THE ROLE OF IMMUNISATION ON CHILD HEALTH OUTCOMES: A CASE OF CHILD MORTALITY IN KENYA.

BY

TOM OSEWE OCHIENG ONEKO

A research project submitted to the School of Economics, University of Nairobi in partial fulfilment of the requirements for the degree of Masters of Science in Health Economics and Policy

November, 2016

ABSTRACT

Immunisation has proved as an economically sound human right approach to be provided to all society members to mitigate against morbidity or fatalities. Despite the recognised benefits of childhood immunization programmes, Kenya has realized limited gains in improving the health of children, with many remaining unreached and prone to risk of vaccine-preventable diseases. Based on these facts, it is important to understand empirically how immunisation uptake would impact child health outcomes in Kenya. The study used the Kenya Demographic and Household survey, 2014 which contains factors associated with child health outcomes (under-five mortality) and full immunisation. The study employed the binary probit regression model in the econometric estimation. The dependent variable used was under five child mortality reported while the independent variable of interest was child immunisation (full) with other control variables being the demographic; socio-economic factors and environmental factors and access indicators. At 1%, 5% and 10% significance levels, the study findings revealed that immunisation; being married, middle wealth quintile and richest wealth quintile; Hospital delivery and central region were found to be statistically significant in determining under-five child mortality. On the other hand age of the mother, education, residence, religion, occupation, wealth index (except third and fifth), Antenatal visits, Mass media, Piped water source, Flush toilets and regions (except central region) were shown to be statistically insignificant at all significance levels. To control child mortality in Kenya, apart from reviewing existing policies on maternal and child health, the study recommends to the government and other relevant stakeholders to target new-born mothers to reduce inadequacies of children in a households reaching full immunisation. This could be done through the creation of awareness through churches and schools countrywide, on the consequences of failing to use immunisation, especially among children under-five which could contribute to the increased incidence of vaccine preventable diseases and prevalence of high child morbidity and mortality rates.

ACKNOWLEDGMENT

I am highly indebted to the Palladium Group for paying my tuition for the entire study period. These made my academic journey a smooth one; I would never have made it without their support.

I would like to express my sincere gratitude and appreciation to my supervisor Prof. Damiano Kulundu for devoting much of his time to guide me through the entire paper and ensuring that I have completed. His advice, constructive criticisms and valuable suggestions helped me a lot in writing this paper. I would also like to thank my mum Catherine Anyango Oneko, Synthia Larcher, siblings, family and friends for their prayers, encouragement and moral support right from the beginning of this study and with this research project. I particularly appreciate them for their endurance for the times I have being away due to work and school commitments.

I would like to appreciate the encouragement I received from my classmates and workmates at the USAID-funded Health Policy Plus. Also, I am grateful to University of Nairobi for the opportunity to study this programme until its completion, much gratitude remains with my lecturers who taught and enlightened me all the way through this course. Finally, I like to remember many other people who contributed either directly or indirectly in my studies, although I have not mentioned their names, thank you for every support you accorded me.

DECLARATION

I declare that this is my work and that it has not been presented or submitted to any University for any degree award.

NAME: TOM OSEWE OCHIENG ONEKO

REG NO: X53/66405/2013

DATE: ……..

SIGNATURE: ……

This research project has been submitted for examination with my approval as University Supervisor:

Signed: ..... Date: .....

SUPERVISOR: PROF. DAMIANO KULUNDU

DEDICATION

To my dad, the Late John Onyango Osewe Oneko

&

Mum, Siblings, fiancée, family and friends.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

ANC	Ante Natal Care
BCG	Bacillus Calmette- Guérin
CDC	Centre for Disease Control
DTaP	Diphtheria, Pertussis and Tetanus
GAVI	Global Alliance of Vaccine Initiative
Hep A	Hepatitis A
Hep B	Hepatitis B
Hib	Haemophilus influenza type B
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome
IPV	Inactivated Polio Vaccine
KDHS	Kenya Demographic and Health Survey
KEPI	Kenya Expanded Program on Immunisation
MDG	Millennium Development Goals
MOH	Ministry of Health
OPV	Oral Polio Vaccine
PCV	Pneumococcal Conjugate Vaccine
RV	Rotavirus
SDG	Sustainable Development Goals
UN	The United Nations
UNICEF	The United Nations Children's Emergency Fund
VPD	Vaccine Preventable Diseases
WHO	World Health Organization

CHAPTER ONE: INTRODUCTION

1.1 Background

Immunisation is considered the most effective and safe form of medicine made from dead or modified disease-causing agents administered either orally or injected, in order to increase the number of protective antibodies and prevent children from being victims of diseases caused by viruses and other infectious organisms. In low and middle-income countries, vaccine-preventable diseases cause 10 million deaths annually among children before most reach their five years (Levin, 2006).

Childhood immunisation is an effective intervention for protecting and improving child survival against preventable diseases such as polio, diphtheria, pertussis, tetanus, pneumonia and diarrhoea because their immune systems are defenseless and not fully developed yet. Missed inoculation of recommended World Health Organization (WHO) vaccines causes most child morbidity and mortality by age two, and once infected can be detrimental to the child's health and well-being (Levine, 2006, CDC, 2009, WHO 2015). WHO recommends inoculation targeting everyone as the most cost effective means and improves all age groups survival. It is estimated to avert between 2 and 3 million deaths and among under-5, about 2.5 million deaths annually. Globally, three-quarters of the child population access basic vaccination, but Sub-Saharan Africa accounts for only half which is further worsened in poorer distant regions of developing countries for only one in twenty children receive immunisation (UNICEF, 2009, WHO, 2015; Okwo-Bele et al, 2015).

Child health outcomes refer to the positive start of a child's early development years to enable them to reach their full potential, while a poor start increases adverse outcomes preventing children from becoming healthy productive adults to contribute significantly to the foreseeable economy and broader society. According to Mugo (2005), under-five health status is an important indicator of the whole populations' well-being because an adult's future health status is primarily defined during the first twenty-four months of a child's life. On the other hand, the Kenya Demographic Health Survey (2014) indicates child death rates as basic pointers of a country's socio-economic level and quality of life status.

Globally, immunisation programs have contributed significantly towards reducing by two-thirds the under-five mortality rates by the year 2015 and attaining Millennium Development Goal (MDG) four. Since inception, the mortality rates have dropped from 91 to 43 deaths per 1000 live births in 2015. However, the reduction rate was still unsatisfactory to reach the target set. The United Nation member states have recently adopted, in 2015, the Sustainable Development Goals (SDGs). In particular, the third goal recommends for countries to create enabling environments in which healthy lives shall be promoted and strive to end preventable deaths of all persons at all ages, including new-borns and under-five. It has set a target to decrease neonatal mortality to below 12 and under-five mortality to 25 per 1,000 live births as a minimum by the year 2030 (WHO, 2015, SDG, 2015; UN, 2015 and Derek, 2015).

Globally, countries are urged to facilitate global access to safe vaccines of proven efficacy, for it significantly reduces illness incidence, disability, death and inequity far wide-reaching in the longer term (Andre et al, 2008). It is primarily viewed as an effective preventive health measure for children against preventable diseases, but still widely underused in Sub-Saharan countries. Despite global immunisation data showing an impressive upward trend of 160 countries reaching 90% DPT3 coverage in 2014, there are still pockets of under-vaccination continuing in some regions of sub-Saharan Africa. In 2013, 21.8 million children did not receive DPT3 vaccine as compared to 22.8 million in 2012. Unfortunately, seventy percent of these children were residents in ten developing economies, including Kenya, South Africa, Nigeria, Pakistan, Democratic Republic of the Congo, India, Mexico, Ethiopia, Indonesia and Viet Nam. The common obstacles identified in the mentioned countries include: lack of optimum coverage of all children born, poor functioning service delivery systems, irregular annual programme review, weak data use and having unsustainable donor-dependent financial support for their immunisation programmes (WHO and UNICEF, 2015)

Unfortunately, like most developing countries, Kenya is still grappling with low human development index at 0.549 and low health status mainly contributed by neonatal causes, acute respiratory infections, pneumonia, diarrhoea, malnutrition, malaria and HIV among its populace. For instance, Rotavirus causes severe diarrhoea which is associated with 28% of cases while pneumonia is associated with 18.3% of child cases (Wamae et al., 2009, Republic of Kenya, 2012, Mariara, 2012, Walker et al, 2013). Kenya's current population proportion below 5 years

is estimated to be at 18 percent while those less than one year at about 4 percent of the total population of 44.2 million. This gives the country a sizeable number of children to nurture to adulthood (UN, 2013; UNDP, 2014; KNBS and ICF Micro, 2015). Since 2000, support from Global Alliance for Vaccine Initiative (GAVI) has enabled the Government of Kenya to present numerous policies and intensified Kenya's expanded program on immunisation (KEPI) to target children with the essential vaccines right from birth and before one year of life. Also, the counterpart support has made it feasible to introduce additional interventions including: implementation of numerous policies i.e. Free Maternity Programme started in June 2013, whose evaluation in 2015 indicated an increase in skilled deliveries from 44% to 61%, standardization of practices and opportunities for vaccination services across the country and introduction of additional serums and offer vaccines free of charge in public health facilities. Besides, Kenya's First Lady, Mrs Margaret Kenyatta through launching the 'Beyond zero campaign' in January 2014 has advocated for private-public partnerships for health aiming at improving HIV control, promote maternal, new-born and child health outcomes through accelerating implementation of national health plans and contribute to the attainment of vision 2030 (MOH, 2010; Beyond zero, 2014).

Kenya adheres to the WHO immunisation schedule and recommends for all children right from birth to 23 months to have received all the essential vaccines and additional booster shots up to six years of age. The schedule for immunisation right from birth through to six years old is summarized in table 1 below. Starting from administering a prescribed amount of BCG and OPV, then three dosages of OPV and pentavalent DPT vaccines at intervals of four, six, ten and fourteen weeks. Yellow fever and Measles vaccines are administered at the age of nine months and yellow fever is commonly given in high-risk prone areas only (WHO and UNICEF, 2008, MOH, 2010).

Table 1-0: WHO recommended immunisation schedule for Children

Age of administration	**Diseases**	**Vaccine - Routine immunisation services**
Birth	Hepatitis B, Tuberculosis	BCG, Hep B
1 Month and 2 Months	Hepatitis B	Hep B
2 Months	Polio, Diphtheria, Tetanus, and Pertussis, Influenzae, Hepatitis B.	Hep B, RV, DTaP, Hib, PCV, IPV
4 Months		RV, DTaP, Hib, PCV, IPV

6 Months		Hep B, RV, DTaP, Hib, PCV, IPV, Influenzae (Yearly)
12-18 Months	Rubella, Mumps, Measles, Influenzae, Hepatitis A, Diphtheria, Tetanus, and Pertussis (Booster Shots)	Hep B, DTaP, Hib, PCV, IPV, Influenzae (Yearly), MMR, Varicella and Hep A
19-23 Months		Influenzae (Yearly) and Hep A
2-3 years		Influenzae (Yearly)
4-6 years		Influenzae (Yearly), DTaP, IPV, MMR and Varicella

Source: Centre for Disease Control and Prevention, American Academy of Paediatrics, 2015

According to the recent Kenya demographic health survey 2014, coverage of children receiving the 1st dose of Pentavalent and polio stood at 98 and 97 percent, BCG (98%), measles (71%), while the third dose of Pentavalent and polio at 90% and 81% respectively. Furthermore, the under-five mortality rates have declined from 96% in 1990 to 52% in 2014, mainly due to immunisation, HIV and malaria prevention programs (KNBS and ICF Micro, 2008/09, 2015 and UNICEF, 2014).

Even though the Kenyan government has achieved significant progress in improving coverage levels and reducing cases of child mortality rates to 14 per 1,000 in 2014 from 23 per 1,000 in 2008/09 and under-five mortality to 52 in 2014 from 74 per 1000 in 2008/09. There is still a huge concern for it denotes that 1 out of every 14 children dies before reaching their first birthday and one in every 19 dies before age five (KNBS and ICF Micro, 2015). Table 1 below adopted from KDHS 2014 report demonstrates developments in infant, child and under-five mortality in Kenya from the first demographic survey in 1989 to the current in 2014.

Table 1.1 Trends in infant, Child and Under-Five Mortality in Kenya

Year	Infant Mortality	Child Mortality	Under 5 Mortality
1989	**61**	**31**	**90**
1993	**62**	**37**	**96**
1998	**74**	**41**	**111**
2003	**61**	**31**	**90**
2008/09	**52**	**23**	**74**
2014	**39**	**14**	**52**

Source: KDHS report, 2014

The same survey KDHS 2014, showed coverage of basic vaccination slumped from 77 percent reported in 2008/09 to the current 71 percent. This was further compounded with consequential coverage disparity in the region and counties. Coverage levels of children being fully immunised in North Eastern (42%), Nyanza (67%) and Nairobi (66%) regions were low while Central and Eastern region had high coverage levels close to 80 percent. At the county level, coverage in Mandera (28%), Wajir (38%) and Migori (38%), were below 40 percent while Nandi (94%), Vihiga (91%), and Tharaka-Nithi (91%) reported over 90 percent. In addition, two percent of children born in Kenya in the 5 years preceding the KDHS were under-vaccinated or missed opportunities of receiving any of the recommended vaccines. This could be due to differentials in coverage across region and counties, thus representing the cohort contributing to the high child morbidity and mortality rates (KNBS and ICF MICRO, 2015).

Moreover, Kenya is ranked 39th with the highest child deaths globally, with children aged two and below remaining most at risk of a vaccine- preventable diseases such as pneumonia, which affects them and is still proving to be a major public health issue (UNICEF, CDC Kenya, 2014).

1.2 Problem Statement

Globally, countries are urged to facilitate global access to safe vaccines of proven efficacy, for it significantly reduces illness incidence, disability, death and inequity far wide-reaching in the longer term (Andre et al, 2008). It is primarily viewed as an effective preventive health measure for children against preventable diseases, but still widely underused in Sub-Saharan countries. Kenya is among 42 countries accounting for 90% of all under-fives deaths in the world, with, pneumonia becoming a leading killer of children, yet it is curable if detected and treated early enough. At present, pneumonia, diarrhoea and malaria still remain a public health concern significantly contributing to the global disease burden for under-five compared to communicable illnesses even with the availabile safe and effective vaccines. Rotavirus causes severe diarrhoea which is associated with 28% of cases while pneumonia is associated with 18·3% of child cases (Wamae et al., 2009, Republic of Kenya, 2012, Mariara, 2012, Walker et al, 2013).

The Kenyan government's effort to offer vaccines free of charge in public health facilities has contributed to the progressive improvement in immunisation uptake noted across the country, but still thousands of children are dying from complications caused by vaccine preventable diseases

which may eventually impact negatively on the overall society and economy, not including the value of years of life lost. There have been limited concerted efforts to promote vaccination as a preventive health measure. Generally, the efforts towards improving vaccination uptake in Kenya have proven unsatisfactory, characterized by low immunisation coverage, irregular annual programme review and conducting of outreach services, which may be contributing to the persistent low coverage levels and variations across regions and counties in Kenya. This raises public health concern needs to be addressed in order to stem a looming crisis in the foreseeable future. (The Republic of Kenya, 2006-2010, KNBS and ICF Micro, 2015).

The low attention and prioritization of vaccination in Kenya may be attributed to the empirical limitation and insufficient understanding of the link between immunisation and child health status outcomes. Globally, there are vast literature focusing on the link (See Mondal 2009; Zewdu, 2010; Eisele et al., 2012; Babaale 2013; Fischer and Walker, 2014), but the few studies conducted in Kenya have focused on child, maternal and household characteristics as the main contributors to child mortality and determinants of child immunisation (Wamae et al, 2009, Otieno, 2012, Murage et al., 2014). Furthermore, the studies are limited to particular diseases or vaccines and often at specific local geographic areas with only a few clarifying the econometric relationship. None has examined the role of immunisation on child health status outcomes in a representative sample of the Kenyan population. There exists a wide evidence gap in this area and this study intends to institute the econometric relationship between immunisation uptake and child health status outcome in Kenya, with a view to addressing the research gap and contribute towards making better the quality of life of all children born and raised in Kenya.

By broadly understanding the inherent distal and proximate factors and identifying the significance of recommended vaccines uptake towards reducing child health risk factors, may present an effective and sustainable solution to mitigate against rising disease incidence cases and eventually reduce child morbidity and mortality rates. This requires an exploration of the association between immunisation and child mortality using a representative sample to identify and understand immunisations' role on child health outcomes in Kenya. The findings may present an entry point for policy makers to promote immunisation as a public health preventive measure and enable the government articulate policies and implement effective programmes that

will address the identified immunisation coverage disparity existing across regions and counties in Kenya.

1.3 Research Questions

This study seeks to answer the following questions:

1. What is the relationship between immunisation and child mortality in Kenya?
2. What is the relevant policy recommendations based on this study?

1.4 Objectives of the study

The general objective of the study is to investigate the role of immunisation on child health status outcomes among under-five in Kenya, critically focusing on child mortality.

The specific objectives include:

1. To examine the relationship between immunisation and child mortality in Kenya.
2. To suggest policy recommendations based on the study findings.

1.5 Justification of the study

Vaccination has been proven as an economically sound human right approach to be provided to all society members to mitigate against morbidity or fatalities. In circumstances where an ill child survives, they usually suffer from chronic health problems for the rest of their lives. Despite the recognized benefits of childhood immunisations, the demographic report shows many children remained unimmunized, thus, placing those unreached at risk of vaccine-preventable diseases. Several studies examined issues of child immunisation in Kenya, including patterns of uptake as well as determinants (Wamae et al, 2009, Mariara, 2012, Mugo, 2012 and Murage et al., 2014). However, few studies in Kenya focus on the role of vaccines on reducing child mortality in a concerted effort of improving the health outcomes of the entire population in the long run. This study will thus explore the association between child immunisation in Kenya and the subsequent child health outcomes with a keen focus on under-five mortality. The findings will contribute to the existing body of knowledge, empirical evidence; inform policies

and programmes relating to this category of children. First, the findings will inform decision makers at both national and county levels on the impact existing guidelines and immunisation programmes have on children, to enable them review and formulate new strategies aimed at improving the level of knowledge, influencing the attitude of parents while reshaping vaccination uptake approaches. Finally, the study will contribute to the existing literature on child health and further provide possible areas of future research to advance the importance of this aspect of child health utilisation.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter presents an assessment of the theoretical and empirical literature regarding immunisation and child health outcomes within the region and across the globe. It also summarises a number of studies done on the role or measures already in place for ensuring and increasing uptake of vaccinations as well as averting child mortality.

2.2 Theoretical Literature

2.2.1 Theory of Human Development

Bronfenbrenner's theory attempts to explain and understand a systematic approach to human and social development. He states that the individual role played by people in the system determines their behaviour and actions (Bronfenbrenner, 1994). It provides associations to show why each individual child develop differently and what aspects of development are within the child's control and those not through observing the influence of environment on one's development. This is by examining five environmental systems including mesosytem, microsystem, chronosystem, macrosystem, and exosystem. The theory focuses on the immediate association the child has with social elements around them and the broad spectrum of culture. Microsystem is the immediate influence within which the child lives in such as family, neighbourhood, peers and other social agents, while mesosystem is the direct relation various events have on one another e.g. family events to school events to church events and how individual interacts and behaves in the different contexts. The exosystem refers to previous similar experiences which influences and determines how one's experience shall be in an immediate similar setting. The chronosystem discusses the interactions of environmental proceedings and changes through the life course, and socio-historical situations. Macrosystem describes the individual's immediate culture including socioeconomic status, poverty, and ethnicity. (Bronfenbrenner, 1994; and Feinstein et al, 2006). This study will, therefore, estimate the effect of demographic (individual, household) societal, economic and environmental factors in influencing vaccination uptake and its relationship on child mortality in Kenya.

2.2.2 The Prospect Theory on Health Outcomes

This theory is purely based on risk management and uncertainty (Tversky and Kanheman, 1979) and is interpreted for this study as it applies to immunisation and health outcomes. The theory argues that mothers take their children for vaccination because they will not prefer either certain or uncertain losses associated with viruses. In principle, the theory describes the apparent predictability in human behaviours when assessing risk under uncertainty. Human beings are not consistently risk-averse; rather they are risk-averse in gains but risk-takers in losses. According to Tversky and Kanheman (1979), persons place more weight on the outcomes that are perceived more certain than mere probable, a feature known as the "certainty effect". Peoples' choices are also affected by 'framing effect'. Framing refers to the way a problem is posed to the decision maker and their 'mental accounting' of that problem.

The value maximisation function of the prospect theory is based on the premise that vaccinating a child will avert the possible risk of contracting preventable diseases thus reducing child morbidity or mortality. During the periods of disease outbreaks, the mother and the entire household will not incur costs of treating the aftermath of the disease and will also save them time meant for other economic activities. The proposition of this theory blends quite well with the intentions of this study in that a household (or a mother) actually prefers to vaccinate their children for certain and uncertain loss associated with illness (Tverskey and Kahneman, 1979; Tversky and Kahneman, 1988). During the period of illness resulting from lack of immunisation, welfare is lowered due to increase in costs of regaining better health status of the child. This is because everyone demands good health in the long run (Grossman, 1972). This study will, therefore, show the association and estimate the consequence of vaccination on child mortality in Kenya.

2.2.3 Rosenstock's Theory of Health Belief Model

This is a health utilisation framework proposed by Rosenstock, Strecher and Becker back in the 1950s. Later the model is known as the health belief model (Rosenstock, Strecher and Becker, 1994). It is described as containing sets of interacting variables relating to utilisation of health care services, in this case, is immunisation services. According to the model, individual actions to treat and prevent diseases are based on consideration of some other factors; firstly, the

individual's perceived susceptibility to disease whereby it is observed that a person will pursue preventive health services if they believe to be susceptible to a particular disease, Secondly, the observation of illness severity. However, if the person fails to perceive the illness as severe, they will not seek treatment or prevention. Thirdly, the person's rational perception of benefits versus costs such that an individual will not take action unless the treatment or prevention is perceived as having greater benefits compared with the associated costs. Finally, the individual's cues to action are determined by other factors such as, the media, family members or relatives, or famous citizens who can provide motivation for prevention. The likelihood of prevention will decrease due to the absence of cues to action. Contextually, the individual's choice to utilize vaccine, therefore, is dependent on other factors that lead to taking action. Immunisation uptake, therefore, averts the likelihood of catching infectious diseases which ultimately influences positive child health outcomes.

2.2.4 Social Determinants of Health: Dahlgren and Whitehead Model

The model described by Dahlgren and Whitehead (1991) examines effects of individual-specific factors on health choices. The model classifies social determinants of health into six different tiers including; Individual specific factors under the first tier which includes age, sex and heredity factors. The second tier is associated with lifestyle choices, e.g. type of diet and frequency of physical activity. The third tier is on social and community networks. This category underscores the benefits of social inclusion and integration in the community at large. The fourth tier is the broad determinants of health which cover a wide range of issues: agriculture, education, water and sanitation, work environs, living and working settings and health systems. The fifth tier is concerned with the general socioeconomic, cultural and environmental conditions while the sixth tier is about global culture, social and economic forces. The model is interested in describing the environmental determinants and the existing relationship between immunisation (preventive) and child mortality. This study will determine the role of vaccine usage in promoting health outcomes in children.

2.3 Empirical Literature

In a qualitative study conducted by Chizoba et al., (2013) determining risk aspects for contracting severe pneumonia in children revealed several relevant risk factors. In that case, low

birth weight, lack of adequate breastfeeding, co-morbidities with tuberculosis, diarrhoea and HIV infection, malnutrition, lack of immunisation against rotavirus, living in crowded environments, low maternal education, drinking surface water, indoor air pollution, and use of non-improved toilet facilities that do not separate waste from human contact qualified as main risk factors for pneumonia considered in any epidemiological study on children.

Zewdu (2010) conducted a study to determine the socio-economic factors determining child mortality in Ethiopia. The study employed probit regression models on the Ethiopia's demographic and health surveys (EDHS). Children's characteristics, maternal characteristics and household characteristics comprised the independent variables while dependent variable was child mortality. The study revealed that mother's age at first birth, current child age, post-primary education, rural residence and household size significantly lowered the likelihood of child mortality. Also, the study established that multiple births, the use of solid fuels for cooking, sex of a child (being a male) and incomplete vaccination were significantly associated with higher death.

Fischer and Walker, (2014) study showed that approximately, 78% of diarrhoeal deaths could be averted by scaling up 7 interventions i.e. vitamin A supplementation, vaccination against the rotavirus, hand washing with soap, zinc supplementation, oral rehydration therapy (ORT), improved sources of drinking water and toilet facilities and breastfeeding. However, other authors such as Eisele et al., (2012) demonstrated that decline in malaria incidence (a disease linked to increasing child mortality) from 2010 to 2012 was attributed to scaling up of Insecticide Treated Nets.

Mariara et al, (2009) examined child existence in Kenya using survival analysis to explain childhood death and hazard functions to analyse the causes of childhood mortality. The study further simulated the effect of policy factors on the probability of child survival and to evaluate the consequences of such policies on the achievement of MDG targets for mortality in Kenya. The study used DHS data from 1993 to 2003 to hypothesise a national time series for child deaths over a period of time from1978 to 2003. The study concluded that favourable child and maternal features and household assets were associated with higher probability of child survival at a given time and that health care services were crucial in determining the high child survival

rates. The simulation of policies integrated into the analysis suggested that maternal education and use of modern contraceptive methods, 100% immunisation coverage for infants and improved coverage of birthing assistance by a professional were main factors for promoting child existence. The study further suggested that the MDG targets will not be achieved.

Murage et al (2014) assessed developments in childhood mortality in Kenya, by looking at the urban–rural and intra-urban differentials using data from the Kenya Demographic and Health Surveys (KDHS) collected between 1993 and 2008 and Nairobi Urban Health and Demographic Surveillance System (NUHDSS) collected in two Nairobi slums between 2003 and 2010, to estimate infant mortality rate (IMR), child mortality rate (CMR) and under-five mortality rate (U5MR). They discovered between 1993 and 2008, there was a rapid decline trend in IMR, CMR and U5MR in both rural and urban areas. The rapid decline was more in rural than in urban areas, hence the gap in urban–rural differentials narrowed over time. Furthermore, childhood deaths in the slums declined between 2003 and 2010, although the rates remained higher compared to rural and non-slum urban areas in Kenya. They determined that the narrowing gap between urban and rural areas may be attributed to the deplorable living conditions in urban slums.

Mondal (2009) utilised logistic regression models in order to determine the factors that affect new-born and under-five child death in Rajshahi District in Bangladesh. The study used primary data with neonatal, post-neonatal and child mortality outcomes adapted as dependent variables while various demographic, socio-economic and environmental variables were utilised as explanatory variables. The econometric results revealed that breastfeeding, immunisation, mother's age at birth, skilled care delivery and preceding birth intervals were significant determinants of mortality across the models. It was noted that the risk of child mortality was found to be lower among children immunised compared to non-immunised children. The study showed that the risk of neonatal deaths was inversely related to preceding birth interval, birth order, mother's education level, access and use of hygienic toilets and exclusive breastfeeding of infants for the first 6 months.

Anyanwu and Erhijakapor (2009) conducted an analysis to provide an econometric indication that linked African countries' per capita total, government health expenditures and per capita

income to two health outcomes: infant mortality and under-five mortality. The study used data obtained from 47 African republics between 1999 and 2004. The study outcomes indicated that total health spending were important contributors to health outcomes and also proved that both infant and under-five death are positively and significantly linked with sub-Saharan Africa. They concluded that the results had important inferences for attaining the targets envisioned by the Millennium Development Goals.

Babaale's (2013) studied elements associated with childhood immunisation in Uganda by using nationally-representative data from Uganda Demographic and Health Survey (UDHS) of 2006. The study used bivariate approaches which involved generating average percentages of children immunised and their pertinent background characteristics and multivariate used maximum likelihood probit technique to generate marginal effects to ascertain the probability of being immunised, given the same background characteristics. It was established that slightly over 50% of children in Uganda were fully immunised with coverage of BCG, DPT, polio and measles vaccines at 89%, 24%, 52%, and 64% respectively and the consequent leading to significant reduction in child deaths. The study concluded that maternal education, exposure to media, maternal healthcare utilisation, maternal age, occupation type, immunisation plan, and regional and local particularities had the significant association with childhood immunisation. Children whose mothers had post-secondary education were twice as likely to have their child fully immunised compared to their counterparts whose mothers had only primary education.

Guerrera (2013) analysed annual reports focusing on under-five death rates and Neonatal death rates under MDG goal 4 and UNICEF's immunisation program which concluded that between 1990 and 2013, the annual number of deaths for children under- five had fallen to 6.6 million, corresponding to a 48% reduction from the 12.6 million deaths in 1990.The study showed that about half of the deaths occurred in only five countries: China, Democratic Republic of Congo India, Nigeria and Pakistan. By 2050, it is estimated that almost 40% of all live births will take place in Sub-Saharan Africa and 37% of the world's children under age five will live in the region. In 2012, about 2.2 million children deaths were attributed to diseases like pneumonia, diarrhoea and malaria, which accounted for a third of all under-five deaths.

Kinney et al (2010) did a review of leading reasons for maternal, new-born, and child health and stated the following factors as major contributors i.e. pregnancy and childbirth complications, new-born illness, childhood infections, malnutrition, and HIV/AIDS. The diseases contributed to about 4.4 million deaths among children including 1.2 million new-borns and 265,000 mothers die in sub-Saharan Africa each year. This translated to 13,000 deaths per day or almost nine deaths every minute. The review showed that Sub-Saharan Africa had half of the world's maternal, new-born, and child deaths. Most countries in sub-Saharan Africa were behind in achieving the Millennium Development Goals (MDGs) for maternal and child health by 2015. The team concluded that advancement in several low-income countries demonstrate that MDGs could still be attained through immediate strategic investments in selected evidence-based interventions and targeted health systems strengthening mechanism.

Oliwa and Marais (2015) assessed the role of routine vaccination against common childhood illnesses in preventing death from pneumonia. They established that pneumonia accounted for 15% of the 6.3 million deaths among children under-five years in 2013, triggering approximately 945,000 deaths worldwide. They established that although there have been great strides in the development and administration of effective vaccines, these countries still carry the largest disease burdens and struggle to immunise their children and newer serums remain out of reach for many. They recommend the need for countries to follow the Global Vaccine Action Plan (GVAP) which has identified priority areas for innovation in research in all aspects of immunisation development and delivery to ensure equitable access to vaccines for all.

Wamae et al (2009) conducted a study aimed at establishing factors associated with child health promotion using a holistic approach after ascertaining the worrying trends in infant and child mortality rates. Using the 2004 Kenya Service Provision Assessment Survey (KSPA) discoveries they assessed current health care providers' practices in managing childhood illnesses and identified opportunities for intervening, for instance through the Integrated Management of Childhood Illness (IMCI) strategy. Adopting data from the 2004 KSPA, the study used dependent variables to represent the holistic care to a sick child such as measuring the full valuation of a sick child; proper counselling of the child's caretaker; and facility auxiliary services. The independent variables considered in the analysis included the type of facility, managing authority, region, provider qualifications and sex of the provider. They concluded that

health providers missed critical openings to conduct a full assessment of sick children offered to them for care and only factored general disease symptoms to determine prognosis.

2.4 Overview of the Literature Review

The literature reviewed gives an analysis of the theoretical underpinning on how vaccination influences the production of positive child health outcomes. Most of the literature reviewed point to the fact that early child immunisation is associated with improved child outcomes where children immunised earlier have the higher chance of being protected against preventable diseases from birth. Empirically, immunisation has been linked to cases of improved child health outcomes across the world (Mondal 2009; Zewdu, 2010; Eisele et al., 2012; Babaale 2013; Fischer and Walker, 2014, and Murage et al., 2014). Children, maternal and household characteristics have been cited as major contributors to child mortality.

Specifically, studies reveal that mother's age at first birth, current child's age, post-primary education, rural residence and household size are significant determinants of child mortality (Wamae et al, 2009, Otieno, 2012, Murage et al., 2014; Babaale 2013; Zewdu, 2010). Other factors revealed in the literature with a clear link to child mortality include; birth weight, breastfeeding, co-morbidities with tuberculosis, diarrhoea, HIV infection, malnutrition, lack of immunisation against rotavirus, living in crowded environments, low maternal education, drinking surface water, indoor air pollution, and use of non-improved toilet facilities that do not separate waste from human contact among other environmental factors (Chizoba et al., 2013). Thus, unlike Chizoba et al., (2013) and Guerrera (2013) whereby the former study results relied on a univariate analysis without controlling for confounding factors while the latter failed to conduct estimation of the actual effect of preventive interventions on child mortality for appropriate policy creation and implementation. This study will consider more factors and other determinants as controlled variables as well as estimate the actual impact of vaccine intervention.

Further, Kinney et al (2010), Guerrera (2013) and Oliwa and Marais (2015) conducted descriptive statistics that focused on showing the relationship between immunisation and child health outcomes only that they were not informative especially on policy utility aspects. The study will thus fill the methodological gap by employing econometric modelling. Finally, other studies like Mondal, 2009 in Rajshahi District in Bangladesh relied on data collected in a facility

or a small location and whose findings may not be generalizable except few like Babaale's (2013) and Murage et al (2014).

There is scantiness of studies in Kenya about immunisation and child health outcomes, critically focusing on child mortality. Specifically, it is not known how uptake of recommended vaccines would impact on the experience of positive child health outcomes, the contribution of mother's characteristic and other health-related behaviours to child's immunisation uptake is unknown. This study proposes to fill the identified information gap. This study will employ a recent national representative dataset collected (during the implementation of free maternity policy in Kenya) on various aspects of households regarding immunisation and under-five mortalities.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter discusses methodology and data to be used in this study. It starts by discussing the preferred conceptual framework forming the basis for this study, econometric model, variable definitions followed by the source of data and type.

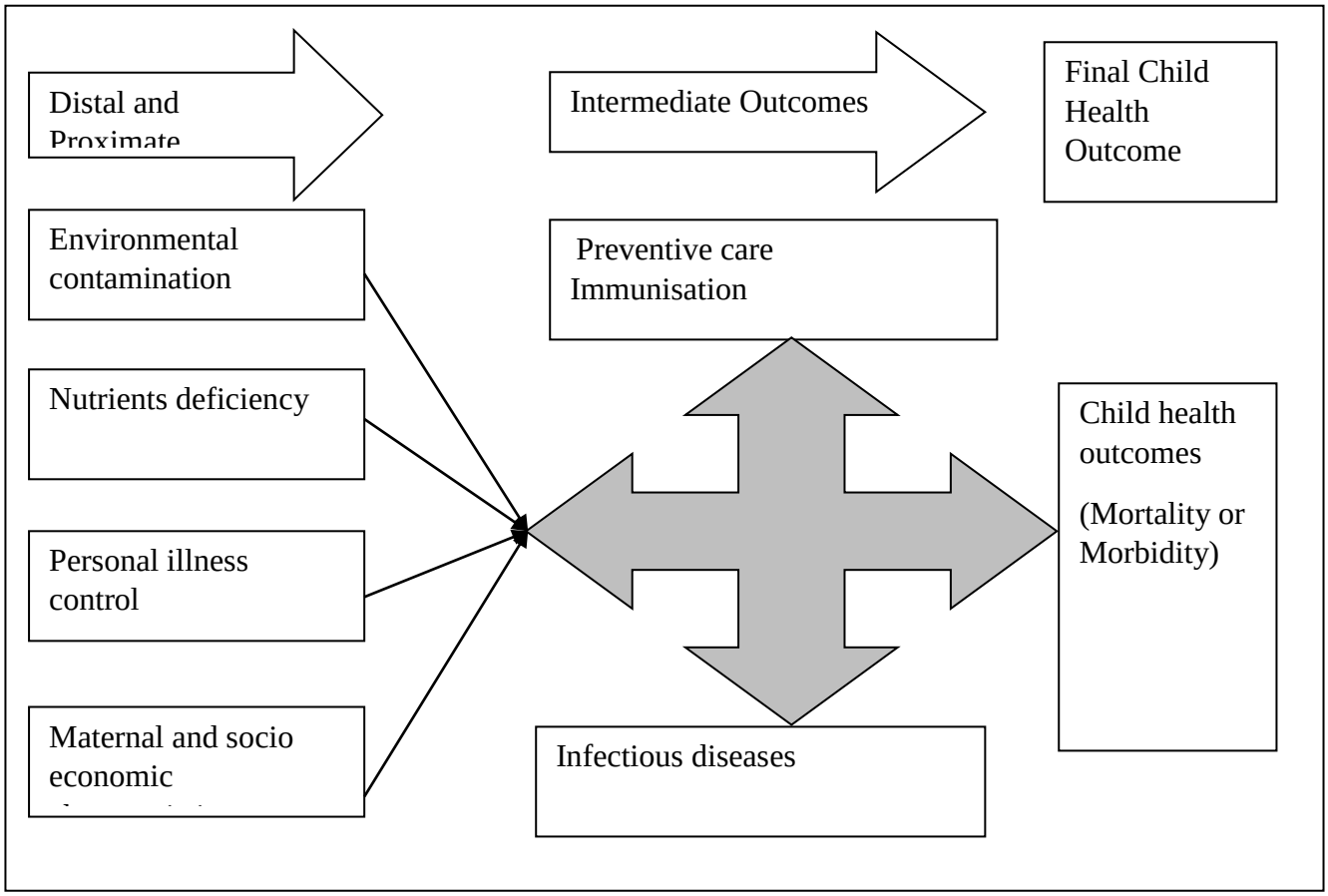
3.2 Conceptual framework

This study will adopt and base its analysis using the conceptual model developed and used by Mosley and Chen (1984). The model describes the socio-economic relationship and other proximate factors as being determinants of mortality. These determinants are also referred to as intermediate determinants classified into five different groups that are: maternal factors, environmental factors, injury and illness control and nutrition, factors. The maternal factors are those related to the child's mother e.g. birth interval, mother's age and maternal education levels. The environmental factors are those related to the various disease transmission mechanisms: air, water and food. On the other hand, nutrition factor is about administering adequate nutrients to children usually conducted through breastfeeding and complementary feeding while illness control involves traditional modes of averting diseases such as adhering to traditional as well as modern methods such as disease immunisation in this case. However, (Otieno, 2000) claims that there is still an un-established relationship between, socioeconomic, illnesses control variables and child mortality such that there is the vivid explanation on how child mortality and illness control variables through modern approach interact. As indicated in the Mosley and Chen analytical framework, our study will consider maternal, socioeconomic, environmental and illness control factors.

This study shall demonstrate using the Mosley and Chen conceptual framework (1984) the role associated factors leading to immunisation have on child health outcomes. For instance, distal and proximate factors will influence a child to be immunised against foreseen diseases and lack of may lead to an adverse child outcome. The factors associated with maternal socio-economic, environmental contamination and personal illness control factors are integrated to produce the conceptual framework illustrated in figure 1 whose constructs are subsequently used in the econometric model specifications for this study. In this case, we use

under-five mortality as an indicator of child health outcome. To achieve this objective, we will employ econometric estimation as described in the next section.

Figure 1.0: The Mosley Chen Conceptual Framework of 1984



Source: Adopted from the Mosley and Chen Framework (1984) with modifications by Author, 2016

It can be observed that the experience of adverse child health status outcome can be influenced by distal and proximate factors through environment contamination, personal illness control, maternal and socio-economic factors and nutrients deficiency. This goes on to influence the response behaviour of either vaccinating a child with the essential vaccines prior to becoming sick or taking action due to an infectious disease occurring.

3.3 Econometric model

Based on the conceptual framework, child mortality is a discrete outcome (Zewdu, 2010). This study pursues to establish the econometric relationship between immunisation and child mortality, the study will apply binary regression model and in this case, probit regression

model. In this study, child mortality is used as a dependent variable being affected by immunisation. The probability that a child dies lays within the interval 0 and 1, where the likelihood of a child dying before the fifth birthday will be coded as '1' and '0' if otherwise. The likelihood of a household observing a child death is estimated using the binary probit model. An assumption is made that the error term takes a standard normal distribution. Since, we cannot observe the latent variable y*, similarly we cannot be able to estimate its variance (Green, 2008). Noting that probit model makes an assumption on normal distribution and assumes there exists a linear relationship between unobservable variable y*, and explanatory factors, which in this case are the proximate and distal factors determining child mortality hence represented as;

$$y_i^* = \chi_i \beta + \varepsilon_i \qquad 1$$

Where

y_i^* this is the unobserved/latent variable (probability of a child dying)

χ the vector of independent variables (immunisation, and other control factors such as the age of the mother after first birth, maternal education etc.).

β the vector of parameters to be estimated, it also indicates the magnitude of the effect of the explanatory variable on utilisation of child health care services

ε is the random error term

From the equation 1 above we shall have the unobserved/latent variable (y_i^*) linked to the observed binary variable y as expressed below;

$$y_i = \begin{cases} 1 \; if \; y_i^* > 0 \\ 0 \; if \; y_i^* \leq 0 \end{cases} \qquad 2$$

From the above equation, child mortality is observed as $y = 1$, while failure to observe mortality is when $y = 0$. We shall consider the cumulative distribution function (cdf) of the probit model as expressed below;

$$prob\, Y_i = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{x_i\beta} e \frac{-(x_i - x_i\beta)^2}{2} dx = \Phi x_i' \beta \qquad 3$$

While probability of observing child mortality will be provided by:

$$\text{prob } Y_i = 1 \ = F(X_i\beta') \qquad 4$$

From the probit equation 4 above $F(X\beta)$ is the cumulative distribution function which yields the following maximum likelihood function below;

$$L = \prod_{Y=0} \Phi(-X_i\beta') \prod_{Y=1}[1-\Phi(-X_i\beta')] \qquad 5$$

The study thereafter makes interpretations on the probability of observing the dependent variable (child mortality). The computation of marginal effects is conducted to this effect.

3.4 Estimable model and definition of variables

3.4.1 Estimable Model

The specified model is expressed as indicated below;

$$M = \alpha 0 + \alpha 1X + \alpha 2\acute{Y} + \varepsilon \qquad 6$$

Where M represents under-five mortality which is a binary variable, X is the immunisation (whether a child receives all basic vaccines), Ý is the vector of other determinants of child mortality (e.g. Mother's age, mother's age at first birth, birth order, maternal education, wealth index, religion, place of residence, access to safe drinking water, toilet facilities, or information, diarrhoeal and dummies for regions as described in the Mosley and Chen framework, α is the coefficient(s) to be estimated while ε is the error term. The model is founded on an assumption the likelihood of observing under-five mortality is determined by various factors as indicated in Table 3.1 below

3.4.2 Definition of variables and categories

Table 3.1: Variables, definition, categories and expected sign

Variable Name	Definition	Categories	Expected Sign
Dependent Variables			
Under 5 mortality	The probability of dying before the fifth birthday	Dummy variable (Binary values [1, 0]); is coded as (1) if the child death is reported in a household and (0) otherwise	
Independent Variables			

Immunisation	Status of immunisation given the age of the child. A child is fully vaccinated when having received all basic vaccinations as considered by WHO.	This is got by merging all the vaccine variables for children between 12-59 months old. coded as (1) if a child receives one or all basic vaccines (0) if otherwise	Negative (Mondal, 2009)
Characteristics of the child			
Sex of Child	The child's gender at birth	Male (1)or Female(0)	Positive (Zewdu, 2010)
Birth Order	The order or number of a child among his/her siblings	1(0) 2-3(1), 4-5(2), 6+ (3)	Positive (Mondal, 2009)
Characteristics of the Mother			
Age of the mother	Mother's current age	Age in complete years	Positive (Mondal, 2009); Zewdu, 2010)
Education	Mother's highest level of education attained.	No education (0), Primary (1). Secondary and Tertiary (2).	A positive sign for mothers who are educated (Zewdu, 2010; Chizoba et al., 2013).
Marital Status	Current marital status Reference Category- Never married (0)	Married- 1 Widowed -2 and Divorced/separated- 3	-
Occupation	Source of Livelihood	Unemployed (0), Employed (1)	Negative (Babaale's, 2013)
Wealth index	Economic status of the mother Reference Category = Poorest (0)	Wealth status. Poor (1), Middle (2), Rich (3)	Negative (Anyanwu and Erhijakapor, 2009)
Place of current residence	Household Cluster type	Urban (1) or (0) if Rural.	Negative (Zewdu, 2010)
Religion	A mother belonging to any religious category	Dummy: 1 if no religion, 0 otherwise; and 1 if Christian/Islam/others, 0 otherwise	Negative or Positive
Access to Healthcare			
Skilled Delivery	Place of delivery	Health facility (1), Otherwise (0)	Positive (Mondal, 2009)
Antenatal care	Visited health	No antenatal visit (0) and at least 4 times (1)	Positive (Mondal,

	facility for pregnancy 4 time or above		2009)
Access to Information media	Able to access Radio, TV, Internet or Newspaper	1 if possess Radio/TV or reads newspaper and 0 otherwise	Negative (Babaale's, 2013)
Environmental Factors	Access to safe drinking water	1 if safe drinking water available 0 otherwise	Negative (Mondal, 2009)
	Access to a safe and clean disposal of human waste.	1 if pit toilet and 0 if otherwise	Negative(Mondal, 2009)
Regional Variation			
Region	The area of residence for the individual parent.	1 if Nairobi region, 0 otherwise 1 if Central region, 0 otherwise 1 if Eastern region, 0 otherwise 1 if North Eastern region, 0 otherwise 1 if Western region, 0 otherwise 1 if Rift Valley region, 0 otherwise 1 if Nyanza region, 0 otherwise 1 if Coast region, 0 otherwise	-

3.4.3 Multicollinearity test

Multicollinearity arises as a result of the collinearity between two pairs of variables which may lead to spurious estimates. This is because their presence inflates the variance of the parameter estimates. The study shall test its presence through Variance Inflation Factors (VIF). Variance inflation factors (VIF) shall be used to detect its presence. If VIF>10, then it is present and if less than 10, then it's absent. If present, one of the collinear variables is dropped. Similarly, the study checked for the misspecification of the model while applying heteroscedastic test for probit models to check for presence of lack of constant variance. If present, we apply robust.

3.5 Data Source

This study will use the 2014 Kenya Demographic Health Survey (KDHS) data set. Household-based cross-sectional survey containing general information on the health status of the entire population, usually conducted for the duration of five years in Kenya. The study design had a representative sample of 40,300 households, out of which 39,679 households were selected in the sample. Of these, 36,430 households were successfully interviewed. According to the 2014 study report, immunization data was collected from vaccination cards and in cases where they were not available, the mother's recall of whether the child received BCG, polio, pentavalent, measles, and the pneumococcal vaccine was accepted. A total of 32,172 women aged 15-49 were eligible, but only 31,079 women aged were interviewed. The survey further collected information on maternal and child health at county levels. The study population is composed of 5,989 children aged 0-59 months delivered by women aged between 15 to 49 years who participated in the 2014 demographic survey. Other information which can be obtained includes the mother's age at first birth, current residence and maternal education levels among other factors related to this study. More specifically, the survey asked questions about the death of a child before the fifth birthday.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1. Introduction

This chapter presents the study results of the role of immunisation on child health outcomes in Kenya. The study used binary probit model in assessing the econometric relationship. Both descriptive and empirical results are presented in tables.

4.2. Descriptive Statistics

The study reports the average, standard deviation, minimum and maximum of the study variables. As indicated in Table 4.1 below, a total of 31,079 mothers were surveyed. Specifically, the study considered under-five child mortality as the dependent variable to represent child health outcomes while the age of the mother, marital status, maternal education, place of current residence, employment, wealth index, access to health services and information including regions as independent variables.

From the study findings, approximately 51.8% of the respondents reported child mortality and 44.1% of the children under-five years received full immunisation.

Birth order of child was assessed and found that most children were either of third or fourth birth order with a similar variation, and most of the children recorded were male with a representation of 63.3%. The mother's age averaged approximately 29 years, with the youngest being 15 while the oldest was 49 years. The variation, in general, was at 9 years compared to the year 2008 which had a variation of 7 years from the average. On maternal education, the study showed 13.5% of most respondents had attained primary education while 50.2% had a primary level of education against those reported in the year 2008 being 20.2% and 55% respectively (see table 4.1).

Table 4.1: Summary Statistics

Variables	Observation	Mean	Std. Dev.	Min	Max
Under five child mortality	7158	0.51792	0.4997	0	1
Immunisation	31079	0.4412	0.4965	0	1
Sex of the child (1=Male)	23245	0.63328	0.4819	0	1
Birth order	23245	3.5961	2.2991	1	15
Age	31079	28.9413	9.3934	15	49
Married	31079	0.5712	0.4949	0	1
Education	31079	1.3149	0.8111	0	3
Type of residence(1=urban)	31079	0.3737	0.4838	0	1

Religion	30968	1.9005	0.6253	0	3
Occupation (1=employed)	14724	0.5740	0.4945	0	1
Wealth index	31079	2.9147	1.4409	1	5
Antenatal visits	14898	0.5432	0.4981	0	1
Hospital delivery	14761	0.5926	0.4914	0	1
Mass media	31079	0.8267	0.3785	0	1
Piped water source	31079	0.3524	0.4777	0	1
Flush toilets	31079	0.0852	0.2791	0	1
Regional variation	6066	3.2676	2.3143	0	7
Nairobi Region	6066	0.1646884	0.3709297	0	1
Central Region	6066	0.1167161	0.3211082	0	1
Coast Region	6066	0.1358391	0.3426459	0	1
Eastern Region	6066	0.1183647	0.323066	0	1
Rift Valley Region	6066	0.1221563	0.3274932	0	1
Western Region	6066	0.1327069	0.3392856	0	1
North-Eastern Region	6066	0.0947906	0.2929497	0	1
Nyanza Region	6066	0.1147379	0.3187316	0	1

Source: Own computation based on KDHS, (2014)

On the other hand, about 57.1% of respondents were married and approximately 37.4% of the respondents resided in the urban areas while 62.6% were rural residents. On religion, most of the respondents were Christians comprising of both Catholics and Protestants (these groups formed the largest category at 84.6%) while Muslims were 13.4% of the surveyed population. About 57.4% of the respondents were employed whereas on wealth index, a majority of the respondents were in the third (middle) wealth quintiles.

Furthermore, the majority of the respondents (82.7%) were shown to own either radio, TV or read newspaper frequently. On access to health care, the study considered antenatal care visits, hospital delivery and environmental factors. The descriptive statistics show that 54.3% of the respondents attended and received sufficient antenatal care. This implies that about 45.7% had less than four antenatal visits as recommended and the antenatal visits variation on average was at 49.8%. Similarly, about 59.3% of the women received skilled delivery which was slightly higher compared to earlier year's reports at 49.1%.

On the regional distribution of the respondents, on average most were between third and fourth. Specifically, Nairobi region led with highest respondents who were 16.5% of the regions considered followed by the Coast, Western, and Rift Valley regions with 13.6%, 13.3% and 12.2% respectively. The rest of the regions had less than 12% of the respondents among the regions under study.

4.3 Diagnostic tests

4.3.1 Multicollinearity Test

A correlation matrix was estimated to establish the relationship between child health outcomes, immunisation and the other independent variables of the study. The Positive and negative signs in the analysis are indicative of the direction of the association between variables. From table 4.2 below, child mortality was found to be positively correlated with immunisation, education, age of mother, residence, religion, employment, wealth index, antenatal visits, hospital delivery, Mass media, Piped water source, flush toilets while the other variables sex of the child, birth order, married and regions had a negative correlation with under five child children. Generally, most of the correlations were less than the absolute value of 0.5 implying absence of Multicollinearity. The results are as indicated below;

Table 4.2: Correlation Matrix

Variables	Under 5 child mortality	Immunisation	Sex of child	Birth order	Age of mother	Married	Education	Residence	Religion	Employment	Wealth index	Antenatal visits	Hospital delivery	Mass media	Piped water source	Flush toilets	Regions
Under 5 child mortality	1.0000																
Immunisation	0.1657	1.0000															
Sex of the child	-0.0288	-0.0245	1.0000														
Birth order	-0.0682	-0.0074	-0.0400	1.0000													
Age of mother	0.0215	0.1082	-0.0254	0.6963	1.0000												
Married	-0.0485	0.0702	-0.0260	0.1309	0.1135	1.0000											
Education	0.0762	0.0486	0.0429	-0.3671	-0.0736	-0.0280	1.0000										
Residence	0.0696	0.0058	-0.0077	-0.2627	-0.0825	-0.0423	0.3080	1.0000									
Religion	0.0396	-0.0033	0.0281	-0.0710	-0.0761	0.0931	0.0242	0.1071	1.0000								
Employment	0.0451	0.0456	0.0084	0.0866	0.2408	-0.0489	0.2218	0.0505	-0.0339	1.0000							
Wealth index	0.1500	0.0590	-0.0158	-0.3387	-0.0323	-0.0421	0.5447	0.6244	0.1534	0.1427	1.0000						
Antenatal visits	0.0812	0.1046	-0.0463	-0.1312	-0.0075	0.0262	0.2070	0.1370	0.0362	0.0416	0.2161	1.0000					
Hospital delivery	0.1594	0.0389	0.0289	-0.3231	-0.0871	-0.0184	0.3837	0.3454	0.0743	0.0772	0.5130	0.2654	1.0000				
Mass media	0.0639	-0.0104	0.0410	-0.2152	-0.0605	-0.0538	0.4707	0.2880	0.0946	0.2243	0.5091	0.1434	0.3475	1.0000			
Piped water source	0.0279	0.0111	-0.0399	-0.1752	-0.0039	-0.0407	0.2146	0.4420	0.0350	0.0746	0.4414	0.1711	0.3033	0.1900	1.0000		
Flush toilets	0.0694	0.0102	0.0010	-0.2132	-0.0338	-0.0703	0.3366	0.4106	0.0357	0.0714	0.4754	0.1552	0.2525	0.1974	0.3317	1.0000	
Regional variation	-0.0785	-0.0168	0.0212	0.1453	-0.0543	0.0880	-0.2345	-0.2965	0.1409	-0.1160	-0.3451	-0.1375	-0.2217	-0.2103	-0.3806	-0.3803	1.0000

Source: Own computation based on KDHS, (2014)

4.3.2 Heteroscedasticity test

The study used the heteroscedasticity probit model test to determine variation/constancy of the variance. Also, robust standard errors were used to address possible presence of heteroskedascity.

4.4. Estimation Results

4.4.1. Introduction

To estimate the effect of immunisation on child health outcomes in Kenya the study used probit model with robust standard errors. Marginal effects of the probit model on various independent variables were estimated for interpretation purposes. Findings are shown in Table 4.3. The study found a p-value of 0.0000 which is less than 5% with the log likelihood ratio statistic of 679.5 implying that the variables considered fit the model well, hence variables used in the model were jointly significant in explaining child health outcomes in Kenya. The pseudo R was very low (0.0753). This is normal for cross-sectional studies.

Table 4.3: Marginal Effects: Dependent variable –Child Mortality

UNDER 5 CHILD MORTALITY	**Robust**		
	MARGINAL EFFECT	**STD ERRORS**	**Z-Statistic**
Immunisation	0.2318***	0.0456	5.09
Sex	-0.0262	0.0232	-1.13
Birth order	-0.0073	0.0088	-0.82
Age	0.0027	0.0027	0.99
Married	-0.0663**	0.0311	-2.13
Education (*Base category - No Education*)			
Primary	0.00293	0.0487	0.06
Secondary	-0.0304	0.0574	-0.53
Higher	-0.0346	0.0720	-0.48
Current place of residence	-0.0045	0.0318	-0.14
Religion (*Base category-No Religion*)			
Christian	-0.04308	0.0566	-0.76
Protestant	-0.0234	0.0507	-0.46
Muslim	0.0621	0.0609	1.02
Employment status	0.0098	0.0256	0.38

Wealth quintiles (*Base category - Poorest Wealth Quintile*)			
Poorer wealth quintile	0.0069	0.0498	0.14
Middle wealth quintile	0.0949**	0.0474	2.00
Richer wealth quintile	0.0663	0.0537	1.24
Richest wealth quintile	0.1034*	0.0592	1.75
Antenatal visits	0.0190	0.0251	0.76
Hospital delivery	0.1042***	0.0287	3.63
Mass Media	-0.0244	0.0391	-0.62
Piped water source	-0.0478*	0.0286	-1.67
Flush toilets	0.0326	0.0450	0.72
Regional variation (*Base category - Nairobi*)			
Central region	0.14056***	0.0495	2.84
Coast region	-0.0126	0.0596	-0.21
Eastern region	0.0560	0.0514	1.09
Rift valley	-0.0798	0.0513	-1.55
Western region	0.0423	0.0509	0.83
North eastern region	-0.0283	0.0759	-0.37
Nyanza region	-0.0040	0.0530	-0.08
Robust Probit Regression			
Number of observations=	1298		
Wald chi2(29) =	101.67		
Prob > chi2 =	0.0000		
Log pseudo-likelihood	=-679.50502		
Pseudo R2 =	0.0753		

*Source: Author's computation. Note: ***Significant at 1%, **Significant at 5% and *Significant at 10%. Regions based on provinces before introduction of counties.*

From the results, immunisation, being married, middle wealth quintile and richest wealth quintile, hospital delivery, piped water source and central region was found to be statistically significant in determining under-five child mortality. On the other hand age of the mother, education, residence, religion, employment/occupation, wealth index (except third and fifth), antenatal visits, mass media, flush toilets and regions (except central region) were shown to be statistically insignificant in determining under-five child mortality.

4.4.2 Discussion of the study results

This subsection discusses the study results in detail. We begin with the variable of interest (immunisation) followed by the significant control variables and finally the non-significant control variables. From Table 4.4, the study indicates significant values at 1%, 5% and 10% significance levels. The study revealed immunization was statistically significant and reduced the probability of child mortality by 23.2% holding other factors constant. This implies that as one gets immunised, the likelihood of attracting preventable diseases like pneumonia which leads to child mortality is decreased. This finding is in line with the results obtained by Mariara et al., 2009 who found out that 100% immunisation coverage for infants were main factors for reducing child mortality. Also, Mondal (2009) found out that immunisation significantly determined newborn and under-five child death in Rajshahi District in Bangladesh. The discussion of other significant control variables is as follows.

The study sought to understand the contribution of marital status whereby being married was shown to lower likelihood of child mortality by 6.63% holding other factors constant. The study findings were contrary to empirical results obtained by Zewdu (2010) who found that marital status to be insignificant in determining child mortality in Ethiopia.

Among the socio-economic factors, both middle and richest wealth quintiles were statistically significantly and increased probability of under-five child mortality by 9.49% and 10.34% respectively holding other factors constant. This was against our *apriori* expectation. This result was different from the findings by Zewdu (2010) who explored the socio-economic factors determining child mortality in Ethiopia and showed wealth index as being a statistically insignificant factor.

Hospital delivery was statistically significant and increased the probability of child mortality by 10.42% holding other factors constant. This was a surprising result as we expected the inverse. This may be associated with mothers who may only deliver in health facilities and fail to proceed with the required hospital visits (postnatal care). This study results was different with the findings of Mariara et al, (2009) who examined child existence in Kenya using survival analysis to explain childhood death and hazard functions to analyse the causes of childhood mortality. The authors concluded that improved coverage of birthing assistance by a professional were main factors for promoting child existence and development.

On the other hand, piped water source was found to be statically significant in contributing to the reduction of child mortality and households with access to clean piped water led to declining child mortality rates by 4.78% holding other factors constant. Consumption of clean water lowers chances of being infected by other water-borne diseases and thus prevents a child from contracting diarrhoea which leads to dehydration which eventually leads to mortality. The findings were supported by findings of Chizoba et al., (2013) who revealed that drinking surface water lowered the risk aspects of contracting severe pneumonia in children. Also, Fischer and Walker, (2014) study results revealed improved sources of drinking water and toilet facilities averted diarrhoeal deaths. Finally, assessment of regional variation revealed significant child health outcomes associated with different regions. Central region was statistically significant compared to Nairobi region and increased the probability of child mortality by 14.1% holding other factors constant.

The non-significant control determinants of child mortality at all levels were found to include the age of the mother, educational level, current place of residence, religious beliefs, employment/occupation, antenatal visits, mass media and flush toilets were shown to be statistically insignificant. This was against our expectations. Other studies found contrary results that showed these factors as being statistically significant in determining child health outcomes- mortality and other child risk factors (Wamae et al, 2009, Otieno, 2012, Murage et al., 2014; Babaale 2013; Zewdu, 2010).

CHAPTER FIVE: DISCUSSIONS AND POLICY IMPLICATIONS

5.1 Introduction

This chapter reflects on the study results, discusses policy implications on the nexus between immunisation and child health outcomes. In addition, launches a more detailed discussion on directions to be considered in future research studies.

5.2 Summary of the study findings

The study explored the link between immunisation and under-five child mortality using the recent Kenya Demographic and Household Survey (KDHS) of 2014 which contains factors associated with child health outcomes (including under-five mortality) and full immunisation. The binary probit regression model was used in estimation. The dependent variable used was under five child mortality while the independent variable of interest was child immunisation (full) with other control variables being the demographic, socio-economic factors, environmental factors and access indicators. The study findings revealed that immunisation; being married, middle wealth quintile and richest wealth quintile; hospital delivery piped water source and central region is statistically significant in determining under-five child mortality. On the other hand age of the mother, education, residence, religion, occupation, wealth index (except third and fifth), antenatal visits, mass media, flush toilets and regions (except central region) were shown to be statistically insignificant. The findings establish that to control child mortality there is the need to consider policies that may stabilise immunisation levels since it has a negative and statistically significant relationship.

5.3 Conclusions of the study findings

Although there have been great strides in the development and administration of effective vaccines, developing countries like Kenya still carry the largest disease burdens among children and struggle to ensure optimal immunisation coverage of all children born in Kenya and in introducing newer serums. Since the study results showed an inverse relationship between child health outcomes and immunisation, a need for wide immunisation coverage is required.

5.4. Policy Implications

Based on the analysed factors influencing immunisation and under-five child mortality in Kenya, the study suggests that there is a need to create awareness and support and encourage improvement of existing policies which safeguard immunisation and lowers child mortality across the country. This could be done through reviewing the existing policies in place and by creating awareness in public forums that target new-born and old mother who have children who are not immunised. Also, the government through the Ministry of Health and other relevant stakeholders need to establish more health facilities in other regions to improve access to health facilities across the counties, pursue sanitation and hygiene programmes to ultimately end diarrhoeal infections and subsidise the cost of accessing care as this would lead to increased utilisation of immunisation. These costs may be in terms of time and distance to immunisation centres.

5.5. Areas of further study

The study has mainly considered the relationship existing between immunisation and under-five child mortality in Kenya using a cross-sectional dataset, however, futures studies may consider applying panel datasets, incorporating qualitative approach and other factors such as the devolved health service delivery and cultural diversity. It would be important to investigate the effect of cultural diversity and decentralisation of health services on promoting immunisation coverage in Kenya by conducting the analysis for each of the 47 counties in Kenya. The current study applied more quantitative approaches to uncover the predisposing and enabling factors that contribute to full immunisation among under-five in Kenya. Further research applying the qualitative approach to determine the role of full immunisation is required. By collecting the additional data will play a big role and provide important information for there is much that we do not know yet, and continuing research will assist in unearthing underlying concerns and recommend best interventions to be adopted from evidence-based point of view.

REFERENCES

Andre, F. E., Booy, R., Bock, H. L., Clemens, J., Datta, S. K., John, T. J., & Santosham, M. (2008). Vaccination greatly reduces disease, disability, death and inequity worldwide. Bulletin of the WHO, 86(2), 140-146.

Anyanwu, J. C., & Erhijakpor, A. E. (2009). *Health Expenditures and Health Outcomes in Africa. African Development Review, 21(2), 400-433.*

Bbaale E. *Factors influencing childhood immunisation in Uganda. J Health Popul Nutr. 2013; 31(1):118–29.*

Bronfenbrenner, U. (1994). *Ecological Models of Human Development*. International Encyclopedia of Education: vol. 3 2nd Ed.

Bryce, J., Boschi-Pinto, C., Shibuya, K., & Black. (2005). RE: WHO estimates of the causes of death in children. The Lancet , 365 (9465), 1147-1152.

CDC Kenya. (2014). Annual Report. Centre for Global Health , Office of the Director of Global Health.

Centre for Disease Control (2012). Global Routine Vaccination Coverage.

Child Health, (2015). World Health Organisation. Retrieved October 15, 2015, from World Health Organisation Website: http://www.who.int/topics/child_health/en/

Chizoba, W., Deloria, M., Feikin, R et al., (2013). *Evaluation of risk factors for severe pneumonia in children. The Pneumonia Etiology Research for Child Health, 54(2), 22-30.*

Countdown to 2015 Maternal, Newborn & Child survival: Kenya, from http://www.countdown2015mnch.org/

Dahlgren, G., Whitehead, M. (1991). Policies and strategies to promote social equity in health. Stockholm: Institute for Futures Studies.

Derek Osborn, A. C. (2015). Universal Sustainable Development Goals: Understanding the transformational challenge for Developed Countries. Stakeholder Forum.

Diseases and Conditions retrieved on October 15, 2015, from http://www.cdc.gov/DiseasesConditions/index.html

Kimani, W., Murage, J.C. Fotso et al (2014). *Trends in childhood mortality in Kenya: The urban advantage has seemingly been wiped out.*

Fischer, W., and Walker, N. (2014). *The lives saved tool (LiST) as a model for diarrhoea mortality reduction. BMC Medicine. 12:70. doi.1186/1741-7015-12-70.*

F.E Andre et al (2008). *Vaccination greatly reduces disease, disability, death and inequity worldwide Bulletin of the World Health Organization Past issues*. Volume 86, Number 2, February 2008, 81-16

Green, W.H (2008). *Econometric analysis*. 7ed. Upper Saddle River. NJ prentice Hall.

Grossman M. (1972). *On Concept of Health Capital and Demand for Health. Journal of Political Economy, Reprint 2001: pgs 223-225.*

Guerrera, G. (2015). *Neonatal and pediatric healthcare worldwide*: A report from UNICEF. Clinica Chimica Acta, 451, 4-8.

Gujarati, D.N (2004). Basic Econometrics. 4th Edition. McGraw-Hill, Book companies, New York.

Immunisation description Retrieved October 15, 2015, from WHO: http://www.who.int/topics/immunisation/en/

Kahneman, D. and Tversky, A., (1979). *Prospect Theory: An analysis of decision under Risk. Econometrica,* 47(2), Pp. 263-291.

KEMRI/CDC (2008). *Demographic Surveillance System Annual Report*, 2007.

Kenya National Bureau of Statistics (2014). ICF Macro. Kenya Demographic and Health Survey 2014. Calverton, Maryland: KNBS and ICF Macro.

Kenya National Bureau of Statistics (KNBS), ICF Macro. Kenya Demographic and Health Survey 2008-09. Calverton, Maryland: KNBS and ICF Macro; 2009.

Kinney, M. V., Kerber, K. J., Black, R. E., Cohen, B., Nkrumah, F., Coovadia, H., ... & Lawn, J. E. (2010). *Sub-Saharan Africa's mothers, newborns, and children: where and why do they die? PLoS Med, 7(6), e1000294.*

Levine O.S., O'Brien K.L., and Knoll M (2006). *Pneumococcal vaccination in developing countries. Lancet. 2006; 367:1880-1882.*

Mariara, J.K, Karienyeh, M.M and Kabubo, F.M. (2012). *'Child Survival and Policy Options in Kenya: Evidence from Demographic and Health Surveys', Journal of Reviews on Global Economics 1, 13-26.*

M.O.H (2006). Division of Vaccines and Immunisation (DVI) Multi- year plan 2006-2010.
M.O.H (2015). Health Sector Working Report: Medium Term Expenditure Framework (MTEF) for the Period 2016-17 to 2018-19.

MDG 4: Reduce child mortality (2015) Millennium Development Goals Report Card: Learning from Progress retrieved from http://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/6014.pdf

MODP (2013) Millennium Development Goals: Status report for Kenya.

Mondal, N., Korban, A., Hossain, K. (2009*). Factors influencing infant and child mortality: A case study of Bangladesh. Journal of Human Ecology, 26(1), 31-39.*

Mosley, W., Chen, L. (1984). *An analytical framework for the study of a childs' survival in developing countries. Population and Development Review, 10, 25-45.http://dx.doi.org/ 10.2307/.*

MPHS (2011). Division of vaccines and immunisation Multi-year plan 2011-2015. Nairobi: Ministry of Public Health and Sanitation.

Mugo, M. (2012). Impact of parental socioeconomic status on child health outcomes in Kenya. In Economic Development in Africa (pp. 18–20). Oxford UK: Cathrine's College.

Mukras M.S. (1993). Elementary Econometrics. Theory, Application and Policy. East Africa Education Publishers Ltd. 162-163.

Okwo-Bele, D. J.M. (2015). WHO. Retrieved October 15, 2015, from WHO: http://www.who.int/mediacentre/commentaries/vaccine-preventable-diseases/en/

Oliwa, J. N., & Marais, B. J. (2015). *Vaccines to prevent pneumonia in children–a developing country perspective. Paediatric Respiratory Reviews.*

Olusanya, B. O. (2010). *Pattern and determinants of BCG immunisation delays in a sub-Saharan African community. Health Research Policy and Systems, 8, 1. http://doi.org/10.1186/1478-4505-8-1*

The Republic of Kenya. (2006-2010), 'Division of Vaccines and Initiatives (DVI) Multi-Year Plan 2006-2010', Nairobi: Government Printers.

Republic of Kenya (2012). Kenya Health Policy2012 -2030. Ministry of Health. Nairobi.

Smith, P.J, Humiston, S.G, Marcuse, E.K, Zhao, Z, Doreli, C.G, Howes, C, and Hibbs B. (2011). *Parental Delay or Refusal of Vaccine Doses, Childhood Vaccination Coverage at 24 Months of Age, and the Health Belief Model', Public Healthy Reports 12(126), pp.135-146.*

Taylor D, Burry, M, Campling N, Carter S, Garfied S, Newbould J, and Rennie, T (2006). A Review of the use of Health Belief Model (HBM), the theory of Reasoned Action (TRA), the 46 theory of Planned Behaviour Model (PBM) and the Trans-Theoretical Model (TTM) to study and predict health related Behaviour Change, London: University of London.

The Baby Bump http://www.thebump.com/a/tuberculosis-baby retrieved on October 14, 2015.

UN (2015). Transforming our world: the 2030 Agenda for Sustainable Development. General Assembly.

UNDP (2014) http://hdr.undp.org/en/countries/profiles/KEN retrieved on July 7, 2016

UNICEF (2008). The state of the world's children 2009: maternal and newborn health (Vol. 9). UNICEF.

UNICEF (2015). (www.unicef.org/infobycountry/kenya_2621.htm) retrieved on November 24, 2015.

Vaccines and Immunisations retrieved from http://www.cdc.gov/vaccines/vpd-vac/default.html on October 10, 15.

Vaccines and Preventable diseases. (2009, May 10). Centre for Disease Control. Retrieved October 17, 2015, from Centre for Disease Control: http://www.cdc.gov/vaccines/vpd-vac/

Wamae, A, Kichamu, G, Kundu, F and Muhunzi, I. (2009), 'Child Health Services In Kenya', Kenya Working Paper, 2. Government Printers: Nairobi.

Walker CL, Munos MK, Black RE. *Quantifying the indirect effects of key child survival interventions for pneumonia, diarrhoea, and measles. Epidemiol Infect. 2013; 141(1):115–131*

WHO (2009). Vaccine-Preventable Diseases: Monitoring System. 2009 Global Summary. Geneva.

WHO (2015). Child development retrieved on October 23, 2015 from http://www.who.int/topics/child_development/en/

WHO, UNICEF (2005). Global Immunisation Vision and Strategy 2006-2015. Geneva, Switzerland.

WHO/UNICEF (2009). Joint reporting process. Geneva: Available from: http://www.who.int/immunisation _monitoring/routine/joint reporting/en/index.html.

WHO; UNICEF (2008). Global Immunisation Data 2008 retrieved from http://www.who.int/immunisation/newsroom/Global_Immunisation_Data.pdf on October 14, 2015.

Zewdu, F. (2010). *Socio-economic factors of early childhood mortality in Ethiopia: Evidence from demographic and health survey. Ethiopian Economics Policy Research Institute, 47(3), 44-60.*