DETERMINANTS OF IMMUNIZATION COVERAGE AMONG CHILDREN AGED 12-23 MONTHS IN KENYA

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Last but not least to the University of Nairobi for the study opportunity.

DECLARATION

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

Signed …………………………………. Date………………………………….

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This thesis has been submitted for examination with my approval as the university supervisor

Signed …………………………………. Date………………………………….

Prof. Damiano Kulundu Manda

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ABSTRACT

The Government of Kenya has made significant investments in improving immunization in the country to prevent diseases, especially among children. Nevertheless, the country is yet to achieve the expected 100% immunization coverage to reduce disease burden and preventable deaths. Whereas the main aim of this study is to estimate determinants of immunization coverage in Kenya among children of the age between 12-23 months, its purpose is to inform relevant National Health policies to improve immunization coverage. In order to achieve its objective, the study utilized cross-sectional data obtained from Kenya Demographic and Health Survey 2014. The data was analyzed using the Heckman sample selection model to determine the factors that influence immunization in Kenya. The inverse Mills ratio was found to be insignificant and therefore the analysis relied on the probit and uncorrected OLS estimators for the analysis.

The study found that mother's education and literacy, place of delivery, antenatal visits as well as household head age significantly increased the chance of child being immunized. Household size had a negative and significant effect on the probability of a child being fully immunized. Marital status of the mother, place of delivery, antenatal visits and literacy level of the mother had a positive effect on the level of immunization coverage. Household size, household head age and birth order negatively affected the level of immunization coverage.

ABBREVIATIONS

BCG………………………………………………………………… Bacillus Calmette-Gue'rin

DHS……………………………………………………………… Demographic Health Survey

DoV………………………………………………………………….... Decade of Vaccines

DTP3…………………………………………………………….... Diphtheria Tetanus Pertussis

DVI…………………………………………………..... Division of Vaccines and Immunization

EPI…………………………………………………………. Expanded Program on Immunization

GAPPD……Integrated Global Action Plan for the Prevention and Control of Pneumonia and Diarrhoea

GAVI……………………………………………………………… Global Vaccine Alliance

GIVS……………………………………………….. Global Immunization Vision and Strategy

GVAP…………………………………………………………….... Global Vaccine Action Plan

KDHS………………………………………………….. Kenya Demographic Health Survey

KEMRI…………………………………………………….... Kenya Medical Research Institute

KEPI……………………………………………….... Kenya Expanded Program on Immunization

KHPF………………………………………………………… Kenya Health Policy Framework

KHSSP…………………………………… Kenya Health Sector Strategic and Investment Plan

MDG………………………………………………………. Millennium Development Goals

MoH……………………………………………………………………… Ministry of Health

NPGI……………………………………………. National Policy Guidelines on Immunization

OPV……………………………………………………………………… Oral Polio Vaccine

PCV…………………………………………………………………..... Pneumonia Vaccine

SOWVI……………………………………………... State of Worlds' Vaccine and Immunization

UNICEF……………………………….. United Nations International Children's Education Fund

WHO……………………………………………………………. World Health Organization

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CHAPTER 1: INTRODUCTION

1.1 Background Statement

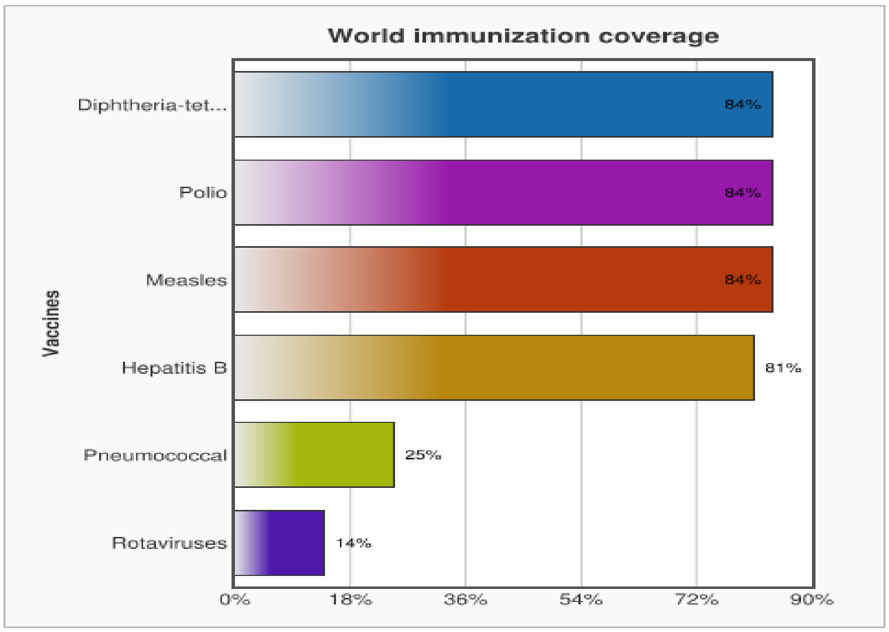
Vaccination coverage remains an important indicator of child health outcomes in virtually all countries. Improving vaccination coverage by ensuring that all children born in or out of a health care setup are vaccinated remains a desire of most nations due to the undesirable health outcomes of non-immunized children. Consequently, the World Health Organization (WHO) in May 2012 formed the Global Vaccine Action Plan (GVAP) as a roadmap to prevent millions of deaths through more equitable access to vaccines. Under this plan, countries hoping to achieve vaccination coverage of at least 90% nationally and at least 80% in each district by 2020. The aim of the plan include accelerating control of all vaccine-preventable diseases, polio eradication, and promoting research and development for the next generation of vaccines(WHO, 2015).

In 2014, WHO statistics showed that global coverage of specific vaccines was less than 100%. Specifically, Diphtheria-Tetanus-Pertussis was at 84%; Polio at 84%; Measles at 84%; Hepatitis at 81%; Pneumococcal at 25%, and Rotavirus at 14% as illustrated in Figure 1. World Health Organization advices that children receive the complete schedule of vaccination before they reach 12 months of age and Kenya Expanded Programme on Immunization (KEPI) follows the WHO guidelines for vaccinating children (KDHS, 1998).

Despite improvements world over in vaccine coverage in the last ten years, still there is regional and local disparities due to factors such as limited resources; competing health priorities; poor management of health systems and inadequate monitoring and supervision (WHO-UNICEF, 2013). In 2013, it was estimated that 21.8 million infants all over the world were not reached with the routine immunization services. Nearly half of the children live in three countries namely, India, Nigeria and Pakistan.

The number of children below the age of one year who never received DTP3 vaccine worldwide was 21.8 million in 2013 compared to 22.8 million in 2012. Nearly 70% of them lived in ten countries, which include Ethiopia, Kenya and South Africa (WHO-UNICEF, 2013). In most developing countries, Kenya included, governments face several challenges in providing immunization services. These include poor logistics and inadequate technical capacity, as well as, political, social, and cultural obstacles that negatively impact access to medical services. Immunization was fundamental to achieving the MDGs, i.e reduction of deaths among under fives (MDG 4). A lot depends on continued government commitment and sustained international community to build on their efforts to improve child survival through immunization to meet the MDGs (SWOVI, 2009).

Figure 1: The 2014 Global Coverage Basic Vaccination



Source: WHO Report 2014

In Kenya, the government's commitments to improvement of its citizen's health by striving to provide health services that are easily accessible and meet the basic needs of the population are visible. The Kenya Health Policy Framework (KHPF 1994-2010), the constitution and the Vision 2030, all greatly influenced the structure in which health services are provided and health status of Kenyans. This constitution brought with it devolution of governance with 47 Counties tasking them with provision and delivery of health care services. The intention was to make the right to health a reality for all Kenyans (Government of Kenya, 2010).

The Government of Kenya through the Ministry of Health (MoH) began on the process of formalizing immunization services following the Alma Ata Declaration[1] of 1978 by the World Health Assembly. The Kenya Expanded Programme on Immunization (KEPI) was then established in the year 1980. Its mission was to coordinate immunization services, which targeted the six common childhood killer diseases existing at the time with the six available antigens, tuberculosis, polio, tetanus, diphtheria, whooping cough, and measles to all children in the country before 12 months of age, and tetanus toxoid (TT) vaccination for all expectant women. Before the year 1980, vaccination services had been provided on an ad-hoc basis mainly through primary schools and the larger health institutions and facilities (NPGI, 2013).

However, having achieved the stated Universal Child Immunization goal which was immunizing at least 80% of the target population in the 1990s, KEPI's then changed its focus to disease control, elimination and eradication. With time KEPI included new vaccines for childhood and vaccination program for antenatal women. The National Policy Guidelines on Immunization (NPGI) first developed in 2000 and lately revised 2013; aims to comprehensively guide all health workers on the priorities of vaccination and acceptable practices for the good of Kenyans. It has recommended guidelines on vaccines for special risk groups, immune-compromised, pregnancy, trauma and occupational prophylaxis and Vitamin A schedule for lactating mothers and children under five (NPGI, 2013). Despite the efforts made by the government, immunization coverage still varies significantly across counties. This study, therefore seeks to determine the factors that determine vaccination cover for children of ages between 12 and 23 months.

1.2 Immunization Coverage among12-23 Months Olds

Kenya with a population of 45 million has 15% (5,939,306 people) below the age of five and reports an overall basic vaccination of 77% of children aged 12-23 months (KDHS, 2014).According to WHO, a child is said to have received all the basic vaccinations when the child gets: a BCG vaccination against (TB) tuberculosis; 3 doses of DPT vaccine to prevent diphtheria, Pertussis and Tetanus (or 3 doses of the vaccine Pentavalent, which includes DPT and vaccinations against both hepatitis B and Haemophilus Influenza type B); at least 3 doses of

[1] The International Conference on Primary Health Care, held in Alma-Ata, USSR on 6-12 September 1978, expressed the need for urgent action by all governments, all health and development workers, and the world community to promote the health of all people of the world, thereby declaring among other declarations that immunization against the major infectious diseases be included as a primary health care program.

polio vaccine; and one dose of measles vaccine. All received during the first year of life (WHO, 2012).

KEPI considers a child fully vaccinated once the child has receives all the basic vaccinations and 3 doses of pneumococcal vaccination. Our National Guidelines on Immunization obliges that counties should strive to achieve and maintain at least minimum coverage of 80% of children fully immunized as captured in the principle of *"the full protection of any child is based on the collective protection of all children"* (NPGI, 2013).Pneumococcal vaccine, which is a key element of the new integrated strategy, had by 2013 been introduced in 102 countries and global coverage was estimated at 25%. Since PCV-10 was introduced in Kenya, scientists at the Kenya Medical Research Institute (KEMRI) have been studying the impact of the vaccine on child health. Their research found that introduction of PCV-10 in Kenya showed an estimated 42.7% reduction in the pneumococcal disease episodes and a 6.1% reduction in immunization related childhood deaths (Ayieko et al, 2013).

1.3 Problem Statement

World Health Organization works with nations and partners with an aim of improving global vaccination coverage, through GVAP and DoV initiatives as adopted by the sitting World Health Assembly in May 2012 (WHO, Fact Sheet $N^0$378 April 2015). In the Kenyan context, the MoH through KEPI has been on the forefront in expansion, improvement and intensification of immunization services within the country. This has been through equipping more health facilities with cold chain (refrigeration) equipment, re-training of health workers, tackling outbreaks through campaigns and continuous monitoring and evaluation of immunization.

However, despite the efforts, the immunization coverage trend in Kenya is worrying. Statistics indicate that in the last two decades, there has been a continuous decline in immunization coverage levels across regions in Kenya with worse trends documented in marginalized areas (KDHS, 2008). According to the 2014 KDHS, basic vaccination coverage reduced from 77 percent in 2008 to 71 percent in 2014. Further, there is evidence that there exists weakness in the Kenyan health systems that have impeded the absorption capacity of the immunization programs, thereby preventing realization of the targeted 90% countrywide coverage by 2015 (Alliance for Health Policy and Systems Research, 2015). Low immunization coverage will lead to an increase in preventable deaths and increased disease burden. This will negatively impact health outcomes and socio-economic development in the country.

A previous study conducted in Kenya on childhood vaccination status of children between 12-23 months who dwell in informal urban settlement of Nairobi (Korogocho and Viwandani) by Mutua *et al.,*2010revealed that children residing in slums are underserved with vaccination hence need for reassessment to ensure children are reached. Another study conducted on immunization coverage determinants among 12-23months old children in a peri-urban area (Kaptembwo,Githima and Mwariki villages in Nakuru) by *Chepkemboi et al.,*2012also revealed that low immunization cover is a challenge in low income populations as well as high population settings thereby need for strengthening awareness strategies like communication, health workers skills and education.

Although several studies have been conducted to identify the factors that determine immunization coverage, they have done so using previous (before 2014) KDHS datasets. Additionally, most studies have done in specific regions in the country (Ndiritu *et al.*, 2006; Lisa *et al.*, 2014; and Lilian *et al*., 2013). Thus, their findings cannot be used to generalize to the country as a whole.

The importance of global immunization coverage cannot be overemphasized. The evident low full immunization coverage studies conducted so far illustrate the need for strategies to realize full immunization coverage. Against this background this study seeks to identify the factors that determine immunization coverage in Kenya. This study, therefore not only aims to fill this knowledge gap by enhancing the understanding among policymakers on why immunization targets are not being met as envisaged, but also inform the policy direction in the Kenyan health sector to improve immunization coverage.

1.4 Research Questions

This research will try to provide answers to the following questions:

i. What socio-economic factors determine variability in immunization performance among the 12-23 months old across counties in Kenya?
ii. To what extent do these factors affect immunization coverage across counties in Kenya?

1.5 Study Objectives

The overall objective of this study is to analyze determinants of immunization coverage among 12-23 months old in Kenya.

Its specific objectives are:

i. To determine the effect of socio-economic factors on immunization coverage among 12-23 months old across counties in Kenya.
ii. To propose possible interventions towards enhancing immunization coverage among 12-23 months in Kenya.

1.6 Significance of the Study

Immunization is an important element of the strategy mix used to combat rising cases of preventable diseases to improve health outcomes in developing countries such as Kenya. In this regard, the proposed study should be of interest to policymakers due to the following reasons. Firstly, the findings of this study are expected to inform relevant national policies to improve immunization coverage levels. The resulting improvement in health outcomes will lead to improved welfare and socio-economic development. Secondly, the study will contribute to the existing literature and data concerning the determinants of vaccination coverage in Kenya. Thirdly, the study will form a basis for future discussions and research in the area of vaccination to facilitate adoption of better strategies to improve access and coverage.

1.7 Organization of the Study

The remainder of the research proposal is organized as follows. Chapter two provides a review of the existing literature. Chapter three highlights the proposed methodology for carrying out the study. Chapter four presents descriptive statistics, discussion of econometric results. Finally, chapter five provides the summary and conclusions of the study, offers policy recommendations and provides suggestions for further research.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter reviews related literature under three sub-headings namely, theoretical literature, empirical literature, and overview of the literature. The theoretical literature covers the various economic theories that explain the effect of socioeconomic, demographic, and health inputs on vaccination coverage. The empirical literature, on the other hand, covers the empirical studies that have analyzed the determinants of immunization coverage. A brief overview that summarizes the gaps in the literature is also presented.

2.2 Theoretical Literature

Several theories confirm that demand for health care services at individual level is mostly determined by socioeconomic and demographic factors. Andersen (1968) developed a model of healthcare utilization. This considered factors such as age, location (either rural or urban), provider incentives, position within social structure, and health belief as key variables in the utilization of health services. This model has been used extensively in studies investigating the use of health services. The theory states that an individual will opt to use health services based on their location, which can either be rural or urban. Individuals in urban areas have a tendency to utilize health services more than their counterparts in rural areas.

An individual's status within the social structure also determines utilization of health services. Individuals better placed in the social structure in terms of higher education and good occupation is likely to utilize health facilities services more than those placed lower in the social structure. The belief an individual has on health also influences the level of utilization of services such as immunization. Individuals' belief of the usefulness of health services is likely to access them.

Other factors that act as enabling characteristics such as resources available in the family and within the community. Individuals of high economic status are expected to utilize health services more than those of low economic status due to their higher purchasing power. He then later reviewed to include the health care system (Anderson 1970). The updated model recognized that the type of health service and purpose will also determine utilization and that health behavior is a direct cause of health outcomes. In the revised model, utilization and frequent use of a specific health care service will have different determinants based on the population characteristics and health services availability (Andersen, 1995; Andersen & Newman, 2005).

Young (1981) ended up proposing a choice-making model based on his ethnographic studies of health services utilization in Mexico. It included 4 components essential to the choice by an individual of health service. The first component is perceptions of gravity which Young describes as how an individual perceives the severity of illness as well as their social network's consideration of the same. If the illness is viewed as severe, individuals would tend to utilize health facilities otherwise they would not. The second component he stated as knowledge of a home treatment by an individual that is efficacious, then they are likely to use it before utilizing a professional health care system due to among other factors convenience and the need to save costs (Wolinsky, 1988b). The third component is faith in remedy which is how much an individual believes if the treatment of the present illness is effective which is the reason whether they will use it or not. The fourth component is access to treatment, which incorporates how an individual evaluates the cost of health services and their availability. He further stated that access may be an important influence on health care utilization. The economic cost of seeking health care includes not only how to pay for cost treatment, but also loss of productive time, and transportation expense which also factors in the time needed to access medical care considering their location geographically, inaccessibility may increase (Young & Young-Garro, 1982).

Grossman (1999) argued that demand for medical care generally and other health inputs are got from basic demand for health. This model considers age, education, health status and income as key variables in health production of through the demand for health capital (Grossman, 1972). Health is therefore demanded by consumers as a consumption commodity because it directly satisfies their utility because sick days act as a source of disutility. Demand for health as an investment commodity is due to the fact that health determines the sum amount of time required for market and non-market related activities. An individual inherits an initial health stock that depreciates with age and may be increased by investment. Grossman (1999) further suggests that the quantity of health capital demanded rises as the wage rate; the higher a person's rate of wage, the greater is the value to him of an increase in healthy time, because more healthy time translates to earning more wages making people invest more in health. Education too increases the efficiency of production of health hence it reduces the quantity of inputs required to produce a certain quantity of health capital. Educated people demand more health since they value their health more but demand less health care than the uneducated.

2.3 Empirical Literature

Ashleshar*et al.*(2005)conducted a study in rural parts of India using data from the National Family Health Surveys 1993 and 1998 consisting of 43,416 children aged 2-35 months. The qualitative study used separate multinomial logit regression models for polio and non-polio vaccines for estimation of the probability whether a child would receive "no cover", "some cover" or "full age-appropriate cover". Based on the best health facility available in the child's village, health infrastructure was used as a hierarchical variable that was assigned to every child as categories (no facility, dispensary or clinic, sub-centre, primary health centre and hospital). It also included the presence of different disciplines of community health workers in the village and other related health infrastructure as variables. The outcomes showed that whereas the availability of health infrastructure had a modest effect, larger and better equipped ones had bigger effects on immunization coverage. Availability of community health workers in the village had no association with increased immunization coverage.

Generally, those who are poor, are more likely not to have their children vaccinated while those from wealthier families are likely to be vaccinated due to their knowledge on better health states. Godi *et al* (2008) undertook both qualitative and quantitative study to show comparison of immunization cover of different vaccines used among tribal and rural children in a distinct socio-economic environment in India. The results showed although majority of mothers were aware of vaccination, their reception of vaccination services was mainly determined by their habitat, caste, and occupation. The qualitative data indicated non-satisfaction by the community of available vaccination services, particularly the rural area. The study concluded that the coverage of some vaccines was moderate in tribal areas and poor in rural areas. The demand for vaccination was dependent on demand for public health service.

According to Olumuyiwa *et al* (2008), education level also determines immunization coverage. In his study of immunization coverage in Nigeria, the researcher found that coverage was higher in areas where most mothers generally had knowledge about vaccine preventable disease symptoms. Additionally, coverage was high in areas where vaccination services were available at a privately funded health facility. The findings are based on primary data, which was analyzed using multiple regression models to identify determinants of full immunization status among 12-23 months old.

Place of residence is also an underlying determinant to vaccination coverage. This perspective is supported by Henry *et al*.(2011)who showed that children living in urban areas had consistently higher immunization rates than their rural counterparts. This is attributed to the fact that immunization services are more accessible in urban areas due to higher availability of health facilities. Overall, whereas a fourth of all children between ages 12-23 months received the 3 recommended polio doses many missed the corresponding 3rd DPT3 dose .

Hussein *et al.*, (2013) used multivariate logistic analysis to identify the factors that influence immunization coverage among children aged 12-23 months in Oromia Regional State, Eastern Ethiopia. This community based cross sectional survey involved both qualitative and quantitative data analysis. Stratified multi-stage cluster sampling technique with simple random sampling was used to select the sample size. The results showed overall low vaccination coverage due to mothers being unaware of the need for immunization; mothers did not return the children for the 2nd and 3rd doses due to fear of side reaction; wrong perception on contraindication of immunization and lack of information on place and/or time of immunization. The study however did not show the effect of involving the health worker to enhance coverage.

Distance to a health facility according to Ibnouf, A. *et al.*, (2007) determines vaccination outcomes. He undertook a cross sectional study in Khartoum State, Sudan and revealed that children whose mothers walked less than 30 minutes to vaccination place were 3.4 times more likely to have had the correct vaccinations than were children whose mothers walked 30 minutes longer. Hence walking time to the nearest vaccination centre had a strong influence on the correct vaccination status of the child..

Belachew*et al.*, (2012) used cross sectional community-based study and a modified WHO EPI cluster sampling method for sample selection to investigate the determinants of immunization coverage. The results showed that whereas the mother's area of residence and her socio-demographic characteristics were not significantly associated with full immunization among children, being born in a health facility; ante-natal care follow-up and mother's knowledge about the age at which vaccination begins were significant determinants of immunization coverage. The study however did not consider that the mothers report may under or overestimate the immunization coverage or that the mother may forget the total dose taken by the child. Moreover, the study did not consider the validity of the doses of vaccine the child took.

Ndiritu*et al.*, (2006) estimated the contribution to timely immunization of family size, seasonal rainfall, distance from clinic and mother's age in Kilifi County Kenya. Cluster sample survey and simple random surveys were conducted in 2002 and 2004 respectively. Coverage was then estimated by inverse Kaplan-Meier survival analysis of vaccine-card and mothers' recall data and corroborated by reviewing administrative records from national and provincial vaccine stores. The model was fit to recurrent vaccination data to determine the contribution of sex, family size, clinic distance, mother's age and rainfall season to immunization rates. The results showed that immunization rate ratios went down with every kilometer of distance from home to vaccine clinic, rainy seasons, and the increase of family size up to four children. The study however did not explore the outcomes to vaccination that occurs during seasonal rains.

Lilian *et al.*, (2013) used descriptive, bi-variate and multivariate logistic regression to identify independent predictors of full immunization among children aged 12-23 months in Kaptembwo location, Nakuru County in Kenya. A cross sectional community based survey was done using cluster sampling method for sample selection. The results showed that the drop-out rate between the first and third pentavalent vaccine coverage was 8.9%. also what predicted full immunization were birth place of child, family size, advice on date of next visit for growth monitoring and how they viewed the kind of health immunization services offered. The study however did not take into consideration health service related factors like accessibility in terms of distance so as to identify defaulters and reduce drop-out rate.

Maternal level of education is also a contributory determinant of vaccination outcomes. Lisa *et al.*, (2014) used primary data to investigate full and timely vaccination coverage and associated factors in children aged 12-23 months in Gem, Siaya County Kenya. Simple random method was used for sample selection. Multivariate logistic regression was applied and results showed that children of mothers with lower maternal education or children in households with the spouse absent were less likely to be fully vaccinated. The study also found evidence of distance decay effect, where vaccination decreased with increasing distance from the vaccination clinic considering the study was conducted in a rural setting.

2.4 Overview Literature

The literature reviewed in the foregoing paragraphs reveals that several studies have been done to analyze the determinants of immunization coverage. Most of the studies relied on cross-sectional data due to lack of time series data on coverage levels. Additionally, most studies were done using data for select regions such as a county or district within a country such as Kenya. The proposed study seeks to fill this knowledge by using KDHS 2008 and 2014 data that covers the entire country to shed new insights on the determinants of immunization coverage in Kenya and also try to compare the results overtime in a bid to establish what is causing the decline in immunization coverage.

CHAPTER 3: METHODOLOGY

3.1 Introduction

This chapter presents the methodology framework, description of measurement variables and data source used for the study.

3.1.1 Conceptual Framework

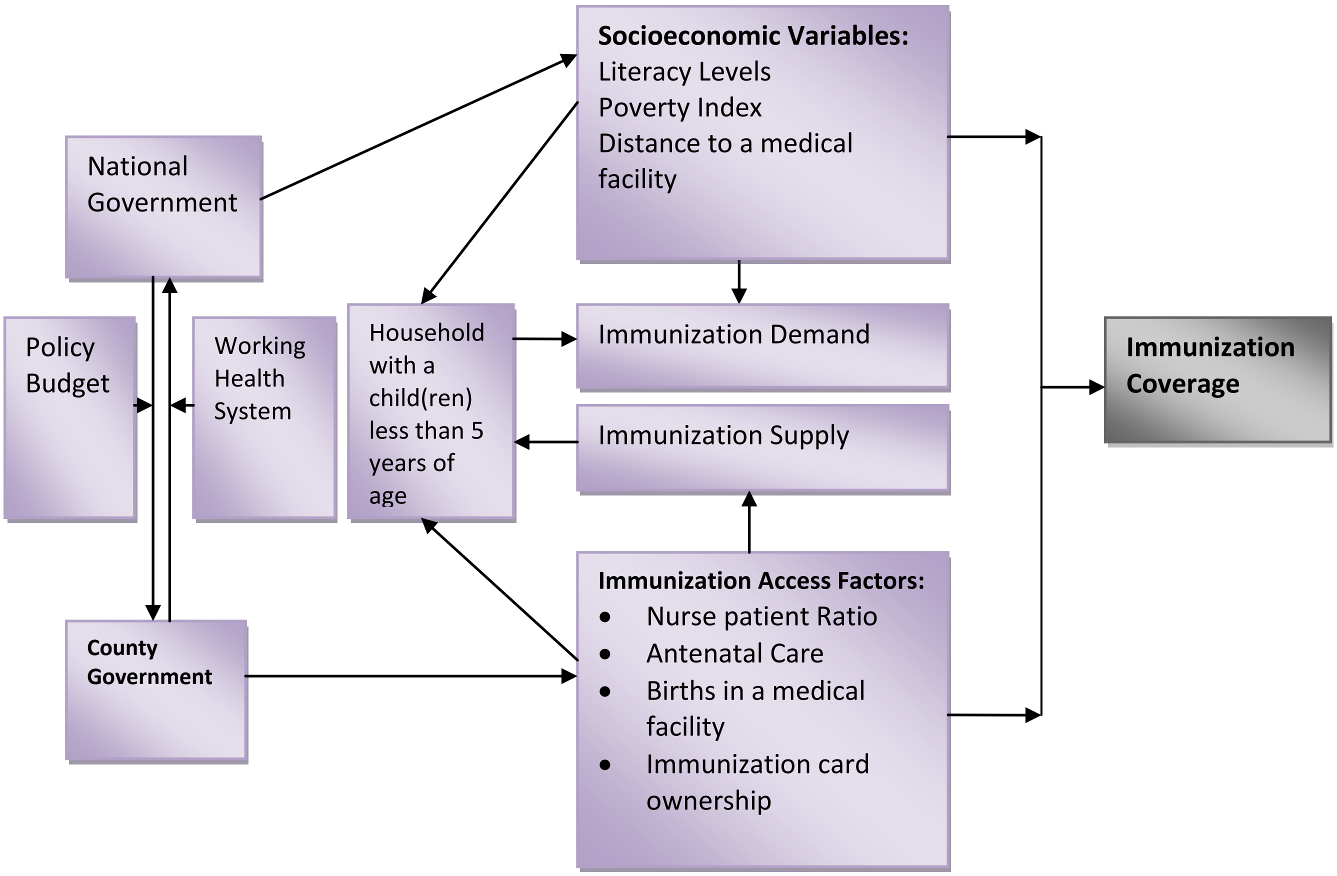
Figure 2 below presents the conceptual framework. In it a number of factors including socioeconomic and health access system characteristics determine immunization coverage. Socioeconomically, literacy levels, poverty index, and distance from health facilities, which signifies the availability of health infrastructure, define the capacity government to provide vaccination services. These factors have also been extensively captured in the literature as drivers of increased immunization coverage. A sound health system is characterized by a high nurse/ doctor patient ratio, access to antenatal care, and births in a medical facility, as well as, ownership of immunization card. Based on existing literature, these factors influence the full immunization in a given community.

The government also has a role to play in facilitating full immunization coverage. For instance, in Kenya, the national government is charged with the responsibility of providing policy direction and resources to the county governments for health care services provision. In return, the county government is required to run a sound health system ensuring access to primary healthcare and management of the health facilities that provide immunization services. County governments, in their jurisdictions hold mandates to take decisions to develop their respective health systems using the resources from the national government. These decisions may include increasing the number of medical facilities to reduce distance to be covered by households in seeking health services or increasing doctor/nurse patient ratio. Besides, both governments have a bigger role in improving literacy levels and reducing poverty levels through various development programs.

Households, especially those with children under five years are responsible of ensuring that the children undergo full vaccinations including the three basic categories of vaccinations including a BCG vaccination, 3 doses of DPT, and the 3 doses of polio as per the WHO standards. However, both demand and supply factors affect households' ability to access vaccination differently.

Figure 2 captures how these factors interact and influence immunization performance.

Figure 2: Conceptual Framework of Factors Affecting Immunization Coverage



Source: Author's Conceptualization

3.1.2 Theoretical Framework

The major factors affecting vaccination coverage in Kenya have been widely explored by the literature in the previous section. Most of these studies used the modified utility maximization theory as used by Rosenzweig & Schultz (1983). This study will also adopt this theory to address the study objectives. The theoretical foundations are based on utility maximization which is subject to the health production function and income constraints with individual demand curve relating to indifference curve preferences and budget constraints. On the other hand, the theory states that consumers allocate income among various goods and services with a concern of welfare maximization.

Below is a household utility maximization function:

$U = f(H, C)$……………………………………………………………………………………1

Where: U is the utility of the household;

C is the consumption goods.

H is the health of the child.

The utility function is maximized by the household subject to a budget constraint and health production function, which depends on market purchased inputs. The following is the expression of the budget constraint;

$P_d A + P_m M + P_c C = Y$……………………………………………………...……….2

Where:

$P_d =$ cost proxied by the distance to the health facility.

$P_m =$ price of other market inputs.

$P_c =$ price of consumption goods.

$Y =$ household income.

The health production function (H) is given by;

H=f(D, M, K)…………………………………………………………………..…………3

Using equation 1, 2 and 3 above, we develop the below langrage function;

L=$f(H,C) + y_i(Y - P_d A + P_m M + P_c C) + y_2(H - f(D, M, K)$…………………..…4

When we solve equation 4 above, we generate the following reduced demand function for vaccination coverage;

$VC = f(P_d, P_m, P_c, Y, K)$…………………………………………………………………5

Where $VC$is the demand for vaccination services, while P_d,P_m,P_c ,Y and Kareas defined earlier.

Through modeling, many researchers including Grossman (1999) modified utility maximization theory proposed by Rosenzweig & Schultz (1983) to accommodate demand factors for medical care and other health inputs. This model considers age, education, health status and income as key variables in the production of health through the demand for health.

3.1.3 Econometric Model and Model Specification

The study seeks to analyze the determinants of immunization coverage across counties in Kenya. The study assumes immunization coverage across counties as the dependent variable. In the Kenyan context, county governments play a critical role in the health sector. Through the fourth schedule of the 2010 Constitution, counties were given functions and powers to manage health services including health facilities and promoting primary health care. Therefore, with variability on immunization coverage being reported across counties, establishing what causes this variability with specific focus on those variables that the county governments have control over is necessary.

To achieve this, Heckman sample selection model will be adopted. In this case, Heckman selection equation arises from the fact that the decisions to invest in promoting primary healthcare including immunization coverage are vested in county governments. Previous studies have established that there is a correlation between increased access to health services and immunization coverage performance across regions (Ndiritu, et., al,. 2006; Balachew, 2012). Immunization coverage is embodied in the availability and access to healthcare services of which the county governments have influence over. Therefore, variability in the vaccination coverage performance within counties with some reporting more than one percent (1%) cases of no vaccination is the selection criterion in this study that necessitate the use of the Heckman model. Heckman is a two stage probability model that accommodates biased samples to entering the analysis, that is, only those counties that reported more than 1% cases of no vaccination (Heckman 1979).

The first stage of the Heckman model estimates what socio-economic factors influence immunization of children between ages 12-23 months with cases of no immunization coverage reported per county as a proxy variable. Therefore, the households' latent (unobserved) propensity to undergo full immunization stages embodied in the missing cases of access as reported by counties is denoted by g_i^* and takes a mathematical form:

$$g_i^* = \beta_0 \chi_{0i} + \varepsilon_{0i} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(6)}$$

Where: g_i^* will take binary values (1, 0); 1 if more than 1% cases of no vaccination is reported in a county; and 0 otherwise (if less than 1% cases of no vaccination is reported in a county). In this case, the three basic categories of vaccinations as considered by WHO include a BCG vaccination, 3 doses of DPT, and the 3 doses of polio. χ_{0i} is a vector of variables that explain this demand for vaccination including socioeconomic factors such as maternal education and literacy levels, wealth index, household size and birth order. β_0 is the associated coefficient vector and ε_{0i} is the error term. The first step relies on an assumption embedded in the probability equation, therefore it takes the form:

$$pr\left(g = 1/X \right) = F(X\beta) = \Phi(X\beta) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(7)}$$

Where Φ is the cumulative distribution function (cdf) of the standard normal distribution, which implies that estimation of the model in equation 7 will yield results that will predict the vaccination probabilities for the respective counties.

The second equation under the Heckman selection model investigates how the various healthcare access factors affect immunization coverage across counties. This is based on percentage vaccination coverage outlined in equation 8. The equation takes the form;

$$r_i = \begin{cases} r_i^* = \beta_1 \chi_{1i} + \varepsilon_{1i} & if \quad g_i = 1 \\ 0 & if \quad g_i = 0 \end{cases} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(8)}$$

Here, χ_{1i} is a vector of two categories of variables namely the socioeconomic as captured in equation 7 above and additional healthcare access factors including access to antenatal care by mothers, deliveries done in health facilities and vaccination card ownership. These additional factors at stage two are critical in ensuring 100% immunization coverage. $\beta_1$is the associated coefficient vector and ε_{1i} is the error term.

Therefore, the results shall be interpreted as changes in the probabilities. The estimates shall represent the impact of a unit increase in the independent variable on the percentage change in the dependent variable. The resulting coefficients will primarily be used to determine sign and statistical significance. In order to evaluate magnitude and economic significance, results are also being reported as predicted probabilities.

3.1.4 Endogeniety, Selection Bias and Correction

Endogeneity arises from the fact that some of the explanatory variables in the model can be simultaneously determined with the dependent variable. On the other hand, the sample selection bias occurs where the dependent variable is observed only for a restricted non-random sample, and in this case only considering counties reporting more than 1% cases of no vaccination coverage.

Therefore, with such possibilities, the Heckman selection model stands out as the appropriate model to be used. Heckman corrects the selection bias problem by including all counties in the analysis, that is, both those that reported less than 1% cases of no vaccination to the total sample in a selection equation for estimating a non-selection hazard. Similarly, with Heckman, endogeneity is handled by simultaneously determining county probabilities that enter the second stage model in form of the inverse Mills ratio (Heckman, 1998).

3.2 Description of Measurement Variables

A summary description and measurement of the variables included in the analysis are as captured in table 1 below.

Table 1: Table showing variables, descriptions and measurement

Variable Name	Description	Measurement
Dependent Variables		
Vaccination decisions ($\boldsymbol{g_i}^*$)	Captures the three basic categories of vaccinations as considered by WHO that includes a BCG vaccination, 3 doses of DPT, and the 3 doses of polio.	Dummy (Binary values [1, 0]; 1 if a child was fully immunized and 0 if otherwise)
Vaccination coverage ($\boldsymbol{r_i}$)	Percentage vaccination coverage reported per county representing the output from the government interventions	Proportion of fully vaccination coverage (%)
Explanatory variables		
Mother's age	Measured in years	Measured in years
Mother's education	To measure how maternal education affects	Measured as a dummy variable,

Variable Name	Description	Measurement
	vaccination	1 if mother was illiterate, 0 if otherwise; 1 if mother had primary education, 0 if otherwise; 1 if mother had secondary and above level of education, 0 if otherwise.
Maternal literacy	Measures the effect of literacy on consumption of vaccination.	Measured as a binary variable, 1 if a mother was literate and 0 if illiterate
Mother's marital status	Measures the influence of being in a marriage union on immunization	Captured as a dummy variable, 1 if mother is married, 0 if unmarried
Place of delivery	Determines the influence of delivery in a health facility on immunization	Measured as a dummy variable, 1 if mother delivered in a health facility and 0 if delivered at home
Antenatal care	Measures the extent/penetration of healthcare services to expectant mothers	Measured by the number of antenatal visits made by mother
Location	Measures how environment affects vaccination	This is captured by a binary variable, 1 if a child lived in an urban area and 0, if in rural area
Birth order	Measures the number of children born by	Measure the number of children born by the same mother
Household wealth	Captures the three categories of wealth; poor, middle income and rich households	Measured using the wealth index
Household head age	Introduced to measure the effect of household head age on vaccination	Measured in years
Household size	These are siblings in a household	Measured by the number of individuals living in the household
Region	Measures region	Measured as a binary variable 1 if a child lived in each one of 8 regions of Kenya, 0 if otherwise

3.3 Data Source

The data to be used in the study will be sourced from the Kenya Demographic and Health Survey (KDHS) 2014 undertaken from May 2014 to October 2014. KDHS is a national sample survey conducted every 5 years and targets households that provide detailed information on health related aspects countrywide. The 2014 survey targeted 40300 households from which vital information for this study including household characteristics, education and employment, marriage, religion, child health and survival was collected. Specifically, the KDHS provided data on the coverage of 3 doses of pneumococcal vaccine which was introduced into Kenya's routine immunization programme for the forty-seven counties; percentage deliveries in health facilities as well proportions of no vaccination cases. The information on the extent of vaccination coverage was got from vaccination cards and from mother’s verbal reports. With the availability of the card, the information was directly recorded otherwise the mother or the father was requested to try and recall whether the child had got a specific vaccination

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Additional information was sourced from the fact sheet of the County Development plans and profiles. The plans were developed with the advent of County Government system in 2013 as documents to inform and guide the development agenda of the respective Counties. The profiles provided vital data on average distance to the health facility, nurse population ratio, literacy levels and poverty rates.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the empirical findings and discusses the results. Subsection 4.2 presents descriptive statistics while subsection 4.3 presents the Heckman regression results of the determinants of immunization coverage among children aged 12-23 months in Kenya.

4.2 Descriptive Statistics

The descriptive statistics of the variables used in assessing the determinants of immunization coverage among children aged 12-23 months are presented in Table 2. Approximately 97% of children aged 12-23 months received at least one vaccination. The average age of mothers in the sample was 27.8 years. The youngest mother was aged 15 years while as the oldest was 48 years. More mothers were married (80.0%) while only a few (20%) were not married.

Table 2: Descriptive statistics

Variable	Observation	Mean	Std. dev.	Min	Max
No of vaccinations	4052	0.9726	0.1632	0	1
Age of mother in years	4052	27.7636	6.3815	15	48
Mother has no formal education	4052	0.2135	0.4098	0	1
Mother has primary education	4052	0.5242	0.4995	0	1
Mother has secondary education	4052	0.2623	0.4400	0	1
Mother is married	4052	0.8000	0.4002	0	1
Mother is literate	4044	0.7218	0.4482	0	1
Size of the household	4052	5.7991	2.5006	1	23
Household is poor	4052	0.5649	0.4958	0	1
Household is middle income	4052	0.1597	0.3663	0	1
Household is rich	4052	0.2754	0.4468	0	1
Mother lives in urban area	4052	0.3112	0.4630	0	1
Mother delivered in hospital	4044	0.5626	0.4961	0	1
Birth order	4052	3.4000	2.2921	1	14
Household head age	4052	37.5138	12.5928	16	90
Antenatal visits	3842	3.9006	4.1267	0	5

On average 21.4% of mothers had no formal education, majority (52.4 %) had primary education, while 21.4% had secondary or tertiary education. However, more mothers (72.2%) were reported to be literate than illiterate (27.8%). The average household size in the sample was 6 persons. The analysis of the data show that most households (56.5%) are poor and fewer 27.5% are rich. The largest household had 23 individuals while the smallest household in the sample had only 1 household member. Most children aged 12-23 months hailed from rural households (68.9) compared to urban households (31.1%). The data also showed that more children came from poor households (56.5%) than rich households (27.5%) and middle income households (16%).

Regarding the place of delivery, the data revealed that 56.3% of children aged 12-23 months were delivered in hospital while 43.7% were delivered at home. This indicates that hospital deliveries surpass the home deliveries in Kenya which is attributable to the free maternal healthcare in Kenya. The assessment of birth order showed that the average number of children born by a mother was 3.4. The lowest number of children born by a mother was 1 while the highest was 14. Table 3 presents the immunization coverage of the eight geographical regions of Kenya. The average age of a household head in the sample was 37.5 years with the youngest being only 16 years while the oldest was 90 years. Finally, on average, mothers had 3.9 postnatal visits with some mothers having no postnatal visit at all.

Table 3: Immunization coverage across regions in Kenya

Region	**Proportion of children who received full vaccination (%)**	**Proportion of children who did not receive full vaccination (%)**
Nairobi	4.09%	2.18%
Central	7.21%	7.17%
Nyanza	16.58%	13.64%
Rift valley	29.17%	33.40%
Western	9.69%	8.77%
Eastern	8.50%	16.20%
North Eastern	13.13%	5.54%
Coast	11.63%	13.10%

Table 3 clearly shows that Rift Valley, Nyanza, North Eastern and Coast geographical regions of Kenya had higher proportion of children who were immunized relative to other regions of Kenya. On the other hand, Rift Valley, Eastern, Nyanza and Coast had the highest number of children aged 12-23 months who were not immunized.

4.3 Econometric Results

The Heckman selection model regression results for the determinants of immunization coverage among children aged 12-23 months in Kenya are presented in Table A1. The results indicate that the likelihood of the selection model is statistically significant at 1 percent level with Wald Chi-square statistic of 88.98. This suggests that the explanatory power of the Heckman selection model was strong. The results show that the inverse Mills ratio (IMR) is positive (0.191) but statistically insignificant at 5 percent level. This means that sample selection bias was not a significant problem so that the application of Heckman selection model in the estimation was not necessary.

The probit model was subsequently used to calculate the probability of a child being immunized while the OLS model was employed to estimate the intensity of immunization in Kenya and the results are presented in Table 4. The estimated coefficients show that the probit model fitted the data suitably for investigating the determinants of immunization coverage among children aged 12-23 months in Kenya.

Table 4: Probit and OLS regression results of the determinants of immunization coverage among children aged 12-23 months in Kenya

Independent variables	Probit	OLS
Age of mother in years	-0.0077	0.0031
	(0.0115)	(0.0023)
Mother has primary education	0.1928	0.0628
	(0.1699)	(0.0431)
Mother has secondary education	0.4085	0.0826**
	(0.2570)	(0.0408)
Mother is married	0.1004	0.0699***
	(0.1279)	(0.0250)
Mother is literate	0.2767**	0.1005
	(0.1285)	(0.0386)
Size of the household	-0.0454*	-0.0089*
	(0.0234)	(0.0052)
Household is middle income	0.1689	0.0347
	(0.1799)	(0.0280)
Household is rich	0.0784	0.0186
	(0.1717)	(0.0280)
Mother lives in urban area	0.0088	-0.0701***
	(0.1307)	(0.0230)

Mother delivered in hospital	0.3597***	0.0629**
	(0.1210)	(0.0258)
Birth order	0.1196	-0.0261***
	(0.0335)	(0.0073)
Household head age	0.0081*	-0.0020**
	(0.0048)	(0.0009)
Antenatal visits	0.3028***	0.0555**
	(0.0972)	(0.0226)
Gender of child	0.0921***	
	(0.0108)	
Central region	0.3930	0.1558**
	(0.4197)	(0.0647)
Nyanza region	-0.2966	-0.0135
	(0.4122)	(0.0841)
Rift Valley region	0.5217	0.1919***
	(0.4235)	(0.0645)
Western region	0.0419	0.0741
	(0.4381)	(0.0665)
Eastern region	0.2251	0.1142*
	(0.4005)	(0.0609)
North Eastern region	0.1789	0.1478**
	(0.4270)	(0.0659)
Coast region	0.2093	0.0396
	(0.4175)	(0.0634)
Constant	1.1976**	2.3891***
	(0.4927)	
Number of observations	4036	
Lambda	0.1908	
Rho (ρ)	0.3364	
Sigma (σ)	0.5671	
Censored observations	109	
Uncensored observations	3927	
Wald chi2 (20)	88.98***	

Source: Author’s computation. Note: ***, ** and * show significance at 1%, 5% and 10% respectively. Standard errors are in parenthesis

The probit estimates in Table 4 show that mother’ age had a positive effect on the decision to immunize a child and was statistically significant. Similarly, mother’s age had insignificant effect on immunization coverage. Mother’s education had a positive effect on the probability of a child being immunized. The computed marginal effects show that mothers with secondary education and above had 3% higher probability of immunizing child compared to mothers without any formal education. This finding was expected since more educated mothers are more aware of the benefits of child immunization which increases their chance of consuming immunization service relative to uneducated mothers. This finding is in line with Adebiyi (2013) but is in conflict with Wanjala (2014) who found insignificant effect of mother’s education on the probability of children immunization in Kenya. Similarly, compared to being illiterate mother, being literate increased the probability of immunizing. The average marginal effects show that being a literate mother increased the probability of child immunization by 1.5 percentage points holding other factors constant. Regarding the coverage of immunization, the OLS parameter estimates show that being literate increased the level of child immunization by 9.9% all else equal.

Marital status of the mother was an important determinant for the coverage of immunization but not on the decision of a child being fully immunized. The estimated coefficients in Table 4.3 show that being a married mother increased the coverage of immunization by 7.0% relative to unmarried mothers. This finding suggests that a mother being in marriage union increases immunization coverage and reflects the idea that marriage increases resources at the disposal of mothers which enhances their uptake of immunization service. The size of a household had an important effect on the likelihood of a child being immunized. The results showed that children from larger families had lower likelihood of being immunized. In particular, an additional household member reduced the probability of a child being immunized by 0.2 percentage points. Household size also had a negative effect on the coverage of immunization. The regression results indicate that for every additional person in the household, the coverage of child's immunization decreased by 1% holding other factors constant. This finding may be interpreted to imply challenges and expenditure constraints of having a large family on consuming child's immunization services.

Household wealth was also included in the regression and the results show that children born to the middle and rich households were more likely to be immunized compared to children belonging to poor. Additionally, the immunization coverage was more in middle income and richer households relative to poor households. However, the effect of household wealth on the likelihood of child being immunized as well as on the coverage of immunization was not statistically significant. Child's area of residence was insignificantly associated with the decision of child being fully immunized. However, this variable had a significant effect on the coverage of immunization. The OLS regression results show that relative to living in rural areas, living in urban areas increased the immunization coverage by 7.4% all else equal.

The place of delivery was an important determinant of the decision to fully immunize the child and on the coverage of immunization. The coefficients on the probit model show that children born in hospitals had a higher likelihood of being immunized compared to similar children born in a non-health facility (home). The average marginal effects show that being born in hospital increased the probability of the child being immunized by 1.5 percentage points, all else equal. On the other hand, the OLS estimates show that a child delivered in a health facility increased the immunization coverage by 5.6% compared to a child delivered at home. These findings reflect the idea that soon after the child is born in health facility, some vaccines such as BCG are normally administered which increases the probability of the child being immunized as well as the immunization coverage. Furthermore, a mother who delivers in a health facility is bound to be more informed concerning the immunization to the extent that she has higher chances of having her child receive the immunizations. A mother who delivers in a hospital is more likely to receive training on benefits of immunization from health service providers. The finding of this study is in line with by Mosand et al (2012) and Mukungwa (2015) who found that children born in health facilities had higher likelihood of being fully vaccinated relative to children born at home.

The analysis of the regression results also reveals that receiving of the antenatal care visits was an important determinant of the decision to immunize children and the immunization coverage. Receiving of the antenatal care increased the probability of the child being immunized by 1.6 percentage points compared to mothers who did not receive antenatal care. The OLS parameter estimates shows that, receiving antenatal care service by mothers increased the level of immunization coverage by 5.0 percent. This finding suggests the idea that antenatal care visits enhances increased awareness by health care service providers of child care by mother for instance through the child immunization. This finding is in line with Pandey and Lee (2011) and Mukungwa (2015).

The birth order was found to be an important determinant of immunization coverage. The OLS estimates show that immunization coverage reduced with birth order. The estimates show that immunization coverage reduced by 7.3% for every birth order. This finding was expected given the fact that mothers are more enthusiastic in giving birth and taking care for the first order children than for the older order children. The finding that immunization declines with high birth order is in line with Patra (2006), Nath et al (2007) and Wanjala (2014). Interestingly, the probit and OLS estimates show that the gender of child was not an important predictor of the decision of child being immunized or the coverage of immunization. However, the estimates indicated that a male child was more likely to be immunized than girl child. Mukungwa (2015) also found insignificant association between child's gender and the decision to fully immunize the child.

Turning to the effect of household head characteristics on child immunization, the parameter estimates from the probit model appeared to suggest that age of the household head had a positive effect on the likelihood of the child being immunized (significant only at 10 percent level) but reduced the immunization coverage. The regression results in Table 4.3 also show that the region of residence had an important effect on the immunization coverage but not on the decision to immunize the child. The coefficients of the probit model appeared to suggest that children living in counties in Nyanza region were less likely to be immunized compared to those living in Nairobi County, though the result was statistically insignificant. The findings show that living in counties in central region of Kenya increased the level of child immunization coverage by 16.2% relative to children living in Nairobi County. Relative to children residing in Nairobi County, children living in counties in the Rift Valley region increased the level of immunization coverage by 20.3%. Children residing in counties in the Eastern region of Kenya increased the extent of immunization coverage by 11.8% and those living in counties in the North Eastern region by 15.6% when compared to children living in Nairobi County.

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND POLICY RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of the findings of the determinants of determinants of immunization coverage among children aged 12-23 months in Kenya. This chapter also provides the key conclusions from which the policy recommendations are made. Finally, this chapter provides suggestions on areas for further research.

5.2 Summary and Conclusions of the study findings

This study analyzed the determinants of immunization coverage among children aged 12-23 months in Kenya. The study has made use of rich dataset drawn from the 2014 Kenya Demographic and Health Survey (KHDS). To analyze the determinants of the decision to immunize the child and the coverage of immunization this study set to apply the Heckman sample selection model in the estimation. However, due to statistical insignificance of the inverse mills ratio in the Heckman's sample selectivity model, this study estimated the probit model and uncorrected OLS model separately. The probit estimator was used to analyze the determinants of immunization at the extensive margin while the uncorrected OLS was applied to study the determinants of immunization at the intensive margin. Since the coefficients of the probit estimator do not directly provide the magnitude of an explanatory variable on the dependent apart from just showing the direction of the effect, our study proceeded to compute the average marginal effects of the probit for the purpose of the interpretation of the parameter estimates.

A battery of variables were included in our empirical model and this comprised: the mother's age, maternal level of education, marital status of the mother, the literacy level of the mother, child's place of residence, child's place of delivery, birth order, gender of the child, whether the mother had any antenatal visit, the household size that the child belongs to, the wealth index of the household, age of household head and the county that a child resides and which was measured using the eight geographical regions of Kenya. The regression results from the probit estimator showed that mother's age, mother's marital status, child's gender and area of residence, birth order and household income were not significant predictors of the decision for child to be fully immunized. The size of household was an important determinant of remittance but was negatively correlated with the likelihood of the child receiving full immunization. Mother's education (secondary and above), maternal literacy, place of delivery, antenatal visits and age of the household head had a positive and significant effect on the probability of child achieving full immunization status.

The estimated coefficients from the OLS estimator show that child's gender, maternal age and education as well as wealth status of the household were insignificant in explaining the immunization coverage. Additionally, the size of household, household head age and child's area of residency negatively and significantly influenced the immunization coverage. Finally, marital status of the mother, maternal education and literacy, place of delivery and antenatal visits had significantly increased the extent of immunization coverage.

In conclusion, this study sought to analyze the determinants of immunization coverage among children aged 12-23 months in Kenya. Using the probit and OLS estimators, the study found that mother's education and literacy, place of delivery, antenatal visits as well as household head age significantly increased the chance of child being immunized. Household size had a negative and significant effect on the probability of a child being fully immunized. Marital status of the mother, place of delivery, antenatal visits and literacy level of the mother had a positive effect on the level of immunization coverage. Household size, household head age and birth order negatively affected the level of immunization coverage.

5.3 Policy Recommendations

This study found that the coverage of immunization for children aged 12-23 months was less than desired (100%). This study has also unearthed the importance of some predisposing and enabling factors in influencing full child immunization. The study found that the decision to fully immunize the child was related to maternal education and literacy. This means that education is vital for attainment of full immunization and this call for the need to raise community and maternal awareness of the importance of child immunization and the use of antenatal care services. This study also found that the place of delivery is positively linked with full immunization of children. This means that there is the need to scale-up the number of health care facilities together with health care service providers. There is also the need to disseminate information on the importance of mothers delivering at a health facility in order to increase access to child immunization. This study also established that household size is negatively associated with immunization. This suggests that there is need for having manageable families. This means that there is the need to promote family planning by educating both men and women of reproductive age the advantage of siring a number of children that are manageable. The regression results also show that children from households with older household heads and higher birth orders were less likely to fully immunize their children against diseases. This suggests that attention to create awareness on the importance of immunizing children should be focused on older household heads and mothers with many children.

5.4 Areas for further Research

To analyze the determinants of immunization coverage in Kenya, the present applied more quantitative approach to uncover the predisposing and enabling factors for full immunization. Further research applying qualitative approach to determine drivers of full immunization is required. Health services have been devolved in the Kenya's new constitution that was promulgated in 2010. The present study took a regional perspective in which a dummy for each eight regions in Kenya was added as an explanatory variable. It would be important to investigate the effect of decentralization on achieving full immunization coverage in Kenya by conducting the analysis for each particular county. Furthermore, the present study applied cross-sectional dataset for the analysis. To achieve the same objective, future studies may instead apply panel datasets.

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Appendix

Table A1: Heckman regression results of the determinants of immunization coverage among children aged 12-23 months in Kenya

Independent variables	Probit	OLS
Age of mother in years	-0.0077	0.0031
	(0.0115)	(0.0023)
Mother has primary education	0.1928	0.0628
	(0.1699)	(0.0431)
Mother has secondary education	0.4085	0.0826**
	(0.2570)	(0.0408)
Mother is married	0.1004	0.0699***
	(0.1279)	(0.0250)
Mother is literate	0.2767**	0.1005
	(0.1285)	(0.0386)
Size of the household	-0.0454*	-0.0089*
	(0.0234)	(0.0052)
Household is middle income	0.1689	0.0347
	(0.1799)	(0.0280)
Household is rich	0.0784	0.0186
	(0.1717)	(0.0280)
Mother lives in urban area	0.0088	-0.0701***
	(0.1307)	(0.0230)
Mother delivered in hospital	0.3597***	0.0629**
	(0.1210)	(0.0258)
Birth order	0.1196	-0.0261***
	(0.0335)	(0.0073)
Household head age	0.0081*	-0.0020**
	(0.0048)	(0.0009)
Antenatal visits	0.3028***	0.0555**
	(0.0972)	(0.0226)
Gender of child	0.0921***	
	(0.0108)	
Central region	0.3930	0.1558**
	(0.4197)	(0.0647)
Nyanza region	-0.2966	-0.0135
	(0.4122)	(0.0841)
Rift Valley region	0.5217	0.1919***
	(0.4235)	(0.0645)
Western region	0.0419	0.0741
	(0.4381)	(0.0665)
Eastern region	0.2251	0.1142*
	(0.4005)	(0.0609)
North Eastern region	0.1789	0.1478**
	(0.4270)	(0.0659)
Coast region	0.2093	0.0396
	(0.4175)	(0.0634)
Constant	1.1976**	2.3891***
	(0.4927)	
Number of observations	4036	
Lambda	0.1908	
Rho (ρ)	0.3364	
Sigma (σ)	0.5671	
Censored observations	109	
Uncensored observations	3927	
Wald chi2 (20)	88.98***	

Source: Author's computation. Note: ***, ** and * show significance at 1%, 5% and 10% respectively. Standard errors are in parenthesis