivery and after delivery.

Maternal Mortality: Refers to the death of a woman while pregnant or within 42 days of a termination of a pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accident and incidental causes.

ABSTRACT

Health is an important socioeconomic component as it promotes the national welfare and fosters economic prosperity. Tanzania has made significant strides with regards to investments in its health sector by developing major health policies meant to enhance sustainability of the health status of its populace. , Significant efforts have been directed towards reduction of disability, morbidity and mortality, further nutritional status and improving life expectancy. However, despite the government's effort to improve access to health services across Tanzania, poor maternal and child nutritional health statuses are still a challenge to date. On the other hand, fertility rate in Tanzania is higher than the global average that poses serious challenges for sustainable development. The core objective of this study was to examine the relationship between fertility, maternal health and child health outcomes in Tanzania. Specifically, the study examined the effects of socioeconomic factors on fertility in Tanzania. Subsequently, the study sought to examine the effect of fertility on child health outcomes using height-for-age Z-score (HAZ) and the probability of a child being stunted as dependent variables. The study also examined the effect of fertility on maternal health status using Body Mass Index (BMI) and the probability of a mother being underweight as dependent variables. Cross-sectional data from Tanzania Demographic Health Surveys for 2010 was used for the analysis. The study used Zero Inflated Poisson regression model to estimate the effect of socio-economic factors on fertility. Subsequently, Ordinary Least Square (OLS), Probit, Instrumental Variable IVProbit and IVregression models and the Control Function Approach (CFA) were employed for the analysis of the effect of fertility on maternal and child health outcomes while controlling for the endogeneity and heterogeneity problems. Based on the study's findings, the age of the mother and marital status significantly affect the number of children in Tanzania. On the other hand, maternal education, mother's employment, contraceptive use, awareness of family planning, access to media and place of residence were associated with significant changes in fertility. Again, fertility significantly lowered the height-for-age z-score (HAZ) and increased the probability of a child being stunted. On the maternal health status, high fertility reduces the women's welfare by reducing the Body Mass Index (BMI) and consequently increasing the probability of a mother being underweight. Results further indicate a presence of heterogeneity arising in the maternal health model. Based on the finding of this study, promotion of family planning is recommended. The study also recommends investing in women's education as a way of rooting out illiteracy on matters related to family planning. There is also a need for the government to increase the proportion of women in the labor force and boost their participation in the same as a means of enhancing their well-being as well as that of their families.

CHAPTER ONE

INTRODUCTION

1.1 Background

For a long time, nations have tried to accomplish the objectives of economic growth and development. Empirical and theoretical research has highlighted the main factors in economic growth and development. A nation's investment in its health sector is a critical component of its human capital. Further, investments in health and education, choices over family size and birth rates, interactions which include human capital and physical capital are identified as essential components of economic growth and development (Becker *et al.,* 1994;Strauss and Thomas, 1998: Namubiru, 2014;). Therefore, health is regarded as a special component of human capital due to its direct effects on productivity and economic growth as an element of the wellbeing of the individual and the nation. Poor health can have a negative impact on children's education and productivity, which further leads to poor human capital; hence exacerbates poverty (Phonvisay, 2011). Furthermore, Mugo (2012) argues that adults who experience health shocks during childhood have relatively lower income than those who do not. This happens because health problems can depress children's learning ability and damage their physical development. Therefore, improving health is a key to realizing better human capital for sustainable development of a country.

Globally, the health sector has made significant contributions to the reduction of poverty and hunger as highlighted in the Millennium Development Goals; hence, it would be imperative if the contributions are extended into the attainment of Sustainable Development Goals (SDGs) that are still underway implementation. Largely, success in the health sector has been enhanced through the public-private sector partnerships considering the increased quality of services and accessibility of the same. As was indicated in the Millennium Development Goals (MDGs) all countries were expected to have made momentous advances towards the accomplishment of the goals, inclusive of goals four and five that focused on the improvement of maternal, newborn and child health. According to the United Nations (2013), most governments of developing countries had put in place specific measures to achieve the set MDGs specifically for the health sector. This was through the establishment of infant and maternal health strategy focused on quality improvement of health care and treatment of malaria, family planning and sanitation. These efforts saw a dramatic decline in maternal mortality ratio globally by 50 percent in the last two decades which was further attributed to the result of global initiatives through the safe motherhood program aimed at reducing maternal morbidity and mortality (WHO, 2014).

Despite both national and global efforts at curbing maternal mortality, the incidence of maternal deaths remains strikingly high especially in many developing countries (WHO, 2014). Worldwide, an estimated 500,000 women and girls die every year from pregnancy- complicated causes and childbirth with over 99 percent of these deaths occurring in developing countries. Causes to the child and maternal wellbeing are attributed to persistent maternal mortality. Child health depends on the availability and access to immunization, proper nutrition, and quality management of childhood illnesses. Improved access to quality health services for the mother and child requires goal-oriented and evidence-based interventions as well as health and social interventions that are adequately informed by superlative practices to succeed (Bahiigwa and Younger, 2005).

Over the past two decades, the global mortality rate of children under five decreased by 2.5 percent every year while the neonatal mortality rate only reduced by 1.8 percent. Also, the proportion of neonatal mortality rate to under- five mortality rose from 36 percent in 1990 to 43 percent in 2011 (WHO, 2014). As for the indicators about maternal health, global maternal mortality reduced by 47 percent over the past 20 years. The largest decline was in East Asia 69 percent, North Africa 66 percent and South Asia 64 percent (UN, 2013). While efforts to curb mortality rates globally seem possible and achievable, they may, however be unsustainable if the causes are not addressed. For instance, halving mortality rates, the prevalence of malnutrition and reducing gender disparities need to remain identified as relevant Sustainable Development Goals.

The objective of halving the proportion of undernourished people globally was expected to be achieved by 2015, but it is yet to be realized. Most of the governments over a decade ago were described as grapplers characterized by high poverty index and low health status among its populace (UNDP, 2006). This development of the linkage between high poverty rates to low health status and ultimately increased mortality rates acts as a potential barrier to the realization of better child and maternal health status (Kabubo-Mariara *et al.,* 2009b).

It is, therefore, striking to understand the link that fertility has to the health risk factors that affect women and children; thus, the understanding of the maternal, child mortality and morbidity rates. According to Gyimah (2002), fertility response to infant mortality is an amalgamation of short-term physiological effects, long term behavioural replacement challenges, and consequent undisputed deaths. Therefore, these deaths are at high risks of taking place frequently should the high fertility rates in the Sub-Saharan countries remain uncontrolled. This shows that the Millennium Development Goal (MDG) of reducing maternal mortality rate in Africa by three-quarter is a huge challenge that is largely dependent on the control of the fertility rates among women (Mwaikambo, 2010).

According to United Children's Fund (2010) Sub-Saharan Africa, is faced with fertility-related health challenges namely, newborn illnesses, pregnancy, childbirth complications and malnutrition. All of these have a direct impact on the socio-economic status of the economy. Like in most African countries, there has been a stagnation or reversal in the progress to achieving MDGs in Tanzania (Tanzania Bureau of Statistics, 2010) which made Tanzania no able to meet some of the International deadline of 2015. For instance, the fertility rate in Tanzania still stands at 5.4 children per woman and the maternal mortality ratio (MMR) hasn't shown any signs of declining but continued to remain high at an estimate of 454per 100,000 live births in 2010 (Tanzania Bureau of Statistics, 2010).Malnutrition, on the other hand, increases the risk of infection and infectious diseases. Also moderate malnutrition is shown to weaken every part of the immune system and can thus lead to early death (Achieng, 2014).

According to the global nutrition report 2015, there is a slow and uneven worldwide progress to the reduction of malnutrition. Nearly, half of all 193 countries face multiple serious burdens of malnutrition such as poor child growth, micronutrient deficiency and adult overweight and obesity. The global nutrition report 2015 further indicates that Tanzania was out of track in achieving the global nutrition targets as established by the World Health Organization 2015.

1.2 An overview of Fertility in Tanzania

There has been a remarkable demographic change in most of the developing countries. An unprecedented decline in childhood mortality has been experienced and in most cases, a significant transition to controlled fertility (Gyimah, 2002). Literature regarding sub-Saharan Africa indicates the existence of high fertility. For example considering the recent demographic and health surveys conducted in most Sub-Saharan Africa, on average 6.0 children are still desired (Westoff, 2010; Lesthaeghe, 2014; WHO, 2014). Further, Ethiopia in 2005 had TFR of 5.1 whereas Rwanda and Kenya had TFR of 3.6 and 3.9 in surveys of 2007 and 2014 respectively while Tanzania recorded a TFR of 5.4 in 2010. These high fertility rates are far beyond the world fertility rate calling for urgent attention. However, much debate surrounds the reasons for the resistance to fertility change which depends on a multiplicity of factors whereby in Tanzania, child and maternal malnutrition is regarded as one of the most important (United Nations, 2013).More often than not, Tanzania has been experiencing rapid population growth and high unstable fertility rates since the early 1990s which are perceived more as obstacles than stimulants to economic growth and development.

Tanzania Demographic Health Surveys shows that total fertility decreased from 6.3 in 1991-1992 to 5.7 in 1999. In Tanzania Demographic and Health Surveys 2010 results, TFR was still high as 5.4 per woman. However, still two third of women in Tanzania say they want more children (Cao, 2011). Figure 1.1 shows trends of fertility rates in Tanzania for the period 1995-2012.

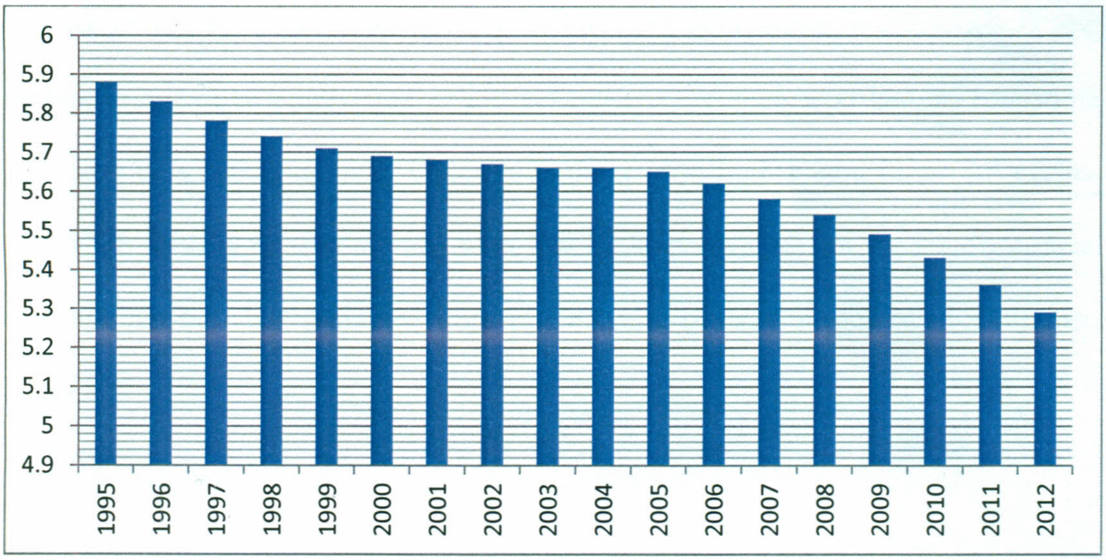

Figure 1.1: Total Fertility Rate Tanzania (1995-2012)

According to Tanzania Human Development Report of 2014, (TDHR) the persistent increase of fertility rate is a major source of rise in population growth rate. From figure 1.1, generally fertility has been declining albeit insignificant. The trend data shows a stall in decline between the years 1999-2006 which was succeeded by a marginal reduction between 2007 and 2012. These marginal declines are attributed to slow speed in usage of contraception among different socioeconomic categories; persistent desire for large family in the same regions and constant unmet need for contraception (TDHR, 2014).

While the world fertility rate as at 2013 averaged 2.5 children, in Tanzania it was 5.4, which is relatively high (World Bank, 2012). Considering fertility rates by socio-economic status in 2011, women from the lowest wealth quintile had a total fertility rate of 7.0 children compared to 3.2 children for those from the richest quintile (United Republic of Tanzania, 2010). For poor households, such a large number of children increased poverty in the next generations because assets are subject to a greater subdivision across generations. Women who had no education had more than twice as many children as those with higher education (7.0 versus 3.0). High fertility rates combined with low birth spacing are among major reasons why malnutrition has remained high in Tanzania (United Republic of Tanzania, 2010).

The general recognition is that rapid population growth is not beneficial to the accelerated capital accumulation speed. On the other hand, fertility is perceived as a determinant of the society's welfare in that families with more children would commit less time and resources to providing basic care and protection required for their children. Schultz (2008) reckons that the public policy interventions that have been in place intended for curative and preventive purposes should be used to promote mortality and fertility rates' decline; thus, improving the well-being of relations and the society as whole. Tanzania has policies in place regarding population issues associated with reproductive health and child survival specifically fertility, infant and child mortality.

The Tanzania national population policy adapted in 1992 created the linkages as well as interrelationships meant to advance population health status. However, the policy failed to achieve the targets of reducing the fertility rates to considerable levels of 2-3 percent. Failure of the policy was attributed to insufficient human and financial resources as well as consequent unilateral strategies mainly relying on the government for accomplishment. Despite the barriers faced the implementation of the population policy of 1992, there has been other policies in Tanzania from both national and international developments. Some of them are incorporated in the 1994 International Conference on Population and Development (ICPD); Copenhagen Social Summit of 1995 and the Tanzania Development Vision 2025. These new strategies have enhanced changes in approaches and policy orientation so as to deal with: population issues in a holistic manner; address issues associated to reproductive health and reproductive rights; and the inter-linkage between population and sustainable development (URT, 2015).

In this regard, the policy recognizes increased levels of pregnancies among adolescents; high maternal, infant and child mortality across the country above the acceptable levels; and unfortunate low status accorded to women in society and thus persistent limited use of contraception in Tanzania (WHO, 2010). For example, available statistics indicate that only 28.8 per cent of all female respondents use contraceptive methods, including modern and traditional (Tanzania National Bureau of Statistics, 2010). Regardless being slightly higher among the married women at 34.4 percent, it was generally lower.

1.3 Child Health Status and Respective Trends in Tanzania

Child health refers to the physical, social and mental well-being of persons below the age of 5 years. Mugo (2012) argues that health status of under-five is an important indicator of the whole population because adult health status is primarily defined during the first twenty-four months of a child life. Essentially child health status can be measured using, birth weight, height-for-age Z-score (stunted), weight-for age Z-score (underweight), weight-for height Z-score (wasting) and child mortality rate.Table 1.1 indicates the trends in malnutrition among under-five children in Tanzania;

Table 1.1: Malnutrition trends among under-five children in Tanzania 1992-2010

Year	Height-for-age (stunting)	Weight-for-age (underweight)	Weight-for-height(wasting)
1992	44	29	6
1996	43.2	30.6	7.2
1999	43	29	6
2004	38	22	3
2010	42	16	5

Source: United Republic of Tanzania (TDHS, 1992; 1996; 1999; 2004 and 2010)

From Table 1.1, the proportion of stunted children was more compared to underweight and wasting through the five surveys. In 2004, stunting reduced by 5 percent from 43 percent in 1999 but increased to 42 percent in 2010. Child nutritional status indicators in Tanzania have persistently remained high for nearly the last decade with 43 and 44 percent of the children being stunted in 1990 and 2000 respectively. Those proportions only fell to 38 percent in 2004 and increased again to 42 percent in 2010 (United Republic of Tanzania, 2012).

On the other hand, child underweight fell from 29 percent to 16 percent between 1990 and 2010, while child wasting increase from 3 percent to 5 percent between 2004 and 2010. Nevertheless, the prevalence of stunting and underweight is still high according to criteria of the World Health Organization (WHO, 2010). Furthermore, millions of children and women in Tanzania continue to suffer from one or more forms of under-nutrition, including low birth weight, stunting, underweight, wasting, vitamin A deficiency, iodine deficiency disorders and anemia.

Malnutrition is a reason for 33 percent of child mortality in Tanzania. Tanzania belongs to the ten worst nations across the globe the globe and positions tenth spot in its commitment to all chronically undernourished children in the world (World Bank, 2010). Within Africa Tanzania is the third most noticeably affected country. Moreover around 130 infants die each day in Tanzania because of malnutrition related sicknesses and it is was likewise approximated 600,000 children aged under-five years were estimated to have died due to malnutrition (WHO, 2014).

1.4 Maternal Health Status and Respective Trends in Tanzania

Over the past years, Tanzania and other world economies have been much concerned with the attainment of global health success; much of which was fuelled by the establishment and implementation of MDGs (WHO, 2014). This success has, however, been achieved in the eradication of vaccine-preventable diseases, yet still a startling number of women die yearly from causes related to pregnancy and childbirth attributed to nutritional status. Malnutrition as an indicator for maternal health status has not been given enough consideration as a cause for maternal mortality in Tanzania. Nutritional status of women is critical, this includes the correct mix and quantity of food nutrients which provides energy, allows growth as well as protection through repairing and regulating body functions (UNICEF, 2010). According to Kavishe (1992) malnutrition can be considered a sign and symptom of various social and biological processes in society. This leads to the ultimate manifestation high death rates among women of reproductive age.

In this study, maternal health status was measured by Body Mass Index (BMI) and the probability of a woman being underweight. BMI is calculated as individual weight in kilograms over the square of the individual's height in meters. According to Wu and Li (2012) BMI is a measure of body fat based on height and weight. This applies to both adult men and women. The measure is used to indicate whether an individual is underweight, normal, overweight or obese. In particular, a woman is said to be underweight or undernourished if she has a BMI less than 18.5. Between 18.5 and 24.9 for normal BMI and obese if she has BMI above 30 (Hiza*et al.,* 2000:

Awiti, 2013). BMI values of above 25 areunhealthy and have been shown to increase the hazard of chronic diseases such as high blood pressure, diabetes, heart disease, stroke, certain types of cancer, arthritis and breathing problems.

In 2004, approximately 10 percent of women in Tanzania were found to be underweight which is as slight increase by 1 percent from the preceding survey of 1996. Also 13 percent of women were shown to be overweight and 4 percent reported to be obese. While in 2010, about 12 percent of women in Tanzania were found to be underweight, 23 percent were overweight and 15 percent were obese (United Republic of Tanzania, 2004; 2010). According to the Tanzania national nutrition strategy of 2011-2016, women who are undernourished before and during pregnancy are more likely to give birth to infants with low birth weight. Similalry, Barker (1998) relates low birth weight to serious consequences for survival, health, growth and development and increases the risk of diet-related non communicable diseases in adulthood.

Children and women in Tanzania experience one or more forms of under-nutrition (low birth weight, stunting, underweight, wasting, and vitamin deficiency among other disorders). This increases the likelihood of diseases and deters quick recovery due to poor nutrition regarding quality and quantity. According to Tanzania nutritional strategy 2011-2016, Malnutrition levels remained essentially constant throughout the surveys. However, there is evidence of overall improved nutritional status between 1999 and 2004 despite a slight increase in the 2010 survey.

1.5 Statement of the Problem

Fertility, maternal and child health outcomes are regarded as essential measures of societal well-being. Healthy mothers deliver healthy children and healthy children have a greater potential to become productive labor force in future (Phonvisay, 2011). Controlled birth lowers likelihood of deterioration of mother's health as well as the exposure to various risks. This also provides a mother with more time to work and earn extra income to support other family members and children.

The lapsed Millennium Development Goals (MDGs) strived to decrease the percentage of undernourished persons globally, improve maternal health status through reduction of maternal mortality by 75 percent and child mortality by two-thirds as well as to provide universal access to maternal reproductive health. Since most countries, inclusive of Tanzania felt short fall of these targets (except reduction of child mortality), they agreed to Sustainable Development Goals (SDGs)with a broad goal of ensuring healthy lives and promotion of well-being for all at all ages.

Despite the steady progress towards achieving improved health outcomes for mothers and children, Tanzania has incredibly highest fertility rate of 5.4 per woman against the world fertility rate of 2.5 per woman. The witnessed high fertility rates in Tanzania could lead to a decline in family resources on each child similar to the mother as a result of children upsurges and the consequent effect on mother's health which could lead to malnutrition (Namubiru, 2014).

In Tanzania approximately600,000 children aged below five years died as a result of inadequate nutrition between 2000 and 2010 (Twaweza, 2010). Also, Tanzania Demographic and Health Survey for 2010 report (TDHS) indicate that 22 percent of under- five years were underweight and up to 44 percent were stunted growth. Further, undernourished women in Tanzania were reported to be 10 percent and 12percent in 2004 and 2010 respectively. Poor nutrition is associated with meager long-term physical growth and development of children and consequently high levels of chronic illness and disability in their adulthood or even death (Kabubo-Mariara *et al.,* 2009b: Harttgen *et al.,* 2012) whereas maternal mortality can be traced back to undernourishment among women in Tanzania.

Literature from both developed and developing countries have shown that fertility is highly associated with child health status (Pelletier and Frongillo, 2003: Henderson *et al.,* 2008; Hatton and Martin, 2009; Kabubo-Mariara *et al*., 2009b; Oyekale 2014). These studies however, are not only country specific but also focus more on the relationship between fertility and maternal labor force participation rather than mother's health status. Despite producing mixed results, there are no sufficient econometric studies that show how fertility influences the health of mothers and children in Tanzania. Understanding of the effect of fertility on maternal and child health status therefore is critical in designing Maternal and Child Health (MCH) policies for the well-being of current and future generations through further reduction of malnutrition and thus child and maternal mortality levels.

1.6 Research Questions

i. What are the effects of socioeconomic factors on fertility in Tanzania?

ii. What are the effects of fertility on child health in Tanzania?

iii. What are the effects of fertility on maternal health in Tanzania?

1.7 Research Objectives

The general objective of this study is to analyze fertility and its effects on health among mothers and children in Tanzania. The specific objectives to:

i. Determine the effect of socio economic factors on fertility in Tanzania.

ii. Analyze the effects of fertility on child health in Tanzania.

iii. Investigate the effects of fertility on maternal health in Tanzania.

1.8 Significance of the Study

Improved health status is an important aspect related to the economic growth of a country. Thus, the understanding of the relationship fertility and maternal and child health are imperative to policy design and implementation. As indicated by UNICEF (2010), malnutrition has a long-term effect on the future of children similar to the health of the mothers. The limited physical and mental functions of a child may ultimately lead to death. Malnutrition is a policy agenda in Tanzania which has been implemented through major policies and strategies set in the Poverty Reduction Strategy Paper (PRSP) of 2001 and in the Millennium Development Goals

(Twaweza, 2010). However, little is known on the influence of family size. Therefore, the findings of this study benefit other researchers, policy makers and stakeholders, particularly in the designing of specific policies for improving the health status of individuals.

In addition, since lower fertility and health of mothers and children positively impact individual incomes and future productivity, the findings of the study contributes towards pro-poor growth policies. In turn, these policies would help to improve the overall health status of children and mothers and consequently alleviate poverty in Tanzania. This study therefore makes a significant contribution to the literature by addressing research gaps in health status with particular reference to fertility, maternal and child health and how they related to each other.

1.9 Scope and Organization of the Study

This study is based on secondary data obtained from the Tanzania Demographic and Health Surveys conducted in 2010. Chapter one introduces the topic, problem statement and study objectives. Chapter two reviews relevant theoretical and empirical literature on fertility maternal, and child health in Tanzania and around the world, chapter three presents the methodology and estimation models adopted for the analysis. Chapter four presents the study findings with respective discussions and chapter five provide a conclusion, summary, policy implications and further areas of research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction to Literature

This chapter reviews the theoretical literature on the fertility and health production function and empirical studies relating to fertility, maternal health and child health. The theoretical literature reviews quantity-quality model and Grossman demand for health based on human capital theory to explaining the relationship between fertility, maternal and child health. The study also reviews empirical literature on the determinants of fertility and the effect of fertility on maternal and child health. Lastly, the chapter gives an overview of existing literature showing the research gap that was filled by the current study.

2.2 Theoretical Literature

Economics and demographic literature have modeled fertility and health outcomes as a function of household, parental, child and community characteristics. Most of the studies have used consumer choice model to model the demand for children (fertility) and other health outcomes based on the utility maximization theory. The consumer choice model emphasizes the quantity-quality trade off; hence, income and price effects of children (Becker 1960; Becker and Lewis 1973). Theories on fertility and health based on household utility maximization behavior are discussed in this section.

2.2.1 Quantity-Quality Model

Becker (1960) developed the theory of demand for children through the quantity-quality tradeoff model. The quantity-quality model suggests a negative relationship between the number of children (quantity) and the quality of children. Accordingly, Becker (1960) argues that children are desired because of the benefits they generate towards the household activities and that children are seen as durable consumer goods that compete with other commodities in the household utility function. Consequently, parents compare the utility of having children with that of other goods and make a choice thereof (Ahene-Codje, 2007).

The model further assumes that parents have preferences concerning the number and the quality of children they would want to have in the household. The quality of children is further linked to their education and health status which is influenced by the total time and resources that parents invest in them. These investments are subs-consequently determined by income and prices. Hence the conclusion was drawn by the theory is that parents increase their investments in the quality of their children (human capital) while decreasing the number of children. Thus, there is trade-off between the quantity and quality of children.

Becker and Lewis (1973) further supported the use of shadow price of children on the number of children to explain the quantity-quality trade-off model. They argued that an increase in quality of children is more expensive if there are more children than if there are few. In the same line, an increase in the quantity of children is more expensive if children are of higher quality.

This means that there is an income and prices effect of an increase in number and quality of children as well as of other commodities in the household demand function (Ahene-Codje, 2007). In their paper, they argued that an increase in family income and women's wage, holding prices constant, has a direct effect on increasing the number and quality of children as well other commodities. The show price of quantity and quality of children is determined by the women's wage and family income. Ahene-Codje (2007) further argues that income is more elastic with respect to quality than quantity. This suggests that when women's wage increases, there is a likelihood of more investment in the quality of children than in their quantity. However, when family/household income increases, the effect of on the demand for children depends on the relative strength of income and the substitution effect. A household could increase both the number and quality of children with an increase in the family income. However, an increase in the quality of children raises the costs of raising children which decrease fertility. Becker and Lewis (1973) state that, higher household income results in fewer high quality children when the substitution effect is stronger than the income effect.

However, Robinson (1997) criticizes the quantity-quality trade off model. The assumption and the proposed theories explaining fertility decline as a result of economic development may not hold. This is because of the time-intensity of the technology necessary for child services and increasing the value of time of women as a result of high opportunity costs of the labor market are sufficient reason for the quantity-quality trade-off theory. In addition, Robison (1997) argued that fertility is likely to be driven by a fall in the expected total utility of child services rather than the changes in consumer preferences of the quantity-quality trade off.

2.2.2 Grossman Model of Health Production

Most of the economic theory on demand for health is based on Grossman human capital theory to health (Grossman, 1972; 2000). This theory has been widely used to explain the health status of an individual. Grossman human capital theory of health analyzed demand for health from the utility function. In this theory, demand for health is modeled like demand for any other commodity as individuals maximize utility subject to given budget and time constraints. According to Grossman (1972:2000), health care services are demanded because they improve health status implying that demand for health services is derived from demand for health. In the model, each person inherits an initial stock of health which decreases with age, but can be increased through investments. The decision to seek medical care as an input help counteract the natural depreciation of the health stock. Other inputs include exercise, education, nutrition and lifestyle choices.

Grossman (1972:2000) argued that medical care is different from other goods and services, since what an individual is buying is better health. In addition to increasing productivity, increased health also increases the total amount of time that can be spent on producing earnings and commodities. Therefore, health is demanded, first as consumption and second as an investment commodity. According to Grossman, (2000) health can directly enters the individual's utility function as well as enhance the stream of more healthy days. This allows market as well as non-market activities. Human capital theory also explains how individuals invest in human capital (education and job training) to increase the productivity of the individual in the labor market.

Thus, the theory highlights the role of human capital in producing earnings and in the household sector to produce commodity which enters back in to the individual utility function (Becker, 1962; Grossman, 1972; 2000). This provides incentives for an individual to invest in schooling or on-the job training. The cost of this investment includes direct outlays on market goods and the opportunity cost of time that must be withdrawn from competing uses.

Grossman (1972; 2000) model of health has played a significant role in economic thought of human capital and demand for health. However, it has weakness since it only applies to the analysis of only one individual when the majority of individuals live in the family which is more than one member. The model also analyses the adults and not children's demand for health as it ignores the fact that individual demand for health can be influenced by other members of the household (Ralsmark, 2008). To make Grossman model more realistic, Jacobson (2000) extended it to include two and three person's family. A life–time perspective that includes children is needed when analyzing the factors that determine child and adult health since the decision of resource allocations, education and job training are made by the family (Wadsworth, 1996:1997). The present study used the human capital theory and Quantity-Quality model to analyze fertility and its effect on maternal and child health outcomes in Tanzania.

2.3 Empirical Literature

2.3.1 Determinants of Fertility

There are various studies that have been conducted to estimate the socio-economic effects of fertility. However, the majority of these studies have based on developed countries and few in developing countries. These studies have used quantity-quality (Becker, 1960: Becker and Lewis, 1973) framework to identify the proximate determinants of fertility. Due to difficulties in estimating the demand for children, reduced from equations and count data models have been estimated. The two common dependent variables in micro-level studies are either children ever born to the mother (Ayoub 2004; Bhargava, 2007; Tadesse and Asefa, 2001) or individual lifetime fertility goals (Tadesse, 2010: Rahman, 2012).Tadesse and Asefa(2001) used cross-sectional data to examine the socio-economic determinants of the demand for children in Jimma, Southern Ethiopia. The results from the Poisson regression model revealed that the number of children desired is a function of household income. The results further show a negative impact of an increase in the level of schooling attained by parents on the number of children. Households that expect financial support from children at later ages had higher fertility desires than those who expect no economic support from their children. The study also indicates that household headed by followers of Muslim religion desired to have more children than couples from other, mainly Christian denominations. While the study was not a nationally representative for Ethiopia, the current study examined the effects of socio-economic factors on fertility in Tanzania using Tanzania Demographic Health Survey Data for 2010.

Schultz and Mwabu (2003) studied the causes and consequences of fertility in contemporary Kenya using Kenyan household data for 1994 and 1997 respectively. They used Instrumental variable approach (IV) to control for the potential endogeneity of log consumption per adult in the fertility model. In their study, the log of consumption per adult was endogenous to fertility, thus validating the use of IV method to provide accurate fertility estimates. The results indicated that family income from returns on physical capital such as land holdings increased fertility whereas income from returns on human capital of women lowered fertility.

The study further found a positive and statistically significant relationship between the anticipated increase in reproductive endowment as reflected by twins and their fertility behavior. Therefore, Schultz and Mwabu (2003) suggested the use of less costly family planning methods and investment in education as policies to lower fertility in Kenya. Though their study controlled for the possible endogeneity between log consumption per adult and fertility, it did not account for the heterogeneity effects which could arise from the effects of unobserved factors that could interact non-linear with consumption per adult. The present study estimated the causes of fertility using Zero Inflated Poisson regression.

Ayoub (2004)used Tanzania Demographic Health Survey for 1996 to estimate the effect of woman's education on the use of contraceptive and fertility level in Tanzania. Negative binomial regression was employed to estimate the relationship between women's schooling and fertility while logit model was used to estimating the effect of education and use of contraceptive. The study considered woman's schooling levels, knowledge of ovulatory cycle, awareness of family planning program, use of contraceptive, mother's age, the number of siblings, place of residence and son preference.

Women's schooling and other socioeconomic variables were found to be significant determinants of fertility and contraceptive use. While the coefficient of higher education was found to be negatively related with fertility, the coefficient was positively related to contraceptive use. The study further suggested that women's education should be enhanced so as to improve their economic opportunities, increasing the value of their time and in turn their desire for large families. Nevertheless, the study failed to control for the endogeneity of contraceptive use in the fertility model. Furthermore, the study did not account for the excess zeros in the fertility equation and the fact that the study used old data set warrant another study in Tanzania.

Maitra (2004) and Hondroyiannis (2004) examined the determinants of fertility in Nepal and Greece respectively. While Maitra (2004) used the Nepalese Living Standard Survey (NLSS) data to examine the effect of socioeconomic, demographic and cultural factors on age of a woman at first marriage and on fertility level, Hondroyiannis (2004) used Cross section data for Greece extracted from the European Community Household Panel Survey (ECHP) wave in 1997.

These studies considered education, the age of a woman at first marriage, place of residence, mother's age, mother's employment status, child mortality and household wealth. While both authors used count data model (Poisson regression models) to estimate the determinants of fertility, Maitra (2004) employed hazard model to estimate the effect of socioeconomic factors on age at first marriage and then the predicted log of age at first marriage was included among explanatory variables in the fertility model. Both studies found that maternal education, women's employment and mother's age at first marriage were negative and statistically significant related to fertility choice of the household in Nepal and Greece respectively. Moreover, child mortality affected the number of children in Greece positively. The present study employed Zero Inflated Poisson regression models to estimate the effects of socioeconomic factors on fertility using the Tanzania Demographic Health Survey Data for 2010.

Dust (2005)carried out a study on the effect of education, income and child mortality on fertility using the South Africa Integrated Household Data for 1993. While examining the effects of these variables on a number of children born, the study controlled for the endogeneity of income and child mortality using household expenditure and access to water and health care facilities as instrumental variables. In addition, the study employed Ordinary Least Square (OLS), and Poisson regression model to account the non-negative property of fertility. The study found a statistically significant effect of secondary and post-secondary education on fertility across all the models. Furthermore, income was found to be negatively correlated with fertility in all the models but significantly only in the OLS and Poisson model. The current study estimated the effects of socio-economic factors on fertility using Zero Inflated Poisson regression models in Tanzania. In addition, the study extends the analysis by examining the effects of fertility on maternal health and child health outcomes using OLS, Probit, instrumental variable and control function approach.

Benefo (2006) examined the role of women's education in regulating fertility and contraceptive use in rural Ghana. The study used surveyed data collected in 1980, and multinomial logit model to examine the effects of women's education in regulating fertility and contraceptive use. The study found that net of woman's characteristics, a woman's interest in regulating fertility and contraceptive use increases with the percent of women education in her community. On the contrary, age, family size and age at first marriage had significant effects on spacing. This study did not consider the fertility characteristics of the count data. Furthermore, the study did not control for the excess zero as characterized in the fertility model. The study in Tanzania has examined the socio-economic as well as demographic factors of fertility using the Zero Inflated Poisson regression models.

Church and Blacklow (2006) examined the supply and demand factors that affect how many children a couple will have in Australia. The study used Household Income and Labor Dynamics in Australia (HILDA) in which 7096 randomly selected household were selected on a wide range of household and personal characteristics. Ordinary Least Squares, Poisson regression, multinomial logit and sequential logit were used to examine the factors affecting fertility in Australia.

The study found that female wage and living in urban were negative and statistically significant at five percent level in reducing fertility while having parents who were migrants raised the number of children. Marital status and housing price were found to be positive and statistically at five percent level with fertility while women's education was found to reduce fertility and the coefficient was negative and statistically significant at one percent level. The current study estimated the effect of socioeconomic factors on fertility using data from Tanzania Demographic Health Surveys for 2010.

Using Ghana Living Standard Survey conducted in 1987/88 and 1998/99, Ahene-Codje (2007) investigated factors responsible for fertility decline over time using Oaxaca-Ransom (1994) decomposition method and Ordinary Least Square method (OLS). The OLS was estimated from the reduced model and include education and other socioeconomic characteristics effects on a number of children in the two survey years in Ghana. The Oaxaca-Ransom (1994) was estimated to determine the source of fertility differences, whether that difference was associated with the observed characteristics of the individual woman or coefficient in both surveys. The study found that education, the age of the mother; urban residence and labor market participation significantly reduced the number of children in Ghana for the two years of the surveys. The expenditure per adult increased the number of children by 12.29

percent with its coefficient being significant at one percent level. However, the use of Ordinary Least Square (OLS) could bias the estimates of fertility since fertility is a count data model.

Osili and Long (2007) studied the relationship between female schooling and fertility in Nigeria. Using data from the Nigerian Demographic Health Survey Data for 1999 and the Introduction of Universal Primary Education in Nigeria as a policy instrumental, the study test whether the relationship between fertility and education was indeed causal. The study used universal primary education as an instrumental variable for education and employed difference in difference model to account for the confounding factors (simultaneity bias) and other omitted variables that could affect the relationship. They found that change in education policy had a significant impact on both female education and fertility in Nigeria. The increase in education by one year reduces fertility by 0.26 births. The study further found that instrumental variable estimates were higher than the Ordinary Least Squares (OLS) estimates. As a limitation, the study did not treat fertility as a count data variable and control for the excess zeros in the model.

Ambel (2007) pooled Ethiopian Demographic Health Survey Data (EDHS) for 2000 and 2005 to examine the effect gender preference and income uncertainty on desired fertility for the women respondents ages 15 to 49. To address the selection problem of non-numeric response of the dependent variable, the study followed Green (1997), Terza (1998), Kenkel and Terza (2001) and used the modified standard poisson model. The study found that fertility desires were high for individuals with low wealth ranking. Fertility desire was also higher for people who are not currently working in and have more preference for more sons. Similarly, the interaction of income uncertainty and son preference was found to be positive and significant in all specifications. The study also found a negative effect of education, positive effects from age and marital status in all the specifications. However, the study failed to account for the excess zeros that may characterize fertility data.

Bhasin *et al.* (2010) used the Instrumental variable method (IV) and the control function to examine the determinants of fertility, incomes and poverty in Ghana. The study used Ghana Living Standard Survey Data for 1998/99. They found that fertility was positively correlated with a log of consumption expenditure. The study further found a positive correlation between fertility and contraceptive use but was negatively affected by education of the woman and her husband. The control function approach confirmed that the consumption expenditure per adult was endogenous and that there was evidence of heterogeneity in the fertility-log consumption expenditure per adult relationship. The study recommended the need to educate the public about proper use of contraceptives, improve access to and utilization of reproductive health services; and to reduce poverty in the country by implementing poverty alleviation projects. However, the study failed to treat fertility as a count variable and control for the excess zeros that may characterize fertility data.

Cao (2011) examined the effect of women empowerment on fertility in Tanzania. The study used Tanzania Demographic Health Survey Data (TDHS) for 2004/05 to examine women empowerment defines as domestic decision-making ability, being less exposed to domestic violence and education. The dependent variable included in the model were: ideal number of children (desired), the actual number of children and the difference between actual and the ideal number of children. Furthermore, the study included contraceptive prevalence, mother's age, mother's height a age, mother's height, and husband's characteristics such as education levels, age, being presented at home and religion, place of residence, wealth index and regional dummies.

The study used Ordinary Least Square (OLS), Probit and Tobit model to analyze the effect of women empowerment on fertility. The study found that women empowerment reduced desired fertility (ideal), but had a weaker effect on actual fertility and the gap between the two. However, domestic decision-making capacity seems to have bigger influence on desired fertility than existence of domestic violence and education. The study further revealed that all explanatory variables including urban, religion, wealth index, region dummies and contraceptives had negative and statistically significant effect on desired and the actual number of fertility. However, the study failed to treat fertility as a count variable.

Aldieri and Vinci (2011) examined the correlation between education and fertility in Italy, using data from the European Union Statistics on Income and Living

Conditions for the period 2004-2007. Zero Inflated Poisson regression model and Poisson model were estimated. The study found a negative relationship between education and fertility while yearly family income, good health and government transfers increased fertility.

In related studies conducted in Bangladesh and Uganda, Islam and Nesa (2009) and Bbaale (2011) used Bangladesh Demographic Health Survey Data for 2001 and Uganda Demographic Health Survey data for 2006. This was to investigate the role of education in fertility and contraceptive use while controlling for other factors like wealth status, the area of residence and region. While Islam and Nesa (2009) used Poisson regression model, Bbaale (2011) used OLS and probit model to estimate the relationship between education and fertility in Uganda. Education, wealth and place of residence reduced the number of children in Bangladesh and Uganda respectively. However, these studies did not control the excess zero in the fertility model. Bbaale (2011) failed to treat the count data property of fertility.

Cheng (2011) treated fertility as a continuous variable to investigating the effects of contraceptive knowledge using mass media and exposure to the social network as a proxy for contraceptive knowledge in Taiwan. The study used cross-sectional data on Knowledge Attitude and Practice of Contraceptives (KAP) for 1965, 1976, 1980 and 1985 for Taiwan. The address the endogeneity of contraceptive knowledge in the fertility equation, the study estimated twos stage least square (instrumental variable) and proposed mass media and exposure to the social network as instrument. The instruments were tested for the validity and strength using Sargan Basmann test and were found to be valid and strong. The study found that mass media and social network play a significant role in converting contraceptive knowledge into behavior which in turn reduces fertility. The study also considered women's working status and years of schooling as prices (opportunity costs) of fertility. These variables turned to be negative and significantly correlated with fertility in Taiwan. Despite the contribution in trying to instrument for contraceptive knowledge, the study did not treat fertility as a count data variable.

Gudbrandsen (2010), Phonvisay (2010), Owoo (2012); Imai &Sato (2013) and Zanin *et al.* (2015) investigated the relationship between, women's autonomy, education, child mortality, contraceptives and other socioeconomic and other demographic factors and fertility in Nepal, Lao, Senegal, Ghana, India, Ethiopia and Malawi respectively. These studies employed data from Demographic Household and Health Survey for Malawi Ghana and Senegal while National Family Health Survey (NFHS) data covered for the period 1992-2006 was used for India. Logistic, Poisson regression model, spatial lag model, Two-Stage Generalized Additive Model (2SGAM), Ordinary Least Square (OLS), Probit and Instrumental variable methods were estimated. While Imai & Sato (2013) and Zanin *et al.* (2015) corrected for the endogeneity on education in the fertility equation for India and Malawi using probit and instrumental variable approach, they failed to treat fertility as a count variable property of fertility and control for the excess zeros in that may characterize fertility data.

These studies confirmed that mother's education, wealth and area of residence, child mortality, employment, contraceptive, mass media, family planning and religious affiliation were important factors affecting fertility in India, Malawi, Senegal, Ethiopia and Ghana respectively.

2.3.2 Effect of Fertility on Child Health

Among the studies that examined the relationship between fertility and child health was that of Rosenzweig and Schultz(1983). The study used probit model to examine the relationship between fertility and child mortality in USA using data from National Natality Foloow-Back Survey of 1967, 1968 and 1969.

As remedies to the problem of endogeneity parents and child heterogeneity, the study applied instrument variables to estimate the child mortality production function. The study found that the OLS and 2SLS coefficient estimates differed substantially, suggesting that 2SLS gives consistent and unbiased results than OLS. For example, using OLS, the study indicates that delay in prenatal care has a small and negative effect on infant mortality. On the other hand, 2SLS results confirmed the anticipated finding that such delay considerably increases the probability of infant death. The present study also followed Rosenzweig and Schultz (1983) to investigate the effect of fertility on maternal health and child health outcomes in Tanzania using OLS, Probit, 2SLS and control function approach.

Schultz and Mwabu (2002) investigated the relationship between the number of children and the well-being of children in Kenya using a theoretical literature on the household models developed by Becker and Tomez (1976).The study used household surveys in Kenya collected in 1994 and 1997 by the Central Bureau of Statistics, Ministry of Finance and Planning. Using instrumental variable and a fractional polynomial of degree m to estimate the effect of fertility on child health, the study found a positive relationship between fertility and child health. Upon controlling for biological factors, the study negative relationship between exogenous increase in fertility and body mass index of Kenyan children. The study recommended that government should invest in programs that reduce fertility and increase women education in order to improve the wellbeing of children in Kenya. As a limitation, Schultz and Mwabu (2002) did not control for the heterogeneity effects due to the unobserved determinants of child health that may interact non-linearly with fertility.

Silva (2005) examined the effect of community environmental factors on the probability of stunted and underweight for the under-five children using Demographic Health Survey Data for 2000 in Ethiopia. The study estimated probit regression model using maximum likelihood estimation techniques (MLE) for stunting and underweight equations. The study found that probability of a child being underweight increases significantly with child's age and BMI while the coefficients for number of children under five, household size and gender were not important variables in both underweight and stunting. The study further revealed that household wealth and community access to water and sanitation decreased the probability of a child being underweight and stunted while female-headed household was found to increase the likelihood of a child being underweight. Lastly maternal education reduced the likelihood of a child being underweight and stunted but the impact was relatively small. However, the study failed to account for the endogeneity of number of children and household size. Furthermore, the study failed to control for the heterogeneity caused by the unobserved determinants of child health that may be correlated with the regressors in the child health.

Glick *et al.* (2007) investigated the consequences of changes in fertility on child health and education in Romania using the first two rounds (1994-5 and 1995-6) Romania Integrated Household Survey. The study used Two -Stage Least Square and natural experiment of the first birth twins as instrumental variables to estimate the effect of changes in fertility and school enrollment of children in Romania. The dependent variables were height-for-age Z-scores for children aged 0 to 60 months and enrollment status of children in Romania. The first stage of the regression model estimated the effect instrumented variable (first birth twins) and other socioeconomic variables on reported fertility while the second stage estimated the effect of the predicted fertility on the two dependent variables.

The results from the first stage regression shown that birth twin was positive and significantly related to fertility which implies that twins were valid instrument variable of fertility in Romania. The study found that the effect of instrumented fertility on height-for-age-z-scores was negative and statistically significant at one percent level. This suggests that an additional child reduced the height-for-age Z-scores. On the other hand, an instrumented fertility showed that an additional child was associated with a small reduction in the probability primary school enrollment. However, the control for heterogeneity caused by the unobserved determinants of child health and fertility was not undertaken by the study.

Kim *et al.* (2005) studied the causal effect of fertility on household welfare using household expenditure per person and expenditure share of food in total expenditure in Indonesia. The study used panel data from Indonesia Family Life Survey conducted between 1993, 1997, 1998 and 2000. The variables considered by the study were number of children, proportion of children in the household, education attainment, marital status, religion, wealth index, employment and age. To establish the causal effect of fertility and household welfare the study employment propensity matching score method (quasi-experimental approach) with fertility being a treatment and household welfare as the outcome variable.

The study found that using household expenditure per person measures of welfare, fertility was positive and significant. However, fertility did not seem to lower household welfare when using expenditure share of food as a measure of welfare. The study suggests little evidence on the negative effect of fertility on household welfare in Indonesia. The study also failed to control for the potential heterogeneity of the unobserved determinants of welfare which may be correlated with fertility.

Broeck (2007) examined the role of child care practice and knowledge and other household, child and community characteristics on child malnutrition in Mozambique. The study used Mozambique Demographic and Health Survey Data for 2003 and height-for-age-z-scores as a measure of child health. While the study focused on the role of childcare practice, wealth and mother's education defines by the years of schooling, the study used possession of radio in the household and family planning programs as instrumental variable for child care practice. The study found that age of the child was negative and significant effect on child health in a rural area and that boys were found to have lower height-for-age z-scores than their girls. Height and Body mass index (BMI) of the mother was found to be positive correlated with height-for-age z-score in both rural and urban. The study also revealed a positive and significant of childcare, education and wealth effects on height-for-age z-sore in rural but not in urban. However, the study did not include fertility as an independent variable neither control for the heterogeneity of unobserved determinants of child health.

Chirwa and Ngalawa (2008) examined the determinants of child nutrition among the under five children in Malawi. The study used weight-for-age Z scores, height-for-age Z scores and weight-for height-Z scores as the dependent variable. Two Stage Least Square (Instrumental variable) model was used to address the problem of endogeneity of poverty (welfare indicator) in the child malnutrition. To account for the endogeneity of poverty, the study used household size, education of the parents and per capita land holdings as instrumental variables. The study found that child characteristics such as sex, age and illness of the child were statistically significant in all models. Specifically, the study found a negative relationship between age of the child and health. The male child was found to have better nourished compared to her male counterparts in all the models. As for the household and community characteristics, the study found that senior primary and junior secondary education of the mother or head of the household were negative related to stunting and wasting respectively at one and five percent significance level whereas reaching senior secondary and being a graduate did not statistically explain child malnutrition. However, the study did not consider fertility (family size) as an explanatory variable and the heterogeneity of child nutritional status caused by the unobserved factors of child nutritional status and explanatory variables.

Hatton and Martin (2009) conducted a study to estimate the effects of fertility decline in child health in Britain. The study used data on the height of children collected from British Family Survey during 1930. In the face of expected family size shock, the author employed probit model with an instrumental variable to account for the endogeneity of family size. The instruments were the incidence of twins, average weekly income for the occupational class of head of household share of the labor force in agriculture and share of the urban population. The study found that household income was positively related with children's height-for-age z-score and negatively to the family size in the household. The evidence suggested that fertility affected the health of children through its influence on both nutrition and disease. Furthermore, rising on household income and family size contributed significantly to improving child health between 1886 and 1938 in Britain. However, the study did not control for the heterogeneity of the confounding factors which may affect the relationship between family size and the height-for-age z-score.

Kabubo-Mariara *et al.* (2009a) used pooled data from Kenya Demographic and Health Survey (KDHS) for 1998 and 2003 to investigate the determinants of child nutritional status. Specifically, they examined the effects of child, parental, household and community characteristics on the children's height-for age z-score and the probability of stunting. The study used survey regression rather than OLS and policy simulation to explore the correlation between child nutritional status and its determinants. The study found a negative and significant effect of household size, birth order, male child and age on child nutritional status. The results further revealed that Mother's age, height, assets index and post-secondary education were found to be positive and significantly related to child's height, and the reverse was observed for the probability of stunting. However, the study did not focus on the fertility effects of child and maternal health status. Furthermore, they failed to control for the endogeneity of wealth and heterogeneity issues arising from the unobserved determinants of child health which may correlate with wealth and other explanatory variables.

Kabubo-Mariara *et al.* (2009b) examined the consequences of fertility on child mortality in Kenya while controlling for the endogeneity and heterogeneity using 2SLS and control function approach (CFA).The study used Kenya Demographic Health Survey (KDHS) Data for 2003 and used cluster share of contraceptives use and birth of multiple (twins) to instrument fertility. The study found that fertility was positive and significantly related to child mortality in the probit, IVprobit and control function model.

The study further revealed that maternal characteristics such as education, age at first birth had large significant effects of reducing child mortality. Upon testing for the presence of heterogeneity, the study found that fertility residuals and the interaction of fertility and fertility residual were significant at one percent level suggesting the presence of heterogeneity arising from the interaction of fertility with the unobservable determinants of fertility.

Amornsiripanitch (2011) used National Longitudinal study of Adolescent or Health Panel dataset in grade 7 to 12 in the United States to estimate the effect of fertility on child quality. The study used multiple birth (twins) and instrumental variable model. The study found mixed results. First, the study found that, having younger twins siblings in the household does not significantly affect the older children's performance in school. Hence, the results did not support the quantity-quality tradeoff model. Secondly, using the grade in science, the number of siblings was significant and negatively related to grade points in science, which imply that an increase in the number of siblings in the household decreases the older children grade in science. The study also found that the main determinants of child quality were the respondent's race, gender, mother's education, interaction with his/her mother, household income and participation in extracurricular activities.

Nonetheless, there was no control for the heterogeneity of the unobserved determinants of child quality in this study.

Using Demographic Health Survey Data to the sample of 43 developing countries Cáceres-Delpiano (2011) examined the effect of family size beyond child investment by studying different measures of development. While the study examines family size impacts on family arrangements, acceptance of violence and contraceptive behaviors, children outcomes were measured by vaccinations, years of education, grade retentions and the likelihood of attending school. Additionally, the study examined the effects of number of children on child mortality and the probability of children living in the same household with their mothers. By using 2SLS with multiple births as an instrumental variable for family size, the study found that number of children increases the likelihood of accepting domestic violence for some samples, raises the time between intercourses and increases the use of contraceptives and sterilization among women. For children's outcomes, the study reveals that more children in a family decreases the likelihood of a complete vaccination schedule, increase child mortality, reduce the probability of attending school and reduce the likelihood of living in the same household with their mothers.

Mulugeta (2012) conducted a study on the determinants of socioeconomic factors for child mortality in Ethiopia using Ethiopian Demographic Health Survey Data (EDHS) for 2011. The study included maternal, child and environmental characteristics. The study estimated 2SLS to account for the endogeneity of fertility in the child mortality equation using age of the mother as an instrumental variable. The findings shows that instrumented fertility was positive and significant related with child mortality. The study further found negative and statistically significant effect of maternal education, age at first birth, toilet facilities, safe water electricity and radio on the likelihood of child mortality. However, the results from this study should be interpreted with caution. Firstly, the validity of current age of the mother as an instrument for fertility could lead to inconsistent and biased estimates of fertility since the age of the mother affect child mortality. Secondly, the study did not take into account the heterogeneity issues that could arise from the unobserved determinants of child mortality that could interact non-linearly with fertility.

Aslam and Kingdon (2012) examined the effect of parental education on child health outcomes and health seeking behavior in Pakistan using panel data administered to 1194 households of Punjab Northwestern Frontier Province in Pakistan. Specifically, the study sought to understand the mechanisms through which parental schooling translate into better child health and improved parental health seeking behavior. The proposed pathways include family income, exposure to media, literacy, better health knowledge, mother's participation in the labor force and the extent of maternal empowerment in the household. The study used OLS and community fixed effect and measured child health outcomes using height-for-age z-scores, weight-for-age z-score. Furthermore, the study used instrumental variables by including additional pathways to control for the endogeneity of parental schooling on child health outcomes and immunization scores. The study found that, while father's education was positively associated with immunization, mother's education was positively related to child health outcomes. An additional year of schooling on the mother increases height-for-age z-score by 0.038 and increases weight-for-age z- score by 0.030 compared to a woman with no education.

Mother's age and parental height were found to be positively related to weight/height-for-age z-score while height-for-age z-score was found to decrease with age of the child implying poor child health outcomes as a child grow older. The study, nevertheless, did not control for the heterogeneity of unobserved factors, neither did consider fertility effects on maternal health.

Mugo (2012) examined the effect of parental socioeconomic on child health outcomes in Kenya using Kenya Integrated Household Budget Survey Data for 2005/2006. The study estimated 2SLS and control function approach using instrumental variables to control for the endogeneity and heterogeneity bias caused by the unobserved determinants of child health and parental socioeconomic factors. The study found positive and significant effect of maternal education on weight-for-age z- score in OLS but negative and significant in the IV and control function models. Conversely, maternal labor force participation was positively related to weight-for-age z-score in all models but only significant in the OLS model.

Being married influence weight-for age z-score positively and significant in both the OLS and IV models while place of residence had a negatively and significant effect on weight-for-age z-score. In all models, the study found positive and statistically significant of child age and height-for-age z-score while the male child was positive and statistically significant with a height-for-age z-score in the OLS model. The control function indicated that the coefficient of labor force participation residuals and their interaction were not statistically significant suggesting absence of heterogeneity bias. The present study also used OLS, 2SLS and control function approach to model the effect of fertility on child health and maternal health in Tanzania.

Awoyemi *et al.* (2012) sought to understand the effect of environmental and socioeconomic correlates on child malnutrition in Iseyin area of Oyo state in Nigeria. The results from probit estimates show that age of the child, diarrhea infection and poor sanitation were the key environmental factors that increased the likelihood of malnutrition in the study area. Age of the child increased the probability of child malnutrition by 21 percent while diarrhea increased the probability of malnutrition by 16 percent. The study further revealed that poor sanitation increased the probability of child malnutrition by 37 percent. However, the study did not find any significant relation between socioeconomic factors and child malnutrition in the study area. The study in Tanzania established the link between fertility, maternal and child health outcomes using OLS, 2SLS and control function approach to address endogeneity of fertility and the potential heterogeneity in the child and maternal health equation.

Ssewanyana and Kasirye (2012) examined the determinants of child nutritional status and health inequalities in Uganda using pooled Demographic Health Survey Data for 1995 and 2005. The study used height-for-age z- score as the dependent variable. The study found that the log of asset index greatly affects the nutrition of children and health inequalities in Uganda.

Additionally, completion of secondary was positive and statistically significant related to child nutrition. However, the impact of post-secondary education was insignificant for the 1995 sample. The study found that multiple births and a male child, birth order and age, negatively influenced child nutrition, while water and sanitation was found to have mixed results. The increased use of water and bore and borehole were both associated with increase in height-for-age z-score. However, the effects were only significant for the 2006 samples. Although the study attempted to control for non-linearity through the interaction of wealth, education and child health, they did no control for the possible endogeneity of wealth in the child nutrition models.

Kuepie and Saidou (2013) examined the effect of fertility on household economic status in Cameroon, Mali and Senegal using Demographic and Health Survey Data for 2004 for Cameroon, 2005 for Senegal and 2006 for Mali respectively. The study estimated OLS, quintile and 2SLS and utilized birth twins and the reported infertility to control for endogeneity of fertility in the welfare equation. The findings indicate that each additional child reduces the household assets by 7 percent in Cameroon as opposed to 10 percent in Senegal in the 2SLS model while additional child reduces household assets by just 4 percent in Mali when estimated using OLS. The study suggested that fertility impacts negatively on the household in all the three countries with greatest effect in Senegal, followed by Cameroon and Mali. Estimating fertility on different portions of household assets using quintile regression, the study found that fertility had a statistically different impact on assets accumulation between the first quartile and the last quartile. However, the study failed to control for the heterogeneity bias caused by unobserved determinants of fertility and household socioeconomic status

Lundborg *et al.* (2013) examined the effect of family size on child health using data from Swedish National Survey Administration between1965-1978. The paper studied the causal effect of family size by comparing the effects two dominance hypothesis; Hygiene hypothesis and resource dilution hypothesis. The study employed OLS and 2SLS to estimate the effect of family size and child health and instrument fertility with occurrence of twin's birth. The findings show that the coefficient of family size was negative and statistically significant at one percent level. The study further revealed a positive and statistically significant of family size on child health in the IVprobit model. The study, however, did not control for the heterogeneity of health size caused by the unobserved factors correlated with family size.

Namubiru (2014) examined the effect household poverty on women's fertility and child nutritional status using Demographic Health Survey Data for 2006 and Uganda National Household Survey (UNHS) for 2005/2006. The study estimated ZIP, 2SLS and control function approach (CFA).The study found that wealth was inversely related to fertility in the OLS and ZIP models but positively related with child nutritional status in the OLS, probit, IVregress, IVprobit and control function model respectively. Mother's age, marital status and mother's primary education were found to be positively related to fertility in the OLS and CFA model whereas women's with secondary education had a negative and significant effect on fertility in the OLS and CFA model. Furthermore, results indicate that boys tend to have lower nutrition compared to girls in the OLS, probit with instrumental variable and CFA model. However, the study did not address maternal health status in Uganda.

Oyekale (2014) analyzed factors influencing child mortality in Ethiopia using Ethiopian Demographic Health Survey data for 2011. The study estimated 2SLS and used household size, mother's age and uptake of health insurance to control for the endogeneity of fertility in the child health equation. Results for the probit and 2SLS show that additional child reduced the probability of child survival in Ethiopia. Furthermore, age of the mother at first birth increased the probability of child survival by 0.0193. However, the use of household size and age of the mother to instrument fertility is likely to be doubtful since the proposed instruments are also important determinants of child mortality.

Peters *et al.* (2014) examined the tradeoff between family size and child health in rural Bangladesh using Matlab Health and Socioeconomic Survey conducted in Bangladesh in 1996.The study used 2SLS and age at menarche to control for family size in the child health equation. The study found little evidence in the support of the tradeoff hypothesis of quantity-quality suggesting that family size was not a significant determinant of child health. However, the study did not control for the heterogeneity caused by the unobserved determinants of child health corrected with fertility.

Kamal and Islam (2014) examined the differential impacts of some socioeconomic, demographic and health-related factors on nutritional status among the under-five children based on the Bangladesh Demographic and Health Survey Data (BDHS) for 2007. The study estimated ordered probit using moderate, mild and severe malnutrition as a measure of child health. They found that maternal and father's education, source of drinking water, the presence of electricity, TV, radio and newspapers were associated with a reduction of malnutrition in Bangladesh. While Kamal and Islam (2014) focused on the determinants of child malnutrition, this study analyzed the determinants of fertility and its effect on the health of mothers and children in Tanzania using zero inflated poisson, OLS, instrumental variable and control function approach.

Shiratori (2014) examined the correlates of child malnutrition of under-five children in Tanzania. The paper employed quintile regression technique to estimate the socioeconomic determinants of child nutritional status using the Tanzania Demographic Health Survey Data for 2010. The study considered effects of individual variables such as sex, age, and household variables such as parental schooling and community variables such as rural/urban on child height for age and hemoglobin. The findings suggested that mother's height and body mass Index (BMI) had a significant effect on height- for- age z-score indicating the crossing of nutritional status from one generation to another. Mother's education had a significant effect on height-for-age z- score but only at the higher level of schooling, which is more than primary completed. Household size significantly associated with height-for-age z-score; however, the number of under-five children in the household reduced the height-for-age z-score. Mother's level of hemoglobin had a significant effect on height-for-age z-score and child hemoglobin level which also support the idea of intergeneration transfer from one person to another. In regard to the education level, the study found both mother's and father's educational attainment had significant effect on height-for-age z-score and hemoglobin level of mothers and children.

Baranowska-Rataj *et al.* (2015) examined the effect of fertility on child health in Sweden using long-term physical and mental health as measures of health. The study used data from Swedish Registers that provide rich information on family structure, socio-economic background and health outcomes of family members. The study used propensity score matching and 2SLS using twin's birth as instrumental variables as proposed by Rosenzweig and Wolpin (1980). The study found that growing up in a larger family did not have a detrimental effect on health. However, some health outcomes turn out to be better among individuals who had more siblings. Although the study provides some evidence for the link between family size and child health outcomes in a context of the developed country, the present study has examined the effect of fertility on child health and maternal health in the context of developing country.

2.3.3 Effect of Fertility on Maternal Health

Ralsmark (2008) examined the relationship between family size and parental health production in Indonesia. Furthermore, the study tested the theory of intrahousehold resource allocation using unitary bargaining models between couples in the household. Blood pressure for both mother's and husbands were drawn from 2000 Indonesian Family Life Survey (IFLS) and analyzed using OLS. The study found that number of daughters living at home in the household was associated with an increase in blood pressure for the mothers but not for fathers. The study further rejected the common preference assumption and supports the bargaining models of household resources allocation. Age square was found to be significant at one percent suggesting that the effect of age and blood pressure is non-linear. Lastly, occupation dummy significantly decreased blood pressure by 3.8 for those working in the retail sector than those working in the other sectors. However the use of OLS did not provide evidence on the causal effect of family size on blood pressure. The study also did not control for the endogeneity of family size and heterogeneity of the parental health interacted with family size.

Wu & Li (2012) examined the impact of family size on maternal health outcomes by exploiting the change in family size introduced under One Child Policy in China. Empirically, the study tested quantity quality trade off theory using China Health &

Nutritional Survey Data for 1993-2006 2SLS. Moreover, they estimate OLS, probit, and ordered probit models on body mass index (BMI) and other health outcomes generated from the body mass index such as underweight, overweight and obesity. The study found that family size was an important determinant of maternal health status in China. It was revealed that mothers with fewer children had lower probability of being underweight and having low blood pressure. At the same time, mothers with fewer children increased the probability of being overweight. The study also found larger impact of number of children on the probability of underweight and low blood pressure for the less educated women and low income women which may reflect a tighter family budget. However, the study did not control for the heterogeneity arises from the unobserved factors of maternal health and family size.

Awiti (2013) examined the effect of preceding birth interval length on maternal health outcomes using pregnancy complications as health variable in Kenya. The study pooled Kenyan Demographic Household and Health Survey for 1998, 2003 and 2008. Addressing endogeneity of the preceding birth interval length, sample selection and heterogeneity bias in the maternal health, the study estimated two stage residual inclusion (2SRI) and Heckman approach. The study did not find the sample selection bias and the potential heterogeneity. However, the study confirmed the endogeneity of the preceding birth interval length in the maternal health equation. Maternal health was found to be influenced by secondary education, mother's age at birth and asset index. The present study in Tanzania used mother's nutritional status to examine the effect of fertility on maternal health. In addition, the study addressed the endogeneity of fertility and the potential heterogeneity bias using 2SLS and control function approach.

Adeoti & Awoniyi (2014) examined the determinants of child health, maternal health status and demand for health care services in Nigeria using Nigerian Demographic Health Survey Data for 2008. They employed OLS, 2SLS and control function to examine determinants of child and maternal health status using log of body mass index and the probability of child stunting. The study also include age, mother's occupation, education, household size, residence and place of delivery. However, place of delivery is endogenous in both mother and child health equation. Therefore, the study instrument place of delivery by access to agriculture land and time spent to fetching water and firewood. The study found that place of delivery was positive and statistically significant at one percent level in improving mother's body mass index (BMI) in the OLS, 2SLS and CFA models.

Furthermore, coefficients for mother's age, no education level and household size were negative and statistically significant at one percent level across all the models in the maternal health status equation. Upon controlling for the heterogeneity, the study found a positive and significant at one percent level on residual and their interaction hence presence of heterogeneity in the model. The present study in Tanzania examined the effect of fertility on child and maternal health status using OLS, 2sls and control function approach.

Muttai (2014) examined the effects of maternal education on maternal health outcomes using pregnancy complication in Kenya. The study utilized data drawn from Kenya Demographic and Health survey Data for 2003 and 2008. Using the binary indicator, pregnancy complication indicates whether or not a woman has ever had a pregnancy that was aborted, miscarried or ended in a stillbirth. The study also controlled for the endogeneity and heterogeneity of maternal education by two stage residual inclusions (2SRI) that may arise from the unobserved determinants of maternal health and education. Comparing the results from the 2003 and 2008 survey years, the study found that mother's education did not have significant effect on pregnancy complications for 2003 survey.

Despite being statistically insignificant for the 2003 data, the 2SRI for 2003 estimates revealed that smoking, working and living in urban residence had a positive impact on pregnancy complications. The 2SRI estimates for 2008 revealed a negative and statistically significant effect of mother's education on pregnancy complications. Moreover, mother's age, smoking, bmi, household wealth, living in urban residence were found to reduce the probability of pregnancy outcomes in Kenya. The coefficients of education residual and the interaction of education and education residual were significant in the 2008 survey year. This means that education was truly endogenous and that controlling for the endogeneity and heterogeneity for pregnancy complication was necessary. However, the study did not establish a causal link between maternal education and pregnancy complication due to lack of good instruments for maternal education.

Achieng (2014) examined the determinants of women nutritional status in Kenya using Kenya Demographic Health Survey Data for 2008. The study examined the effects of parental, household and community factors on the probability of mother being underweight, overweight or obese using 2SLS and probit model. The 2SLS controlled for the endogeneity of socioeconomic status (wealth index) in the maternal nutritional status. The study suggested household size as an instrumental variable for the socioeconomic status in the mother's nutritional status model. However, the proposed Instrumental variable approach failed suggesting that socioeconomic status (wealth index) was truly exogenous to maternal nutritional status.

The study found that mother's age, marital status, and mother's education, employment status, place of residence, socioeconomic status, and type of toilet facility and source of drinking water were found to important determinants of underweight, over weight and obese in Kenya. Although the study did not examine fertility effects of maternal nutrition in Kenya, the study can still serve as a benchmark to examining the effects of fertility on maternal health status in Tanzania.

Jayawardena (2014) examined the determinants of child and maternal malnutrition in Sirlanka using Sirlanka Demographic and Health Survey (SDHS) for 2006/07. While the study measured child malnutrition using the probability of stunting, maternal health was measured by the probability of underweight.

The probit estimates indicated a negative effect of low birth weight, mother's education and height on malnutrition for both mothers and children. The study also found negative effect of number of children and the food intakes on child malnutrition in Sirlanka. However, the study did not control for the endogeneity of children in both maternal and child health equation.

Kulkarni and Gaiha (2014) examined the factors affecting the likelihood of underweight and overweight among the Indian women between 22 to 49 years. The study utilized Human Development Survey Data for 2005 and used probit model and the variation in the ratio of underweight to overweight. Per capital expenditure and higher education were found to be associated with lower probability of underweight for women in the urban areas but the corresponding elasticity value was much larger than in the rural areas. Age, sanitation and hygiene lowered the probability of being underweight while marital status and media exposure had a positive and significant effect on overweight. However, the study did not consider the effect of fertility on underweight and heterogeneity of the unobserved determinants of underweight.

In a related study, Dahiya and Viswanathan (2015) used data from India Human Development Survey, 2005 to examine the effect of multiple factors on women's nutritional status in India using body mass index (BMI). The study analyzed wealth index, per capita consumption expenditure, clean water, cooking fuel and education dummies using OLS and quintile regression model. They found positive and significant effect between Kerosene, electricity and toilet facility and the body mass index in the OLS and quintile regression model while household size and family with children between 0 and 4 moths had a negative and significant effect on body mass index. The study further revealed that education dummies except for higher education were positive and significant for the OLS estimates but many of the coefficients were not significant across the quintile.

However, the study did not account for the endogeneity of household composition (proxy for fertility) and heterogeneity that may occur from the unobserved determinants of BMI.

2.4 Overview of Literature

The theoretical literature has reviewed quantity-quality model and the Grossman demand for health based on the theory of human capital. These theories provide strong foundation for explaining the link between fertility, maternal and child health in both developing and developed countries. Furthermore, each of these theories provides the analytical and methodological approach that can be used to examine the determinants of fertility and the link between fertility on health. For example, transition from high to low fertility rates and how to improve health, nutrition and population outcomes of individual are discussed. From the empirical literature, vast majority of the studies examined the determinants of fertility in both developed and developing countries. Studies have also linked fertility with health outcomes using child mortality and child nutritional status. Depending on the measure of child health used, studies have revealed positive and significant relation while others found no evidence of significant relationship.

From the empirical literature, the relationship between fertility, maternal and child health was estimated using OLS, poisson regression and its variants, negative binomial regression and 2SLS. However, studies that used zero inflated poisson regression models to control for the excess zeros are few. The applications of this model were done in studies mainly in developed countries and a few from developing countries. In Tanzania for instance, Ayoub (2004) used the negative binomial regression treating fertility as a count variable taking the TDHS data for 1996 to estimate the socioeconomic determinants of fertility in Tanzania. The study did not account for the excess zeros that may characterize the fertility data. Furthermore, the study failed to control the endogeneity of contraceptive use in the fertility model. The empirical literature review, further discussed several studies on the effects of fertility on child and maternal health where models included other control variables such as the socioeconomic determinants of health status. Most studied used health indicators such as child nutritional status, birth weight, child mortality, body mass index and blood pressure.

To link fertility and child health, empirical literature also considered as control variables the wealth index, income, education levels, birth order, mother's age, child's age, gender of the child, age of the household head and health inputs such as prenatal. On the other hand, maternal health outcomes were linked to family size, health care utilization, mother's marital status, education, occupation, birth interval, place of residence and several other socioeconomic characteristics. In some cases, the effect of fertility on maternal health was proxied by household size.

In the literature review, the relationship between fertility and maternal health outcomes are country specific and there are hardly any studies that have been done on Tanzania's case. Most studies used panel and cross sectional data as well as various estimation methods such as OLS, logit, and probit models for child and mother health outcomes. To account for potential endogeneity of fertility in the child and mother's health equation most studies used instrumental variable (2SLS), while control function approach was used to account for the potential heterogeneity effect of unobserved determinants of health status which may be interacted non-linearly with fertility. Empirical literature has also focused on the relationship between fertility and labor productivity of mothers, and education of children.

Health outcomes being a special component of human capital have received little attention especially in developing countries where maternal and child health status is still poor. In Tanzania, for instance studies have focused on the utilization of maternal health status while ignoring the link between fertility and maternal and child health outcomes. Based on the reviewed literature, there is still need to shed light on the ongoing maternal and child health issues in Tanzania such as (i) measuring the direct relationship between fertility and health outcomes both for mother and child; (ii) addressing the endogeneity of fertility and the potential heterogeneity bias that might be present in these relationships; and (iii) taking into consideration the data characteristics in terms of fertility as count data in the theoretical model and estimation methods

CHAPTER THREE

METHODOLOGY

3.1 Introduction to Methodology

This chapter presents the methodology adopted for the study. It includes the research design, the theoretical framework, the model specification, estimation techniques and the definition and measurement of variables, data sources, collection and analysis.

3.2 Research Design

The study analyzed the relationship between fertility, maternal and child health outcomes in Tanzania using non-experimental cross sectional research design. The non-experimental research design does not involve any treatment of the situation or experimental of the participants (Creswell 2003) and entail analyzing data collected from a cross sectional survey of Tanzania Demographic Health survey Data for 2010.

3.3 Theoretical Framework and Model Specification

The relationship between, fertility, maternal health status and child health outcomes has been explored by various country specific studies in the literature such as Kabubo-Mariara *et al.* (2009b), Mulugeta (2012), and Oyekale (2014).

These studies used the modified utility maximization theory introduced by Rosenzweig and Schultz (1983). This study also modified the Rosenzweig and

Schultz model to formulate the fertility, child health outcomes and maternal health outcomes models for Tanzania.

The theoretical foundations of the models follow a standard economic model of household in which utility is maximized subject to the health production function for both child health and maternal health, and income constraints. The household utility depends on the number of children (C), consumption of health neutral goods (X), consumption of health related goods (Y), and health status both for child health status (H_c) and the mother health status (H_m) given as:

$$U = U(C,\ X,\ Y, Z, H_c,\ H_m) \text{-----------------------------} (3.1)$$

Equation 3.1 is the objective function which is maximized subject to the income constraint facing the household.

In Rosenzweig and Schultz model, the child health household production function is a function of the consumption of health related goods (Y), health investment goods (Z), and υ ,which is the component of child health either due to generic or environmental conditions known to but not controlled by the household (see also Mwabu & Ajakaiye, 2007), and expressed as:

$$H_C = f(Y,\ Z,\ \mu) \text{-------------------------} (3.2)$$

Similarly, therefore, the maternal health production function is based on the consumption of Y and Z goods and the unknown variable, μ and given as:

$$H_M = f(Y,\ Z,\ \mu) \text{-----------------------------} (3.3)$$

The production function described in equations(3.2) and (3.3) may be considered to be restrictive, since intuitively, the production of household health may not be limited to the consumption of Y and Z goods, and with the considerations of genetic and environmental factors. In this particular study, equations (3.2) and (3.3) are modified to account for other factors that may affect health productions by the households.

These factors include the number of children or fertility (C), socio-economic, institutional, household, and community characteristics (E). Therefore, the modified household health production function child and maternal health care respectively as follows:

$$H_C = f(Y,\ C,\ Z,\ E,\ \mu) \text{---------------------------------} (3.4)$$

$$H_m = f(Y,\ C, Z,\ E,\ \mu) \text{-----------------------------------} (3.5)$$

Both equations (3.4) and (3.5) are in general form maybe referred as

$$H = f(Y,\ C,\ Z,\ E,\ \mu)$$

The household utility, in this case maximizes equation (3.1) with the consideration of equations (3.4) and (3.5) subject to a budget constraint in equation (3.6) as follows;

$$I = XP_x + \ YP_y + \ ZP_z \text{------------------------------} (3.6)$$

where, I is the household income, and P_x ,P_y, $P_z$are prices of health neutral goods (X), health related goods (Y) and, health investment goods (Z) respectively. From equation (3.1), (3.4), and (3.5), the health investment good is purchased for purposes of improving the quality of household health, hence Z only enters the utility function through H, the household health production function.

The utility maximization problem is solved through the Lagrangian approach. The expression for the Lagrangian equation is expressed as:

$$L = U(C, X, Y, H_c, H_M) + \lambda\{I - XP_x - YP_y - ZP_z\} ---------------- (3.7)$$

Substituting the health production function into the utility function and representing both child and maternal health by *H*, for simplicity, the utility function is rewritten as:

$$L = U\{C, X, Y, f(Y, C, Z, E, \mu)\} + \lambda\{I - XP_x - YP_y - ZP_z\} --------------------- (3.8)$$

The differentiation of the Lagrangian function in equation (3.8) with respect to X, Y, Z, C and λ yields the first order conditions (FOCs) for household utility maximization given in equations (3.9) to (3.13):

$$\frac{\partial L}{\partial X} = U_x\{C, X, Y, f(Y, C, Z, E, \mu)\} - \lambda P_x = 0 ----------------- (3.9)$$

$$\frac{\partial L}{\partial Y} = U_y\{C, X, Y, f(Y, C, Z, E, \mu)\} * f_y(Y, C, Z, E, \mu) - \lambda P_y = 0 ------ (3.10)$$

$$\frac{\partial L}{\partial Z} = U_z\{C, X, Y, f(Y, C, Z, E, \mu)\} * f_z(Y, C, Z, E, \mu) - \lambda P_z = 0 ------ (3.11)$$

$$\frac{\partial L}{\partial C} = U_c\{C, X, Y, f(Y, C, Z, E, \mu)\} * f_c(Y, C, Z, E, \mu) = 0 --------- (3.12)$$

$$\frac{\partial L}{\partial \lambda} = I - XP_X - YP_Y - ZP_Z = 0 -------------------------- (3.13)$$

Technically, there is a need to solve these FOCs simultaneously to arrive at the demand functions for X,Y,Z and the optimal number of children, C that will maximize household utility. However, these FOCs are functional in nature and since the study has not assumed any functional form for the utility function and the health production function, thus, it is easier to inspect carefully these expressions and arrive at the expressions given in equations (3.14) to (3.17) (see Chiang, 1984 pp. 204-214):

$$X = x(P_x, Py, Pz, I,, E, \mu) \quad \text{.......... (3.14)}$$

$$Z = z(P_x, Py, Pz, I, E, \mu) \quad \text{.......... (3.15)}$$

$$Y = y(P_x, Py, Pz, I, E, \mu) \quad \text{.......... (3.16)}$$

$$C = c(P_x, Py, Pz, I, E, \mu) \quad \text{.......... (3.17)}$$

This study follows Rosenzweig and Schultz (1983) and Mwabu (2008) and formulates a hybrid maternal and child health functions. However, both maternal and child health cannot be purchased from the market To consume the health quantities, the household has to produce them using inputs shown in equation (3.4) and (3.5) which are the health production models being estimated in the study.

3.3.1 The Effect of Socio-Economic Factors on Fertility

The reduced form of fertility equation given in equation (3.17) from the theoretical model will be estimated using the Zero Inflated Poisson (ZIP) model to account for the nature of the data characteristics. The zero inflated helps to account for the two specificities of fertility, firstly, it is a count variable that is discrete and positive with limited range, and secondly it will account for many childless women that might be present in the data set and would result into excess zero observations.

The starting point for estimating models with count variables is the standard poisson regression model where the variable is assumed to have a poisson distribution. More specifically for this study, the probability that fertility (C) takes a specific value (c_i), is given as (see Baundin, 2008; Cameron and Trivedi, 2005):

$$\Pr[C = c_i / v_i] = \frac{e^{-\omega i} \omega_i^{ci}}{c_i!} \text{-------------------}(3.18)$$

where c_i = 0, 1, 2, …is the observed fertility outcomes or the number of children, ω_i is the mean parameter, v_i are the covariates of fertility, and Pr represents probability. Often, the mean parameter, ω_i, is expressed in log-linear model (see Greene, 2012), that is :

$$\ln \omega_i = v_i' \beta \quad \text{or}$$

$$\omega_i = \exp(v_i' \beta) \text{--------------------}(3.19)$$

where β is a vector of unknown parameters

According to Baundin (2008) individual fertility data often show an excess of zero observations. Equation (3.18), however, does not account for those observations. Therefore, it is best to apply count data models that account for those excess zeros in studying fertility. Meanwhile, the poisson model is usually criticized as it assumes that the variance and the mean being equal, yet this may not hold in reality, i.e. for count data, the variance often exceeds the mean, a term called over dispersion.

The ZIP model allows modeling excess zeros in a dataset where the endogenous variable is a count variable (Cameron & Trivedi, 2005; Erdman et al., 2008).More specifically in this study, the ZIP model simultaneously estimates the number of children born with a poisson model, and the choice of not having children using a logit model (see Baundin, 2008). Let G^0 denotes a group of women with no children or zero counts that is fertility is always 0.Then, the probability that a woman belongs to this group, that is $G^0 = 1$, is given by a logit model as follows:

$$\Pr[G^0 = 1/\rho_i] = \Omega_i = \frac{e^{\varphi'\rho_i}}{1 + e^{\varphi'\rho_i}} \text{-----------------}(3.20)$$

where ρ_i is a vector of independent variables that affect the decision whether or not to have children, and φ are parameters to be estimated.

Since a woman will either have children or no children, it follows that the probability of a woman who is not in the zero group $(G^0 = 0)$ is equal to $(1 - \Omega_i)$ and her fertility is distributed following a poisson distribution. It is also important to note that the assumed ZIP model for fertility as a count variable is different from the standard poisson model. The overall probability for a zero count is expressed as follows:

$$\Pr\lfloor c_i = 0 / v_i, \rho_i \rfloor = \Omega_i + (1 - \Omega_i) \Pr\lfloor c_i = 0 / v_i, G^0 = 1 \rfloor \text{----------}(3.21)$$

On the other hand, the probability for a woman having a positive count is expressed as follows:

$$\Pr\lfloor c_i = j > 0 / v_i, \rho_i \rfloor = (1 - \Omega_i) \Pr\lfloor c_i = j > 0 / v_i, G^0 = 0 \rfloor \text{------}(3.22)$$

The equations (3.21) and (3.22) above make up the ZIP model, such that during the estimation process equation (3.21) becomes a logit model and (3.22) is the modified poisson model (Cameron and Trivedi 1990:2005). In the poisson case, the expected value of c_i given v_i and ρ_i, is as follows (Greene, 2012):

$$E[c_i / v_i , \rho_i] = (1 - \Omega_i)\omega_i$$

where $\omega_i = \exp(v_i ' \beta)$ given in equation (3.19).

Equation (3.22) increases the chances of having zero counts relative to a standard Poisson regression model. Since the standard Poisson and ZIP models are not nested, they cannot be used to decide whether the distribution really has excess zeros, thus a Vuong (1989) test is often run to choose between the standard Poisson and the ZIP model. The equivalent empirical equation model may be expressed as:

$$Fertility = \beta_0 + \beta_1 Age + \beta_2 Asgesq + \beta_3 Education + \beta_4 Wealth + \beta_5 Employment + \\ \beta_6 Marital + \beta_7 Contr + \beta_8 Urban + \beta_9 Radio + \beta_{10} News + \beta_{11} Awaren + \varepsilon_i \text{ -----(3.23)}$$

3.3.2 Effect of Fertility on Child Health

To establish the effect of fertility on child health outcomes, the study used nutritional status as dependent variable. Nutritional status for the children aged 0 to 59 months was measured in terms of height-for age-z scores (HAZ) and the probability of stunted growth generated from the height-for-age-z scores variable. In this study fertility is defined as the total number of children born to a woman aged 15-49.

In terms of estimation, if fertility is assumed to be exogenous to child health, then the relationship may be estimated simply by using the ordinary least square (OLS) regression to analyze the effect of fertility on HAZ, and a probit model to determine the effect of fertility on the probability of child being stunted (Namubiru, 2014). Since being a stunted child variable is a binary variable denoted by CH_i taking on two possible outcomes, 0 and 1, a probit model is specified (see Wooldridge, 2002; Cameron & Trivedi, 2005; and Schmidheiny & Basel, 2013). Thus, the observed child health outcome is defined as follows:

$$CH_i = \begin{Bmatrix} 1 & if\ HAZ\ is < -2\ s\tan dard\ deviation \\ 0 & otherwise \end{Bmatrix} ---------------------(3.24)$$

Equation (3.23) above states that a child is being stunted such that CH_i=1 when his/her HAZ-scores are <–2sd; and otherwise for a child who is not stunted. The study assumes that there is an unobserved or latent variable H^* which represent a true child health status which is linked to the observed child health status via the following equation.

$$CH_i = \begin{Bmatrix} 1 & if \quad H_i^* > 0 \\ 0 & if \quad H_i^* \le 0 \end{Bmatrix} ---------------------(3.25)$$

The latent variable H^* which represents the threshold of the ideal child health condition is in turn linked to the covariates by the following equation:

$$H^*{}_i = \beta_0 + \beta_1 F + \lambda' X + \varepsilon_i ------------------------(3.26)$$

where now, F is used as an indicator for the fertility which is defined as the number of children; X is the vector of control variables such as education, mother's age, child's age, diarrhea, piped water source, place of residence, hospital delivery, mother's height, birth order, sex of the household head, mother's employment, marital status and wealth quintiles. β's and λ's are parameters to be estimated and ε is the stochastic error term assumed to have a standard normal distribution with zero mean and variance equals to one.

Following Long and Freese, (2006), and Cameron and Trivedi, (2010) for a given value of F and X it can be shown that:

$$\Pr(CH_i = 1 \mid F, X) = \Pr(H_i^* > 0 \mid F, X) \ldots\ldots\ldots (3.27)$$

From the equation (3.24) and (3.25), it can be shown that:

$$\Pr(CH_i = 1 \mid F, X) = \Pr(-\varepsilon_{1i} \leq \beta_0 + \beta_1 F + \lambda' X \mid F, X) = F(\beta_0 + \beta_1 F + \lambda' X) \quad (3.28)$$

where F(.) is the cumulative density function of ε_i. Since the random error, ε_i is assumed to have a standard normal distribution, equation (3.27) becomes:

$$\Pr(CH_i = 1 \mid F, X) = F(\beta_0 + \beta_1 F + \lambda' X) = \Phi(\beta_0 + \beta_1 F + \lambda' X) -------- (3.29)$$

where Φ (.) is cumulative distribution function (CDF) of the standard normal distribution.

More specifically in this study, the equivalent empirical model of equation (3.24) may be expressed as follows:

$$CH_i = \beta_0 + \beta_1 Fertility + \beta_2 Education + \beta_3 Urban + \beta_4 Wealth + \beta_5 Mother's\, age + \beta_6 Mother's\, age\, square + \beta_7 Mother's\, height + \beta_8 Married + \beta_9 Sex\, HH + \beta_{10} Birth\, order + \beta_{11} Child's\, age + \beta_{12} Child's\, agesquare + \beta_{13} Sex\, child + \beta_{14} Hosp\, delivery + \beta_{15} Antenatal + \beta_{16} Mother\, emplo + \beta_{17} Diarrhea + \beta_{18} Piped\, water + \varepsilon_i \ldots\ldots\ldots\ldots (3.30)$$

According to Schultz and Mwabu (2002), Kabubo-Mariara *et al.* (2009), Oyekale (2014) and Peters *et al.*(2014), fertility is potentially endogenous in the child health equation. Endogeneity occurs when the variable of interest (fertility) is correlated with the error term, thus resulting to biased parameter estimates even when there is sufficiently large number of observations. Literature on health proposes a simultaneous or bi-directional causality between fertility and health outcomes. To this end, the study estimated fertility equation using instrumental variables and other socioeconomic factors specified in the following equation:

$$F = \alpha_1 + \alpha_2 X + \alpha_3 Z + u_{1i} ------------------ (3.31)$$

where Xis the socio economic factors that influence fertility, and Z represents factors that influence fertility but do not directly impact child health.

Therefore, they would be applied as instrumental variable for the fertility. The study used cluster share use of modern contraceptive and birth of twins as instrumental variables (Z) for fertility (see for example, Kabubo-Mariara *et al.,*2009).

To address the problem of heterogeneity, the study employed the control function approach (CFA) as proposed by Mwabu and Ajakaiye (2007), Florence *et al.* (2008), and Kabubo-Mariara *et al.* (2009b). Mwabu and Ajakaiye (2007) and Kabubo-

Mariara *et al.* (2009b) argued that heterogeneity arises when the unobserved determinants of health are interacted non-linearly with the variable interest. In this case, heterogeneity is likely to be caused by the preferences or taste whereby a woman decision for large or smaller family size is known to the individual but unknown to the researcher (Kabubo-Mariara et *al.,* 2009b and Mwai, 2014).

Control function involves generating residuals (F*) from the reduced form fertility model given in equation (3.30) above using ordinary least square (OLS). Afterwards, the fertility residual is added as an additional regressor in the child health equation below. Lastly, the fertility residual is interacted (F*F) with the endogenous regressor (fertility) as additional regressor in the structural equation.

The study generated fertility residuals from equation (3.33) and the specified control function model is presented as follows:

$$CH_i = \delta_0 + \delta_1 X + \delta_2 F + \gamma_i F^* + \gamma_2 FF^* + e_{1i} \quad (3.32)$$

3.3.3 Effect of Fertility on Maternal Health Status

In this study, the maternal health status is measured using the woman's Body Mass Index and the woman's underweight as an indication of malnutrition. The effect of fertility on maternal health status may be estimated using various models depending on the assumption whether fertility is treated as exogenous or endogenous to the system. Firstly, if fertility is exogenous, a simple estimation using ordinary least square maybe used for the regression of Body Mass Index (BMI) on fertility. On the other hand, probit model maybe used to determine the effects of fertility on the probability of women underweight.

In the probit model, a binary variable H_i may be used to define whether or not a woman is underweight given as:

$$Hi = \begin{cases} 1 & if\ a\ mother\ is\ underweight \\ 0 & otherwise \end{cases} \text{------------------- (3.33)}$$

Let H^* be the underlying latent variable for the maternal health status through the following equation:

$$H_i = \begin{cases} 1 & if\ \ H_i^* > 0 \\ 0 & if\ \ H_i^* \leq 0 \end{cases} \text{------------------------(3.34)}$$

The latent variable is in turn linked to the covariates via the following equations:

$$H^*{}_m = \theta_0 + \theta_1 F + \phi' X + \xi_i \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.35)$$

where X is the vector of control variables, F is fertility variable, θ_0 ,θ_1,ϕ are the unknown parameters to be estimated, and ξ_i is the stochastic error term. Given the values of X and F, the probability of H_i is shown as follows:

$$\Pr(H_i = 1/F, X) = \Pr(H_i^* > 0/F, X) \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.36)$$

Substituting equation (3.34) into equation (3.35) yields:

$$\Pr(H_i = 1/F, X) = \Pr(-\xi_i \leq \theta_0 + \theta_1 F + \phi' X / F, X) = F(\theta_0 + \theta_1 F + \phi' X) .. (3.37)$$

where again, F(.) is the cumulative density function of ξ_i. Assuming a standard normal distribution for ξ_i leads to a probit model given by:

$$\Pr(H_i = 1 / F, Z) = \Phi(\theta_0 + \theta_1 F + \phi' X) \text{-------------------------} (3.38)$$

where again, $\Phi(.)$ is the cdf of the standard normal distribution.

In the study, the equivalent empirical model for equation (3.37) may be expressed in the following maternal health function:

$$\begin{aligned} H_i = \theta_0 + \theta_1 Fertility + \theta_2 Age + \theta_3 Age^2 + \theta_4 Hhsize + \theta_5 Education + \theta_6 Married + \\ \theta_7 Wealth + \theta_8 Delivery + \theta_9 SexHh + \theta_{10} \mathrm{Re}sidence + \theta_{11} Water + \theta_{12} News + \\ \theta_{13} Employment + \xi_i \text{-----------------------------} (3.39) \end{aligned}$$

Since Fertility (F) is potentially endogenous, the use of instrumental variables was necessary discussed in section (3.3.2). The reduced form fertility equation was formulated to link to the various covariates as follows:

$$F = \eta_1 + \eta_2 X + \varsigma' W + u_{2i} \text{---------------------------} (3.40)$$

Where X the vector of socio economic factors, W is is the vector of instruments; η_1, η_2, and $\varsigma$are unknown coefficients; and u_{2i} is the stochastic error term. The study used cluster share of contraceptive use and birth of twins as instrumental variables.

Again, to control for the unobserved heterogeneity the study used control function method by including the estimated residuals (F*) and the interaction variable (FF*) between fertility and fitted residuals as an additional regressors in the structural model of interest (see section 3.3.2).

$$H_i = \kappa_0 + \kappa_1 X + \kappa_2 F + \pi_1 F^* + \pi_2 FF^* + e_{2i} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.41)$$

where F^* are the fitted residuals from OLS fertility model, $\pi_1 F^*$ captures the non-linearity effects of fertility on maternal health status and $\pi_2 FF^*$ control for the effects of unobserved factors.

Note that both fundamental equations (child and maternal health productions) in this study have been derived successfully by fertility *ceteris paribus*. Validity of the model(s) in the analysis is attainable if child health and maternal health are uncorrelated. However, this is not the case in this study. Maternal health affects child health and vice versa. Therefore, one cannot estimate the two health production functions independently without making the assumptions. The study made the following assumptions;

i. Maternal health which is omitted from the child health production function is the in the structural error term of the child health equation but is uncorrelated with fertility.
ii. The similar assumptions for child health in maternal health model (see i-above).

3.4 Definitions and Measurement of Variables

The next section defines and explains how variables in these empirical models in section (3.3.1) (3.3.2) and (3.3.3) are measured. Moreover, the expected effects of these variables on dependent variables are also explained.

Fertility: This thesis measures fertility as the total number of children ever born to a woman in a household. This number accounts for all the children who were born alive and later died, children who are living with or living elsewhere of the sample women (range from 1 to 15 children). Fertility is expected to have a negative effect on both child and mother's health.

Height-for-age-Z scores: The thesis measures child health outcomes using height-for-age Z-scores. It is defined as $Z\ scores = \frac{T_i - T_{median}}{\sigma_T}$ where T_i is the height of child; T_{median} is the median height of the reference population of the same age and gender while σ_T is the standard deviation from the media of the reference population. This variable is used as one of the dependent variable in the child health equation.

Stunted Growth: A child is said to be stunted or suffer from chronic malnutrition if his/her height-for –age Z-scores falls below -2 standard deviation from the median of the reference population. It is defined by the study as 1 and 0 otherwise. The variable is used as one of the dependent variable in the child health equation

Body Mass Index (BMI): The thesis used Body Mass Index to assess maternal health status. It is defined by the weight in kilogram divided by the square of height in meters. This variable is used as one of the dependent variable in the maternal health equation

Underweight: The mother is said to have underweight or chronic energy deficiency if $\text{BMI} < 18.5 kg/m^2$. The study assigns the value of 1 for women with underweight while those without underweight are given the value 0 .This variable is used as one of the dependent variable in the maternal health equation

Age of the mother: was measured in number of years from birth. The variable was included in the study to account for the mother specific characteristics. Age of the mother was expected to increase the health status as suggested in the literature (Ramachandra *et al.,* 2006, Kabubo-Mariara *et al.,* 2009a).

Mother's age squared: was measured in years to reflect the lifecycle effects. Mother's age squared was expected to be negative in the child, mother and fertility equations.

Place of residence (Urban or rural): was measured as a dummy variable given as 1 if urban and 0 otherwise. The urban variable was expected to have lower fertility, higher height-for-age Z-score and lower probability of child and maternal malnutrition.

Marital status: Measured as dummy variable given as 1 if woman is married and 0 otherwise (the unmarried categories also include divorce and widowed). Married women were expected to have better nutritional status, improve child health status and increase fertility than their unmarried counterparts.

Wealth index of woman's household: The study measured wealth index as dummy variable where a value was 1 if poorer and 0 otherwise, 1 if middle and 0 otherwise, 1 if richer and 0 otherwise, 1 if richest and 0 otherwise. The poorest quintile was given the value of 0 as a reference category. This variable is expected to have a negative effect on fertility and positive effect on both child and maternal health.

Woman's education: Four categories were considered; no education, primary education, secondary education and higher education. The study assigned each of these categories a dummy value 1 and 0 otherwise. No education was used as reference category. Education is expected to have a negative effect on fertility and positive effect on both child and maternal health

Height of the mother: This is a continuous variable and measured in centimeters. Mother's height was expected to control for the child genetic endowment and was expected to have positive effect on child health outcomes.

Diarrhea: was a dummy given as 1 if a child had diarrhea in the last two weeks before the survey and 0 otherwise. This variable is expected to have a negative effect on child health

Household size: was measured by the number people reported living in a household

Birth order: was measured into four categories. Birth order 1st (first child), birth order 2nd (2-3 children), birth order 3rd (4-5 children) and birth order 4th (6+ children).This was used as proxy of child biological endowment.

Child's age: was measured in months (0-59 months). This is expected to have a negative effect on child health

Child's age squared: was measured in months. This is expected to have a positive effect on child health.

Sex of the child: was measured as dummy variable with value 1 if the gender of the child was male and 0 otherwise.

Hospital delivery: The study measured hospital delivery as dummy variable assigning value 1 if a mother delivered in a hospital and 0 otherwise. This variable is expected to have positive effect on both child and maternal health.

Antenatal care: dummy variable clustered and assigned 1if a mother attended at least four antenatal care clinics and 0 otherwise. This variable is expected to have positive effect on both child and maternal health.

Woman's employment status: was a dummy variable given as 1 if woman is employed and 0 otherwise.This refers to respondents who had formal or informal employment at the time of the survey and if otherwise, further if they were employed in the 12 months preceding the survey. Employed women were expected to lower fertility, have better nutritional status and improve child health their unemployed counterparts.

Piped water source: Dummy variable with the value1if a household had access to piped water and 0 otherwise. The uni-piped includes: wells, springs, rive, dam, lake ponds, stream, canal, rain water and other sources. This variable is expected to have positive effect on both child and maternal health

Flush toilet: was a dummy given as1if household had access to flush toilet and 0 otherwise. This variable is expected to have positive effect on both child and maternal health

Sex of the household head: Dummy variable give as1if the head of the household is a male and 0 otherwise.

Listening to radio: Dummy variable given as 1 if the respondents ever listen to radio and 0 otherwise.

Reading newspapers: Dummy variable given the value 1 if respondents ever read newspapers and 0 otherwise.

Family planning awareness: Dummy variable given the value 1 if a woman has ever heard of a local family planning and 0 otherwise.

Proportional of contraceptive use: This is measured as percentage of women reporting to use any contraceptive method computed at the regional level.

Birth of twins: The study defines twins as dummy variable with 1 if the child was born as twin and 0 otherwise.

3.5 Data Type and Sources

The study used Tanzania Demographic and Health Survey Data (TDHS) for 2010 to analyze fertility, maternal health status and child health outcomes. Tanzania Demographic and Health Survey is a nationally representative survey which collects detailed information on fertility, family planning, infant and maternal mortality, maternal and child health. Moreover, the survey collects information on breastfeeding and nutrition, malaria and household assets among others. The survey was conducted on 10139 women aged 15 to 49 years and 2527 men aged to 54 years as well as 8023 children of under five years. The survey covered all regions in the country where a representative probability sample of 10, 300 households were selected.

The 2010 TDHS sample was stratified, clustered and collected in two-stage probabilistic sampling method based on the list of enumeration areas of the Tanzania Population and Housing Census for 2002.The TDHS sample was selected in two stages. In the first sampling stage, 475 clusters were selected from the list of enumeration extracted from the Population and Housing Census of 2002. Twenty five percent (25%) sample points were selected from Dar es Salaam and 18 were selected in each of the twenty regions in the mainland Tanzania. Additionally, 18 clusters were selected in each region for a total of 90 sample points in Zanzibar.

The second stage consisted of a complete household listing which was carried out in all selected clusters between July and August 2009. Household were then systematically related for a participation in the survey where twenty two (22) households were selected from each of the clusters in all regions except for Dar es salaam where ten (10) listed household were selected.

3.6 Data Entry and Cleaning

All the data collected from Tanzania Demographic and Health Survey for 2010 was entered in the data sheet, coded and cleaned appropriately. Data cleaning involved cross checking for inconsistencies and missing data. In addition, the coded data was edited to check for the errors and omissions. Finally, relevant questions in the TDHS questionnaire that were used to collect data on specified variables in the study were identified and then the data on specific variables included in this study was sorted.

3.7 Data Analysis

The data was analyzed using descriptive statistics and regression analysis. First, descriptive statistics for the computed variables in the study were computed. Second, regression analysis was used to analyze the data according to the objective of the study. The first objective which sought to estimate the effect of socioeconomic factors on fertility was achieved by estimating zero inflated poisson regression models. According to Cameron and Trivedi (2005) this method is appropriate for the two reasons; one it accounts for the limitations of the standard poisson and negative binomial model and secondly it takes into account the excess zeros on dependent variable.

The second objective sought to examine the effect of fertility on child health outcomes using height-for-age Z-score and the probability of a child being stunted as dependent variable. To address this objective, Ordinary Least Square (OLS) which treats fertility as exogenous was estimated and instrumental variable accounting for the endogeneity of fertility. Control function approach was also estimated to take into account for potential heterogeneity in the child nutritional status. The study also estimated probit since, the stunted growth is a binary variable and the instrumental variable probit model was estimated to account for the endogeneity of fertility. Similarly, control function approach was estimated to control for the potential heterogeneity in the child nutritional status.

The third objective sought to investigate the effect of fertility on maternal health status using body mass index and the probability of a woman being underweight. To address this objective an Ordinary Least Square (OLS) which treat fertility as exogenous and instrumental variable accounting for the endogeneity of fertility was estimated. The control function to account for the potential heterogeneity in the child nutritional nutrition status was estimated. Since the probability of child being stunted is a binary variable, probit model which treats fertility exogenous and instrumental variable probit for endogeneity of fertility were estimated. Lastly, control function approach was estimated to take into account for the potential heterogeneity in the maternal health status.

CHAPTER FOUR

EMPIRICAL FINDINGS

4.1 Introduction to Findings

This chapter presents the study's findings and discussion of empirical results. Presentation and discussion of descriptive and empirical findings are conducted. The empirical findings are presented according to the research objectives.

4.2 Descriptive Statistics

The descriptive statistics were used to describe the basic features of the data employed in the study. The summary of statistics of the data utilized in the study is presented in Table 4.1 and Table 4.2. The statistics include the mean, standard deviation, percentages, number of observations, and the range of the values of the observations. The major variables are fertility, wealth quintiles, frequency of listening to radio, employment status, mother's age, mother's age square, sex of the household head, household size, mother's education levels, child's height-for–age Z-scores (HAZ), child's stunting, mother's body mass index, motherbeing underweight, sex of the child, birth order, child's age, child's age square, piped water, diarrhoea, proportion of contraceptive use and the birth of twins.

Table 4.1: Summary Statistics for the Continuous Variables

VARIABLES	Mean	Std. Dev.	Minimum	Maximum	Observations
Fertility	2.94	2.85	0	15	10041
Age of mother (in years)	28.72	9.68	15	49	10041
Age of mother square (years)	918.90	597.92	225	2401	10041
Height-for-age Z-scores	-1.62	1.44	-5.95	5.81	6792
Body Mass Index	22.98	4.36	12.07	70.62	7417
Birth order	4.07	2.59	1	15	7417
Mother's height (centimeters)	156.36	5.91	135	185.8	6792
Age of child (in months)	28.26	17.22	0	59	6792
Age of child squared (month)	1095.28	1034.97	0	3481	6792
Contraceptive prevalence	28.89	14.55	6.83	63.22	7417
Antenatal visits	3.5	1.39	0	16	7417
Household size	7.25	3.82	3	38	7417

***Source*: Author's calculations based on TDHS (2010)**

Table 4.1 shows that on average, women in Tanzania have three children (2.94) per woman using 10,041 observations used in the study taken from the 2010 Tanzania Demographic Health Survey (TDHS). This is consistent with the average of three (2.88) children per woman indicated in the TDHS (2010) report findings. The average number of children should not be confused with Tanzania total fertility rate (TFR) of 5.4. Total fertility rates are calculated as the average number of children that would be born over the woman's lifetime if she were to experience current age-specific fertility rates through her lifetime and if she were to stay alive from the moment she starts giving birth to the end of her reproductive cycle. Total fertility is higher than the average number of children per household as the latter represents younger women who are yet to complete their reproductive cycle.

The women surveyed in TDHS were between the ages of 15 to 49 years with an average age of 29 (28.7) years with the variation of approximately 10 (9.7) years while their average height was about 156m. The average household size was seven members with a maximum of 38 members. The average body mass index (BMI) for the surveyed women was reported to be 23 (22.98) weights per heights in meters square with a minimum BMI of 12 weights per heights and a maximum of 71 (70.62) weights per height. Table 4.1 also shows that the mean of contraceptive prevalence was 29 (28.89), varying from 6.83 to 63.22.

The contraceptive prevalence was used as the proportion of women in each region using contraceptive methods including folkloric, traditional and modern methods. The results indicate that the average height-for-age Z-scores of the children aged between 0-59 months were -1.62 with a minimum of -5.95 units and a maximum of 5.81 units. These figures are relatively consistentto those reported by the TDHS of 2010. Table 4.1 further shows that on average most children were on their fourth birth order with the mean age of 28 months.

Table 4. 2: Summary Statistics for Categorical Variables

VARIABLES	Measurement	Percentage	Observations
Sex of the child	1 if male 0 otherwise	49.64 50.36	6792
Education	No education	18.71	10041
	1 if Primary 0 otherwise	58.02 41.98	10041
	1if secondary 0 otherwise	22.80 77.2	10041
	1 if Higher 0 otherwise	0.004 99.9	10041
Piped water	1 if piped water 0 otherwise	32.09 67.91	6792
Flush Toilet	1 if flush toilet 0 otherwise	1.10 98.9	6792
Place of residence	1 if urban 0 otherwise	28.5 71.5	10041
Hospital delivery	1 if delivered at hospital 0 otherwise	50.06 49.94	7417
Mother Employed	1 if employed 0 otherwise	2.93 97.07	10041
Twins	1 if twins(first multiple) 0 otherwise	3.3 96.7	7411
Stunted	1 if stunted 0 otherwise	42.15 57.85	6792
Mother's Underweight	1 if underweight 0 if otherwise	11.76 88.24	7417
Diarrhea	1 if diarrheal 0 otherwise	16.53 83.47	6792
Marital Status	1 if Currently Married 0 otherwise	58.45 41.55	10041
Wealth Quintiles	1 if Poorest 0 otherwise	13.3 86.70	10041
	1 if poorer 0 otherwise	14.75 85.25	10041
	1 if middle 0 otherwise	18.83 81.17	10041
	1 if richer 0 otherwise	22.68 77.32	10041
	1 if richest 0 otherwise	34.10 65.90	10041

***Source*: Author's calculations based on TDHS (2010)**

Table 4.2 shows that 12 (11.76) percent of the surveyed women had malnutrition in the form of being underweight (BMI below 18.5) in Tanzania. Moreover, the proportion of stunted children in Tanzania was reported to be 42 percent. Both figures are quite consistent those reported by the TDHS of 2010. There was an almost one-to-one correspondence between a male and female child, which is 50 percent male and 50 percent female. 16.53 percent of the surveyed children were reported to have diarrhea in Tanzania. Finally, there was about 3.3 percent of children reported twins.

Regarding education, 18 percent of the surveyed women did not have formal education, 58 percent had primary education, 22 percent possessed secondary education while 0.04 percent possessed higher education.Marital status was captured in two categories; married and not marrried where not married include divorced, widowed and separeted.A majorityof women in the sample (58 percent) were married while 41.55 percent were not married. Lastly, three (2.93) percent of women in Tanzania were reported to be employed while 25 (24.69) percent had an unmet need for family planning. Following the TDHS (2010) classification, wealth status was categorized into quintiles such as poorest (1st quintile), poorer (2nd quintile), middle (3rd quintile), richer (4th quintile) and richest (5th quintile).

The study found that 15.90 percent of mothers were in the poorest category, 18.62 and 18.83 percent from the poorer and middle wealth categories, respectively while mothers on the richer and richest wealth quintiles were 22.68 and 23.95 percent respectively. Moreover, about 28.5 percent of the surveyed women resided in urban areas whereas 71.5 percent lived in rural areas. The survey further indicates that about 37.78 percent women had access to media through reading newspapers while

74.5 percent had access to media through listening to the radio. The TDHS also provide information on the availability of community infrastructure. About 32 percent of the surveyed women had access to piped water (safe drinking water). However, only 1.10 percent of the sample had access to a flush toilet. The study also revealed that 49.73 percent of the women delivered their babies in a hospital compared to 51 percent who delivered their babies at home, as reported in TDHS 2010 report.

4.3 Effects of Socio-Economic Factors on Fertility in Tanzania

The first objective of this study was to examine the effect of socioeconomic factors on fertility. In this study, fertility is demarcated as the number of children born per woman. To analyse the effects of the different factors on fertility, a Zero-Inflated Poisson (ZIP) regression model was specified, since fertility is a count variable. ZIP was estimated to account for the high proportion of women with no children in the dataset, which was about 2782 observation (28 percent). The model generated two sets of results: first or regime one, is where the values of the count variable is always zero. The logit model determines whether the count is zero or a woman belongs to a group of zero children (Green, 1997 and Namubiru, 2014). Second or regime two, the poisson regression results show the fertility count model of women with children (non-zero counts).

Before the final estimation, model selection tests were conducted. The first is the test between the model of equidispersion and overdispersion, which refer to the poisson regression and negative binomial regression model, respectively using the Likelihood ratio (LR) test. Based on the LR statistics of 0.0014 with the probability value of 0.483, the null hypothesis of equidispersion was not rejected. Therefore, the study favored the poisson regression model over the negative binomial regression model. Secondly, Vuong test was estimated to determine whether zero-inflated Poisson was preferred over the standard Poisson regression model. This test has a limiting standard normal distribution. Since the Z-value was 17.14 with a probability value close to zero, therefore, the test concludes that zero-inflated models were preferred over the standard Poisson regression model. Therefore, based on these various tests, the ZIP model is the preferred model.

The explanatory variables used in the ZIP models are primary, secondary, higher education, place of residence, mother's employment, wealth index, contraceptives prevalence, mother's age, marital status, access to informationof (listening to radio) and reading newspapers) and family planning awareness. The estimation results are presented in Table 4.3 and Table A1 in the appendix. Table 4.3 reported the marginal effects, and the actual estimated coefficients are presented in the appendix (Hill *et al.,* 2012).

4.3.1 ZIP Model – Explaining Fertility

The coefficient of mother's age was positive and statistically significant at one percent level. This shows that the older the woman the higher the number of children born to her holding other factors constant. Based on the estimation results, an increase in the woman's age by one year, fertility would have a marginal increase of 0.26, holding other factors constant. However, the coefficient of mother's age square was negative but also significant at one percent level. This means that the relationship between age of the woman and fertility is non-linear. The significance of the coefficient mother's age square implies that as age increases and the woman reproductive system becomes viable; the number of birth should increase. However, at some threshold age, the chances of sterility increases and thereby reducing the number of birth (Hyatt and Milne, 1993). These results are consistent with the study findings of Hyatt and Milne (1993); Ayoub (2004); Namubiru (2014); Zanin *et al.* (2015) who found a positive relationship between fertility and age of the woman in Kenya, Uganda, Malawi and Tanzania, respectively.

Table 4.3: Socio-economic determinants of fertility using Zero-Inflated Poisson Model

Variables	Marginal Effect	Std. Error	P-Value
Mother's Age	0.257***	0.004	0.000
Mother's Age square.	-0.008 ***	0.000	0.000
Mother's Primary Education	-0.103**	0.041	0.012
Mother's Secondary Education	-0.599***	0.070	0.000
Mother's Higher Education	-0.817**	0.386	0.034
Wealth Quintile: Poorer	-0.019	0.048	0.681
Middle	-0.029	0.051	0.578

Richer	-0.194***	0.054	0.001
Richest	-0.685***	0.073	0.000
Married	0.882***	0.046	0.000
Mother's employment	-0.430***	0.125	0.001
Contraceptive Use	-2.008***	0.105	0.000
Family Planning awareness	-0.083**	0.037	0.024
listening to radio	-0.129***	0.040	0.001
reading newspapers	-0.105***	0.039	0.008
Place of residence (urban=1; rural=0)	-0.168***	0.054	0.002
Inflate (Probability of zero birth)			
Contraceptives use	-0.152***	0.018	0.000
Mother's primary education	0.029***	0.009	0.001
Mother's secondary education	0.129***	0.009	0.000
Mother's higher education	0.144***	0.034	0.000
Age of the mother	-0.017**	0.000	0.000
Married	-0.177***	0.005	0.000
Place of residence (1=urban)	0.002	0.006	0.806
Zero observations	2782		
Non-zero observations	7259		
No. of Observations	10041		
LR Wald chi2 (20)	7555.31		
Likelihood Ratio Test (Poisson vs. Negbin)	0.0014		0.483
Vuong test of zip vs. standard Poisson	Z= 17.14		0.000

Notes: *, **, * denote significance at 1%, 5%, and 10%, respectively.**
***Source:* Author's Calculations.**

The coefficients of primary and higher education were negative and statistically significant at five percent while the coefficient of secondary education was negative and statistically significant at one percent level. This shows that women with primary, secondary and higher education were likely to have fewer children than those with no education. Based on the estimation results, women with primary education were likely to have fewer children by a margin of 0.10 while those with secondary and higher education would reduce their fertility by a margin of 0.59 and 0.82 compared to those with no education holding other factors constant. It is clear from the result that as one moves from the lower level of education to higher levels, the magnitude of fertility lowers by higher margins. Women who are educated are well informed or more likely to be aware of modern methods of controlling births. The findings are in line with Ayoub (2004); Kabubo-Mariara *et al.* (2009b); and Zanin *et al.* (2015) who found similar results for Tanzania, Kenya and Malawi respectively.

The coefficients of richer and richest (fourth and fifth wealth quintiles) were found to have a negative and statistically significant effect on fertility at one percent level. Women in the fourth wealth quintile (richer) were likely to reduce fertility by a margin of 0.19 compared to women in the poorest wealth quintile while holding other factors constant. Similarly women in the fifth wealth quintile (richest) were likely to reduce fertility by a margin of 0.69 compared to women in the poorest wealth quintile holding other factors constant.

The negative effect of wealth index on fertility could be explained by the fact that wealthier women attach a higher value on the quality of their children and thus the number of children matters (Becker 1960; Becker and Lewis 1973). Therefore, wealthier mothers would prefer investing more resources to their children through education and health than having additional children who may add more costs to the family (Gauthier *et al.,* 2004). These findings support the findings obtained by

Ayoub (2004), Owoyo (2012) and Namubiru (2014) who found a negative impact of wealth on fertility in Tanzania, Ghana and Uganda respectively.

The coefficient of marital status was positive and statistically significant at one percent level. This implies that married women are more likely to have higher number of children than those who have never been married holding other factors constant. Based on the estimation results, the fertility of married women increased by a margin of 0.88 compared to women who were not married holding other factors constant. Theoretically, a married woman is expected to have children. This is in tandem with the expectation of African cultures. This, therefore, exerts pressure on married women to have an extra child compared to other women in other categories thus increasing fertility. These results are consistent with the findings obtained by Namubiru (2014) who found a positive relationship between married women and fertility in Uganda. Further, Moultrie and Timaeus (2001) concurs that unmarried mothers have fewer children than married mothers of the same age.

The coefficient of marital status was positive and statistically significant at one percent level. This implies that married women are more likely to have higher number of children than those who have never been married holding other factors constant. Based on the estimation results, the fertility of married women increased by a margin of 0.88 compared to women who were not married holding other factors constant. Theoretically, a married woman is expected to have children. This is in tandem with the expectation of African cultures. This, therefore, exerts pressure on

married women to have an extra child compared to other women in other categories thus increasing fertility. These results are consistent with the findings obtained by Namubiru (2014) who found a positive relationship between married women and fertility in Uganda. Further, Moultrie and Timaeus (2001) concurs that unmarried mothers have fewer children than married mothers of the same age.

The coefficient of mother's employment was found to be negative and statistically significant at one percent level. This shows that employed women would reduce fertility by a margin of 0.43 compared to unemployed women holding other factors constant. The finding implies that the opportunity cost of rearing children is higher for the employed women than the unemployed counterpart. The finding is consistent with the study findings of Becker (1960), Becker and Lewis (1973) and Becker and Tomez (1979) who found negative effect of women's employment on fertility. Eyasu (2015) on the other hand, found a positive impact of women's occupation with fertility in Ethiopia, which is contrary to this study finding.

The coefficient of the contraceptive was negative and statistically significant at one percent level indicating that as contraceptive use increases the number of children born per women decreases. From the estimation results, women who used contraceptive had fertility with a lower margin of 2.01, holding other factors constant compared to those who never used contraceptives. Contraceptive use increases birth spacing as well as protecting a woman from being pregnant which effectually leads low likelihood of a woman conceiving. This eventually lowers fertility. This finding is consistent with the widely held view of the role of contraceptive in fertility behavior. The findings support the results by Bongaart *et al.* (1990), Ayoub (2004) and Tumain *et al.* (2007) who found that the increased use of contraceptive is a primary cause of fertility declines in many developing countries.

Family planning awareness was considered to be an important variable in explaining fertility in Tanzania with its coefficient being negative and statistically significant at one percent level. The result indicated that for those respondents who were aware of the family planning program, their fertility was reduced by a margin of 0.08 compared to women who have never heard any of the family planning programme holding other factors constant.

This shows that if a woman is aware of a family planning programmes, there is a high likelihood of using or practicing any of the methods, which would, in turn, prevent her from being pregnant and thus control the number of children born to her. This indicates that local dissemination of family planning programmes is important in influencing fertility behavior. Contrary results were reported by Ayoub (2004) who found a positive effect of family planning on fertility in Tanzania.

Access to media also turned out to be an important determinant of fertility. The coefficients of listening to the radio and reading newspapers were negative and statistically significant at one percent level. This shows that women who read newspaper or frequently listen to the radio reduced fertility by margins of 0.13 and 0.11 compared to their counterparts who have never read newspapers or listen to radio respectively while holding other factors constant. The findings may be an indicative of the spread of media messages relating to the attractiveness of smaller family sizes thus lowering fertility. These results support the studies by Owoo (2012) and Daka (2013) who found negative relationship between access to media and fertility in Ghana.

The coefficient of urban residence was found to be negative and statistically significant at one percent level. This shows a negative relationship between women who live in urban areas and fertility. From the estimated result, the fertility of women residing in urban areas was found to be lower by a margin of 0.17 compared to those living in rural areas holding other factors constant.

This maybe explained by the fact that women living in the urban are likely to be educated, working and be informed about family planning as well as limited time to take care of an additional child. Based on this argument, a woman in urban residence is associated with lower levels of fertility, but they may be associated mainly with the proximate determinants of fertility (Bongaart *et al.,* 1990). This support the findings of Ainsworth *et al.* (1996) and Ayoub (2004) who concluded that urban women have lower fertility than rural women in South Africa and Tanzania respectively. Similar results were reported by Sharlin (1979) and Bongaart *et al.*(1990) who established that the population that lives in urban is associated with the fundamental revolution in economic basis and that socio-economic phenomena related to the urbanization tend to reduce birth rates in the long run.

4.3.2 ZIP Model – Explaining Zero Births

Education levels were found to be important in determining the likelihood of a mother experiencing zero births. The coefficient of primary education, secondary and higher education levels were found to be positive and statistically significant at one percent level with the probability of observing zero birth. A woman with primary, secondary and higher education had a higher probability of choosing not having children by 0.03, 0.13 and 0.14 percentage points. The results suggest that educated women are likely to be employed and thus working meaning that they may have limited time to take care of additional children born to them.

A married woman was found to have a lower probability of zero births with 0.18 percentage points holding other factors constant. This implies that when a woman is married, there is a high likelihood that there will be non-zero births. This is not surprising since, in African culture, a married woman is expected to conceive and have children (Mautrie and Timaeus, 2001).

The coefficient of mother's age and contraceptive use were negative and statistically significant at one percent level. The marginal effects for mother's age and proportional of contraceptive were 0.017 and 0.152 respectively. This implies that an additional age of the mother by one year the probability of a mother observing zero birth would be reduced by 0.02 percentage points holding other factors constant while a woman using contraceptive would have the likelihood of observing a zero birth lowered by 0.152 percentage points holding other factors constant. Theoretically, contraceptives are indicated to have an inverse relationship with fertility. However, this may not be the case if a woman fails to adhere to the laid down guidelines on their correct use for improved outcomes.

4.4 Effect of Fertility on Child Health in Tanzania

The second objective of the study was to examine the effects of fertility on child health outcomes. In this study, child health was measured using the height-for-age-z-scores and stunted growth. Height-for-age z-score is a long-term measure of child nutritional status (Ssewanyana, 2003; Kabubo-Mariara *et al., 2009a*). Height-for-age z-score suggests that stunted children are those that are shorter than their expected age and gender cohorts in the reference population due to their past chronic nutritional deficiencies (Sahn and Santiel, 2002: WHO, 2004). In other words, the child is said to be stunted if his/her height-for-age z score falls below -2 standard deviations from the median of the reference population (Namubiru, 2014). To analyze the effects of fertility on child health, two models were estimated. The first model used the height-for-age z-score (HAZ) as a dependent variable and was estimated using two stage least square and the control function approach (CFA). The second model used stunted growth as a dependent variable and estimated using instrumental variable two stage least square as well as the control function approach (CFA). For the purpose of results robustness, the Ordinary Least Square (OLS) and probit models were estimated. The results are provided in the appendix2 Table A2, Table A3, Table A4, Table A5, Table A6, Table A7 and Table A8.

The explanatory variables used in both models are fertility, mother's age, mother's age square, child's age, child's age square, birth order, hospital delivery, antenatal care, gender of household head, presence of diarrhoea, mother's height, marital status (married), wealth quintile (poorer middle, rich and richest), sex of the child, mother's education levels (primary, secondary and higher education), place of residence, mother's employment, unmet need and birth of twins.

As described in Chapter 3, fertility is an endogenous explanatory variable since some of the regressors in the child health model are also used to explain fertility. Therefore, there could be some feedback effect on child health and fertility. Thus, the study chooses the instrumental variable estimation to rectify the simultaneous effect. Moreover, the control function approach which is one of the latest models in econometric modelling (Wooldridge, 2007; Terza *et al.,* 2008) and used in many health economics studies (Ajakaiye and Mwabu, 2007; Kabubo-Mariara *et al.,* 2009; Bhasin *et al.,* 2009; Adeoti and Awoniyi; 2009; Mugo, 2012; Adeoti and Awoniyi, 2014; Kimani, 2014; Machio, 2014; Mwai, 2014 and Namubiru 2014) was employed in the model estimation.To take into account the feedback or simultaneous relationship between fertility and child health outcomes, the study used the birth of twins and unmet need as instrumental variables for fertility in the child equation.

The results of the Two Stage Least Square are presented in Table4.4 and Table 4.5

Table 4.4: Effect of fertility on child health: Height- for –age- Z score)

Explanatory variables	IV/ESTIMATES USING 2SLS (HAZ)		
	Coefficient	Std. Error	P-Value
Fertility	-0.694***	0.132	0.000
Child's age	-0.129***	0.006	0.000
Child's age square	0.002***	9.00e-05	0.000
Mother's age	0.311***	0.052	0.000
Mother's age square.	-0.001***	0.0001	0.001
Height of mother	5.280***	0.371	0.000
Married	0.162**	0.071	0.022
Wealth Quintile: Poorer	0.099	0.069	0.155
Middle	0.225***	0.072	0.002
Richer	0.158*	0.084	0.059
Richest	0.387***	0.113	0.000
Sex of the child (male=1)	-0.142***	0.044	0.001
Birth Order	-0.069	0.059	0.248
Primary education	0.028	0.058	0.634
Secondary education	0.309***	0.089	0.000
Higher education	0.519	0.428	0.226
Piped water source	0.159***	0.054	0.003
Diarrhea	-0.226***	0.039	0.000
Place of residence (Urban=1)	-0.048	0.073	0.516
Hospital delivery	0.043***	0.010	0.000
Sex of Household Head	0.039	0.063	0.533
Antenatal visits	-0.0002	0.018	0.989
Mother employed	0.443**	0.219	0.043
Constant	-9.536***	0.671	0.000
No. of observations	4,646		
R-sq. /Pseudo R sq.	0.0201		
F(2,4621) Test for excluded instruments	52.2194		
Partial R.sq for excluded instruments	0.0204		
Durbin (score) chi2(1)	23.2598		0.0000
Wu-Hausman F(1,4621)	30.8029		0.0000
Sargan statistics ch2(1) (over id of instruments)	1.82169		0.1771

Note *, **, * denote Significance at 1% 5% and 10% respectively.**

***Source*: Author's Calculations**

4.4.1 Model with Height-Age-Z Scores: Results from 2SLS-IV)

The regression results in Table 4.4 give the effect of fertility on child health using height for age z-score as a continuous variable. The employed method controls for the endogeneity of fertility in the child health production function. The coefficient of fertility was negative and significant at one percent level. The coefficient of fertility was -0.69. This implies that an additional child reduces height-for-age-z score by 0.69, ceteris paribus. This result may be linked to a thinner distribution of resources among competing people in the household, in addition to the ease of spread of diseases in families with many children, which lead to low height for age among children in the households. The results of the study support the findings of Handerson *et al.* (2008) and Owoo (2012) who found a negative relationship between the number of household's children and children's nutritional status in Indonesia and Ghana respectively. In a similar study using Child mortality, Benefo and Schultz (1996) and Kabubo-Mariara *et al.* (2009b) also found that increasing the number of children by one would reduce the probability of survival for Ghana and Kenya respectively.

In controlling the endogeneity of fertility in the child health production model, the study used the birth of twins and unmet need as instrumental variables. To validate the instruments, over identification, relevance and exogeneity test was conducted. The results showed that the employed instruments had an F-statistic higher (F>10=52.2194) than the recommended threshold. The implication is that the used instruments were appropriate and strong.

The study failed to reject the null hypothesis of no over-identification given the Sargan statistics Chi (1) of 1.82 and respective probability of 0.18. On the other hand, Durbin-Wu-Hausman test for exogeneity was conducted to explore the presence of endogeneity of the fertility in the model. It was revealed that the D-Wu-Hausman coefficient of 30.8029 was statistically Significant at one percent level, suggesting that fertility was endogenous in the child health production function.

The coefficient of child age in months was found to be negative and significant at one percent level. This shows a negative relationship between child's age and nutritional status holding other factors constant. The study found that an increase in child age by one month led to a consequent decrease in height- for- age- z-score by 0.12 holding other factors constant. The significance of coefficient for the child's age squared confirms a non-linear relationship between child age and height-for-age-z-score. The finding is consistent with studies by Kabubo-Mariara *et al.* (2009a) and Namubiru (2014) who found a negative impact of child's age on the nutritional status of children in Kenya and Uganda respectively.

The coefficient of the age of the mother was positive and statistically significant at one percent level while its squared was negative and significant at one percent level. The height-for-age-z score increased by 0.31 as a mother age advances, holding other factors constant. The negative and significant coefficient of the mother's age squared further indicates a higher risk of children born to elderly women. The study finding is consistent with the study by Namubiru (2014) who found a positive effect of mother's age and the height-for-age-z score in Uganda.

The height of the mother was found to be an important determinant of child height-for-age zscore. The coefficient of the mother's height was positive and statistically significant at one percent level. This implies that a one-centimetre increase in the height of the mother increases in the height-for-age-z score by 5.3 holding other factors constant. The influence of maternal height on height-for-age over time is likely to involve genetic and non-genetic factors (nutrition-related intergenerational influences on growth) that prevent the attainment of genetic height potential. This finding support previous studies by Horton (1988), Strauss (1990), Kabubo-Mariara *et al.* (2009) and Namubiru (2014) who found a positive impact of mother's height on the nutritional status of children.

Diarrhea is associated with severe acute malnutrition among the children of below five years of age. In this study, the coefficient of diarrhea had a negative and statistically significant one percent level on height-for-age-z score. It was shown that a child with diarrheal infection lowered height-for-age-z score by 0.23 holding other factors constant compared to the one without diarrheal infection. This result may be associated with the loss of water from the body as well as the inability of converting the available food supply into the growth of bone and strength by children experiencing diarrheal infections. The study findings are similar to findings in an earlier study in Nigeria that found a negative effect of diarrhea on height-for-age-z score for children aged between 0-59 months (Awoyemi *et al.,* 2012).

As in section 4.3, wealth index was divided into five categories, namely: poorest (1st wealth quintile), poorer (2nd wealth quintile), middle (3rd wealth quintile), richer (4th wealth quintile) and richest (5th wealth quintile). The poorest (1st wealth quintile) was used as a reference category in the study. While the coefficient of richer was positive and statistically significant at five percent level, middle and richest were positive and statistically significant at one percent level. This shows that the effect of middle and richest was stronger than that of richer wealth quintile. The study found that a child born of a mother who is in middle wealth quintile had 0.23 height-for-age z scores higher than those born to the mothers in the poorest group, holding other factors constant. Similarly, a child born of a mother who is in the richest was 0.39 height-for-age-z score higher than those born to the mothers in the poorest group, holding other factors constant, while those born of a mother in the richer was 0.16 height-for-age-z scores higher than those born to the mother in the poorest group.The findings support Sahn and Stifel (2003), Borooah (2005) and Namubiru (2014) who found that wealth was an important determinant of the better nutritional status of children.

The study considered the sex of the child as an important determinant of child health. The coefficient of the sex of the child was found to be negative and statistically significant at one percent level. This shows that boys tend to have lower nutritional status compared to girls. The findings indicate that compared to the girl child, boys' height-for-age z-score was 0.14 holding other factors constant. The implication is that the male children had lower nutritional status compared to their female counterparts. It implies that either a girl tend to grow faster than boys (physiological) or due to more time spent with their mothers compare to time spent by boy child with their mothers (sociological factors). The study results support findings by Ssewanyana (2003) and Teshome *et al.* (2009) who found negative impact of male child on nutritional status of children in Uganda and Ethiopia respectively.

The coefficient of secondary education was positive and statistically significant at one percent level. This shows that other factors held constant, mother's secondary education increases the height for age z-scores. A child born of mothers with secondary education was 0.31 height-for-age z-scores higher than those whose mothers with no education. The positive effect of education can be explained by the fact that maternal education may facilitate the acquisition of general health knowledge in the form of care practice such as hygiene and ability to detect and seek treatment of illness (Glewwe, 1999). In turn access to such knowledge can improve child nutritional status (Namubiru, 2014).

On the other hand, the coefficient of higher education positively affects the height-for-age z-score, this effect was insignificant. One possible explanation for this result may be the low levels of higher education found in our sample where less than one percent of mothers had higher education. The findings are in agreement with the findings from other studies on child health, which found that secondary was associated with the increase in nutritional status of children (Glewwe, 1999; Dance and Rammohan, 2008 and Namubiru, 2014).

Health environmental factors were examined through the piped water. The coefficient of piped water source was positive and statistically significant at one percent level. Children with access to piped water increased the HAZ by 0.16 than those without piped water, ceteris paribus. The positive association of piped water and height-for-age z-score suggests that their roles in improving the overall hygiene and reducing the risk of infection which in turn improve child health outcomes. The study support findings in Oyekale and Oyekale (2009), Chirwa and Ngalawa (2008) and Adewara and Visser (2011) who found a positive effect of piped water on height-for-age z scores and weight for age z-scores in Gambia, Niger, Nigeria and Malawi respectively.

Access to health care or facilities was estimated through hospital delivery. The coefficient of hospital delivery was positive and statistically significant at one percent level. Children whose mothers used hospital facility at birth were 0.04 z-score taller than children whose mothers delivered elsewhere holding other factors constant. This implies hospital delivery is associated with skilled delivery which is shown to improve child and mother's well-being as mothers are exposed to breastfeeding and general feeding habits to new-born which in turn leads to better well-being and thus height-for-age z-score. The results obtained from this study are in line with earlier related works conducted in Mozambique, Kenya and Uganda (Garcia & Alderman 1989; Kabubo-Mariara *et al.,* 2009a and Namubiru 2014). These studies found that hospital delivery improves the nutritional status of children suggesting that mothers acquire relevant information on child nutritional status from nurses which could improve child health.

The study lastly revealed that the coefficient of mother's employment was positive and statistically significant at five percent level. The results suggest that if a mother is employed, there would be an increase in the child's height-for-age z-score by 0.44, ceteris paribus. As an indicator of empowerment, in this case, employed mothers are likely to earn income which enable them purchase the necessary inputs for their children and thus better their health status. The results support the findings of other studies on child health, which found that mother's employment was associated with the increase in the nutritional status of children (Chirwa and Ngalawa 2008 and Owoo, 2012).

The study further provides the regression results based on ordinary Least Square (OLS) as shown in Table A2 in the appendix2. Using OLS model, the study found that the coefficient of fertility was negative and statistically significant at one percent. The results confirm the robustness of the effect of fertility on child health outcomes obtained in the instrumental variable (2SLS) model indicated in Table 4.4. Although the Instrumental variable regression results presented in Table 4.4 controls the endogeneity of fertility thus making results more preferable than the ordinary least square (OLS), they do not control for the heterogeneity. On the other hand the study used control function approach to control for the heterogeneity making the results more preferable to those of OLS and IV model.

The coefficient of fertility residual was found to be positive and statistically significant at one percent level (Table A3 in the appendix 2). The significance of fertility residual implies that fertility was endogenous and therefore, controlling for endogeneity using instrumental variable approach was appropriate. However, Table A4 (in the appendix 2) shows that the coefficient of interaction term of fertility with its residual was not statistically significant suggesting absence of heterogeneity that would arise from unobserved that affect child health but may be correlated with fertility.

Table 4.5: Effect of fertility on Child Health Outcomes (Dependent Variable: Stunted Growth)

	IV/ ESTIMATES USING 2SLS		
Explanatory variables	**Coefficient**	**Robust Standard Error**	**P-Value**
Fertility	0.155***	0.029	0.000
Child's age	0.029 ***	0.002	0.000
Child's age square	-0.0004***	0.000	0.000
Mother's age	-0.073***	0.011	0.000
Mother's age square.	0.0004***	0.0001	0.001
Height of mother	-0.347***	0.128	0.000
Married	-0.026	0.019	0.191
Wealth Quintile: Poorer	-0.040**	0.019	0.038
Middle	-0.059***	0.019	0.002
Richer	-0.029	0.024	0.222
Richest	-0.073**	0.034	0.030
Sex of the child (male=1)	0.049***	0.013	0.000
Birth Order	0.005	0.017	0.771
Primary education	0.007	0.015	0.659
Secondary education	-0.074***	0.025	0.003
Higher education	-0.264	0.172	0.125
Piped water source	-0.027*	0.014	0.063
Diarrhea	0.050***	0.009	0.000
Place of residence (Urban=1)	-0.004	0.021	0.834
Hospital delivery	-0.009***	0.002	0.000
Sex of Household Head	-0.016	0.018	0.374
Antenatal visits	-0.002	0.005	0.742
Mother employed	-0.044	0.058	0.446
No. of observations	4,646		
LR chi2(23)	868.29		
Wald test of exogeneity (prob>chi2)	0.0003		

Note *, **, * denote Significance at 1% 5% and 10% respectively.**
***Source*: Author's Calculations**

4.4.2 Results from the IVPROBIT/2SLS

This section presents and discusses the results for the effect of fertility on child health using stunted growth as a dependent variable. In this study stunting was estimated using probit, instrumental variable (IVprobit) and the control function approach (CFA). The coefficient of fertility was positive and statistically significant at one percent level in the IVProbit model. This shows that other factors held constant, increasing the number of children increase the probability of stunting for the child aged 0-59 months.

The marginal effect was 0.15. This implies that an additional child increases the probability of stunting by 0.15, ceteris paribus. However, it is important to note that the coefficient of fertility was much higher in the control function (0.17) compared to 2SLS and probit model (see Table A6, Table A8 and Table A9 in the appendix 2). Similar findings were reported by Schultz and Mwabu (2003) and Owoo (2012) who found a positive impact of fertility on child nutritional status in Kenya and Ghana. On the other hand, using different measure of child health outcomes, Handerson *et al.* (2008), Kabubo-Mariara *et al.* (2009b) and Oyekale (2014) found that fertility increases the likelihood of child mortality in Kenya and Ethiopia respectively.

The coefficient of the age of the child was found to be positive and statistically significant at one percent level. The marginal effect was found to be 0.029. This implies that the likelihood of a child being stunted was 0.03 with an extra month in child's age holding other factors constant. This means that younger children are less likely to be stunted when fed with sufficient breast milk as anew born. However, as a child age in month's increases, weaning and less breast milk makes them more vulnerable to malnutrition. This supports the findings of Garcia *et al.* (1989), Ssewanyana (2000), Chirwa and Ngalawa, (2008) Kabubo-Mariara *et al.* (2009a), Adewara and Visser (2011) and Namubiru (2014) who found positive impact of child age and stunted growth in Uganda, Ethiopia, Malawi and Kenya and Pakistan respectively. The study also discovered that the coefficient of age square was negative and statistically significant at one percent. This depicts a U-shaped relationship between child's and nutritional status. The U-shaped relationship implies that child malnutrition declines as they mature and a variety of food are introduced (Kabubo-Mariara *et al.,* 2009a).

Age of the mother was found to be an important determinant of child nutritional status. The coefficient of the age of the mother was negative and statistically significant at one percent level. An increase in the age of the mother reduces the probability of a child being stunted by 0.073. This suggests that other factors held constant, the probability of a child being stunted reduces as the age of the mother increases compared to younger mothers. On the other hand, the coefficient for mother's age squared was positive and statistically significant at one percent level. However, the coefficient was too small. This indicates nonlinearity of the age of the mother and the probability of a child being stunted. Similar findings were reported by Kabubo-Mariara *et al.* (2009a) and Adeoti and Awoniyi (2012) support the study findings by showing that as the age of the mother increases, the probability of being stunted reduces in Kenya and Nigeria respectively.

The coefficient of the height of the mother was negative and statistically significant at one percent level. The marginal effect was 0.35. This implies that the probability of a child being stunted was 0.35 with one-centimeter increase in mother's height, ceteris paribus. This implies that a child who is born of a taller mother will have a lower stunted growth than children born from shorter mothers. Maternal height captures the maternal nutrition of the mother and is likely to be correlated with their offspring nutritional status. The results can be explained by the fact that maternal height incorporates the genetic factors and family background characteristics which affect child nutrition as well but are not captured by other maternal characteristics such as education (Sahn and Aldemarn, 1997; Kabubo-Mariara *et al.,* 2009a). Other findings which are consistent with studies include Strauss (1990) and Horton (1988) which indicates that mother's height lowers the likelihood of stunting in children.

The coefficients of poorer and richest wealth were found to be negative and statistically significant at five percent level except the middle wealth quintile, which was negative and statistically significant at one percent level. The marginal effects were 0.04, 0.06 and 0.07 respectively. The probability of a child being stunted was 0.04, 0.06 and 0.07 for a child born to the mother in the poorer, middle and richest wealth quintiles than those born to the mother in the poorest wealth quintile holding other factors constant. A child born to the mother in the poorer, middle and richest wealth quintiles are likely to get the necessary nutrients for their growth. The study findings are similar to results from a study in Uganda (Namubiru, 2014), which found negative effects of wealth index on a child's stunting for the children aged 0-59 months.

The coefficient of secondary education was negative and statistically significant at one percent level while the coefficient of primary and higher education were statistically insignificant. The study found that the probability of a child being stunted was 0.07 for children born of mothers with secondary education relative to children whose mothers have no education. This suggests that mother's secondary education level exposes them to better feeding habits which in turn improve child nutritional status. In addition, secondary education may provide mothers with information on dietary as they can read and create a better linkage compared to mothers who never had any formal education. The study findings support studies by Kabubo-Mariara *et al.* (2009a) and Mugo (2009) which concluded that maternal education is an important determinant of child nutritional status in Kenya.

Health environmental factors were examined through the provision of clean water. The coefficient of piped water source was negative and statistically significant at ten percent level. The study showed that the probability of a child being stunted was 0.03 for a child born to a woman with access to piped water holding other factors constant compared to those without piped water. Similar results were found by Cuesta (2007), Adewara and Visser (2011), Owoo (2012) and Awoyemi *et al.*

(2012), where the probability of stunted and wasting was found to be negatively related to the use of piped water source in Philippines, Nigeria and Ghana.

The coefficient of hospital delivery was negative and statistically significant at one percent level. The probability of a child being stunted was 0.009 for children whose mothers used hospital services at delivery compared to children of mothers who did not use such services holding other factors constant. One of the possible explanations for the findings is that the skilled services received by the mother during delivery enhance the health status of the newborns as the mothers who deliver at the health facility have an opportunity of; for example receiving first doses of BCG and measles, which prevent them from being infected with polio and measles. The findings from this study is consistent with the findings of the earlier studies in Ghana and Uganda where the use of health facility for delivery was found to be negatively related to malnutrition (Owoo, 2012 and Namubiru, 2014).

The coefficient of diarrhea was positive and significant at one percent significance level. The marginal effect was 0.05. This implies that the probability of a child being stunted was 0.05 for the children with diarrhea infection compared to those without the infection holding other factors constant. This could be explained by the fact that diarrhea tends to reduce appetite and interfere with the digestive and absorption of food consumed. This, in turn, exacerbates malnutrition, which makes the child more vulnerable to diseases. The study's finding are in tandem to those obtained by Oyekale and Oyekale (2009), Awoyemi *et al.* (2012) and Kamal and Islam (2014) who found that children experiencing diarrhea in the last two weeks significantly increased the probability of stunting in Gambia and Senegal, Nigeria and Bangladesh respectively.

Finally, the study results in the probit and control function approach (see Table A6, Table A9, Table 8 and Table A11 in the appendix 2) confirm the robustness of the effect of fertility on child health model used in the study. The coefficient of fertility residual in the control function was negative and statistically significant at one percent level. The significance of fertility residual in the control function model implies that fertility was indeed endogenous and therefore controlling for the endogeneity using instrumental variable was appropriate. The control function further revealed that the coefficient of interaction of fertility and its residual was statistically insignificant (see Table A11 in the appendix 2) confirming that heterogeneity was not a problem in the stunted specification. The coefficients of all variables are similar with little to no differences in both models in the magnitude of the standard errors; however these did not alter the inferences derived from the IV regression. Theoretically, the results from both models are the same (Woodridge, 2007).

4.5 The Effect of Fertility on Maternal Health Status in Tanzania

The third specific objective was to examine the effect of fertility on maternal health status in Tanzania. This was addressed by using instrumental variable approach (IVregress, IVProbit) and control function approach. In addition, ordinary least square (OLS) and probit model were estimated for purpose of results robustness and the results are presented in the appendix 3 Table A12, Table A13, Table A14 Table A15, Table A17, Table A20, Table A21 and Table A23 respectively.

The first part of the analysis examined the effect of fertility on maternal health status using body mass index (BMI) and the second part used the probability of underweight as a dependent variable. The body mass index was computed by dividing the weight of the mother in kilogram over height in meters square. In this case, the dependent variable is a continuous variable and the explanatory variables consisted of continuous and categorical measures. They included mother's age, mother's age square, education levels (primary, secondary and higher), marital status (currently married), wealth index (poorest, poorer middle, richer and richest), place of residence, sex of the household head, piped water, hospital delivery and household size. In the second part of the analysis, the dependent variable was categorical in nature; 1 if a mother was underweight and 0 otherwise. Fertility was instrumented using proportion of contraceptives and birth of twins. The instruments were used to account for the simultaneous effect between fertility and maternal health status as shown in Table 4.6 and Table 4.7.

Table 4.6: Effect of fertility on Maternal Health: Body Mass Index-BMI)

	IV/ESTIMATES USING 2SLS		
Explanatory Variables	**Coefficients**	**Robust Standard Error**	**P-Value**
Fertility	-0.396***	0.131	0.002
Mother's age	0.411***	0.067	0.000
Mother's age square	-0.004***	0.001	0.000
Hospital delivery	-0.043	0.122	0.725
Wealth Quintile: Poorer	0.289**	0.138	0.036
Middle	0.716***	0.149	0.000
Richer	1.568***	0.180	0.000
Richest	3.199***	0.293	0.000
Primary education	0.266**	0.132	0.043
Secondary education	0.849***	0.231	0.000
Higher education	2.187***	0.718	0.002
Piped water source	0.352***	0.133	0.008
Place of residence	0.138	0.192	0.471
Married	-0.055	0.207	0.791
Sex of household head	-0.025	0.158	0.872
Household size	0.076***	0.026	0.003
Mother's employment	0.935*	0.517	0.070
Listening news	0.446***	0.192	0.004
Constant	13.814***	1.081	0.000
No. of observations	5971		
F(19, 5951)/ LR Wald chi2 (22)	479.28		
R-sq. /Pseudo R sq.	0.1629		
F(2,5951) Test for excluded instruments	172.761		
Partial R. sq. for excluded instruments	0.0565		
Durbin (score) chi2(1)	9.03624		0.0026
Wu-Hausman F(1,5951)	9.03122		0.0027
Sargan Statistics chi2(1) (Over id. of Instruments)	0.2493		0.6175

Note *, **, * denote Significance at 1% 5% and 10% respectively.**

***Source*: Author's calculations**

4.5.1 Result from IV/2SLS Approach: BMI

The study finding showed that the coefficient of fertility was negative and statistically significant at one percent level. The coefficient of fertility was -0.39. This implies that additional child in a household reduces BMI by 0.39, other factors held constant. Being among the members of household, mothers could also face resource competition which reduce body mass index as the number of children increases. This is consistent with the theory of quantity-quality trade off proposed by Becker (1960), and Becker and Lewis (1976). Similar results were reported by Wu (2012) who found that fertility was negatively related to BMI in China.

To instrument fertility in the maternal health model (BMI-model), the study identified two instruments (contraceptive and birth of twins). These instruments were later tested for strength, exogeneity and relevance. The study confirmed that both instruments satisfied all the three properties of strength, validity and exogeneity. The magnitude of the first stage F-statistics and P value (F-statistics=172.761 and P-value=0.000) suggests that contraceptive and twins are strong and relevant instruments for fertility. Sargan test was conducted to test for the over identification and to check whether if the instruments were correlated with an error term of the BMI equation. The results indicate that the Sargan Statistics chi2 (1) of 0.2493 with a p-value of 0.6175 led to rejecting the null hypothesis that the instruments are correlated with the error term in the structural model suggesting the absence of over-identification.

Lastly, the study conducted a test whether fertility was endogenous in the BMI model. This was achieved by testing for endogeneity through the Durbin-Wu-Hausman test which was found to be significant at one percent level. The study found that both Durbin (score) chi2(1) = 9.0326 with a p-value of 0.0026 and Wu-Hausman F (1,5946) =9.03122with a p-value of 0.0027. The study rejected the null hypothesis of exogenous fertility suggesting that fertility was indeed endogenous. Reduced fertility residuals from the control function approach were found to be statistically significant confirming the endogeneity of fertility in the maternal health model (see Table A10 in the appendix 3).

The coefficient of the age of the mother was found to be positive and statistically significant at one percent level. An additional age of the mother by one year increases the Body Mass Index by 0.41 holding other factors constant. This implies that the health of a woman improves with age. There is a high possibility that as a mother advances in age, she learns more and better ways of managing her health. The non-linearity of age is indicated by its square which is significant. The study findings are similar to findings of an earlier study in Nigeria that found a positive effect of mother's age on body mass index (Adeoti and Awoniyi, 2012).

Using the poorest group (first wealth quintile) as a base category, the study found wealth index to be an important determinant of maternal health status. The coefficients of middle, richer and richest wealth quintiles were positive and statistically significant at one percent level except poorer wealth quintile which was positive and statistically significant at five percent level. Women in the poorer, middle, richer and richest wealth quintile increased their BMIs by 0.29, 0.72, 1.57 and 3.2 respectively compared to women in the poorest group holding other factors constant. The result further revealed that as an individual moves from lower wealth quintile to the highest wealth quintile, health status also improves based on the magnitudes in their respective wealth quintiles. Compared to women in the poorest wealth quintiles, women in the upper categories are better placed to good nutritional status. The finding is consistent with the study findings of Ajieroh, (2009) who found a positive effect of wealth index on maternal health status in Nigeria.

The coefficient of primary education was positive and statistically significant at five percent level while secondary and higher education levels were positive and statistically significant at one percent level. Primary, secondary and higher education levels increased the woman's BMI by 0.27, 0.23 and 2.19 respectively relative to women without education holding other factors constant. Considering the magnitudes of the coefficients, women with higher education levels have more effects than primary and secondary education levels. This implies that despite all educational levels significantly contributing to better maternal health, higher education level, therefore, should be of priority in policy formulation. This is in line with the study findings obtained by Adeoti and Awoniniyi, (2012) and Wu (2008) who found a positive effect of maternal education on the nutritional status of women in Nigeria and China.

The study further considered piped water source as an environmental factor affecting maternal health status. The coefficient the piped water source was positive and statistically significant at one percent level. The results suggest that access to piped water source increase the woman's BMI by 0.35 compared to women without access to piped water holding other factors constant. These findings may be attributed to the fact that women who access clean drinking water (piped water) become unsusceptible to infections and thus stronger health in the long run. The study result on piped water source concurs with the finding of Dahiya and Viswanathan (2014) and Adeoti and Awoniyi (2012) who revealed that piped water was associated with the higher Body Mass Index in India and Nigeria. The study results, on the other hand, conflict with the finding of Achieng (2014) who found insignificance of piped water source to maternal health status in Kenya.

The coefficient of household size was shown to be positive and statistically significantly at one percent level. An extra member of a household was found to raise BMI of a mother by 0.08 holding other factors constant. According to Ajieroh (2009), large households with able-bodied persons of working age, then partly by economies of scale may translate to the enhanced welfare of household members thus leading to improved nutritional status. The positive relationship revealed in this study may be associated with the economic activities of the members of the household, which benefit other members of the family including the mother and in this case their BMI increases. Also, the findings may be attributed to the good health of the members of the household which enables each member to undergo day to day activities. Finally, the proportion of dependents in a household is less leading to less resource competition and thus high BMI of the mother. This finding supports the result obtained by Dahiya and Viswanathan (2014) in India where household size was found to be positively related to BMI of the mothers.

The coefficient of the mother's employment was found to be positive and statistically at ten percent level. The study found that an employed mother had a BMI of 0.94 points higher compared to unemployed mothers. This can be explained by the fact that employed mothers are empowered economically, and decision-making is solely done by them. In this case, they are in a position to determine their dietary which improves their welfare. This is consistent with the study results by Adeoti and Awoniyi, (2012), Achieng (2014) and Muttai (2014) who found a positive effect of women employment on maternal health status in Nigeria and Kenya respectively.

Finally, access to news through radio was found to be an important determinant of maternal health status in Tanzania. The coefficient of listening to the news was positive and statistically significant at one percent level. Listening to the radio at least once a week was shown to raise mothers BMI by 0.45 compared to mothers who did not listen to radio at all holding other factors constant. This implies that health information accessed by mothers is vital in exposing mothers to the kind of foods that mothers need to take in order to better their own welfare. This supports the findings of Dahiya and Viswanathan (2014) who found that access to information through radio was associated with higher BMI of women in India.

The study further estimated Ordinary Least Square (OLS) and control function model as indicated in Table A12, Table A13, Table A14 and Table A15 in the appendix 3. The study found that the coefficient of fertility was found to be negative but insignificant in the OLS model. This suggests that fertility did not have significant effect on Body Mass Index which could be explained by the endogeneity of fertility in the OLS model.

The coefficient of fertility residual in the control function model was positive and statistically significant at one percent level (see Table A13 in the appendix 3). The significance of fertility residual implies that fertility was endogenous and that controlling for endogeneity through two stage least square (IVregress) was appropriate. The study further tested for the heterogeneity by interacting fertility and its residuals and the coefficient was found to be significance suggesting the presence of heterogeneity in the BMI model (see Table A14 in the appendix 3). To address heterogeneity, the study estimated the interaction of fertility, fertility residual and the instrumental variables (Kabubo-Mariara *et al.,* 2009b; Mwai, 20014 and Machio, 2014). The coefficient was insignificant suggesting absence of heterogeneity arising from interaction of fertility with the unobserved determinants of maternal health status such as the biological endowments of the mother (see Table A15 in the appendix 3).

4.5.2 Results from IV Probit Model (Underweight)

The coefficient of fertility was positive and statistically significant at five percent level. The marginal effect of fertility was 0.06. This means that an additional child born to a woman leads to increase the probability of underweight by 0.06 holding other factors constant. This implies that more children in the family means fewer resources are allocated to each member of the family. Mothers also compete with the children about the investment in their own quality, which is reflected in underweight. This supports the findings of Wu (2012) who found that woman with two children was associated with underweight in China.

Based on the findings indicated in Table 4.7, the study verified the validity of the endogeneity of fertility through the Wald test of exogeneity. At five percent significance level, the study led to rejection of the null hypotheses implying fertility was endogenous in the maternal health model

Table 4.7: Effect of fertility on Maternal Health Outcomes (Underweight)

	IVPROBIT ESTIMATES USING 2SLS		
Explanatory Variables	Marginal Effect	Standard Error	P>Z Value
Fertility	0.058**	0.028	0.045
Mother's age	-0.028***	0.009	0.004
Mother's age square	0.0002***	0.000	0.001
Hospital delivery	-0.022*	0.012	0.065
Wealth Quintile: Poorer	-0.034***	0.013	0.007
Middle	-0.033**	0.014	0.015
Richer	-0.049**	0.019	0.012
Richest	-0.053	0.036	0.146
Primary education	-0.024**	0.009	0.012
Secondary education	-0.018	0.017	0.284
Higher education	0.073	0.045	0.107
Piped water source	0.007	0.009	0.444
Place of residence	0.054		0.480
Married	-0.050**	0.024	0.037
Sex of household head	-0.014	0.011	0.192
Household size	-0.008*	0.004	0.047
Mother's employment	0.001	0.019	0.970
Listening news	0.006	0.012	0.594
No. of Observations	7411		
LR Wald chi2 (21)	223.80		
Log Likelihood	-16786.913		
Wald test of exogeneity (Prob > chi2)	5.40		0.0201

Note *, **, * denote Significance at 1% 5% and 10% respectively.**
***Source:* Author's Calculations**

The coefficient of mother's age was negative and statistically significant at one percent level. The marginal effect of mother's age was 0.03. This implies that an additional age of a mother by one year reduces the probability of a mother being underweight by 0.03, holding other factors constant. This suggests that as woman gets older, experience on good feeding habits increases thus reducing the likelihood of being underweight. The magnitude of age of the mother square is very small

(0.0002). This is expected. Nevertheless, age square was significant confirming nonlinearity of age of the mother. This findings support the findings of earlier studies conducted in Kenya, Nigeria, China, Sirlanka, and India where maternal age was found to be negative related with underweight and maternal anemia (Adeoti and Awoniyi, 2012; Achieng, 2014: Wu, 2008: Jayawardena 2014: Dahiya and Viswanathan 2014).

The coefficient of hospital delivery was negative and statistically significant at ten percent level. The marginal effect of hospital delivery was 0.022. This implies that the probability of a woman being underweight was lower by 0.02 for mothers who delivered at hospital compared to those who delivered elsewhere holding other factors constant. This is in line with the theory since hospital delivery improves the health of the woman through other teachings advocating for the good feeding habits in an effort to eliminate undernourishment as per the government policy. This finding is consistent with study by Ajieroh, (2009) who found a negative relationship between hospital delivery and the probability of a woman being underweight in Nigeria.

Using the poorest group (first wealth quintile) as a base category, maternal health outcomes increased in the respective wealth quintile. The coefficients of poorer (2^{nd} wealth), middle (3rd wealth) quintile and richer (4^{th} wealth) quintile except the richest (5thwealth) quintile were found to be negative and statistically significant at one and five percent level. However, the most important factor was women in the richer (fourth) wealth quintile since among the significant categories; the magnitude of the women in the fourth wealth quintile was high. The results further reveal that women in richer wealth quintiles enjoy better health (nutritional) status compared to those in the lowest (poorest) wealth quintile. For instance, in the poorer, middle and richer wealth quintiles reduced the probability of being underweight by 0.03, 0.03 and 0.05 respectively holding other factors constant.

This implies that household with higher socioeconomic status would be positively associated with food security needed for nutritional intake and improved nutritional status of household members. Studies that support similar findings were those of Girma (2007), Ajieroh, (2009), Adeoti and Awoniyi, (2012), Achieng (2014) and Fitso and Kuate-defo (2015) who found negative relationship between probability of a woman being underweight and economic status measured by wealth index in Ethiopia, Nigeria, Kenya and Ghana.

The coefficient of primary education was found to be negative and statistically significant at five percent level. The marginal effect of primary education was 0.024. This suggests that a woman with primary level of education compared to those with no education lowered the probability of a being underweight by 0.02 holding other factors constant. This implies that women with primary education level have a lower risk of undernourishment. This could be as a result of increased knowledge on food nutrient and health knowledge offered through formal schooling.

This finding concurs with the findings obtained by Girma (2007), Adeoti and Awoyini (2012) and Achieng (2014) who both found inverse relationship between maternal underweight and education in Ethiopia, Nigeria and Kenya.

The coefficient of marital status was negative and statistically significant at five percent level. The marginal effect of marital status was 0.05. The probability of a woman being underweight was by 0.05 for the married women compared to their unmarried counterparts holding other factors constant. This result could be as a result of better socioeconomic status and economic status associated with marital status which may further be attributed by the fact that the eating habits for married women differ from those of women in other categories. Kulkarni and Gaiha, (2009) while investigating the double burden of malnutrition in India focusing on underweight and obese, revealed that being married was associated with healthful feeding habits (more fruits and vegetables) leading to improved maternal health status thus supporting this study finding. On the other hand, Achieng (2014) found that being married led to a reduction in the likelihood of being underweight by 3.7% and showed that being married was associated with better social and economic status. Studies which are in line with the study finding includes; Girma (2007), and Betew and Telake, (2010).

Further, the study revealed a negative relationship between household size and the probability of mother being underweight. The coefficient of household size was negative and statistically significant at one percent level. The marginal effect was 0.008. This means that an additional member of household is likely to reduce the probability of a mother being underweight by 0.008 holding other factors constant. Mukherjee and Benson (2003) are of the opinion that there are varied outcomes of nutrition as a result of household size. In this case, mother's welfare is improved due to the overall improvement of the nutritional status of other household members. Further, the findings imply less competition of resources as a result of low dependents among the members of the household. The finding concurs with the study result of Black *et al.* (2008) and Ajieroh (2009) in their respective studies on maternal and child malnutrition.

The results from the estimated maternal health models revealed hospital delivery, place of residence, married, and sex of the household head were found to be statistically insignificant at all levels of significance in the BMI model while the fifth wealth quintile, secondary education, higher education, piped water source, place of residence, sex of the household head, mother's employment and listening to news were found to be statistically insignificant at all levels of significance in the underweight model.

Finally, the study estimated Control Function Approach on underweight as indicated in the Table A19, Table A20 and Table A21 in the Appendix 3. The findings of the CFA model (s) show that the coefficient of fertility residuals was positive and statistically significance which confirm the endogeneity of fertility in the underweight model. The coefficient of interaction of fertility and its residuals was also significant implying the presence of heterogeneity arising from the interaction of fertility with the unobserved determinants of underweight (See Table A23, appendix 3). The findings of the CFA models are not varying so much but it tallies with the IVregress and IVprobit models.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

5.1 Introduction

This chapter presents the summary of the study as well as conclusion. The chapter also suggests policy implications based on the study findings and contribution to knowledge. Suggestions for further study are also made as a way of filling the gaps identified in the study.

5.2 Summary of the Study

Tanzania has been experiencing rapid population growth and high fertility rates which are perceived more as obstacles than stimulants to economic growth and development. Families with more children commit less time and resources to providing basic care and protection required for their children. Accordingly, millions of children and women in Tanzania continue to suffer from one or more forms of under-nutrition, including low birth weight, stunting, underweight and wasting. In Africa, Tanzania is the third most noticeably affected by child and maternal mortality where around 130 infants die each day because of malnutrition related sicknesses. Moreover, approximately 600 thousand children aged under-five years were estimated to have died due to malnutrition.

With the launched of the Millennium Development Goals in 2000, Tanzania and other world economies have been much concerned with the attainment of global health success. This success has, however, been achieved in the eradication of vaccine-preventable diseases, yet still a startling number of women die annually of causes related to pregnancy and childbirth attributed to nutritional status. This study explored the relationship between fertility, child and maternal health outcomes in Tanzania using the Tanzania Demographic and Health Survey data (2010). The specific objectives the studies were: (i) to determine the effect of socioeconomic factors on fertility; (ii) to analyze the effect of fertility on child health; and (iii) to investigate the effect of fertility on maternal health in Tanzania.

In the first objective, the study analyzed fertility through the measurement of the effects of various socio-economic factors on its behavior. The study employed the zero inflated poisson (ZIP) model in estimation and the number of children ever born to a woman as a measure of fertility which is also used as the dependent variable. From the findings of this study, age of the mother and being married had positive and significant effect on fertility while education levels (primary, secondary and higher) had negative and significant effect on fertility. Similarly, household wealth (4th and 5th wealth quintiles), mother's employment, proportion of contraceptive use, family planning, urban residence, access to health information (frequency of listening to radio and reading newspapers) had negative and significant effect on fertility.

The second objective sought to examine the effect of fertility on child health. The study employed nutritional status of the child such as height-for-age z-score, and the probability of a child being stunted as indicators of child health outcomes in Tanzania. Different estimation techniques such as ordinary least square (OLS), probit, 2SLS (IVProbit and IVregress) models, and control function approach (CFA) were employed. On the other hand, proportion of contraceptive and occurrence of twins were used as instrumental variables for fertility in the child health outcomes model to account for possible endogeneity problem that is the simultaneous relationship between fertility and child health outcomes. The OLS, 2SLS (HAZ as dependent variable), and CFA, all suggested that fertility had a negative and significant effect on height-for-age z-score. Similarly age of the child, sex of the child and diarrhea were found to significantly reduce the height-for-age z- score while age of the mother, height of the mother, being married, household wealth (middle, richer and richest quintiles), secondary education, piped water, hospital delivery and mother's employment significantly increased the height-for-age z-score (i.e. they increased the welfare of the child).

Results from the probit, IVProbit and CFA (stunted as dependent variable), showed that fertility had a positive and significant effect on the probability of a child being stunted. Household, child and community characteristics were also found to have an important impact on the probability of a child being stunted. Specifically mother's age, height of the mother, household wealth (poorer, middle and richest), secondary education, piped water and hospital delivery significantly reduced the probability of a child being stunted. On the other hand, child age, sex of the child and diarrhea were found to increase the probability of a child being stunted. Lastly, the study established that coefficient of fertility residuals in the control function approach was significance suggesting the endogeneity of fertility in the child health equation. However, further interaction of fertility and fertility residuals was not significant implying absence of heterogeneity caused by the unobserved determinants of child health and fertility.

In the third objective, the study investigated the effect of fertility on maternal health outcomes in Tanzania. This study used BMI and a mother being underweight as dependent variables. The study employed OLS, probit, 2SLS (IVregress and IVProbit) models, and CFA models in estimating the effect of fertility on maternal health outcomes. Again, the study used unmet needs, the occurrence of twins and proportion of contraceptive as instruments for fertility in the maternal health outcomes model to account for possibility of endogeneity problem.

Fertility was found to have negative and significant effect on Body Mass Index (maternal health) in the IVregress and Control Function models. In addition, age of the mother, household wealth quintiles (poorer, middle and richer), primary, secondary and higher education, household size, mother's employment and listening to news had positive and significant effect on Body Mass Index BMI). The study further found that both the coefficient of fertility residual and its respective interaction was found to be significant implying the endogeneity of fertility as well as presence of heterogeneity in the maternal health equation in the Control Function Approach (CFA) model.

Finally, as for the IVProbit (Underweight model) result, it is noted that the probability of a mother being underweight was significantly reduced by age of the mother, hospital delivery, wealth quintiles (poorer, middle and richer), primary education, marital status and household size while fertility was the only factor which significantly increased the probability of a mother being underweight.

5.3 Conclusions of the Study

Based on the evidences implied by the findings of this study using the TDHS 2010, it may be concluded that many socioeconomic factors significantly influence fertility in Tanzania. In particular, the current age of the mother and marital status have significant positive impact on fertility. Whereas mother's education (primary, secondary and higher), household wealth (richer and richest quintile), mother's employment, contraceptive, family planning awareness, frequency of listening to radio and reading newspapers and place of residence have significant negative effects on fertility.

The study has also demonstrated how fertility influences the health of mothers and children in Tanzania. The magnitude of the effect of fertility on maternal and child health status however, has slight differences. The study presented evidence that an increase in fertility led to lower child health status in terms of height-for-age z-score. Moreover, increase in fertility also significantly increases the probability of a child being stunted. Therefore, this implies that additional births are detrimental to child health. The study further gave evidence that secondary education, piped water, household wealth (middle, richer and richest wealth quintiles), hospital delivery, mother's age, height of the mother and mother's employment significantly improved child health status, but reduced the probability of a child being stunted. Child's age, sex of the child, and diarrhea evidently reduced significantly the child health status in terms of height-for-age z-score but significantly increased the probability a child being stunted. Birth order, primary and higher education, place of residence, sex of the household head and antenatal visits did not have significant affect in height-for-age z-score and the probability of a child being stunted.

In terms of methodology, this study established the endogeneity of fertility in the child health equation and therefore, a simultaneous relationship between fertility and child health outcomes. In other words, fertility impacts child health, while child health affects fertility through the factors that influences both variables. The significance of the fertility residuals in the CFA justifies the endogeneity of fertility in child health equation; however further interaction of fertility and fertility residual was not significant implying absence of heterogeneity.

For the maternal health outcomes, it is also evident that an increase in fertility significantly raised the probability of a mother being underweight. This relationship was established when using a more robust model that is the instrumental variable estimation. The mother's age, household wealth (poorer, middle, richer and richest), primary education, secondary and higher education, household size, mother's employment, listening to news and piped water significantly increased the body mass index (BMI). Likewise, these factors significantly reduced the probability of a mother being underweight except for secondary and higher education, piped water, listening news, hospital delivery, mother's employment. However, being married, household size and primary education significantly reduced the probability of a mother being underweight.

Addressing endogeneity of fertility in maternal health equation led to robustness of the model. In the control function approach, both fertility residual and its respective interaction with other variables were significant and therefore justified the endogeneity of fertility as well as presence of heterogeneity in the maternal health equation.

5.4 Policy Implications

Based on the empirical findings, the study draws the following policy implications that can be used in addressing fertility, maternal and child health outcomes in Tanzania:

(i) Promotion of family planning programmes

Based on the empirical results, it is necessary for the government of Tanzania through the Ministry of Health and Social Welfare to design relevant programmes targeting the creation of awareness on the effects of increased fertility on a household. The government should aim at strengthening family planning services so as to improve women's health and limit fertility rate. For example, the government may organize workshops for females to sensitize them on the need for family planning among other lessons. These programmes may be carried out throughout the country that is both in the urban and rural areas, churches, schools, barazas, and in any other gathering to disseminate information on aspects of family planning and even better feeding habits. This is because contraceptive use, family planning awareness, urban residence and access to health information significantly influenced fertility in Tanzania.

The findings further indicated fertility to be associated with poor child and mothers' health status. Failure to address fertility upsurge, the government will be at the crossroads on distribution of the national resources in terms of health provision to the general public which in turn may adversely influence the health status of its people especially the future potential labor force. Therefore, by curbing fertility, the government will have met the goal of improving the general well-being of children and mothers in Tanzania.

(ii) Investment in education

Education is an essential investment which can curb the rising fertility and improving maternal and child health outcomes in Tanzania. Investing in education especially female education need to be promoted based on the study findings which indicated a negative and significant influence of education on fertility.

Women with primary, secondary or higher education levels were found to be associated with significantly lower fertility levels. On the other hand, education was found to have a positive and significant relationship with child and mother's health status. The current government in Tanzania introduced free primary and secondary education. Nevertheless, the government of Tanzania needs therefore to effect the existing free primary and secondary education by releasing the resources (educational funds) in time and ensuring proper utilization of the same funds.

Therefore, there is a need to also have more institutions of higher learning (post-secondary) to contain increased upsurge for higher education. This is based on the higher magnitude associated with lower fertility among women with higher education levels as well as better child and maternal health outcomes. If little is done to promote and improve education levels of female population, there is increased likelihood of mothers being ignorant on basics of their own health, health of the newborns and ultimately health of the population. To promote this policy, the government needs to increase educational infrastructures that are equipped with better equipment of learning to encourage female education in Tanzania.

(iii) Promotion of Female Employment

Development discourse of fertility is believed to be influenced by woman empowerment through employment. Employed mothers earn income which empowers them to make decision on reproductive and sexual health and rights awareness and these are likely to reduce fertility in Tanzania. This based on the negative effect of mother's employment on fertility and consequent increase in the height-for-age z-score and Body Mass Index of children and mothers respectively.

If mothers are economically weakened, aspect of dependence on their husbands may lead to lack of dependence when making decisions on the number of children that a woman would like to have during her reproductive years. This may ultimately contribute to the high fertility rates in the country and eventual poor maternal health status. Therefore, there is need for the government to implement policies aimed at raising household income and women in particular. Increasing women participation in the labor market or even in non-labor market activities can enhance their own well-being as well as that of the families. Further, increase in female labor force participation raises the opportunity cost of having children and lessens the number of children born to a woman.

(iv) Income Distribution Strategies

To be able to provide women and children with adequate and quality health, the government of Tanzania needs to introduce programs that will enhance their economic status. This can mainly be achieved through the enhancement of income distribution among population especially the women fraternity. If this aspect is not well addressed, emerging classes of few women in higher wealth quintiles and significant majority of them in the lower or poor wealth levels especially single mothers will be a reality. There are a number of ways that the government of Tanzania can apply in conducting the redistribution activities including the cash transfer schemes to the poor households. If this is accomplished, the poor women will be enabled move to higher wealth quintiles; thus, reduce women's fertility and improve their well-being and that of their children. To be able to provide women and children with adequate and quality health, the government of Tanzania needs to introduce programs that will enhance their economic status.

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Further, the government can focus on and revitalize the existing programmes of eradicating poverty in the country. Having implemented these income redistribution strategies, the anticipated results would be women attaining higher wealth indices and significantly lowering their fertility. This implies that the height-for-age z-score and Body mass index for the children and their mothers will increase. Subsequently, attaining higher wealth quintiles through adequate redistribution of income strategies will result in lower probability of chronic malnutrition among the women and children in Tanzania. This is based on the study findings whereby women in the household with higher wealth quintiles richer and richest (fourth and fifth) significantly lowered fertility while height-for-age z-score and Body Mass Index for children and mothers were shown to increase. On the other hand, wealth quintiles considered in this study showed that women in household with higher wealth quintile led to lower probability of underweight among the women in Tanzania.

5.5 Contribution to Knowledge

This thesis makes a number of contributions to the literature. First, the study address estimation issues of endogeneity of fertility and the potential heterogeneity that would arise from the unobserved determinants of child health but may be correlated with fertility. Accounting for endogeneity of fertility and the potential heterogeneity avoid biased estimates and misleading policy conclusions.

Second, the thesis contributes to the fertility literature by using new techniques of estimation such as the Zero-Inflated Poisson (ZIP) that account for the data characteristics in terms of fertility as count data in the theoretical model and estimation methods. To account other aspects ignored by other studies. One such aspect is fertility being count data variable. This thesis is the first study to use ZIP model to analyze determinants of fertility as a count data variable in Tanzania.

Third, the study contributes to the literature by measuring the direct relationship between fertility and health both for mothers and children in Tanzania. Empirical analysis has also focused on the relationship between fertility and mother's labor force participation and education of children. Health which is a special component of human capital has received little attention especially in developing countries where maternal and child health is still poor. In Tanzania for instance studies have focused on the utilization of maternal health services while ignoring the link between fertility and maternal and child health.

5.6 Areas for further study

This paper mainly concentrated in analyzing fertility, child health and maternal health status using data collected from the Tanzania Demographic and Household Survey (TDHS). The study mainly used the number of children ever born to a woman; the probability of a child being stunted and height-for-age-z score; and the probability of a mother being underweight and BMI as the dependent variables for fertility, child health and maternal health models. For comparison, the study recommends more studies using wasting or underweight of children for child health model while for maternal model, other studies could consider using blood pressure, overweight or obesity as dependent variables. Finally, other studies need to consider intra-household food distribution and physical activities assessing women nutritional status both at regional and national levels.

Based on the literature, there are a number of other factors that were not included in model formulation and estimation in this study, which may be considered in the future models. Further, there is need to employ experimental treatment designs/approaches in economics while investigating the effect of fertility on health status in order to control for endogeneity of fertility. There is also need to conduct further studies using the recent Demographic Health Survey Data for 2015 which was not available at the time of the data analysis of this thesis. This is to establish whether or not results will concur with the current study.

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APPENDICES

Appendix 1: Actual Coefficients from ZIP

Table A.1: Estimation of Zero Inflation Poisson Regression Model: Socio-Economic Determinants of Fertility

Variables	Coefficients	Robust Std Error	P-Value
Mother's Age	0.087***	0.001	0.000
Mother's Age square.	-0.003***	0.000	0.000
Mother's Primary Education	-0.029**	0.014	0.035
Mother's Secondary Education	-0.165***	0.024	0.000
Mother's Higher education	-0.219*	0.133	0.098
Wealth Quintile: Poorer	-0.007	0.016	0.681
Middle	-0.009	0.017	0.578
Richer	-0.066***	0.018	0.000
Richest	-0.233***	0.025	0.000
Married	0.224***	0.016	0.000
Mother's employment	-0.146***	0.043	0.001
Contraceptive Use	-0.757***	0.036	0.000
Family Planning Awareness	-0.028**	0.012	0.024
Frequency of listening to radio	-0.044***	0.014	0.001
Frequency of reading newspapers	-0.036***	0.013	0.008
Place of residence (urban=1; rural=0)	-0.064***	0.018	0.001
Constant	1.356***	0.024	0.000
Inflate (Probability of zero birth)			
Proportion of contraceptives	-5.183***	0.455	0.000
Mother's primary education	0.416	0.271	0.126
Mother's secondary education	2.704***	0.345	0.000
Mother's higher education	4.019***	0.824	0.000
Age of the mother	-0.315***	0.044	0.000
Married	-5.267***	0.765	0.000
Place of residence (1=urban)	-0.465**	0.194	0.017
Zero observations	2782		
Non zero observations	7259		
No. of Observations	10041		
LR Wald chi2 (20)	10379.48		
Likelihood Ratio Test (Poisson	0.0014		0.483

vs. Negative Binomial)			
Vuong test of zip vs. standard Poisson	Z= 17.14		0.000

Notes: *, **, * denote significance at 1%, 5%, and 10%, respectively.**

Appendix 2: Results for OLS, Probit, IVprobit, and Control Function Approach

Table A.2: Effect of fertility on Child Health (Dependent Variable: HAZ)

	Ordinary Least Square (OLS)		
Explanatory variables	**Coefficient**	**Robust Std Error**	**P-Value**
Fertility	-0.052***	0.019	0.007
Child's age	-0.114***	0.005	0.000
Child's age square	0.002***	9.00e-05	0.000
Mother's age	0.087***	0.022	0.000
Mother's age square.	-0.001***	0.0001	0.002
Height of mother	4.929***	0.322	0.000
Married	0.005	0.006	0.426
Wealth Quintile: Poorer	0.104	0.064	0.101
Middle	0.172***	0.065	0.008
Richer	0.289***	0.071	0.000
Richest	0.587***	0.093	0.000
Sex of the child (male=1)	-0.162***	0.039	0.001
Birth Order	-0.019	0.056	0.722
Primary education	0.077	0.050	0.129
Secondary education	0.286***	0.078	0.000
Higher education	0.698***	0.230	0.002
Piped water source	0.112**	0.048	0.020
Diarrhea	-0.035***	0.009	0.000
Place of residence (Urban=1)	0.007	0.063	0.918
Hospital delivery	0.104***	0.044	0.017
Sex of Household Head	-0.006	0.056	0.905
Antenatal visits	0.032**	0.015	0.036
Mother employed	0.427*	0.228	0.061
Constant	-9.060***	0.586	0.000
No. of observations	4,646		
R-sq. /Pseudo R sq.	0.2163		

Note *, **, * denote Significance at 1% 5% and 10% respectively**

***Source*: Author's Calculations.**

Table A.3: Effect of fertility on Child Health (Dependent variable: HAZ)

	Control Function Approach		
Explanatory variables	**Coefficient**	**Robust Std Error**	**P-Value**
Fertility	-0.694***	0.132	0.000
Fertility Residual	0.656***	0.118	0.000
Child's age	-0.129***	0.006	0.000
Child's age square	0.002***	9.00e-05	0.000
Mother's age	0.311***	0.052	0.000
Mother's age square.	-0.001***	0.0001	0.001
Height of mother	5.280***	0.371	0.000
Married	0.162**	0.071	0.022
Wealth Quintile: Poorer	0.099	0.069	0.155
Middle	0.225***	0.072	0.002
Richer	0.158*	0.084	0.059
Richest	0.387***	0.113	0.000
Sex of the child (male=1)	-0.142***	0.044	0.001
Birth Order	-0.069	0.059	0.248
Primary education	0.028	0.058	0.634
Secondary education	0.309***	0.089	0.000
Higher education	0.519	0.428	0.226
Piped water source	0.159***	0.054	0.003
Diarrhea	-0.226***	0.039	0.000
Place of residence (Urban=1)	-0.048	0.073	0.516
Hospital delivery	0.043***	0.010	0.000
Sex of Household Head	0.039	0.063	0.533
Antenatal visits	-0.0002	0.018	0.989
Mother employed	0.443**	0.219	0.043
Constant	-9.536***	0.671	0.000
No. of observations	4,646		
R-sq. /Pseudo R sq.	0.221		

Note *, **, * denote Significance at 1% 5% and 10% respectively.**

Source: Author's Calculations

Table A.4: Effect of fertility on Child Health (Dependent variable: HAZ)

	Control Function Approach		
Explanatory variables	**Coefficient**	**Robust Std Error**	**P-Value**
Fertility	-0.695***	0.116	0.000
Fertility Residual	0.638***	0.125	0.000
Interaction (ferti*fertility Res)	0.003	0.007	0.669
Child's age	-0.129***	0.005	0.000
Child's age square	0.002***	9.00e-05	0.000
Mother's age	0.311***	0.046	0.000
Mother's age square.	-0.001***	0.0001	0.001
Height of mother	5.280***	0.326	0.000
Married	0.161**	0.064	0.013
Wealth Quintile: Poorer	0.099	0.069	0.155
Middle	0.224***	0.065	0.001
Richer	0.159**	0.075	0.033
Richest	0.388***	0.099	0.000
Sex of the child (male=1)	-0.142***	0.039	0.000
Birth Order	-0.069	0.052	0.193
Primary education	0.028	0.051	0.582
Secondary education	0.309***	0.079	0.000
Higher education	0.517**	0.249	0.039
Piped water source	0.159***	0.048	0.001
Diarrhea	-0.226***	0.035	0.000
Place of residence (Urban=1)	-0.048	0.064	0.451
Hospital delivery	0.043***	0.009	0.000
Sex of Household Head	0.038	0.056	0.497
Antenatal visits	-0.0002	0.018	0.992
Mother employed	0.444**	0.227	0.051
Constant	-9.536***	0.591	0.000
No. of observations	4,646		
R-sq. /Pseudo R sq.	0.221		

Note *, **, * denote Significance at 1% 5% and 10% respectively.**

Source: Author's Calculations

Table A.5: Effect of fertility on Child Health: (Dependent Viable: Stunting-Actual Coefficients from Probit.

	PROBIT ESTIMATES RESULT		
Explanatory variables	**Coefficient**	**Standard Error**	**P-Value**
Fertility	0.046**	0.019	0.014
Child's age	0.013***	0.002	0.000
Child's age square	-0.001***	0.000	0.000
Mother's age	-0.025***	0.007	0.000
Mother's age square.	0.001***	0.000	0.001
Height of mother	-0.026***	0.006	0.000
Married	0.031	0.055	0.578
Wealth Quintile: Poorer	-0.133**	0.060	0.028
Middle	-0.156**	0.063	0.012
Richer	-0.172**	0.068	0.011
Richest	-0.356***	0.093	0.000
Sex of the child (male=1)	0.187***	0.093	0.000
Birth Order	-0.069	0.043	0.109
Primary education	-0.046	0.048	0.340
Secondary education	-0.258***	0.080	0.001
Higher education	-1.032**	0.511	0.044
Piped water source	-0.055	0.045	0.235
Diarrhea	0.027***	0.009	0.002
Place of residence (Urban=1)	-0.031	0.065	0.632
Hospital delivery	-0.007	0.005	0.201
Sex of Household Head	-0.017	0.057	0.769
Antenatal visits	-0.028*	0.015	0.056
Mother employed	-0.145	0.187	0.439
No. of observations	4649		
Constant	0.276	0.268	0.303
Pseudo R2	0.0887		
LR chi2(23)	-2846.096		
Wald chi2(23)	484.43		

Note *, **, * denote Significance at 1% 5% and 10% respectively.**

Source: Author's Calculations.

Table A.6: Effect of fertility on Child Health: Stunted as Dependent Variable-Marginal Effects from Probit.

	Marginal Effects from Probit Results		
Explanatory variables	**Coefficient**	**Robust Standard Error**	**P-Value**
Fertility	0.016**	0.007	0.014
Child's age	0.004***	0.002	0.000
Child's age square	-0.001***	0.000	0.000
Mother's age	-0.009***	0.002	0.000
Mother's age square.	0.0003***	0.001	0.001
Height of mother	-0.009***	0.002	0.000
Married	0.011	0.019	0.578
Wealth Quintile: Poorer	-0.046**	0.021	0.028
Middle	-0.055**	0.022	0.012
Richer	-0.060**	0.024	0.011
Richest	-0.124***	0.033	0.000
Sex of the child (male=1)	0.065***	0.013	0.000
Birth Order	-0.024	0.015	0.109
Primary education	-0.016	0.017	0.340
Secondary education	-0.090***	0.028	0.001
Higher education	-0.360**	0.179	0.044
Piped water source	-0.019	0.016	0.235
Diarrhea	0.009***	0.003	0.002
Place of residence (Urban=1)	-0.011	0.023	0.632
Hospital delivery	-0.002	0.001	0.201
Sex of Household Head	0.006	0.019	0.769
Antenatal visits	-0.009*	0.005	0.056
Mother employed	-0.051	0.065	0.439
No. of observations	4649		
Pseudo R2	0.0887		
LR chi2(23)	-2846.096		
Wald chi2(23)	484.43		

Note *, **, * denote Significance at 1% 5% and 10% respectively.**

Source: Author's Calculations

Table A.7: Effect of fertility on Child Health: Stunted as Dependent Variable-Actual Coefficients from IVProbit Estimation.

	IVPROBIT ESTIMATES USING 2SLS		
Explanatory variables	**Coefficient**	**Robust Standard Error**	**P-Value**
Fertility	0.477***	0.099	0.000
Child's age	0.088***	0.005	0.000
Child's age square	-0.001***	0.0001	0.000
Mother's age	-0.226 ***	0.037	0.000
Mother's age square.	0.001***	0.0003	0.001
Height of mother	-0.154***	0.372	0.000
Married	-0.079	0.062	0.196
Wealth Quintile: Poorer	-0.124**	0.059	0.037
Middle	-0.184***	0.060	0.002
Richer	-0.089	0.072	0.218
Richest	-0.225**	0.102	0.027
Sex of the child (male=1)	0.153***	0.039	0.000
Birth Order	0.015	0.053	0.772
Primary education	0.021	0.048	0.659
Secondary education	-0.229***	0.078	0.003
Higher education	-0.815	0.529	0.124
Piped water source	-0.082*	0.044	0.063
Diarrhea	0.155***	0.029	0.000
Place of residence (Urban=1)	-0.013	0.064	0.834
Hospital delivery	-0.028***	0.008	0.000
Sex of Household Head	-0.049	0.055	0.374
Antenatal visits	-0.005	0.016	0.742
Mother employed	-0.135	0.178	0.446
No. of observations	4,646		
Constant	6.335	0.650	0.000
LR chi2(23)	-9483.946		
Wald chi2(23)	868.29		
Wald test of exogeneity (prob>chi2)	0.0003		

Note *, **, * denote Significance at 1% 5% and 10% respectively.**

Source: Author's Calculations

Table A.8: Effect of fertility on Child Health: Stunted as Dependent Variable-Actual Coefficients from Probit-Control Function Approach

	Control Function Approach		
Explanatory variables	**Coefficient**	**Standard Error**	**P-Value**
Fertility	0.523***	0.132	0.000
Fertility residuals	0.481***	0.134	0.000
Child's age	0.099***	0.006	0.000
Child's age square	-0.001***	0.000	0.000
Mother's age	-0.249***	0.051	0.000
Mother's age square.	0.001***	0.000	0.001
Height of mother	-0.649***	0.350	0.000
Married	-0.086	0.067	0.199
Wealth Quintile: Poorer	-0.139**	0.061	0.024
Middle	-0.206***	0.064	0.001
Richer	-0.102	0.073	0.164
Richest	-0.256**	0.100	0.011
Sex of the child (male=1)	0.172***	0.039	0.000
Birth Order	0.014	0.134	0.800
Primary education	0.023	0.049	0.650
Secondary education	-0.257***	0.081	0.002
Higher education	-0.915	0.569	0.108
Piped water source	-0.091*	0.047	0.053
Diarrhea	0.169***	0.039	0.000
Place of residence (Urban=1)	-0.016	0.067	0.812
Hospital delivery	-0.031***	0.009	0.001
Sex of Household Head	-0.018	0.019	0.353
Antenatal visits	-0.002	0.006	0.695
Mother employed	-0.051	0.063	0.417
No. of observations	4,646		
Log Likelihood ratio	-2763.625		
Wald chi2(24)	713.67		

Note *, **,* denote Significance at 1% 5% and 10% respectively.**

Source: Author's Calculations

Table A.9: Effect of fertility on Child Health: Stuntedas Dependent Variable-Marginal Effects from Probit-Control Function Approach

	Control Function Approach		
Explanatory variables	**Coefficient**	**Standard Error**	**P-Value**
Fertility	0.178***	0.045	0.000
Fertility residuals	0.163***	0.045	0.000
Child's age	0.034***	0.002	0.000
Child's age square	-0.0004***	0.000	0.000
Mother's age	-0.085***	0.017	0.000
Mother's age square.	0.0004***	0.0001	0.001
Height of mother	-0.577***	0.112	0.000
Married	-0.029	0.023	0.198
Wealth Quintile: Poorer	-0.047**	0.208	0.024
Middle	-0.069***	0.022	0.001
Richer	-0.035	0.245	0.163
Richest	-0.087**	0.034	0.011
Sex of the child (male=1)	0.058***	0.013	0.000
Birth Order	0.014	0.056	0.800
Primary education	0.008	0.017	0.650
Secondary education	-0.087***	0.027	0.002
Higher education	-0.310	0.172	0.125
Piped water source	-0.031*	0.016	0.053
Diarrhea	0.058***	0.009	0.000
Place of residence (Urban=1)	-0.005	0.013	0.000
Hospital delivery	-0.030***	0.009	0.002
Sex of Household Head	-0.016	0.018	0.374
Antenatal visits	-0.006	0.016	0.694
Mother employed	-0.044	0.058	0.446
No. of observations/	4,646		

Note *, **, * denote Significance at 1% 5% and 10% respectively.**

Source: Author's Calculations

Table A.10: Effect of fertility on Child Health: Stunted asDependent Variable-Actual Coefficients from Probit-Control Function Approach

	Control Function Approach		
Explanatory variables	**Coefficient**	**Standard Error**	**P-Value**
Fertility	0.525***	0.133	0.000
Fertility residuals	0.464***	0.139	0.000
Interactions(fertility*residuals)	0.003	0.007	0.652
Child's age	0.099***	0.006	0.000
Child's age square	-0.001***	0.000	0.000
Mother's age	-0.249***	0.051	0.000
Mother's age square.	0.001***	0.000	0.001
Height of mother	-0.649***	0.350	0.000
Married	-0.086	0.067	0.199
Wealth Quintile: Poorer	-0.138**	0.061	0.025
Middle	-0.206***	0.064	0.001
Richer	-0.103	0.073	0.162
Richest	-0.257**	0.100	0.011
Sex of the child (male=1)	0.172***	0.039	0.000
Birth Order	0.014	0.056	0.800
Primary education	0.022	0.050	0.659
Secondary education	-0.257***	0.081	0.002
Higher education	-0.911	0.567	0.108
Piped water source	-0.091*	0.047	0.054
Diarrhea	0.170***	0.039	0.000
Place of residence (Urban=1)	-0.015	0.067	0.812
Hospital delivery	-0.031***	0.009	0.001
Sex of Household Head	-0.054	0.059	0.359
Antenatal visits	-0.006	0.006	0.416
Mother employed	0.151	0.186	0.417
No. of observations	4,646		
R-squared /Pseudo R-squared	0.1144		
Log Likelihood ratio	-2763.5235		
Wald chi2(25)	713.88		

Note *, **,* denote Significance at 1% 5% and 10% respectively.**

Source: Author's Calculations

Table A.11: Effect of fertility on Child Health:Stunted as Dependent Variable-Marginal Effects from Probit-Control Function Approach

	Control Function Approach		
Explanatory variables	**Coefficient**	**Standard Error**	**P-Value**
Fertility	0.178***	0.044	0.000
Fertility residuals	-0.157***	0.047	0.001
Interactions(fertility*residuals)	**0.001**	0.002	0.652
Child's age	0.034***	0.002	0.000
Child's age square	-0.0004***	0.000	0.000
Mother's age	-0.085***	0.017	0.000
Mother's age square.	0.0004***	0.000	0.001
Height of mother	-0.577***	0.112	0.000
Married	-0.289	0.023	0.201
Wealth Quintile: Poorer	-0.047**	0.021	0.024
Middle	-0.069***	0.022	0.001
Richer	-0.035	0.025	0.161
Richest	-0.087**	0.034	0.010
Sex of the child (male=1)	0.058***	0.013	0.000
Birth Order	0.014	0.056	0.800
Primary education	0.007	0.017	0.659
Secondary education	-0.087***	0.027	0.002
Higher education	-0.309	0.193	0.108
Piped water source	-0.031*	0.016	0.054
Diarrhea	0.058***	0.013	0.000
Place of residence (Urban=1)	-0.005	0.022	0.819
Hospital delivery	-0.010***	0.003	0.002
Sex of Household Head	-0.018	0.019	0.359
Antenatal visits	-0.002	0.005	0.894
Mother employed	0.005	0.019	0.800
No. of observations	4,646		
R-squared /Pseudo R-squared	0.1144		
Log Likelihood ratio	-2763.5235		
Wald chi2(25)	713.88		

Note *, **,* denote Significance at 1% 5% and 10% respectively.**

Source: Author's Calculations

Appendix 3: Results for OLS, Probit, IVprobit (Actual), and Control Function Approach

Table A.12.: Effect of fertility on Maternal Health (Dependent Variables: Body Mass Index-BMI)

	Ordinary Least Squares (OLS)		
Explanatory Variables	Coefficients	Robust Standard Error	P-Value
Fertility	-0.002	0.029	0.933
Mother's age	0.268***	0.039	0.000
Mother's age square	-0.003***	0.001	0.000
Hospital delivery	0.111	0.106	0.293
Wealth Quintile: Poorer	0.425***	0.117	0.000
Middle	0.855***	0.125	0.000
Richer	1.844***	0.139	0.000
Richest	3.458***	0.222	0.000
Primary education	0.322***	0.109	0.003
Secondary education	1.081***	0.204	0.000
Higher education	2.535***	0.661	0.000
Piped water source	1.761***	0.582	0.000
Place of residence	0.162	0.164	0.320
Married	0.279**	0.118	0.017
Sex of household head	0.080	0.123	0.514
Household size	-0.006	0.012	0.637
Mother's employment	1.018**	0.444	0.022
Listening news	0.638***	0.126	0.000
Constant	15.785***	0.589	0.000
No. of observations	7417		
F(18, 7398)/ LR Wald chi2 (22)	69.53		
R-sq. /Pseudo R sq.	0.1858		

Note *, **, * denote Significance at 1% 5% and 10% respectively.**

Source: Author's Calculations

Table A.13: Effect of fertility on Maternal Health (Dependent Variables: Body Mass Index-BMI)

	Control Function Approach		
Explanatory Variables	Coefficients	Robust Standard Error	P-Value
Fertility	-0.396***	0.131	0.002
Fertility residual	0.404***	0.134	0.003
Mother's age	0.411***	0.067	0.000
Mother's age square	-0.004***	0.001	0.000
Hospital delivery	-0.043	0.122	0.725
Wealth Quintile: Poorer	0.289**	0.138	0.036
Middle	0.716***	0.149	0.000
Richer	1.568***	0.180	0.000
Richest	3.199***	0.293	0.000
Primary education	0.266**	0.132	0.043
Secondary education	0.849***	0.231	0.000
Higher education	2.187***	0.718	0.002
Piped water source	0.352***	0.133	0.008
Place of residence	0.138	0.192	0.471
Married	-0.055	0.207	0.791
Sex of household head	-0.025	0.158	0.872
Household size	0.076***	0.026	0.003
Mother's employment	0.935*	0.517	0.070
Listening news	0.446***	0.192	0.004
Constant	13.814***	1.072	0.000
No. of observations	5971		
F(19, 5951)/ LR Wald chi2 (22)	54.73		
R-sq. /Pseudo R sq.	0.1854		

Note *, **, * denote Significance at 1% 5% and 10% respectively.**

Source: Author's Calculations

Table A.14: Effect of fertility on Maternal Health (Dependent Variables: Body Mass Index-BMI)

	Control Function Approach		
Explanatory Variables	Coefficients	Robust Standard Error	P-Value
Fertility	-0.454***	0.129	0.000
Fertility residual	0.295**	0.141	0.037
Interaction (fertility*residual)	0.032***	0.011	0.002
Mother's age	0.427***	0.067	0.000
Mother's age square	-0.004***	0.001	0.000
Hospital delivery	-0.033	0.121	0.786
Wealth Quintile: Poorer	0.278**	0.133	0.037
Middle	0.704***	0.145	0.000
Richer	1.553***	0.178	0.000
Richest	3.165***	0.291	0.000
Primary education	0.278**	0.129	0.031
Secondary education	0.847***	0.229	0.000
Higher education	2.129***	0.709	0.003
Piped water source	0.355***	0.132	0.007
Place of residence	0.139	0.191	0.467
Married	-0.054	0.206	0.794
Sex of household head	-0.017	0.158	0.915
Household size	0.078***	0.025	0.002
Mother's employment	0.914*	0.517	0.079
Listening news	0.441***	0.156	0.006
Constant	13.628***	1.071	0.000
No. of observations	5971		
F(20, 5950)/ LR Wald chi2 (22)	52.97		
R-sq. /Pseudo R sq.	0.1868		

Note *, **, * denote Significance at 1% 5% and 10% respectively.**

Source: Author's Calculations

Table A.15: Effect of fertility on Maternal Health (Dependent Variables: Body Mass Index-BMI)

	Control Function Approach		
Explanatory Variables	Coefficients	Robust Standard Error	P-Value
Fertility	-0.452***	0.137	0.000
Fertility residual	0.299**	0.143	0.037
Interaction (fertility*residual)	0.029**	0.014	0.034
Fert*residual*contraceptive	0.004	0.010	0.700
Fert*residual*twins	0.002	0.006	0.766
Mother's age	0.427***	0.068	0.000
Mother's age square	-0.004***	0.001	0.000
Hospital delivery	-0.034	0.121	0.780
Wealth Quintile: Poorer	0.279**	0.134	0.038
Middle	0.705***	0.146	0.000
Richer	1.553***	0.179	0.000
Richest	3.167***	0.294	0.000
Primary education	0.277**	0.129	0.032
Secondary education	0.847***	0.229	0.000
Higher education	2.135***	0.711	0.003
Piped water source	0.358***	0.132	0.007
Place of residence	0.139	0.191	0.468
Married	-0.054	0.206	0.794
Sex of household head	-0.015	0.156	0.921
Household size	0.077***	0.026	0.003
Mother's employment	0.919*	0.524	0.080
Listening news	0.442***	0.156	0.005
Constant	13.629***	1.096	0.000
No. of observations	5971		
F(22, 5948)/ LR Wald chi2 (22)	48.22		
R-sq. /Pseudo R sq.	0.1868		

Note *, **, * denote Significance at 1% 5% and 10% respectively.**

Source: Author's Calculations

Table A.16: Effect of fertility on Maternal Health: Underweight as Dependent Variable-Actual Coefficients from Probit Estimation

	PROBIT ESTIMATES		
Explanatory Variables	Coefficient	Robust Standard Error	P>Z Value
Fertility	0.018	0.011	0.103
Mother's age	-0.050***	0.018	0.004
Mother's age square	0.001***	0.000	0.002
Hospital delivery	-0.028	0.047	0.555
Wealth Quintile: Poorer	-0.239***	0.061	0.000
Middle	-0.242***	0.061	0.000
Richer	-0.412***	0.065	0.000
Richest	-0.535***	0.094	0.000
Primary education	-0.154***	0.049	0.001
Secondary education	-0.148*	0.082	0.070
Higher education	0.197	0.208	0.342
Piped water source	-0.272	0.235	0.246
Place of residence	0.025	0.069	0.719
Married	-0.037	0.090	0.487
Sex of household head	-0.068	0.054	0.486
Household size	0.001	0.005	0.816
Mother's employment	-0.055	0.158	0.725
Listening news	-0.194***	0.055	0.000
No. of Observations	7411		
Constant	-0.039	0.275	0.887
LR Wald chi2 (18)	153.93		
Pseudo R2	0.0340		
Log Likelihood	-2325.6116		

Note *, **, * denote Significance at 1% 5% and 10% respectively.**

Source: Author's Calculations.

Table A.17: Effect of fertility on Maternal Health: Underweight as Dependent Variable-Marginal Effects from Probit Estimation

	Marginal Effects from Probit Estimates		
Explanatory Variables	Coefficient	Robust Standard Error	P>Z Value
Fertility	-0.003	0.002	0.103
Mother's age	-0.009***	0.003	0.005
Mother's age square	0.001***	0.000	0.002
Hospital delivery	-0.005	0.007	0.553
Wealth Quintile: Poorer	-0.041***	0.010	0.000
Middle	-0.041***	0.061	0.000
Richer	-0.069***	0.011	0.000
Richest	-0.091***	0.016	0.000
Primary education	-0.026***	0.008	0.002
Secondary education	-0.025*	0.014	0.070
Higher education	0.033	0.035	0.342
Piped water source	-0.046	0.039	0.246
Place of residence	0.004	0.012	0.719
Married	-0.006	0.009	0.487
Sex of household head	-0.068	0.054	0.486
Household size	0.000	0.001	0.816
Mother's employment	-0.009	0.027	0.725
Listening news	-0.033***	0.009	0.000
No. of Observations	7417		
LR Wald chi2 (18)	153.93		
Pseudo R2	0.0340		
Log Likelihood	-2325.6116		

Note *, **, * denote Significance at 1% 5% and 10% respectively.**
Source: Author's Calculations.

Table A.18: Effect of fertility on Maternal Health: Underweight as Dependent Variable-Actual Coefficients from IVProbit Estimation

	IVPROBIT ESTIMATES USING 2SLS		
Explanatory Variables	Coefficient	Robust Standard Error	P>Z Value
Fertility	0.276***	0.105	0.003
Mother's age	-0.135***	0.032	0.000
Mother's age square	0.001***	0.000	0.001
Hospital delivery	-0.107**	0.050	0.034
Wealth Quintile: Poorer	-0.162**	0.069	0.020
Middle	-0.158**	0.075	0.034
Richer	-0.233**	0.115	0.043
Richest	-0.253	0.201	0.207
Primary education	-0.115**	0.049	0.020
Secondary education	-0.085	0.083	0.304
Higher education	0.349*	0.201	0.082
Piped water source	0.034	0.045	0.453
Place of residence	0.038	0.064	0.555
Married	-0.241***	0.090	0.008
Sex of household head	-0.068	0.053	0.200
Household size	-0.039**	0.015	0.010
Mother's employment	0.003	0.092	0.970
Listening news	0.029	0.053	0.579
No. of Observations	7411		
LR Wald chi2 (18)	223.80		
Log Likelihood	-16786.913		
Wald test of exogeneity (Prob > chi2)	5.40		0.0201

Note *, **, * denote Significance at 1% 5% and 10% respectively.**

Source: Author's Calculations

Table A.19: Effect of fertility on Maternal Health: Underweight as Dependent Variable-Actual Coefficients from Probit-Control Function Approach

	Control Function from Probit		
Explanatory Variables	Coefficient	Robust Standard Error	P>Z Value
Fertility	0.319***	0.097	0.000
Fertility Residual	0.341***	0.098	0.001
Mother's age	-0.156***	0.035	0.000
Mother's age square	0.001***	0.000	0.001
Hospital delivery	-0.124**	0.055	0.024
Wealth Quintile: Poorer	-0.175***	0.064	0.007
Middle	-0.162**	0.069	0.018
Richer	-0.244***	0.089	0.006
Richest	-0.259*	0.150	0.085
Primary education	-0.129**	0.050	0.010
Secondary education	-0.093	0.086	0.270
Higher education	0.413*	0.224	0.065
Piped water source	0.037	0.048	0.440
Place of residence	0.040	0.070	0.565
Married	-0.278***	0.091	0.002
Sex of household head	-0.082	0.057	0.154
Household size	-0.046***	0.015	0.002
Mother's employment	-0.025	0.100	0.804
Listening news	0.027	0.047	0.564
No. of Observations	7411		
LR Wald chi2 (19)	165.44		
R-sq./Pseudo R sq.	0.0344		
Log Likelihood	-2324.6833		

Note *, **, * denote Significance at 1% 5% and 10% respectively.**
Source: Author's Calculations

Table A.20: Effect of fertility on Maternal Health: Underweight asDependent Variable-Marginal Effects from Probit-Control Function Approach

	Control Function Approach from Probit		
Explanatory Variables	Coefficient	Robust Standard Error	P>Z Value
Fertility	0.054***	0.017	0.000
Fertility Residual	-0.058***	0.017	0.001
Mother's age	-0.027***	0.006	0.000
Mother's age square	0.0002***	0.000	0.001
Hospital delivery	-0.021**	0.009	0.024
Wealth Quintile: Poorer	-0.029***	0.011	0.007
Middle	-0.028**	0.012	0.018
Richer	-0.041***	0.015	0.006
Richest	-0.044*	0.025	0.085
Primary education	-0.022**	0.008	0.010
Secondary education	-0.016	0.015	0.278
Higher education	0.069*	0.038	0.065
Piped water source	0.006	0.008	0.440
Place of residence	0.007	0.012	0.565
Married	-0.047***	0.015	0.002
Sex of household head	-0.014	0.009	0.154
Household size	-0.008***	0.003	0.002
Mother's employment	-0.004	0.017	0.804
Listening news	-0.005	0.008	0.564
No. of Observations	7411		

Note *, **, * denote Significance at 1% 5% and 10% respectively.**

Source: Author's Calculations

Table A.21: Effect of fertility on Maternal Health: Underweight as Dependent Variable-Actual coefficients from Probit-Control Function Approach

	Control Function Approach from Probit		
Explanatory Variables	Coefficient	Robust Standard Error	P>Z Value
Fertility	0.313***	0.109	0.004
Fertility Residual	-0.274**	0.111	0.014
Interactions (fertility*residual)	-0.011**	0.005	0.021
Mother's age	-0.071***	0.025	0.005
Mother's age square	0.0001***	0.000	0.001
Hospital delivery	-0.079	0.625	0.195
Wealth Quintile: Poorer	-0.142***	0.073	0.052
Middle	-0.139*	0.078	0.075
Richer	-0.191*	0.101	0.059
Richest	-0.266	0.171	0.121
Primary education	-0.082	0.059	0.165
Secondary education	-0.078	0.097	0.424
Higher education	0.467*	0.237	0.048
Piped water source	0.019	0.054	0.721
Place of residence	0.007	0.012	0.565
Married	-0.085	0.123	0.490
Sex of household head	-0.056	0.073	0.440
Household size	-0.049***	0.017	0.003
Mother's employment	-0.060	0.107	0.576
Listening news	-0.071	0.054	0.185
No. of Observations	7411		
R-squared /Pseudo R-squared	0.0301		
Log likelihood	-1806.6651		
F/Wald Chi/LR chi2	LR chi2 (20)=112.23***		

Note *, **, * denote Significance at 1% 5% and 10% respectively.**

Source: Author's Calculations

Table A.22: Effect of fertility on Maternal Health: Underweight as Dependent Variable-Marginal Effects from Probit-Control Function Approach

	Control Function Approach from Probit		
Explanatory Variables	Coefficient	Robust Standard Error	P>Z Value
Fertility	0.051***	0.109	0.004
Fertility Residual	-0.045**	0.111	0.014
Interactions (fertility*residual)	-0.002**	0.005	0.021
Mother's age	-0.012***	0.025	0.005
Mother's age square	0.0001***	0.000	0.001
Hospital delivery	-0.013	0.100	0.195
Wealth Quintile: Poorer	-0.023*	0.073	0.052
Middle	-0.022*	0.078	0.075
Richer	-0.031*	0.101	0.059
Richest	-0.043	0.171	0.121
Primary education	-0.082	0.059	0.165
Secondary education	-0.013	0.015	0.424
Higher education	0.076*	0.039	0.048
Piped water source	-0.003	0.008	0.721
Place of residence	-0.016	0.013	0.565
Married	-0.014	0.020	0.490
Sex of household head	-0.009	0.011	0.440
Household size	-0.008***	0.003	0.003
Mother's employment	-0.009	0.018	0.576
Listening news	-0.112	0.008	0.185
No. of Observations	7411		
R-squared /Pseudo R-squared	0.0301		
Log likelihood	-1806.6651		
F/Wald Chi/LR chi2	LR chi2 (20)=112.23***		

Note *, **, * denote Significance at 1% 5% and 10% respectively.**

Source: Author's Calculations

Table A.23: Effect of fertility on Maternal Health: Underweight-Dependent Variable-Marginal Effects from Probit-Control Function Approach

	Control Function Approach from Probit		
Explanatory Variables	Coefficient	Robust Standard Error	P>Z Value
Fertility	0.051***	0.109	0.004
Fertility Residual	-0.045**	0.111	0.014
Interactions (fertility*residual)	-0.002**	0.005	0.021
Fert*residual*twins	0.0001	0.006	0.876
Mother's age	-0.012***	0.025	0.005
Mother's age square	0.0001***	0.000	0.001
Hospital delivery	-0.013	0.100	0.195
Wealth Quintile: Poorer	-0.023*	0.073	0.052
Middle	-0.022*	0.078	0.075
Richer	-0.031*	0.101	0.059
Richest	-0.043	0.171	0.121
Primary education	-0.082	0.059	0.165
Secondary education	-0.013	0.015	0.424
Higher education	0.076*	0.039	0.048
Piped water source	-0.003	0.008	0.721
Place of residence	-0.016	0.013	0.565
Married	-0.014	0.020	0.490
Sex of household head	-0.009	0.011	0.440
Household size	-0.008***	0.003	0.003
Mother's employment	-0.009	0.018	0.576
Listening news	-0.112	0.008	0.185
No. of Observations	5971		
R-squared /Pseudo R-squared	0.0301		
Log likelihood	-1806.6651		
F/Wald Chi/LR chi2	LR chi2 (20)=112.23***		

Note *, **, * denote Significance at 1% 5% and 10% respectively.**

Source: Author's Calculations