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DETERMINANTS OF DEMAND FOR ORAL POLIO VACCINE III (OPV3) VACCINE IN ZAMBIA

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CHAPTER ONE

1.0 INTRODUCTION

Childhood immunizations is the initiation of immunity through application of vaccine (WHO,2008).It is considered important for improving child survival (Lee,2005).This is because more than 10 million children in developing countries die every year because they do not access effective interventions such as immunization that could fight common and preventable childhood illness.

Although about three quarters of the world's child population is reached with the required vaccines, only half of the children in sub-Saharan Africa get access to basic immunization. Further in poorer remote areas of developing countries, only one in twenty children have access to vaccination (UNICEF, 2009).

Immunization against vaccination preventable diseases (VPDs) through the expanded programme of immunization (EPI) is one of the most economical public health interventions available (UNICEF, 2002) that contributes extensively to achieving the Millennium Development goals to reduce the mortality rate of children under five by two thirds between 1990 and 2015 (UNICEF 2002, World Bank 1993).The expanded programme for immunization was established in 1974 against six vaccine preventable diseases. These are diphtheria, poliomyelitis (also refered to as Acid Flaccid Paralysis), tuberculosis, measles, pertusis and tetanus.

1.1 Background

Reducing child mortality is one of the main challenges in Zambia's development. Child mortality contributes considerably to Zambia's low Human Development Index (HDI) ranking. The Millennium Development Goals (MDGs) for health, in 2002, set targets for countries to reduce under-five mortality rate by two-thirds by 2015, from the base year 1990 (UN Report). Although child mortality in Zambia has been declining in recent past, it is still quite high. According to the 2011 MDGs report for Zambia, the number of under-five deaths dropped from 190.7 per 1, 000 live births in 1992 to 119 in 2013. Infant mortality has also declined from 107.2 per 1, 000 live births in 1992 to 70 in 2013.

Child mortality in Zambia is determined by a diversity of factors. Malaria accounts for 40% of deaths in infants (2013-14 ZDHS). Communicable diseases are a major contributor to child mortality in Zambia. As such prevention interventions, particularly child immunization, can contribute significantly to improvements in reducing child mortality. It is said that vaccines are amongst the most effective preventive health measures in reducing child mortality, morbidity, and disability (Omer et al). The introduction of suitable vaccines for routine use on infants can result into far-reaching reductions in vaccine preventable diseases.

Oral Polio Vaccine III (OPV3) immunization is one of a combination of vaccines aimed at preventing Measles which is one of the major killers of children in Sub-Sahara Africa, Zambia included.

Zambia, as of the rest of the Continent, is grappling with the challenge of increasing coverage of child immunization interventions in order to prevent communicable diseases which are leading causes of child mortality. Declining levels of child immunization including OPV3, in recent years as indicated in the 2013-14 ZDHS, is a source of great concern given the important link between child mortality and immunization.

Research indicates that there are a number of factors that can influence the uptake of immunization vaccines in general and OPV3 in particular. A descriptive analysis of the vaccination coverage from the 2013-14 ZDHS reveals different levels of coverage of all types of vaccines for different population sub-groups. This implies that uptake of immunization vaccines is related to specific number of factors of the child and the household within which they come, and possibly, their geographical location. It is from this background that this research will

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investigate the determinants of OPV3 in relation to demographic and socioeconomic factors. Zambia has a broad multiyear plan (cMYP), which provides the framework for the country‘s immunization activities. It covers the period between 2006-10 and is built on the Global Immunization Vision and Strategy (GVIS).

The Zambian cMYP has five goals:

(i) Protect more people by use of safe and effective vaccines;

(ii) Accelerate the reduction of morbidity and mortality from vaccine preventable diseases;

(iii) Strengthen immunization program financing and sustain the introduction of additional vaccines;

(iv) Strengthen Expanded Program for Immunization (EPI) disease surveillance in the context of overall improvement of the national health information system.

(v) Integrate EPI with other interventions in the context of strengthening the health system.

The plan is implemented through the annual planning cycle that integrates it with other health sector activities (through the annual action plans).

Zambia had scored significant successes in the prevention of childhood illnesses and specifically in its immunization program. Some highlights included;

(i) The introduction of vaccines to prevent hepatitis and Haemophilus influenza type B (Hib), and also introduction of Rota Vaccine to prevent severe diarrhea in under-fives;

(ii) Eradication of poliomyelitis through mass immunization campaign, mainly during National Immunization Days (NIDs);

(iii) Being awarded certification following the intensified Maternal and Neonatal Tetanus Elimination (MNTE) activities in 2007; and

(iv) Having put in place sustainable immunization systems that offered relatively good physical access to services and encouraged wider customer acceptance and utilization of services.

1.2 Statement of the problem

Zambia is faced with the challenge of increasing coverage of child immunization interventions so that it prevents communicable diseases which are leading causes of child mortality. Declining

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levels of child immunization including OPV3, in recent times as data can show, is a source of significant concern given the important link between child mortality and immunization. Research indicates that there are a number of factors that can influence the uptake of immunization vaccines in general and OPV3 in particular. A descriptive analysis of the vaccination coverage from the 2013-14 Zambia Demographic and Health Survey (ZDHS) reveals different levels of coverage of all types of vaccines for different population sub-groups. That is to say that uptake of immunization is related to specific number of factors of the child and household within which they come, and possible their geographical location. It is against this background that this research investigates the determinants of OPV3 in relation to demographic and socioeconomic factors. In order to improve coverage of OPV3 immunization, it is important to understand the factors which determine the uptake of OPV3 immunization. From an economic perspective, getting an immunization vaccine can be considered within the framework of demand analysis.

1.3 Objectives of the Study

1.3.1 General Objective:

The overall objective of the study will be to analyze the determinants of full series of OPV vaccines in Zambia using data drawn from the 2013-14 Zambia Demographic and Health Survey.

1.3.2 Specific Objectives:

Particularly, the study intends:

(i) To investigate the influence of socioeconomic and demographic factors on coverage for OPV3 immunization in Zambia;

(ii)To Explain the main drivers of OPV3 vaccination coverage among Zambian children; and

(iii)To explore policy options for improving coverage of OPV3.

1.4.0 Significance of the Study:

Immunization in children is important in preventing morbidity and mortality due to vaccine preventable illnesses. Despite several studies being published on determinants of immunization uptake in children, fewer studies have been conducted in Zambia. This study attempts to identify significant socio-demographic factors that are associated with immunization uptake; these factors could be useful in implementation strategies aimed at improving the uptake of OPV vaccination. This will help in ensuring that interventions are targeted to vulnerable groups. Such interventions might include outreach activities and community health education. If policy efforts were to focus on ensuring that all children receive full vaccination, the country achieve higher levels of immunization coverage. Control of infectious diseases through vaccination will lead to reduced mortality in children aged below five years. Subsequently, government expenditure on management of disease outbreaks will reduce with funds being redirected to scaling up of other healthcare service delivery programmes.

A study on the determinants of OPV3 will help us understand specific factors that influence the uptake of OPV3. The rationale for conducting this study is twofold; first, there are very few studies which have investigated the determinants of OPV3 coverage in Africa and Zambia specifically. The study will contribute to the body of knowledge on the determinants of demand for OPV3 coverage in Zambia. Second, the study will provide policy information that could be used to improve the coverage of OPV3.

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CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

There are several studies that have been done in the determinants of immunization utilization in the third world countries. Most of them have focused on the responsiveness determinants of full immunization similar to the approach adopted in the study. The literature models the utilization of immunization as a function of socioeconomic factors at household level.

In Nigeria, Diddy antai (2009) used multilevel multivariate regression analysis on a national representative sample of women aged 15-49 years from the 2001 Nigeria Demographic health survey. Multilevel regression analysis was performed with children (level 1) nested within mothers who were in turn nested within communities (level 3).

Results showed that the pattern of full immunization clusters within families and communities and those socioeconomic characteristics are important in explaining the differentials in full immunization among the children in the study. At the individual level, ethnicity, mothers' occupation and mothers' wealth were characteristics of the mothers associated with full immunization of the children. At the community level, the proportion of mothers that had hospital delivery was a determinant of full immunization status.

Vaccine-preventable diseases are a challenge in most developing countries, especially in sub Saharan Africa where it accounts for 25% of the deaths in infants (World Bank, 2006). Despite vigorous vaccination campaigns, immunization coverage for Polio, DPT and Measles remains low in many sub-Saharan countries such as Kenya, Uganda and Zambia (American Red Cross, 2004).Kenya is no exception, as infant deaths from immunizable diseases are evident in many parts of the country. Infant mortality rate deteriorated in Kenya from 88 deaths per 1,000 live births in 2000 to 90 deaths per 1,000 live births in 2005 (MFPED, 2007). The vast majority of deaths to children were caused by immunizable childhood diseases. Others were as a result of prenatal and early neonatal conditions, malaria, meningitis, pneumonia and HIV/AIDS (MFPED, 2007).

2.2 Theoretical Literature Review

The emphasis on attaining universal coverage also helped to induce improved programme management and there was a noticeable increase in equitable access (Cooley, 2004). With the universal coverage approach the effort may be more likely seen as a safe and worthwhile investment of public funds (Hay, 1987). However, sustained coverage – especially at the peripheral levels - can be challenging as it significantly increases the costs, and requires improvements in staffing, financing and guidelines, as well as in the ability to procure a constant vaccine supply (Milstien, 2007 and Lauria, 2009).

One possible explanation of the failure to improve access to the immunization system may be related to the socio-cultural acceptability of some of the new vaccines. Vaccines - for example HPV vaccines – may be associated with sexually transmitted infections [STIs] and therefore can encourage stigmatization. It has been found that the introduction of HPV led to media messages that adversely affected HBV uptake (Watson, S.*et al*. 2009). Similarly, messages need to be more pertinent to the situations of migrant and ethnic minorities (Pulido, 2001, Allen 2009 and Wong, 2009). Opposition from socially conservative groups and ethical considerations has been found to negatively affect the social acceptability of new vaccines (Schneider, 2007). Indeed, it has been found that an increase in uptake sometimes required changes in the types of messages provided (Goldstein, 2001 and Watson, 2009 *et al*).

It has been suggested that the increased training can increase a brain-drain out of the health sector, if the training programmes are not accompanied by necessary adjustments to the human resource frameworks and career paths, or to adequate remuneration arrangements (Pfeiffer,2008)**.**In some instances – especially where the levels of financial involvement and commitment by the national governments have been very limited, it may not be possible to sustain the necessary level of effort - with negative outcomes for the longer term sustainability of the immunization programme**.**

2.3 Empirical Literature Review

Various socioeconomic and demographic factors may influence immunization services utilization. Maternal characteristics, sex of child and birth order of the child, place of delivery and antenatal care (ANC) follow up, household income/economic status, knowledge about immunization and vaccine preventable disease, and residence are the main factors associated with immunization coverage and immunization services utilization among children.

Maternal characteristics are the most known determinant factors of child immunization. A comparative study done among slum and non-slum dwellers in Bangladesh children age below years in three zone of Dhaka demonstrated that complete coverage is associated with educational status of the mother, income and living conditions (Kidane, T*et al*., 2006). The study revealed that mothers with lowest education, households with limited monthly income and people living in slum area were less likely to complete a child immunization. It also indicated that children whose mothers were born in a rural area or an urban slum, and those whose mothers were aged less than 30 years are 0.35 and 0.43 times less likely to be fully immunized respectively (Perry, R, *et al*., 1998). But in Kenya young age of mothers was associated with high immunization coverage as compared with the older mother (Kamau and Esami 2001).

Knowledge is another factor which affects the immunization status of the child. These include knowledge and attitude toward vaccination and vaccine preventable disease. Study done in Nigeria on determinants of immunization status children in rural area showed that mothers of higher knowledge score more fully immunize their children. Also more than half of mother can correctly calls the symptoms of vaccine preventable disease. And 99% the mothers felt immunization is good for the child (Olumuyiwa O, *et al*., 2008).

Health facility is another factor which contributed to full immunization of the child. Different studies showed the importance of availability and accessibility of health facility in immunization coverage. Families nearer to the health facility are more likely to complete the immunization than those far from it. In a cross sectional study done in India, Assam district showed that immunization status of the children was significantly higher where the distance of the health center was less than 2km compared with those residing in remote inaccessible areas with a distance of more than 5km to the health center (Rup KP, *et al*., 2008).

Cheyne (1994) carried out a study on immunization in urban areas in China. The study revealed that poor uptake of immunization in urban areas was associated with lack of mother's awareness about repeat visits to achieve complete immunization rather than overall vaccine awareness. Furthermore, anti-vaccine rumours such as pathogenicity of a vaccine and propaganda of vaccines weakening their children which were encountered in the community, affected immunization coverage attained. Negative perceptions as well about vaccination and antivaccine rumours in some communities were found to affect the level of immunization coverage. Is-information about the side effects of vaccine during illness and false contraindications also contributed to the level of immunization coverage.

Sebahat and Nadi (2006) investigated the reasons for non-vaccination and the effects of sociodemographic factors on vaccinations in a district of Istanbul, Turkey. The study revealed that distance from the health center and internal migration from less developed parts to more developed parts of the country, were significantly related to the level of immunization coverage whereas immunization coverage was associated with educational level of the father and the mother. Children whose mothers' education level was at least primary school were more likely to be fully immunized than those whose mothers had no education.

Rafiqul, *et al*. (2007) conducted a study on child immunization coverage in 700 households in the slum areas of Rajshahi City, Bangladesh. They revealed that full immunization was higher (92.3%) in the higher ages (24+ months) than the age 12-23 months (89.5%). The high coverage in the higher ages of 24+ months was attributed to demographic and socio-economic factors such as mother's education, husband occupation and family's monthly income. The study found that the place of delivery and exposure to mass media had highly significant effects on child immunization. In other words, the mothers who were exposed to any mass media were more likely to have their children immunized compared to the mothers who were not exposed to any mass media. Furthermore, mothers who delivered at health institutions such as hospitals and clinics were more likely to have their children given the Polio vaccine on delivery than those who delivered at home.

Nath *et al*. (2007) explored the determinants of immunization coverage in 510 children aged 12 23 months in urban slums in India. They reported that only 44% of the children were fully immunized. Incomplete immunization and unimmunized status of the children were associated with low socio-economic status which constrained the poor parents to take their children for repeated visits to complete immunization schedules, higher birth orders which are associated with low child care with a mentality that high numbers act as insurance for those that may die, home delivery and Muslim religion which limit access to immunization centers. Singh and Yadav (2001) undertook an investigation into childhood immunization of 6300 children in urban

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slums of India. They found that slum dwellers did not demand immunization services. The authors argue that slum dwellers are unable to demand for services owing to weak community organization and low collective confidence, which is known to increase utilization of health services in public institutions. This is possibly related to the observed low utilization of health services including immunization services. This study also used WHO 30- cluster survey method with modification similar to the one used in a study by Kidane and Takie (2000). This method includes all the eligible children in the household in the sample and only the first household in each cluster is randomly selected.

Odiit and Amuge (2003) carried out comparison of vaccination status of children born in health units and those born at home of 486 children under five years in Jinja, Uganda. The duo used across-sectional descriptive study which revealed that 68% of the children were up to-date with their vaccines. The study showed that a child born in a health unit was more likely to be up to date with their vaccination compared to a child born at home. Being born at home was found to be a risk factor for incomplete or non- vaccination. Continuation of vaccination was similarly observed to be poor in children born at home and those born in health centers.

Ibnouf, *et al*. (2007) used a cross-sectional survey on factors influencing immunization coverage among 410 children under five years of age in Khartoum State Sudan. They found out that children in urban and rural areas differed significantly in their reported vaccination coverage and their receipt of each vaccine. In urban areas, accessibility to immunization centers is high compared to rural areas where amidst the few centers immunization is schedule based. The study also confirmed that vaccination coverage increased with an increase in the age of the children and the education level of the mother. Furthermore, the study found that the mothers' knowledge of and attitude to vaccination showed a strong relationship with the vaccination status of their children. This study used a similar method as applied by Chabra *et al*. (2007).

Datar *et al*. (2005) conducted a study on health infrastructure and immunization coverage of 43,416 children aged 2-35 months residing in rural India. They found that the availability of health infrastructure significantly improved immunization coverage for non-Polio vaccines. The study further revealed that larger and better equipped facilities such as hospitals and health centers had bigger effects on immunization coverage including the nature of health infrastructure

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i.e. hospitals and health centers play an important role in increasing immunization coverage. Tugumisirize, *et al* (2002) used cross-sectional descriptive study of 408 care takers with children aged 12-23 months. They explored the missed opportunities and caretaker constraints to childhood vaccination in Kiyeyi, Uganda. They established that complete vaccination coverage was 44.6% where reasons for non-completion of vaccination included caretaker not being bothered, being busy or ill, and feared health workers. Other reasons were; not knowing immunization schedule, low level of formal education, fear of vaccine side effects and perceived contraindications to vaccinations.

Baluka (2003) conducted a participatory study of 114 participants to assess the impact of decentralization of health services in Ntungamo District in Western Uganda. The study revealed that routine immunization coverage in infants below one year for DPT, Polio, Measles and BCG was high, averaging 80% since 2000. The study found that the decentralization of services as reported by community members was instrumental in improving accessibility to health services. Hence the existence of decentralized health services could be important in explaining factors associated with immunization coverage in Kenya given the country is under devolved governments.

Ndiritu *et al*. (2006) investigates immunization coverage and risk factors for failure to immunize children below one year for DPT. They carried out a cluster survey with sample size of 204 children aged 9-23 months. Simple random sampling which requires a population listing was applied and each chosen subject was located and questioned. The study reveals that immunization coverage decreases with increasing distance from the vaccination clinics. The findings further showed that immunization coverage was more strongly associated with annual patterns of rainfall.

Borus (2004) used cross sectional study on missed opportunities and immunization coverage of 418 children under two years in Nairobi slum areas. The study found that 80% of the children were immunized against Measles, 96.7% had received BCG, 85% against DPT and 75% against Polio. Overall 84% of the children were fully immunized. The reasons revealed by the study for child not being fully vaccinated included vaccine was out of stock, vaccine scheduled not to be given that day, child was sick or under-weight, child not yet of age and syringe out of stock. The researcher argues that the lower immunization coverage for Polio which had a representation of

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2A WHO 30-cluster sampling method together with simple random sampling method was used in the study.

75% compared to DPT with 85% was due to missed opportunities arising from shortage of Polio vaccine that was reported in the period proceeding to and during the survey.

2.4 Theoretical Framework

The empirical framework in this study was based on the Grossman model of demand for healthcare and the behavioral model of health care utilization. On Grossman's model, the empirical framework was guided by the theoretical model of demand for health and health care,particularly demand for health investment. The literature was based on the Grossman model of demand for health capital (Grossman, 1972). To explain and simplify our framework, extensions of Grossman's work were utilized and this included a framework for analyzing specifically demand for health prevention (Kenkel, 1994). The Grossman's model like many other models in health care services is focused on the family as a unit of analysis, because the medical care an individual receives is most certainly a function of the demographic and socioeconomic characteristics of a family as a unit (Zweifel, Breyer and Kifmann).

According to the behavioral model which was developed in the 1960s, it suggests that people's use of health services in general and in particular immunization is a function of their predisposition to use services, factors which enables or impede use and their need for care (Ronald M Anderson, 1995). The behavioral model has been questioned whether it was meant to predict or explain the usage of health care services (mechanic 1979; Rundell 1981). But according to recent works of 1995 by Anderson, it was discovered that the behavioral model can do both; on the other hand, each component might be conceived as of making an independent contribution to predicting use, while on the other hand, the model suggests an explanatory process or causal ordering where the predisposing factors might be exogenous (especially demographic and socioeconomic structures). Demographic factors such as age and gender represent biological imperatives, suggesting the likelihood that people's need for health varies (Huka and Wheat 1985).

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2.5 CONCEPTUAL FRAMEWORK

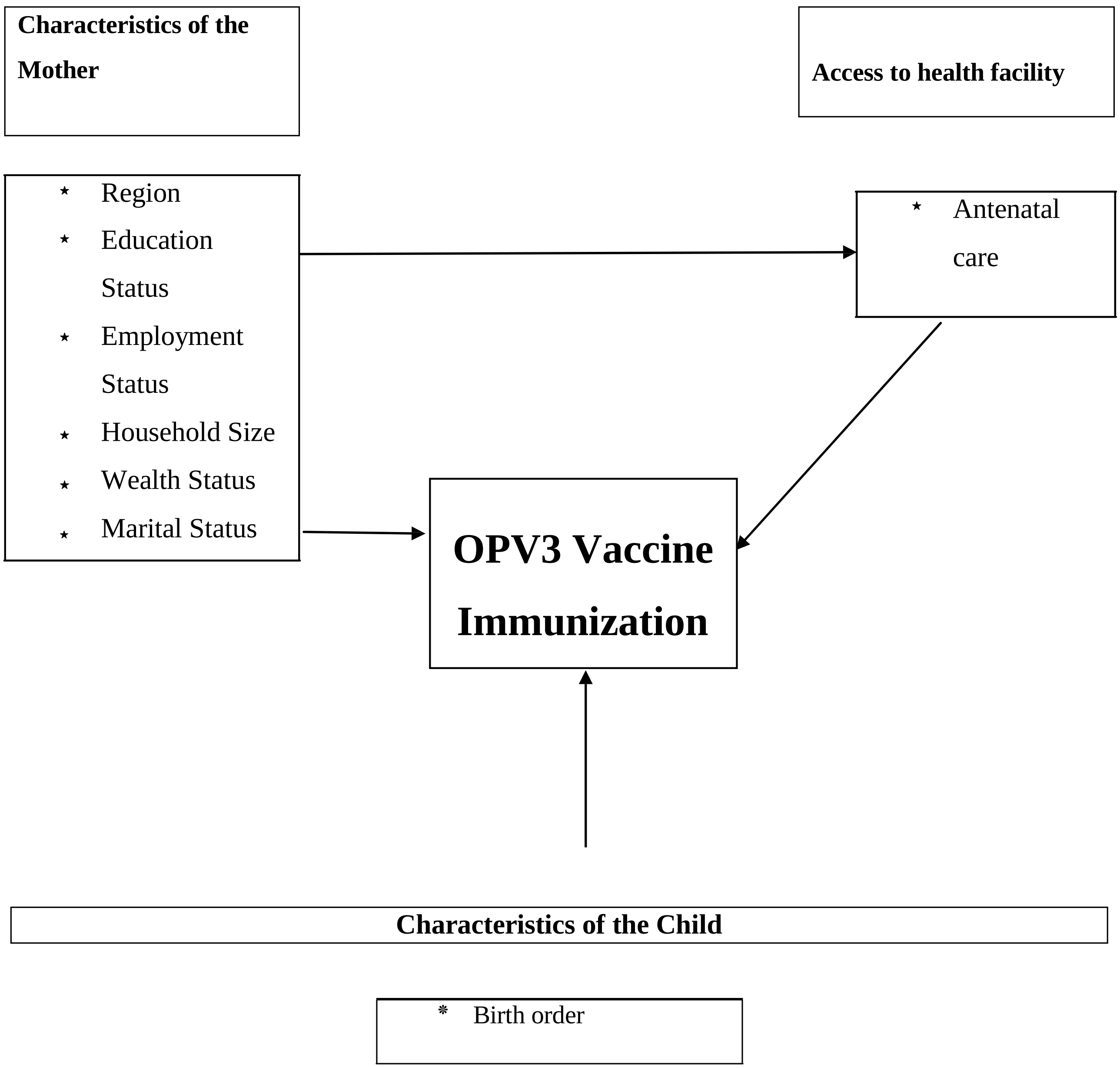

Figure 1: Conceptual framework for determinants of demand for OPV3 immunization in children aged 12-23 months.

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CHAPTER THREE METHODOLOGY

3.1 Introduction

This chapter describes the methods and procedures that were used to help in the achievement of stated objectives. The chapter also describes the study area, sample that was used and the method of collecting and analyzing data.

3.2 Statement of Theory and Hypotheses

Based on the theoretical framework, our hypothesis draws from the Grossman's model and Behavioral model. According to the Grossman model of Demand for health, individuals invest in themselves through education, training and health. The goal is to increase earnings. As the study tries to establish the determinants that influence the uptake of the full series of OPV3 vaccines against selected socioeconomic and demographic variables, in this research paper we have decided just to test two hypotheses among many possible hypotheses that can be tested. The following hypotheses to be tested;

Hypotheses Key: Ho-Null hypothesis, Ha-Alternative hypothesis

1. **Ho**: Income (Wealth) status of the mother does not affect the child‘s uptake of all the four (4) doses of OPV (Poliomyelitis vaccine).

Ha: Income (Wealth) status of the mother does affect the child‘s uptake of all the four (4) doses of OPV (Poliomyelitis vaccine).

2. **Ho**: Education level of the child‘s parents does not affect the child‘s uptake of all the four (4) doses of OPV (Poliomyelitis vaccine).

Ha: Education level of the child‘s parents does affect the child‘s uptake of all the four (4) doses of OPV (Poliomyelitis vaccine).

3.3 Sample size and Data collection

Secondary data was used in this study. Data was sourced from the 2013-14 Zambia Demographic Health Survey (ZDHS).The 2013-14 Zambia Demographic Health Survey (2013-14 ZDHS) follows similar surveys conducted in 1992, 1996, 2001-02, and 2007.A national sample size used in the 2013-14 Zambia demographic health survey was used in this research paper. In the 201314

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ZDHS, a national representative sample of 18,052 households was used (ZDHS 2013-14 Report, p: 7). 16, 411 women aged 15-49 were interviewed and the proportion of women in each age group decreases with increasing age, reflecting the comparatively young age structure of the population in Zambia.

Demographic Health Surveys, particularly the 2014 ZDHS collects information on vaccination coverage for all living children born in the five years prior to the survey. Information on vaccination coverage is collected in two ways; firstly from child vaccination cards shown to the interviewer and from mothers' verbal reports, if the cards were available, the interviewer copied the vaccination dates directly onto the questionnaire: BCG; polio 0-4, DPT 1-3, DPT-Hep B-Hib 1-3, and measles vaccines. When there was no vaccination card for the child or if a vaccination had not been recorded on the card, the respondent was asked whether the vaccine had been given to her child; the resulting information is from mother's recall.

3.4 VARIABLES AND DEFINITION

The explanatory variables to be used in this study are shown in table 2 below:

Table 1: Showing Variables and their definition

Variable Type	Variable Name	Variable Definitions
Outcome	Full series OPV3	Child of 12 months of age and older having received all three series of OPV3 0 = has not received all three doses 1 = has received all three doses
	Birth order(bord)	1=0 2-3=1 4-5=2 ≥6 =3
	Mother 's education	Categorized as;
		1= If Educated 0=If not educated

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	Mother‘s employment status	Categorized as; 1 = If Worked in the past years 0 = If Not working
	Wealth Index	Categorized as; 1 = Poorest 2 =Poorer 3 = Middle 4 = Richer 5 = Richest
	Region	Categorized as; 1 = Urban 0 = Rural
	Visits(Mother)	Categorized as; 1 = If visited health center 0= If not
	Marriage (Mother)	Categorized as; 1 = If Married 0 =If not

3.5 Model Estimation and Justification for use:

An immunization coverage model was used in this study to estimate the effects of selected background variables on the determinants of OPV3 immunization. The measure of a child‘s OPV3 immunization will be treated as a binary variable since it indicates Yes if a child has had received all three doses of OPV vaccinations or zero if not. Since the dependent variable is binary/dichotomous, during analysis we used a binary logit regression model. The binary logit model was specified as;

$$Prob\ (\mathbf{OPV3=1}) = \Lambda\ (\boldsymbol{\beta}_0 + \boldsymbol{\beta}_1 Region + \boldsymbol{\beta}_2 Edu\_status + \boldsymbol{\beta}_3 Employed + \boldsymbol{\beta}_4 Bord + \boldsymbol{\beta}_5 hhsize + \boldsymbol{\beta}_6 Wealth + \boldsymbol{\beta}_7 Visit + \boldsymbol{\beta}_8 Marriage + e_i) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

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Where (i). The symbols are defined above (under definition of variables)

(ii) $\Lambda(\boldsymbol{z}) = \frac{1}{1+e^{-Z}}$ is the logistic distribution function. As **Z** tends to infinity, $\boldsymbol{e}^{-Z}$ tends to 0 and p has a limiting upper bound of 1. As Z tends to minus infinity, $\boldsymbol{e}^{-Z}$ tends to infinity and p has a limiting lower bound of 0. Hence, there is no possibility of getting prediction of the probability being greater than 1 or less than 0.

Where:

$$\boldsymbol{Z} = \boldsymbol{\beta 0} + \boldsymbol{\beta 1}\text{Region} + \boldsymbol{\beta 2}\text{Edu status} + \boldsymbol{\beta 3}\text{Employed} + \boldsymbol{\beta 4}\text{Bord} + \boldsymbol{\beta 5}\text{hhsize} + \boldsymbol{\beta 6}\text{Wealth} + \boldsymbol{\beta 7}\text{Visit} + \boldsymbol{\beta 8}\text{Marriage}$$

$\boldsymbol{e}$ represents the base of the natural logarithms, which is approximately equal to **2.718** and **P** is the estimated probability of OPV3 vaccination given the **X**s.**Z** won't be treated as a response variable but a linear function of predictor variables.

$$\frac{\boldsymbol{P}}{\boldsymbol{1-P}} = \boldsymbol{e^{z}} = \boldsymbol{\Omega} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(2)}$$

$$\mathbf{log}\,\frac{\boldsymbol{p}}{\boldsymbol{1-p}} = \boldsymbol{z} = \mathbf{log}\,\boldsymbol{\Omega}$$

Hence we have:

$$\mathbf{log}\,\boldsymbol{\Omega} = \boldsymbol{\beta 0} + \boldsymbol{\beta 1}\text{Region} + \boldsymbol{\beta 2}\text{Edu status} + \boldsymbol{\beta 3}\text{Employed} + \boldsymbol{\beta 4}\text{Bord} + \boldsymbol{\beta 5}\text{hhsize} + \boldsymbol{\beta 6}\text{Wealth} + \boldsymbol{\beta 7}\text{Visit} + \boldsymbol{\beta 8}\text{Marriage} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(4)}$$

Where **Ω** is the expected value of the outcome variable and denotes the probability of successes represents the coefficients of the explanatory variables.

According to the behavioral model which was developed in the 1960s, it suggests that people's use of health services in general and in particular immunization is a function of their predisposition to use services, factors which enables or impede use and their need for care (Ronald M Anderson, 1995).Hence our choice of the above stated variables.

Further description of the model refer to Agresti and Finlay, (1997); Retherford and Choe (1993) and Agresti (1996).

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3.6 Econometric Approach and Estimation procedures

The model that is going to be used to estimate the data is a binary logit; the model is estimated using the maximum likelihood method because ordinary least square methods cannot be used to estimate logit models. Unlike OLS regression, logistic regression does not assume linearity of the relationship between the dependent and independent variables, does not require normally distributed variables, does not assume homoscedasticity, response values are not measured on a ratio scale and the error terms are not normally distributed, and in general has less stringent requirements.

In our analysis, the regression coefficients will be transformed into the marginal effects (ME). Marginal Effect is the change in the probability of a child receiving OPV3 for a unit change in the independent variable. This will enable us to have the quantitative effects of a variable on a particular variable on the probability of occurrence of the event (OPV3). This is equivalent to the gradient of the logistic cumulative Distribution Function), evaluated at its mean value. This is similar to the slope coefficient in the case of Ordinary Linear Regression. In interpretation, the study will place much emphasis only on the sign of the marginal effect. A positive marginal effect will indicate an increase in the likelihood of a child receiving OPV3. All analysis will be done using STATA 13.

Microsoft excel was also used to organize the outputs. Estimates` of the parameters β was estimated by maximum likelihood.

There after the following three (3) diagnostic tests were conducted:

(i) Link Test (for correct model specification)

(ii) Classification Test (for model sensitivity test)

(iii) Variance Inflation factor (VIF) to detect multicollinearity

3.7 Limitation of Study

The major limitation of this was recall bias because the data on immunization was collected from vaccination cards and in cases where these were not available or a vaccination was not recorded on the card, the mother‘s recall of vaccination was accepted and this may affect the result of the analysis. Also being a cross sectional study, it was not possible to establish whether the independent variables preceded the outcome, and thus cause and effect relationships are not certain.

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Ethical Consideration

Clearance to conduct the study was sought from the department of Economics, School of Humanities at the University of Zambia Great East Road campus.

This study is a secondary data analysis. Permission to use the ZDHS data in this study was sought and obtained from www.DHSmeasures.com.

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CHAPTER FOUR

PRESENTATION OF RESULTS

4.1 Introduction

This chapter presents findings of this study under selected characteristics of Child, mother and access to health facility in relation to demand for OPV3 vaccination in Zambia.

4.2 Diagnostic Tests:

We first carried out Diagnostic tests to check for Model sensitivity/predictability, for correct model specification and for multicollinearity. For the purpose of such tests, we ran our specified model and the following were the results;

```
Iteration 0:   log likelihood = -7524.2278
Iteration 1:   log likelihood = -7442.5453
Iteration 2:   log likelihood = -7442.2085
Iteration 3:   log likelihood = -7442.2085

Logistic regression                               Number of obs   =      12644
                                                  LR chi2(8)      =     164.04
                                                  Prob > chi2     =     0.0000
Log likelihood = -7442.2085                       Pseudo R2       =     0.0109
```

opv3	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
region	.0695272	.0561783	1.24	0.216	-.0405803	.1796347
educ_status	.2918137	.0617852	4.72	0.000	.1707168	.4129106
employed	.0068288	.0413543	0.17	0.869	-.0742242	.0878818
bord	.0124523	.0092956	1.34	0.180	-.0057668	.0306715
hhsize	-.0228867	.0082134	-2.79	0.005	-.0389846	-.0067888
wealth	.1389124	.0208311	6.67	0.000	.0980842	.1797406
visit	.1420738	.0435901	3.26	0.001	.0566387	.2275088
marriage	.1325194	.0516974	2.56	0.010	.0311944	.2338445
_cons	.1794044	.098217	1.83	0.068	-.0130974	.3719063

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4.3 Descriptive presentation of results

4.3.1 Description by Region and Province

Table 2: Showing Frequency and percentage distribution of children 12-23 months of age who received OPV3 immunization in Zambia, 2013-2014

REGION	OPV3		Total %
	Not Vaccinated %	**Vaccinated %**	
Rural (o)	30.67	69.37	100
Urban (1)	24.21	75.79	100
PROVINCE			
Central	31.15	68.85	100
Copperbelt	20.74	79.26	100
Eastern	29.40	70.60	100
Luapula	30.00	70.00	100
Lusaka	25.62	74.38	100
Muchinga	31.65	68.35	100
Northern	25.02	74.98	100
North Western	27.68	72.32	100
Southern	30.88	69.12	100
Western	29.88	70.12	100
Total	28.28	71.72	100

A total number of 12,700 mothers of children aged between 12 – 23 months old were included in this study; about 28.28% of respondents live in urban areas while the remaining 71.72% were from the rural part of Zambia.

From the above result in Table 2, the research results show that there were more children who received OPV3 vaccination in the urban areas as compared to the rural areas. The other notable distribution of the sample was provincial variation, age of the mother including her marital status. The sample was fairly distributed in all the provinces with an average of 70%.

There are not so much provincial variations in explaining determinants of full series of OPV3, though it is clear that children from some provinces like Southern, Muchinga and Central

Provinces had the lowest coverage while Lusaka and Copperbelt recorded significantly high vaccination.

4.3.2 Summary of Results

Table 3: Showing summary of results

Variable	Obs	Mean	Std. Dev.	Min	Max
opv3	12700	.7172441	.4503565	0	1
region	13457	.3714052	.4831984	0	1
educ_status	13446	.8877733	.3156569	0	1
employed	13415	.5778606	.4939189	0	1
bord	13457	3.739615	2.457087	1	15
hhsize	13457	6.597013	2.685308	1	23
wealth	13457	2.707439	1.33354	1	5
visit	13448	.7046401	.4562213	0	1
marriage	13457	.803671	.397235	0	1

The summary results above shows that the actual number of individual observations on OPV3 uptake was less than the number of individual observations from respondents. The reason might be that the information on OPV3 was obtained from Under five Cards and were cards were not available, from the mothers. This could have led to information bias, hence the variations in the mean.

4.3.4 Presentation of the Model4.3.5 Model Fit

From the regression results: shown below: Stata‘s default LR test compares to null model

```
Iteration 0:   log likelihood = -7524.2278
Iteration 1:   log likelihood = -7442.5453
Iteration 2:   log likelihood = -7442.2085
Iteration 3:   log likelihood = -7442.2085
```

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Logistic regression Number of obs = 12644
LR chi2(8) = 164.04
Prob > chi2 = 0.0000
Log likelihood = -7442.2085 Pseudo R2 = 0.0109

opv3	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
region	.0695272	.0561783	1.24	0.216	-.0405803	.1796347
educ_status	.2918137	.0617852	4.72	0.000	.1707168	.4129106
employed	.0068288	.0413543	0.17	0.869	-.0742242	.0878818
bord	.0124523	.0092956	1.34	0.180	-.0057668	.0306715
hhsize	-.0228867	.0082134	-2.79	0.005	-.0389846	-.0067888
wealth	.1389124	.0208311	6.67	0.000	.0980842	.1797406
visit	.1420738	.0435901	3.26	0.001	.0566387	.2275088
marriage	.1325194	.0516974	2.56	0.010	.0311944	.2338445
_cons	.1794044	.098217	1.83	0.068	-.0130974	.3719063

From above regression results:

LR Chi2 (8) =164.04 indicates for 8 degrees of freedom

Probability > Chi2 is a p-value < 0.05 indicating a significantly better model

4.3.6 Hypothesis Testing:

```
Iteration 0:   log likelihood = -7524.2278
Iteration 1:   log likelihood = -7442.5453
Iteration 2:   log likelihood = -7442.2085
Iteration 3:   log likelihood = -7442.2085

Logistic regression                               Number of obs   =      12644
LR chi2(8)       =     164.04
                                                  Prob > chi2     =     0.0000
Log likelihood = -7442.2085                       Pseudo R2       =     0.0109
```

opv3	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
region	.0695272	.0561783	1.24	0.216	-.0405803	.1796347
educ_status	.2918137	.0617852	4.72	0.000	.1707168	.4129106
employed	.0068288	.0413543	0.17	0.869	-.0742242	.0878818
bord	.0124523	.0092956	1.34	0.180	-.0057668	.0306715
hhsize	-.0228867	.0082134	-2.79	0.005	-.0389846	-.0067888
wealth	.1389124	.0208311	6.67	0.000	.0980842	.1797406
visit	.1420738	.0435901	3.26	0.001	.0566387	.2275088
marriage	.1325194	.0516974	2.56	0.010	.0311944	.2338445
_cons	.1794044	.098217	1.83	0.068	-.0130974	.3719063

The hypothesis was only conducted on two variables, Wealth status and Education. Other variables were merely control variables to stabilize the model.

1. Wealth status of the Household: From the regressing results above P>|z| = 0.000 which is < 0.05, and hence significant and because of this the null hypothesis is rejected. We can also see from the positive coefficient (0.1389124) that wealth status of the mother does actually influence OPV3 immunization uptake positively.

2. Education status of the mother: From the regression results P>|z| = 0.000 which is < 0.05, and hence significant and thus the null hypothesis is rejected and hence resort to the alternative hypothesis that Education status of the mother actually does influence OPV3 uptake by the child and the effect is a positive relationship as can be seen from the positive coefficient (0.2918137).

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4.4 Diagnostic Tests

4.4.1 Link Test

```
Iteration 0:   log likelihood = -7524.2278
Iteration 1:   log likelihood = -7442.8027
Iteration 2:   log likelihood =  -7442.205
Iteration 3:   log likelihood = -7442.2049

Logistic regression
Number of obs   = 12644

LR chi2(2)      = 164.05

Prob > chi2     = 0.0000

Log likelihood  = -7442.2049
Pseudo R2       = 0.0109
```

opv3	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]
_hat	.962489	.449887	2.14	0.032	.0807267 1.844251
_hatsq	.020587	.2431132	0.08	0.933	-.4559062 .4970802
_cons	.0157693	.2007628	0.08	0.937	-.3777186 .4092572

This test was conducted to check if the model was correctly specified .For the model to be correctly specified _hat must be significant while _hatsq must not be significant.

In our Model the _hat was significant at 95% confidence interval with P>|z| = 0.032 while _hatsq was insignificant at 95% confidence interval with P>|z| =0.933.

In conclusion with the above results, the Link test shows that the Model was correctly specified.

4.4.2. Classification test

```
Logistic model for opv3
```

True Classified	D	~D	Total
+	9075	3569	12644
-	0	0	0
Total	9075	3569	12644

```
Classified + if predicted Pr(D) >=.5
True D defined as opv3 != 0

Sensitivity                       Pr( +| D)  100.00%
Specificity                       Pr( -|~D)    0.00%
Positive predictive value         Pr( D| +)   71.77%
Negative predictive value         Pr(~D| -)       .%

False + rate for true ~D          Pr( +|~D)  100.00%
False - rate for true D           Pr( -| D)    0.00%
False + rate for classified +     Pr(~D| +)   28.23%
False - rate for classified -     Pr( D| -)       .%

Correctly classified                          71.77%
```

This test was done to check if the OPV3 vaccinations were correctly categorized.

The Model yields predicted $p > 0.5$ for 12644 children less than one (1) year of age; only 9075 of them actually received OPV3.

Overall, this logit Model offers extremely accurate predictions as 71.77% of children less than one (1) year of age were correctly classified.

In conclusion the Model fitted correctly and that it is highly sensitive in making predictions.

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4.4.2.Test for Multicollinearity :

VIF uncentered

Variable	VIF	1/VIF
wealth	9.30	0.107498
hhsize	7.67	0.130313
educ_status	7.06	0.141614
marriage	4.81	0.208075
bord	4.34	0.230284
visit	3.27	0.305687
region	2.90	0.345294
employed	2.40	0.417140
Mean VIF	5.22	

This test was conducted to detect presence of multicollinearity. Multicollinearity is the existence of a linear relationship among the independent variables. A classic symptom of multicollinearity is a high $\boldsymbol{R^2}$ (and a significant F value).Though with a logit model a typical test for multicollinearity is vif uncentered and is mainly interpreted using variance inflation factor. Multicollinearity is when the independent variables are highly correlated with each other. Multicollinearity leads to inflated standard errors which consequently results in very few significant t-values and few significant estimated parameters. With multicollinearity individual variable partial marginal effects towards the dependent variable OPV3 cannot be isolated. A variance inflation factor (VIF) >10 indicates presence of multicollinearity.

4.4

From the VIF uncentered results above, it can be seen that all the variance inflation factors (VIFs) are less than 10 and hence we conclude that multi-collinearity was absent in the model.

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4.4.4 Interpretation of results using Marginal Effects Marginal effects after logit:

$$y = pr(OPV3)\ (predict)$$

$$= 0.72053374$$

Variable	Marginal effects	Std error	z	P>|z|	[95% CI]	x
Region*	0.0139443	0.01122	1.24	0.214	-0.008047,0.035936	0.371006
Education status*	0.615605**	0.01359	4.53	0.000	0.034934,0.088187	0.889513
Employed*	0.0013754	0.00833	0.17	0.869	-0.014954,0.017704	0.579959
Bord (Birth Order)	0.0025075	0.00187	1.34	0.180	-0.01161,0.006176	3.7417
Hhsize(Household size)	-0.0046086**	0.00165	-2.79	0.005	-0.007849,-0.001368	6.63461
Wealth	0.0279721**	0.00419	6.68	0.000	0.019765,0.036179	2.71006
Visit*	0.0289698**	0.00899	3.22	0.001	0.011343,0.046596	0.705947
Marriage*	0.0271534**	0.01077	2.52	0.012	0.006046,0.048261	0.806469

(*)** dy/dx **is for discreet change of dummy variable from 0 to 1, **Significance level = at 5%

For Marginal effects only variables with significant p-values were interpreted.

a. **Education status:** If a mother was educated, the probability of a child receiving OPV3 immunization increased by 6.156%.

b. **Household Size:** An increase in household size reduced the probability of a child receiving OPV3 immunization by 0.46%.

c. **Wealth status:** An increase in wealth increased the probability of a child receiving OPV3 immunization by 2.8%.

d. **Visit:** If a mother visited a health facility, the probability of a child receiving OPV3 increased by 2.9%.

e. **Marriage:** If a mother was married, the probability of a child receiving OPV3 immunization increased by 2.7%.

CHAPTER 5 DISCUSSION OF RESULTS

This study was done to identify predictors influencing OPV3 immunization among children 0 11 months old in Zambia. The percentage of children that received OPV3 immunization was found to be 78%.Comparing the OPV3 immunization coverage of children between ages 12 – 23 months in Zambia with that of 2007, the percentage of children that received OPV3 immunization is higher by about 1%.

The significant predictors of OPV3 immunization in this study were maternal education, household size, wealth status, maternal visit to health facility and marriage.

There was a strong positive association between maternal education and OPV3 immunization of a child. Education helps to improve health seeking behaviour of an individual. This finding is consistent with other literatures like Tadesse et al., (2009) and Breiman et al., (2004) that found that maternal education was a significant predictor of completeness of immunization because highly educated mothers will be more aware of the importance of immunization. The role of maternal education as an important cause of immunization uptake has also been shown by Mahy,(2003) and Onyiriuka,(2005).In contrast, in a study conducted in Libya by Mabrouka and Bofarraji in 2011,there was no significant relationship between immunization status and mother ‘s education level.

The 10 regions in Zambia consist of different population sizes and levels of development. These differences tend to affect the range of child immunization campaign effectiveness across the country (Antai, 2009) and which could be linked with differences in vaccine supply between areas within different regions. However on the contrary in this study, there was no association between region and OPV3 immunization uptake.

Household size also portrayed a negative influence on the uptake of OPV3 and this in conformity with the behavioural model. As the number of children in a household increased the lesser the chance of child getting vaccinated of OPV3.

Several studies have found a true relationship between wealth status and vaccination status (INDEPTH NETWORK 2005; Ndiritu et al.,(2006),Jamil et al.,(1999) and Babalola.,(2009).Children from wealthier households may be more likely to have their vaccination status checked and to receive missing doses of vaccines when attending a health care facility than children from poor households. Also it could be because children who are from poor

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homes find it difficult to be reached by the health workers and also parents may encounter barriers to reach health facility compared to rich children. In the study conducted by CastrolLeal., (1999) and Pande, (2003), they found no association between wealth status and full child immunization.

Mother's employment status could have a close relationship with OPV3 immunization but no association was found in this study.

This study also shows that a child whose mother attended antenatal clinic during pregnancy for four times and more likely to get OPV3 immunization. This could be true because antenatal clinic is a means for women to be aware of immunization programme (Mutua et al., 2011).This is consistent with the finding in the research conducted by Adedayo et al.,(2009) that showed that about 65% of the women got their awareness of immunization at the antenatal clinics. Birth order could have a close relationship with immunization status but no association was in this present study because it was found not significant.

In this study children from urban areas had the highest coverage rates (71.72%). This is probably partially due to the general distribution of health care facilities in the country, which tends to favour large number of people in the urban areas of the country. It could also be attributed to the lack of awareness of the importance of vaccination between mothers in rural areas in comparison to those in urban areas.

The study finding also portrayed that the mother's marital status plays a positive role in women's utilization of medical services for children. As the literature review earlier on indicated, this finding also is in conformity with the behaviour model as discussed in the literature review.

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CHAPTER SIX CONCLUSION AND RECOMMENDATION

6.1.1 CONCLUSION

The result of this study has clearly indicated using an econometric model that the likelihood of a child in Zambia getting OPV3 vaccination is dependent on a number of socioeconomic and demographic characteristics of the child as well as the household in which the child resides. The study also shows that children in urban areas are more likely to get OPV3.

The challenge however is that women without education and women that are poor seem not to still take their children for immunization and this affects the percentage of children immunized against OPV3 and conversely them attaining full immunization. This is because the majority of people in Zambia belong to these sub groups. Concerned authorities should put in place deliberate measures to ensure that uneducated and poor parents let their children get immunized since low coverage will always draw back the efforts of fighting vaccine preventable diseases. Promotion of small family is also an important campaign, as children of lower birth order are more likely to be immunized. The other important results that can be concluded from the study is that there is need to discourage early marriages, and the immunization sensitization should target young mothers, as it was clearly observed that immunization chances increases with the mother's age.

However, there are bottlenecks from both supply-side and demand-side that can indeed influence any particular intervention like the immunization program in a developing country like Zambia. It is argued that immunization coverage can also be influenced by supply-side financial constraints, though this may not be the case in Zambia where enough resources have been devoted to Universal Child Immunization Programme (UCIP). Thus supply-side analysis was beyond the scope of the study. The study, hence only concentrated entirely on the demand-side assuming the ceteris paribus supply-side constraints. Hence due to the above limitation, further researches of the determinants of OPV3 vaccination and immunization can be targeted on the influence of supply-side variables such as budgetary allocation, number of health centres and distance from health facilities play etc. It can also be interesting for further research to focus specifically on the influence of female education on the complete uptake of OPV3 vaccine.

6.1.2 RECOMMENDATIONS FOR POLICY FORMULATION

For health and healthcare policy to be successful it must be equitable, participatory and must have an intersectional approach. Zambian government should improve on supplementing immunization activities such as NIDs (National immunization days) and catch up campaigns that are already in place. These programs should be planned and regularly carried out based on how to improve routine immunization coverage and control out-breaks situations of Acid Flaccid paralysis (AFP). Further, policies in other sectors must be knowledgeable and influenced by public health consideration. The following are some of the policy recommendations drawn from this study;

- Zambian MOH should conduct immunization campaign frequently such campaigns should be specific communication focused on all the required vaccines;
- Zambian MOH should strengthen antenatal clinic by training more health care workers since this finding shows that children whose mothers visited antenatal clinics had their children immunized against polio;
- Education programmes that can target poor and uneducated women should be put in place so that they are able to make informed decisions regarding immunization of their children;
- In addition government should work with traditional leaders in Muchinga, central and southern provinces so as to improve uptake of OPV3 vaccine;
- Government must generate enough employment for women as this will improve their wealth index;
- Discourage early marriages and immunization to target young mothers as it was seen that immunization increases with the mother's age; and
- Zambian MOH should make an effort to sensitize parents about the importance of their children getting immunized against polio.

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