UNIVERSITY OF CAPE COAST

CHILDHOOD VACCINATION IN GHANA FROM 1998 TO 2014

BY

EUGENE BUDU

Thesis submitted to the Department of Population and Health of the Faculty of Social Sciences, College of Humanities and Legal Studies, University of Cape Coast in partial fulfilment of the requirements for the award of Masters of Philosophy Degree in Population and Health

JULY 2020

DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original research and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature…….. Date…….

Name: Eugene Budu

Supervisors' Declaration

I hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of the thesis laid down by the University of Cape Coast.

Supervisor's Signature…….. Date…….

Name: Prof. Eugene K. M. Darteh

ABSTRACT

The adverse effect of vaccine preventable diseases (VPDs) on the health of children cannot be overemphasized. These diseases are major causes of illness, disability and death in childhood, and account for 17 percent of global total under-five mortality per year. Vaccination remains one of public health's greatest achievements. It is one of the major ways to reduce child morbidity and mortality from common VPDs. The vaccines given to children as part of the Extended Program on Immunisation in Ghana includes polio 1, 2 and 3, measles, Bacille Calmette-Guerin (BCG), Diphtheria-Pertussis-Tetanus (DPT) 1, 2 and 3 as well as yellow fever vaccines. Using the health care service utilisation model, this study assessed childhood vaccination in Ghana from 1998 to 2014. Mothers of children who are aged 0-23 months from four rounds 1998, 2003, 2008 and 2014 of the Ghana Demographic and Health Survey were used for the study. Univariate and multivariate analyses were employed in the study. Over the period, BCG was the most received vaccine while the least received vaccine was measles. Vaccination coverage for all the four vaccines received by children increased from 1998 to 2014. Thus, from 83% to 94% for BCG, 54% to 71% for DPT, 54% to 79% for polio and 43% to 50% for measles. Age of the mother, occupation, education, religion and parity were the factors that influenced the uptake of the vaccination. There is the need for MoH and the Ghana Health Service to strengthen interventions and messages targeting mothers and potential mothers on the importance of vaccination and immunisation for their children.

KEY WORDS

Determinants

Extended Programme on Immunization (Epi)

Immunization

Trends

Vaccination

ACKNOWLEDGEMENTS

I am particularly grateful to a number of people who have contributed immensely to this work from its conceptions. I am highly indebted to my supervisor, Prof. Eugene K. M. Darteh for meticulously reading through the work and for encouraging me.

During the work, I received support from some colleagues and friends individually and severally. To all these colleagues and friends, especially Bright, Ivy, Joojo and Ishmael, I say a very big thank you for all your support.

To my family, especially to my father, Mr. Solomon S. Budu, I say thank you very much for supporting and encouraging me throughout the work. Thank you for showing so much interest in this work and giving me the reason to complete the work.

DEDICATION

To my family

TABLE OF CONTENTS

CHAPTER THREE:METHODS OF DATA COLLECTION AND ANALYSIS

CHAPTER FOUR: RESULTS AND DISCUSSION

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

BCG	Bacillus Calmette Guérin
CDD	Control of Diarrhoea Diseases
DHS	Demographic and Health Survey
DPT	Diphtheria-Tetanus-Pertusis
EPI	Expanded Programme on Immunisation
GAVI	Ghana Demographic and Health Survey
GDHS	Ghana Statistical Service
GSS	Global Action for Vaccination and Immunisation
HepB	Hepatitis B
KDHS	Kenya Demographic and Health Survey
MoH	Ministry of Health
NGO	Non-Government Organization
OPV	Oral Polio Vaccine
PHC	Primary Health Care
UNICEF	United Nations Children Fund
VPD	Vaccine Preventable Disease
WHA	World Health Assembly
WHO	World Health Organization
ZDHS	Zimbabwe Demographic and Health Survey

CHAPTER ONE

INTRODUCTION

Background to the Study

The adverse effects of vaccine-preventable diseases on the health of children cannot be overemphasized (Asamoh, Agardh, Petterson & Ostergen, 2014). Vaccine-preventable diseases infectious disease for which an effective preventive vaccine exists. The most common and serious vaccine-preventable disease tracked by the World Health Organization (WHO) are diphtheria, Haemophilus influenza serotype b infection, hepatitis B, measles, meningitis, mumps, pertussis, poliomyelitis, rubella, tetanus, tuberculosis and yellow fever (WHO, 2012). These diseases are major causes of illness, disability and death in childhood. Morbidity and mortality of children under five years of age could be largely reduced through measures that are both affordable and available (United Nations International Children's Emergency Fund [UNICEF], 2013). According to UNICEF, though two to three million childhood deaths are prevented through immunisations, 17 percent of children still die every year from vaccine-preventable diseases. Immunisation has been useful in delaying over two million deaths each year worldwide (UNICEF, 2013) and it is one of the three most successful public health initiatives (WHO & UNICEF, 2012).

Globally, about three-quarters of the world's child population is reached with the required vaccines but in sub-Saharan Africa, a little above half of the child population get access to basic immunisation (WHO, 2015). Further, in poorer remote areas of developing countries, only 1 in 20 children have access to

vaccination (WHO, 2015). A significant proportion of these deaths are attributable to vaccine-preventable infectious diseases (Liu et al., 2012). Increased attention to this problem led to the initiation of the Expanded Programme on Immunisation (EPI) in 1974 when less than five percent of children worldwide were immunised (WHO, 2012).

In Africa, the EPI was launched in 1978 and by the mid-eighties, all countries had established national immunisation programmes (WHO, 2012). A mid-decade evaluation conducted in 1985 indicated that the regional immunisation coverage in Africa was still around 20% for all antigens and therefore, the year 1986 was adopted the "African Immunisation Year", with various accelerated efforts implemented till 1990 (Bee & Barakamfitiye, 1994).

Ghana, just like other African countries, accepted and launched the EPI in 1978, after a period of feasibility studies (NDPC, 2006 cited in Duah-Owusu (2010)). The objective of Ghana's EPI was to fully immunise 80% of its children aged 0 – 11 months by 1983 (Ghana Health Services [GHS], 2012). However, after 20 years of the launch of the programme, that is, 1998, the proportion of fully vaccinated children before age one was 51% nationally (Ghana Statistical Service [GSS], 1999).

The GDHS show an increase in the vaccination coverage of Ghana over the years. For instance, the 1988 GDHS reported a vaccination coverage of 47 percent, which rose to 55 percent in the 1993 GDHS. In 1998, 2003 and 2008 GDHS, the vaccination coverage of Ghana was 62 percent, 69 percent and 79 percent

respectively. In the 2014 GDHS, there was a marginal decline in the vaccination coverage to a rate of 77 percent (GSS, GHS & ICF International, 2015).

From the 2014 Demographic and Health Survey (GDHS), it was realised that, although 90% of children nationally received BCG and the first dose of DPT and OPV vaccine before age one, only two-thirds of these children had received the third dose of DPT and OPV by this age (GSS, GHS & ICF International, 2015). This shows a nation-wide high dropout rate. Despite the increase, these figures are short of the target of 80% coverage which the programme aimed at. The vaccines given to children as part of the EPI in Ghana include polio 1, 2 and 3; measles; BCG; DPT1, 2 and 3 as well as yellow fever vaccines.

Studies on child immunization have focused extensively on maternal characteristics. Particularly, educational attainment and literacy (Ataguba et al., 2016; Barata et al., 2012), employment status, age and age at birth, media exposure, marital status, religion and place of residence have been found to have strong relationships with the immunization status of a child. The presence of such strong maternal effects on child immunization coverage is a reflection of the traditional childcare responsibility of mothers in most developing countries, which dovetails to the policy recommendation that empowering women in the household decision-making process, such as child health, may be crucial to achieving universal immunization coverage among underserved populations (Chan, 2014).

Statement of the Problem

Over the years, Vaccine-Preventable Diseases (VPDs) have caused more deaths among children under five (WHO & UNICEF 2012). One major way to

reduce child morbidity and mortality from common VPDs is immunisation (Brenzel, 2016). Vaccination remains one of the public health greatest achievements (Asamoh, Agardh, Petterson & Ostergen, 2017). Vaccines have been able to stop the spread of diseases and, in some cases, eradicate those diseases completely. A very good example is the smallpox disease which claimed a lot of lives before a vaccine was discovered (UNICEF, 2014).

VPDs bring a lot of cost, both monetary and non-monetary (Cynthia, Whitney, Zhou, Singleton, & Schauchat, 2014), to the individual, the society, the nation and the world as a whole. (Cynthia et. al, 2014). National immunisation survey of the United States of America observed that immunisation has the potential to prevent an estimated 322 million illnesses, 21 million hospitalisations, 732,000 deaths and a net savings of $295 billion direct cost as well as a net saving $1.38 trillion in total societal cost between the periods of 1994 to 2013 (Cynthia et al., 2014).

The World Health Organization estimated that, in 2014, a total of about 5,427,000 individuals died from a vaccine-preventable disease, with more than half of the deaths (about 57 percent) occurring in Africa. These deaths generally occur mostly among pre-school children usually less than five years old (WHO, 2016).

To improve vaccine coverage in the world, particularly in Africa, the WHO instituted the EPI in 1974, with the aim of improving immunisation coverage in the world by improving availability and accessibility to vaccines (Cynthia et al., 2014). Today, some areas in the world have been able to reach 80% and over coverage of their populace eligible to receive various vaccines (WHO, 2014). It is worth noting

that, before the inception of the EPI, Africa was recording less than five percent of total immunisation coverage (WHO, 2014). Refusal and obstacles to immunisations, therefore, serve as a major contributory factor to the spread and devastating effects of vaccine-preventable diseases (Schwartz, 2013).

Vaccine-preventable diseases are usually cause-specific; that is, they are either caused by viruses or bacteria (WHO, 2009). These diseases become more serious in populations where people are vulnerable or not immunised against the disease-causing organism; however, if the majority of the population are protected, they provide herd immunity which turns to protect those not immunised (Fine, Eames & Heymann, 2011). When childhood vaccines are delivered at the right time, they increase the protection of children from vaccine-preventable diseases, minimise the risk of children getting infected and decrease the chance of outbreaks of the disease (McNair, 2014)

WHO estimates that 17 percent of global annual childhood mortality could be prevented through increasing routine vaccination coverage of which 2.2 percent could be prevented through pertussis vaccination, 2.3% through Hib vaccination, 1.3% through measles vaccination, 0.7% through tetanus vaccination, 5.2% through rotavirus vaccination and 5.4% through pneumococcal vaccination (WHO 2013).

Immunisation and vaccination are a key indicator of the Sustainable Development Goal (SDG) 3. Target 3.1.1, which is a proportion of the target population covered by all vaccines included in their national programme and target 3.8.1 which is coverage of essential health services or “universal health coverage (UHC)- index of which immunisation is 1 of 16 tracer indicators aggregated

together (UNDP, 2016). This makes immunisation and vaccination essential since it has the potential for contributing to the achievement of SDG 3. A set target for vaccination coverage by WHO is 80%. There has been an increase in the vaccination coverage in Ghana over the years. From 47 percent in 1988 to 77 percent in 2014 which is very close to the national target of 80 percent (GSS, GHS and ICF Marco, 2015; WHO, 2015). There exist urban-rural differences and regional disparities with regards to vaccination in Ghana (WHO, 2015). There are also some children who do not receive any of the vaccines (Armah *et al.*, 2016). The question one may ask is: why is it that some children do not receive some of the vaccines? why are some children not receiving any of the childhood vaccines?

Few studies have been conducted in Ghana over the years about vaccination and immunisation in Ghana. Some of the studies concentrated on issues relating to a particular type of vaccine against a specific health outcome (Armah et al., 2016; Binka et al., 2003; Coleman, Levison, Sangi-Haghpeykar, 2011; Enweronu-Laryea, et al., 2014; Woods & Shattuck, 2000).

Also, there is evidence suggesting that most of the studies on childhood vaccination have been conducted in some selected places in Ghana (Adokiya, Baguune & Ndago, 2017; Bruce, 2017). Studies that have been conducted nationwide considered the effects of childhood immunisation (Matthews and Diamond, 1997) and the inequalities in child immunisation (Asuman et al., 2018). However, there has been no studies that consider a nationwide investigation into the determinates of childhood vaccination and it is for these reasons that there is a need for a nationally representative study in Ghana to assess childhood vaccination

in Ghana from 1998 to 2014 with emphasis on children under 24 months to fill the gap and contribute to the discourse of childhood vaccination. The focus is on children under 24 months because according to Ghana's vaccination schedule, by age 23 months, a child is expected to receive all the needed vaccines.

Objectives of the Study

The main objective of the study is to assess childhood vaccinations in Ghana from 1998 to 2014. Specifically, the study seeks to:

1. Analyse the trend of childhood vaccination coverage from 1998 to 2014
2. Examine the patterns of childhood vaccination from 1998 to 2014
3. Assess the determinants of childhood vaccination from 1998 to 2014

Research Questions

1. What is the trend of childhood vaccination coverage in Ghana from 1998 to 2014?
2. What are the patterns of childhood vaccination in Ghana from 1998 to 2014?
3. What are the determinants of childhood vaccination in Ghana from 1998 to 2014?

Rationale of the Study

The health of infants and children is of great concern to the international community and in recent times, has gained much attention. As a result of this, both the Millennium Development Goals (MDGs) and the Sustainable Development Goals (SDGs) attest to this fact. It is, therefore, necessary to understand the trends

and determinants of vaccination among children in Ghana because it affects their health.

Secondly, the study will be relevant to key institutions such as the Ministry of Health (MoH), GHS and Non-Governmental Organisations (NGOs) to understand the trends and determinants of vaccination in Ghana. The study will inform health policies to improve child survivorship and reduce child mortality and morbidity.

The study will further provide an understanding of childhood vaccination in Ghana and add to existing discourse on the subject. It will also serve as the basis for further research on issues of child health.

Organisation of the Study

The study is organized in five chapters. Chapter One includes the background to the study, statement of problem, objectives of the study, hypothesis of the study, rational of the study and the organization of the study. Chapter Two presents the literature on coverage and determinates of childhood vaccination and related issues as well as the theoretical and conceptual frameworks of the study.

The third chapter also focuses on the methods of the study. Among these issues are the study area, target population, research design, sources of data, sampling design and sample size, acquisition of data and analysis of the data, and limitations of the study. The analysis and discussion of results are presented in Chapter Four. The last chapter is devoted to summary of the main findings, conclusions, recommendations, and suggestions for further research.

CHAPTER TWO

LITERATURE REVIEW

Introduction

Vaccination of children has become a worldwide concern and has attracted much attention; hence, the introduction of the EPI in 1974 as a means of providing the needed vaccines, especially for children under five years of age (WHO, 2012). This chapter comprises the empirical and theoretical literature as well as the conceptual framework. The empirical literature explores the history of EPI and specific issues on childhood vaccination. The theoretical literature reviews the Theory of Planned Behaviour, the Health Belief Model and the Health Care Service Utilisation Model.

Concepts of Vaccination and Immunisation

Vaccination is the administration of antigenic material (a vaccine) to stimulate an individual's immune system to develop adaptive immunity to a pathogen (Chang, Brewer, Rinas, Schmitt & Smith, 2009). Vaccines can prevent or ameliorate infectious diseases. The effectiveness of vaccination has been widely studied and verified (Chang et. al., 2009; Fiore, Bridges & Cox, 2009). It is the most effective method of preventing infectious diseases (United States Centres for Disease Control and Prevention, 2013). Vaccination is largely responsible for the worldwide eradication of smallpox and the elimination of diseases such as polio, measles, and tetanus from much of the world (WHO, 2015).

Immunisation is the process of stimulating an active immunology defence in preparation for meeting the challenge of future exposure to disease (Elder & Bullough, 1990). Thus, it is the introduction of weakened, live or dead micro-organism called vaccines to the body system to stimulate the production of the antibodies to confer immunity. In other words, immunisation consists of the administration of a modified or attenuated product of a micro-organism to mimic natural infection and evoking an immunologic response that presents little or no risk to the recipient.

A vaccine is a suspension of antigens in a base (Fatriregun & Etukiren, 2014). Vaccines are either made from the organisms which are dead or alive but are harmless. They may also be made from toxoid which relates to the toxins or poisons produced by the organism which do no damage but protect the body. There are three main types of vaccines: live vaccines, dead vaccines, and antitoxins (CDC, 2013). A live vaccine consists of living but weakened micro-organisms (attenuated) grown in the laboratory. Examples of these vaccines are the Poliomyelitis, Measles and BCG vaccines. A dead vaccine contains dead micro-organisms but when introduced into the body, enables it to produce antibodies. An example of such vaccines is DPT/HibHepB vaccine. Antitoxins are the altered harmless toxins of the organism which, when injected into the body, cause it to make antibodies. An example is the tetanol toxoid vaccine (CDC, 2013).

History of Vaccination

According to Gross and Sepkowitz (1998), the process of inoculation was first used by Chinese physicians in the 10th century. According to Ole Lund, the

earliest documented examples of vaccination are from India and China in the 17th century, where vaccination with powdered scabs from people infected with smallpox was used to protect against the disease (Mehmed & Basri, 2016). The tradition of vaccination may have originated in India in AD 1000 (Mehmed & Basri, 2016).

The mention of inoculation in the *Sact'eya Grantham*, an Ayurvedic text, was noted by Henri Marie Husson in the journal *Dictionaire des sciences médicales* (Iseman, 2002). However, according to Wujastyk (1995), the idea that inoculation originated in India has been challenged, as few of the ancient Sanskrit medical texts described the process of inoculation. Accounts of inoculation against smallpox in China can be found as early as the late 10th century and it was reported to be widely practiced in China in the reign of the Longqing Emperor during the Ming Dynasty (Needham *et. al*, 2013). Evidence from Silverstein (2009) indicates that two reports on the Chinese practice of inoculation were received by the Royal Society in London in 1700; one by Dr. Martin Lister who received a report by an employee of the East India Company stationed in China and another by Clopton Havers. According to Voltaire (1742), the Turks derived their use of inoculation from neighbouring Circassia. Voltaire does not speculate on where the Circassians derived their technique from, though he reports that the Chinese have practiced it "these hundred years".

The Greek physicians Emmanuel Timonis (1669–1720) from the island of Chios and Jacob Pylarinos (1659–1718) from Cephalonia practised smallpox inoculation at Constantinople in the beginning of 18th century (Karaberopoulos,

2006) and published their work in *Philosophical Transactions of the Royal Society* in 1714 (Pylarinum, 1714; Timonius & Woodward, 1716). This kind of inoculation and other forms of variolation were introduced into England by Lady Montagu, a famous English letter-writer and wife of the English ambassador at Istanbul between 1716 and 1718, who almost died from smallpox as a young adult and was physically scarred from it. Inoculation was adopted both in England and in America nearly half a century before Jenner's famous smallpox vaccine of 1796 (Henricy, 1796) but according to Gross and Sepkowitz (1998), the death rate of about 2% from this method meant that it was mainly used during dangerous outbreaks of the disease and remained controversial. It was noticed during the 18th century that people who had suffered from the less virulent cowpox were immune to smallpox, and the first recorded use of this idea was by a farmer, Benjamin Jesty at Yetminster in Dorset, who had suffered the disease and transmitted it to his own family in 1774, his sons subsequently not getting the mild version of smallpox when later inoculated in 1789.

It was Edward Jenner in Berkeley, who established the procedure by introducing material from a cowpox vesicle on Sarah Nelmes, a milkmaid, into the arm of a boy named James Phipps. Two months later, he inoculated the boy with smallpox and the disease did not develop. In 1798, Jenner published *An Inquiry into the Causes and Effects of the Variolae Vacciniae*, which coined the term *vaccination* and created widespread interest. He distinguished 'true' and 'spurious' cowpox and developed an "arm-to-arm" method of propagating the vaccine from the vaccinated individual's pustule. Early attempts at confirmation

were confounded by contamination with smallpox, but despite controversy within the medical profession and religious opposition to the use of animal material, by 1801, his report was translated into six languages and over 100,000 people were vaccinated (Gross & Sepkowitz, 1998).

Since then, vaccination campaigns have spread throughout the globe, sometimes prescribed by law or regulations. Vaccines are now used against a wide variety of diseases. Louis Pasteur, further, developed the technique during the 19th century, extending its use to killed agents protecting against anthrax and rabies. The method Pasteur used entailed treating the agents for those diseases so they lost the ability to infect, whereas inoculation was the hopeful selection of a less virulent form of the disease, and Jenner's vaccination entailed the substitution of a different and less dangerous disease. Pasteur adopted the name *vaccine* as a generic term in honour of Jenner's discovery.

Maurice Hileman, who was an American microbiologist and specialized in vaccinology, was the most prolific vaccine inventor, developing successful vaccines for measles, mumps, hepatitis A, hepatitis B, chickenpox, meningitis, pneumonia and 'Haemophilus influenza' (Offit, 2007). In modern times, the first vaccine-preventable disease targeted for eradication was smallpox (WHO, 2014). WHO coordinated this global eradication effort. The last naturally occurring case of smallpox occurred in Somalia in 1977. In 1988, the governing body of WHO targeted polio for eradication by 2000 (WHO, 2014). Although the target was missed, eradication is very close (UNICEF, 2015). In 2000, the Global Alliance for Vaccines and Immunisation was established to strengthen routine vaccinations and

introduce new and under-used vaccines in countries with a per capita GDP of under US $1000.

The Extended Program on Immunisation

The WHO initiated the EPI in May 1974, with the goal of ensuring universal availability of key life-saving vaccines to children in the developing world. In the recommendation of the World Health Assembly (WHA), the programme was to ensure that member states develop or maintain immunisation and surveillance programme against measles, poliomyelitis, tuberculosis, diphtheria, pertussis and tetanus (WHO, 1996). In furtherance of this recommendation, a special fund was established to support EPI and a Global Advisory Group (GAG), involving experts in immunisation and disease control, was convened (Sebastian & Weiser, 1979). In 1984, WHO established a standard schedule for these vaccines targeting optimal points of early childhood in order to allow children to develop immunity safely, effectively and as early as possible (WHO, 2012). According to Plotkin and Plotkin, (2008), this schedule takes into account age-specific risks of disease, age-specific risks of complications and age-specific patterns of immunity. Immunisation against VPDs through EPI is one of the most economical public health interventions available (UNICEF, 2002) that contributed extensively to achieving the MDG to reduce the mortality rate of children under five by two thirds between 1990 and 2015 (UNICEF, 2015). Immunisation against major diseases was one of the eight elements of the PHC, thus making the EPI an integral part of the PHC system.

In May 1982, the World Health Assembly reviewed the EPI and urged member states of WHO to immunise all their children by 1990 (UNICEF, 1983).

At this Assembly, member states were called on to promote EPI within the context of Primary Health Care (PHC), invest adequate human and financial resources in EPI, ensure that programmes are continuously evaluated and pursue research efforts as part of the programme operations. UNICEF also developed the Universal Child Immunisation Programme and set a global target of 80% immunisation coverage among infants worldwide by 1990.

Ten years after the initiation of the EPI, in 1984, the WHO established a standardized vaccination schedule for the original EPI vaccines: Bacillus Calmette Guérin (BCG), diphtheria-tetanus-pertussis (DTP), oral polio and measles. Increased knowledge of the immunologic factors of disease led to new vaccines being developed and added to the EPI's list of recommended vaccines: Hepatitis B (HepB), yellow fever in countries endemic for the disease, and Haemophilus influenza meningitis (Hib) conjugate vaccine in countries with high burden of disease (Jamison *et. al.*, 2013).

In 1999, the Global Alliance for Vaccines and Immunisation (GAVI) was created with the sole purpose of improving child health in the poorest countries by extending the reach of the EPI. The GAVI brought together a grand coalition, including the UN agencies and institutions (WHO, UNICEF, the World Bank), public health institutes, donor and implementing countries, the Bill and Melinda Gates Foundation and The Rockefeller Foundation, the vaccine industry, non-governmental organisations (NGOs) and many more (McCoy *et. al.*,2009). The creation of the GAVI has helped to renew interest and maintain the importance of

immunisations in battling the world's large burden of infectious diseases (McCoy *et. al.*,2009.).

The current goals of the EPI are:

- to ensure full immunisation of children under one year of age in every district,
- to globally eradicate poliomyelitis,
- to reduce maternal and neonatal tetanus to an incidence rate of less than one case per 1,000 births by 2005,
- to cut in half the number of measles-related deaths that occurred in 1999, and
- to extend all new vaccine and preventative health interventions to children in all districts in the world.

In addition, the GAVI has set up specific milestones to achieve the EPI goals: that by 2010 all countries have routine immunisation coverage of 90% of their child population, that HepB be introduced in 80% of all countries by 2007, and that 50% of the poorest countries have Hib vaccine by 2005 (Halder, Cochi, Bilous & Cutts, 2004).

Implementation of the EPI

In each of the United Nations' member states, the national governments create and implement their policies for vaccination programs following the guidelines set by the EPI (WHO, 2012). Setting up an immunisation programme was multifaceted and contained many complex components including a reliable cold chain system, transport for the delivery of the vaccines, maintenance of vaccine stocks, training and monitoring of health workers, outreach educational

programs to inform the public, and a means of documenting and recording which child receives which vaccines. Each region has slightly varying ways of setting up and implementing its immunisation programs based on their level of health infrastructure (WHO, 2012).

Some areas will have fixed sites for vaccination (for example, health care facilities such as hospitals or health posts that include vaccination with many other health care activities). But in areas where the number of structured health facilities is small, mobile vaccination teams consisting of staff members from a health facility can deliver vaccines straight to individual towns and villages (McKee, 2016). These 'outreach' services are often scheduled throughout the year, however, in especially under-developed countries where proper communication and infrastructure are absent, cancellation of the planned immunisation visits leads to deterioration of the program. A better strategy in such countries is the 'pulse immunisation' technique, where 'pulses' of vaccines are given to children in annual vaccination campaigns (Jamison et. al., 2013; McKee, 2016)

Additional strategies are needed if the area of the program consists of poor urban communities, because such areas tend to have low uptake of vaccination programs. Door-to-door canvassing, also referred to as channeling, is used to increase uptake in such hard-to-reach groups. Finally, periodic national-level mass vaccination campaigns are being increasingly included in the programs (McKee, 2016).

Evaluation of the EPI

In each country, immunisation programs are monitored using two methods: an administrative method and through community-based surveys. The administrative method uses immunisation data from public, private, and NGO clinics. Thus, the accuracy of the administrative method is limited by the availability and accuracy of reports from these facilities. This method is easily performed in areas where government services deliver the immunisations directly or where the government supplies the vaccines to the clinics. In countries without the infrastructure to do this, community-based surveys are used to estimate immunisation coverage (McKee, 2016)

Community-based surveys are applied using a modified cluster sampling survey method developed by the WHO. Vaccine coverage is evaluated using a two-stage sampling approach in which 30 clusters and seven children in each cluster are selected. Health care workers with no or limited background in statistics and sampling are able to carry out data collection with minimal training (McKee, 2016). This provides a way to get information from areas where there is no reliable data source. It is also used to validate reported vaccine coverage (for example, from administrative reports) and is expected to estimate vaccine coverage within 10 percent (Jamison et. al., 2013).

Surveys or questionnaires, though frequently considered inaccurate due to self-reporting, can provide more detailed information than administrative reports alone. If home-based records are available, vaccination status is determined and dates of vaccination can be reviewed to determine if they were given at an ideal age

and in appropriate intervals. Missed immunisations can be identified and further qualified. Systems of vaccine delivery besides clinics used for administrative evaluation can be identified and included in the analysis (McKee, 2016).

Results of the Implementation of the EPI

Before the initiation of the EPI, child vaccination coverage for tuberculosis, diphtheria, pertussis, tetanus, polio, and measles was estimated to be fewer than 5 percent. Now, not only has coverage increased to 79 percent (CDC, 2006), it has been expanded to include vaccinations for hepatitis B, Haemophilus influenzae type B, rubella, tetanus, and yellow fever. The impact of increased vaccination is clear from the decreasing incidence of many diseases. For example, measles deaths decreased by 60% worldwide between 1999 and 2005, and polio, although missing the goal of eradication by 2005, has decreased significantly as there were fewer than 2,000 cases in 2006 (CDC, 2006).

The Expanded Programme on Immunisation in Ghana

The Expanded Programme on Immunisation was adopted by Ghana in 1978. According to MOH/WHO/UNICEF in 1989, the EPI policy states that, "The government of Ghana has adopted the policy of reducing to manageable levels the morbidity and mortality of children under 5 years against the following common childhood preventable diseases, tuberculosis, measles, diphtheria, poliomyelitis, pertussis, neonatal tetanus, and yellow fever, through the Expanded Programme on Immunisation (EPI)."

The Specific Objectives of the Programme were:

- to promote continued immunisation of infants through the existing health delivery system.
- to combat diseases for which there are effective vaccines and immunisation methods.
- to ensure that by 1990, all children in the first year of life will have ready access to immunisation and 80% of them will be fully immunised.
- to ensure that a course of tetanus toxoid immunisation is started in at least 80% of women aged between 12-44 years in any particular year.
- to reduce the incidence and mortality due to measles, whooping cough, polio and tetanus by 80%, and tuberculosis by 50% of the present levels.
- to improve data collection and to establish better disease surveillance through regular reporting from all the health facilities.
- to achieve immunisation in all health facilities.
- to promote EPI with Control of Diarrhoea Diseases (CDD) within the framework of Primary Health Care (PHC) delivery system.
- to improve EPI services and coverage through research.
- to strengthen intersectoral co-operation as well as teamwork amongst health workers and the community in order to improve acceptance and coverage of EPI and CDD services.
- to improve and expand the coverage of health education.

The EPI schedule of Ghana specifies the age at which a particular vaccine is to be given and the disease that is to be protected against. Table 1 below shows the present EPI schedule for Ghana.

Table 1: The EPI schedule for Ghana

Vaccine	Age Given	Disease Protected Against
Bacille Calmette-Guerin (BCG)	At Birtth	Tuberculosis
Oral Polio Vaccine (OPVo)	At Birth	Poliomyelitis
OPV_1	6 week	Poliomyelitis
OPV_2	10 weeks	Poliomyelitis
OPV_3	14 weeks	Poliomyelitis
DPT (Diphtheria-Pertussis -Tetanus)	6 week	Diphtheria -Pertussis – Tetanus
DPT	10 weeks	Diphtheria -Pertussis – Tetanus
DPT	14 weeks	Diphtheria -Pertussis – Tetanus
Measles	9 months	Measles
Yellow Fever	9 months	Yellow Fever

Source: Ministry 0f Health, Ghana (1989)

There was an update in 1997 of the EPI policy guidelines and the following goals were set:

- Control of Measles;
- Elimination of Neonatal Tetanus;
- Eradication of Poliomyelitis;
- Control of Hepatitis B; and
- Control of yellow fever all by the year 2000.

EPI and the Health Sector Reforms

The MoH began implementing institutional health reforms in 1997. The thrust of the reforms is decentralization to the district (the operational) level and the integration of services at the district level. EPI services have, therefore, been decentralized to the district level where its operational activities are a component of an integrated package of health interventions provided by the District Health Management Teams (DHMT), the health providing institutions (public, private, and NGO), and the Sub District Health Teams. Though some targeted funds are still received for some EPI activities (RED approach, Surveillance, Training of Midwives in EPI, and Injection Safety), most of the funding comes through the "common basket".

The capacity of the district level to operate as a viable, efficient and technically competent unit was enhanced by several initiatives and policies. The Strengthening of District Health Systems (SDHS) initiative (between the late 80s and early 90s) was geared towards strengthening the capacity of the District Health Management Teams to undertake situational analysis, problem identification and analysis, planning, implementing and evaluation of their work. The District and sub-districts were, therefore, trained to strengthen the planning process of district operations. The District Health System Operation (DISHOP) training in the late 90s followed this intervention. The District Director of Health Services (DDHS) is ultimately responsible for the Management of EPI in the District. This responsibility is often delegated to a DHMT member who is either a Technical Officer (DC) or a public health nurse.

The creation of Budget Management Centres (BMCs) envisaged that funds are made available to meet the operational cost of implementing the operational plans of such BMCs. The operational planning and funding of EPI activities within the district and sub-districts are very much dependent on the availability of funds to the DHMT and the Sub District Health Teams (SDHT). It is also very much dependent on the discretion and priorities of the leadership of especially the DHMTs. EPI service delivery is actually done by the sub-district health teams, consisting largely of community health nurses, field technicians, midwives, and public health nurses. Inadequate or non-release of BMC funds to the sub-districts by the DHMT remains a real threat to the effective EPI service delivery in the country.

The Comprehensive Multi-Year Plan

The comprehensive multi-year plan (cMYP) is the medium-term plan for the Expanded Programme on Immunization (EPI) in Ghana. As expected, it provides the strategic direction of the immunization programme for the period. The cMYP is always prepared in consonance with the 5-year strategic plan of the health sector. The current cMYP (2007-2011) had to be revised to 2014 to accommodate the plans to introduce three new vaccines – pneumococcal, rotavirus and second dose measles. Ghana launched the Expanded Programme on Immunization (EPI) in June 1978 with six antigens – BCG, measles, diphtheria-pertussis-tetanus (DPT) and oral polio for children under one year of age together with tetanus toxoid (TT) vaccination for pregnant women. The launch was in response to the national health policy to reduce morbidity and mortality of vaccine preventable diseases which

then contributed significantly to both infant and child mortality in the country. It was also in consonance with the immunization policy of the government which sought to ensure that all children receive these vaccines before their first birthday of life. Three strategies are implored for the delivery of the immunization services in the country- static, outreach and campaigns to reach out to most of the unreached populations.

The goal is to reduce burden of vaccine preventable diseases with the view of contributing to the overall poverty reduction and health care strengthening in the country. The Expanded Programme on Immunization (EPI) which is responsible for immunization in Ghana is located within the Diseases Control Department (DCD) of the Public Health Division of the Ghana Health Service. It is headed by a Public Health Specialist and assisted by trained personnel who are specialists in areas that include logistics management, data management, cold chain management, injection safety, social mobilization and communication. Ghana's first major challenge and experience in introducing new vaccines into the routine immunization programme was at the time of introducing the haemophilus influenza type b (Hib) and the hepatitis B vaccines in the combination of DPT-HepB+Hib (also referred to as pentavalent) in 2002 with GAVI support.

The National Immunization Programme is one of the most successful and cost effective programmes implemented in Ghana. The uniqueness of the NIP has been the innovativeness and adaptation it has gone through with the support of national and international partners. As a vertical programme the NIP has successfully transformed itself and integrated within the country's decentralized

health system. EPI in Ghana aims at protecting every child in Ghana from nine common childhood diseases; namely, tuberculosis, poliomyelitis, diphtheria, neonatal tetanus, whooping cough, hepatitis B, haemophilus influenza type b, measles and yellow fever. The development of immunization in Ghana was very slow in the early 1990s. In the early 2000s, the delivery was accelerated with the global initiative and support from GAVI. Subsequently with the introduction of new and underutilized vaccines and sustained NIDs, more children have been immunized.

Greater attention has also been drawn to the importance of the national immunization programme and its integration with the health systems, gaining overall policy support. Immunization continues to be one of the most cost-effective of all child survival health interventions. Traditionally, immunization has had children and women as the main foci of attention but recently this is being broadened to include the wider population in line with the current global immunization vision and strategy (GIVS). Ghana intends to introduce two new vaccines (Rotavirus and Pnneumocco) and a second dose for measles.

Goals and Objectives

This comprehensive Multi-Year Plan (cMYP) of Action covers the fiscal years 20010-2014. The objectives and activities set forth in this Multi-Year Plan provide the framework required to meet the previously stated goal of reducing infant and child mortality and morbidity associated with vaccine -preventable diseases (VPD). Further, this Plan addresses new challenges and expands the previous plan by providing guidelines for the introduction of new

vaccines. The 2010-2014 cMYP of Ghana is aimed at achieving five major goals which are within the context of the goals of GIVS with strategic components as described below:

1. Reach out and protect more people than being done currently
2. Rapidly increase immunity to selected VPDs in order to accelerate Reduction of morbidity and mortality from VPDs
3. Introduce New & Under-utilized Vaccines
4. Strengthen surveillance
5. Integrate EPI with other Interventions in the context of Health System Development

Objectives of the cMYP

Ghana immunization objectives are linked to the sector objectives (objective 3) and the efforts for achieving the MDGs. The specific objectives of the National Immunisation Programme are

1. Reach everyone targeted for immunization to achieve and sustain by 2014, 94% coverage in all childhood immunisations and 85% for Tetanoid Toxins for Pregnant women
2. Improve communication, advocacy and information dissemination
3. Strengthen surveillance system
4. Improve programme management and integration with health systems

The cMYP provides a comprehensive overview of the NIP and is the document to provide direction guidance to national and sub-national levels for

incorporation into their annual plans. It is also the documents that will advise national policies in setting national targets for all immunization indicators. National performance will therefore be monitored based on the indicators set in the cMYP. The cMYP contain a set of programme and financial indicators. These indicators will be monitored and feedback provided to policy and programme managers. Monitoring of the cMYP will be done within the existing health sector monitoring and reporting framework.

Trends of Childhood Vaccination

Rates of vaccine-preventable diseases have decreased in many parts of the world in the past few decades, but many children remain unvaccinated (de Figueiredo *et al.,* 2016). In 2012, WHO reported that 21·8 million children younger than 1 year had not completed diphtheria, tetanus, and pertussis (DTP) immunisation series, with a similar number not receiving a single measles vaccination (WHO, 2012). This brought a reason for researchers across the globe to have carried out studies on trends of childhood vaccination

Semali (2010) carried out a study that aimed at determining the trend in disparities in completion of immunisation using Tanzania Demographic and Health Surveys (DHS). The last three data sets (1990, 1996 and 2004) were downloaded and analysed, of which all children between 12 -23 months would have completed all vaccinations required by the 12th month. Results from the study showed that, across the time periods 1990, 1996 to 2004/05, the percentage of children completing vaccination was similar (71.0% in 1990, 72.7% in 1996 and 72.3% in 2005).

Similarly, Singh (2013) assessed the urban-rural and gender difference in child immunisation coverage during 1992–2006 across six major geographical regions in India. Three rounds of the National Family Health Survey (NFHS) conducted during 1992–93, 1998–99 and 2005–06 were analysed. Bivariate analyses, urban-rural and gender inequality ratios, and the multivariate-pooled logistic regression model were applied to examine the trends and patterns of inequalities over time. The analysis of change over one and half decades (1992–2006) showed considerable variations in child immunisation coverage across six geographical regions in India. Full immunisation coverage had increased from 35% in 1992 to 44% in 2006.

Again, Tao, Petzold and Forsberg (2013) evaluated the change in routine vaccination coverage over time based on survey data and compared it to estimations by the WHO and United Nations Children's Fund (UNICEF). Data of vaccination coverage of children less than 5 years of age was extracted from Demographic and Health Surveys (DHS) conducted in 71 low- and middle-income countries from 1986 to 2009. Overall, trends for vaccination coverage of tuberculosis, diphtheria, tetanus, pertussis, polio and measles were analysed and compared to WHO and UNICEF estimates. Results from the study showed that from 1986 to 2009, the annual average increase in vaccination coverage of the studied diseases ranged between 1.53 and 1.96% units according to DHS data. Vaccination coverage of diphtheria, tetanus, pertussis, polio and measles was all under 80% in 2009.

Ushie, Fayehun and Ugal (2014) carried out a study to examine the trends in vaccination coverage for the assessment of successes or failures of the

immunisation efforts. The study used four NDH surveys datasets between 1990 and 2008, which generated child health information including the proportion that had had any or all basic childhood vaccines. A combined total of 44,071 (weighted) children were involved in the study. Results of the study showed that more complete vaccination coverage was reported in the 1990 survey, followed by 2008, 1999 and 2003.

Maternal Age as a Determinate of Childhood Vaccination

In relation to maternal age as a determinant of childhood vaccination, Kamau and Esamai (2001) conducted a study to establish the factors that determine the levels of immunisation among children under five years in Mathare Valley. A cross-sectional study describing the situation at a point in time was employed in the study. The study population was mothers with children under five years in Mathare Valley who had been resident there for a period not less than five years prior to the study. Results from the study showed that age is a significant determinant of immunisation coverage.

Russo et al. (2015) carried out a study to identify determinants for incomplete vaccination status and to assess the risk of poliovirus spread in the study population. A cross-sectional household survey was conducted in November-December 2013, using the WHO two-stage sampling design. An interviewer-administered questionnaire was used to obtain information from consenting parents of children aged 12–23 months. Vaccination coverage was assessed by vaccination card and parents' recall. Results from the study showed that incomplete immunisation status was associated with younger mothers.

Lastly, Adokiya, Baguune and Ndago (2017) evaluated the immunisation coverage and its associated factors among children aged 12–23 months in Techiman Municipality, Ghana. A cross-sectional cluster survey was conducted among 600 children. Data was collected using a semi-structured questionnaire through face-to-face interviews. Descriptive statistics such as percentages, frequencies and cross-tabulations were performed to estimate the odds ratio of not being fully immunised. Results showed that children of older mothers were more likely to be fully immunised. For example, the AOR was 0.15 (95%CI 0.05–0.87) when the age was 40–49 years, compared to less than 20 years.

Maternal Educational Level as a Determinate of Childhood Vaccination

On maternal education as a determinant of childhood vaccination, Kamau and Esamai (2001) conducted a study to establish the factors that determine the levels of immunisation among children under five years in Mathare Valley. A cross-sectional study describing the situation at a point it time was employed in the study. The study population was mothers with children under five years in Mathare Valley who had been resident there for a period not less than five years prior to the study. Results from the study showed that level of education is a significant determinant of immunisation coverage.

Hu, Li, Chen, Chen and Qi (2013) carried out a study to determine the coverage of childhood immunisation appropriate for age among socio-economically disadvantaged recent migrants living in East China and to identify the determinants of full immunisation uptake among these migrant children. The study was a cross-sectional survey of 1,426 migrant mothers with a child aged ≤24

months, who were interviewed with a pretested questionnaire. Results of the study showed that the likelihood of a child receiving full immunisation rise with parents' educational level.

Mukungwa (2015) utilized the Zimbabwe Demographic and Health Survey (ZDHS) data to analyse the variables of immunisation status of children aged 12-23 months in Zimbabwe. A multivariate binary logistic regression analysis of the data was performed. The data consisted of 978 children aged 12-23 months from the selected households. Results showed that children of mothers with secondary education and above were more likely to be vaccinated than children of mothers with no formal education.

Finally, Mbengue *et al.*, (2017) assessed routine immunisation uptake and factors associated with full immunisation status among Senegalese children aged 12–23 months. The study used the 2010–2011 Senegalese Demographic and Health Survey data. The DHS was a two stages cross-sectional survey carried out in 2010–2011. The analysis included 2199 children aged 12–23 months. The interviewers collected information on vaccine uptake based on information from vaccination cards or maternal recall Univariate and multivariable logistic regression models were used to identify the determinants of full childhood immunisation. Results from the study showed that mothers who attended at least secondary education level had full childhood immunisation compared to those with less than secondary level education.

Wealth Status as a Determinant of Childhood Vaccination

Hu, Li, Chen, Chen and Qi (2013) carried out a study to determine the coverage of childhood immunisation appropriate for age among socio-economically disadvantaged recent migrants living in East China and to identify the determinants of full immunisation uptake among these migrant children. The study was a cross-sectional survey of 1,426 migrant mothers with a child aged ≤24 months, who were interviewed with a pretested questionnaire. Results of the study showed that higher household income significantly increases the likelihood of full immunisation.

Mukungwa (2015) utilized the Zimbabwe Demographic and Health Survey (ZDHS) data to analyse the variables of immunisation status of children aged 12-23 months in Zimbabwe. A multivariate binary logistic regression analysis of the data was performed. The data consisted of 978 children aged 12-23 months from the selected households. Results showed that the likelihood of vaccination increased with wealth status.

Lakew, Bekele and Biadgilign (2015) carried out a study to identify factors associated with full immunisation coverage among children aged 12-23 months in Ethiopia. This study used the 2011 Ethiopian Demographic and Health Survey data. The survey was cross sectional by design and used a multistage cluster sampling procedure. A total of 1,927 mothers with children of 12-23 months of age were extracted from the children's dataset. Mothers' self-reported data and observations of vaccination cards were used to determine vaccine coverage. In terms of wealth status, there was a 40 % (AOR 95 % CI; 1.4 (1.06-1.94)) more likelihood in

receiving full vaccination among children born to mothers of rich wealth index group compared with children from women of poor wealth index group.

Finally, Ekouevi *et al.,* (2018) carried out a study to estimate the immunisation coverage among children aged 12–23 months and to identify factors associated with incomplete immunisation status in Togo. A cross-sectional survey was conducted in the six health regions of Togo. Children aged 12 to 23 months who were living with one of their parents or guardians from selected households were recruited for the study. Data was collected using a pre-tested questionnaire through face-to-face interviews. Multilevel logistic regression analyses were performed to assess factors associated with incomplete immunisation coverage. Results from the study showed that the likelihood of incomplete immunisation in children decreased with the increase in household's income (a OR = 0.73, 95% CI (0.58–0.93)).

Region as a Determinant of Childhood Vaccination

In terms of region as a determinant of childhood vaccination, Mukungwa (2015) utilized the Zimbabwe Demographic and Health Survey (ZDHS) data to analyse the variables of immunisation status of children aged 12-23 months in Zimbabwe. A multivariate binary logistic regression analysis of the data was performed. The data consisted of 978 children aged 12-23 months from the selected households. Results showed a significant association between region and variations in immunisation.

Lakew, Bekele and Biadgilign (2015) carried out a study to identify factors associated with full immunisation coverage among children aged 12-23 months in Ethiopia. This study used the 2011 Ethiopian Demographic and Health Survey data. The survey was cross-sectional by design and used a multistage cluster sampling procedure. A total of 1,927 mothers with children of 12-23 months of age were extracted from the children's dataset. Mothers' self-reported data and observations of vaccination cards were used to determine vaccine coverage. With region, women from Afar, Amhara, Oromiya, Somali and Southern Nation and Nationalities People administrative regions were less likely to fully vaccinate their children compared to women who reside in Addis Ababa.

Finally, Mbengue *et al.,* (2017) assessed routine immunisation uptake and factors associated with full immunisation status among Senegalese children aged 12–23 months. The study used the 2010–2011 Senegalese Demographic and Health Survey data. The DHS was a two stage cross-sectional survey carried out in 2010–2011. The analysis included 2199 children aged 12–23 months. The interviewers collected information on vaccine uptake based on information from vaccination cards or maternal recall Univariate and multivariate logistic regressions models were used to identify the determinants of full childhood immunisation. Results from the study showed that region has a statistically significant effect on immunisation.

Place of Residence as a Determinate of Childhood Vaccination

In terms of place of residence, Fernandez, Awofeso and Rammohan (2011) investigated rural-urban differentials in measles vaccination coverage among young Indonesian children and sought to identify key factors influencing the

probability of a child receiving the first dose of measles vaccination in Indonesia. Data used in the analyses were sourced from the nationally representative Indonesia Demographic and Health Survey, 2007. The influence of location of residence, household wealth, maternal and paternal education, total children ever born and use of skilled birth attendants on measles vaccination coverage was investigated using bivariate analysis and chi-square tests. The independent effects of these variables were established using binomial logistic regression analysis. Results from the study showed significantly higher rates of first-dose measles vaccination in urban as compared with rural areas.

Again, Ushie, Fayehun and Ugal (2014) carried out a study to examine the trends in vaccination coverage for the assessment of successes or failures of the immunisation efforts. The study used four NDH Surveys datasets between 1990 and 2008, which generated child health information including the proportion that had had any or all basic childhood vaccines. A combined total of 44,071 (weighted) children were involved in the study. Results from the study showed that children in urban areas have consistently higher immunisation rates than those in rural areas.

Abshoko (2016) carried out a study to statistically identify and analyse the various possible determinants of full immunisation among children in rural and urban households of SNNPRS, Ethiopia. The sampling technique employed was multistage stratified cluster sampling. Analysis of the study revealed that only 18.3% of children under 5 years of age were fully immunised in the region. Results of the multiple binary logistic regression showed that place of residence was an important determinant factor affecting full child immunisation in the region.

Finally, Murtaza, Mustafa and Awan (2016) investigated the determinants and reasons for not vaccinating children in Pakistan. The study used the Pakistan Integrated Household Survey/Household Integrated Economic Survey 2001–2002 data. Demographic, distance to health facility, poverty status, literacy and education, and location of residence were used as determinants of non-immunisation of children. Descriptive statistics, including frequency distribution, proportions for categorical variables and mean for continuous variables, and logistic regression analysis were done using the Stata 11.0. Results indicated that a child living in the rural area had almost 1.7 times higher odds of not receiving vaccination as compared to a child living in the urban area.

Mother's Occupation as a Determinate of Childhood Vaccination

In relation to occupation and childhood vaccination, Tagbo *et al.* (2014) assessed the vaccination coverage and its associated factors in children aged 11 -23 months in Enugu Metropolis. A cross-sectional study in which caregivers and their children pair, aged 11 -23 months attending children's outpatient clinics in Enugu Metropolis was undertaken. Respondents were selected consecutively while data were collected using a pretested interviewer-administered semi-structured questionnaire. Data were analysed using SPSS version 20.0 while level of significance was set at $p < 0.05$. Logistic regression analysis was used to identify independent predictors of full vaccination.

Awasthi *et al,* (2015) conducted a study to identify the determinants of complete immunisation status among children aged 12–23 months in urban slums of Varanasi in India. A modified WHO EPI cluster sampling method was used for

sample selection. Data on 384 children were collected using a pretested questionnaire through house to house visit. Chi-square test, bivariate and multivariate logistic regression were used to assess the factors associated with complete immunisation status in the urban slums of Varanasi. Results from the study showed that employment status of mother is a strong determinant of complete immunisation.

Again, Russo *et al.* (2015) carried out a study to identify determinants for incomplete vaccination status and to assess the risk of poliovirus spread in the study population. A cross-sectional household survey was conducted in November-December 2013, using the WHO two-stage sampling design. An interviewer-administered questionnaire was used to obtain information from consenting parents of children aged 12–23 months. Vaccination coverage was assessed by vaccination card and parents' recall. Results from the study showed that immunisation status was associated with mother's employment status.

Finally, Adenike, Adejumoke, Olufunmi and Ridwan (2017) worked on maternal characteristics and immunisation status of children in North-central part of Nigeria. The objective of the study was to compare the mother's characteristics and the child's immunisation status in some selected rural and urban communities in the North-central part of Nigeria. A descriptive cross-sectional study, using a multistage sampling technique was used to select 600 respondent women with an index child between 0-12 months. Results from the study showed that there was a statistically significant association between respondents' employment status and the child's immunisation status ($P<0.05$).

Ethnicity as a Determinate of Childhood Vaccination

In relation to ethnicity and childhood vaccination, Muiru (2009) investigated the factors influencing the utilisation of immunisation services in the low and high childhood mortality regions in Kenya. The study used secondary data obtained from KDHS 2003 and focused on 1,206 children aged 12 to 24 months. Cross tabulation was used to examine the hypothesized association between immunisation status and various independent variables. Chi-square test was carried out to show the level of significance of the association. Logistic regression was applied to show the effect of the selected variables on the dependent variable. The factors that were found to influence utilisation of immunisation services included ethnicity.

Duah-Owusu (2010) investigated the relationship between social determinants of health and immunisation using data from the 2003 Ghana DHS (Demographic and Health Survey). The analyses utilised data from 5691 women who took part in the survey. It compared a national sample with the three northern-most regions rural sub-sample. These samples were women who were permanent residents of a household with a firstborn child below five years. The weighted national and three northern-most rural regions usual resident extracted sample numbered 2460 and 462, respectively. Bivariate correlation analyses and logistic regression analyses were carried out in both samples. The analyses showed that being fully immunised was associated with ethnicity. According to Duah-Owusu (2010), full immunisation was seen to be high with children born by women who are Akans.

Morever, Duru *et al*. (2016) conducted a study to determine the immunisation coverage, status and the determinants in under 5-year-old children in Owerri Municipal, Imo State. The study was a community-based cross-sectional study involving 420 women and 743 under 5-year-old children. A multistage sampling technique was employed and data were collected using a pretested, semi structured interviewer administered questionnaire. The bivariate analysis showed statistically significant associations between the immunisation status of the children and ethnicity ($p < 0.01$).

Lastly, Adokiya, Baguune and Ndago (2017) evaluated the immunisation coverage and its associated factors among children aged 12–23 months in Techiman Municipality, Ghana. A cross-sectional cluster survey was conducted among 600 children. Data was collected using a semi-structured questionnaire through face-to-face interviews. Descriptive statistics such as percentages, frequencies and cross-tabulations were performed to estimate the odds ratio of not being fully immunised. Results showed that, in comparing other ethnic groups to Akan (the main ethnic group), Frafra (AOR = 4.71, 95%CI = 146–15.18) have a higher likelihood of not being fully immunised whereas Kusaasi (AOR = 0.09, 95%CI = 0.02–0.51) have a higher likelihood of being fully immunised.

Parity as a Determinate of Childhood Vaccination

On parity as a determinant of childhood vaccination, Mukungwa (2015) utilized the Zimbabwe Demographic and Health Survey (ZDHS) data to analyse the variables of immunisation status of children aged 12-23 months in Zimbabwe. A multivariate binary logistic regression analysis of the data was performed. The

data consisted of 978 children aged 12-23 months from selected households. Results showed that children of the 1st birth order were more likely to be vaccinated than children of birth order 6+.

Again, Awasthi *et al.* (2015) conducted a study to identify the determinants of complete immunisation status among children aged 12–23 months in urban slums of Varanasi in India. A modified WHO EPI cluster sampling method was used for sample selection. Data on 384 children were collected using a pretested questionnaire through house to house visit. Chi-square test, bivariate and multivariate logistic regression were used to assess the factors associated with complete immunisation status in the urban slums of Varanasi. Results from the study showed that parity less than three (OR = 2.84, 95% CI 1.98–3.73) is a strong determinant of complete immunisation

Russo *et al*. (2015) conducted a study to identify determinants for incomplete vaccination status and to assess the risk of poliovirus spread in the study population. A cross-sectional household survey was conducted in November-December 2013, using the WHO two-stage sampling design. An interviewer-administered questionnaire was used to obtain information from consenting parents of children aged 12–23 months. Vaccination coverage was assessed by vaccination card and parents' recall. Results from the study showed that incomplete immunisation status was associated with being the $\geq 3^{rd}$ born child in the family.

Similarly, Yenit, Assegid and Abrha (2015) also conducted a study to identify factors associated with incomplete childhood vaccinations among children 12-23 months of age in Machakel Woreda, East Gojjam Zone, and Northeast

Ethiopia. Community-based unmatched case-control study design with quantitative and qualitative methods of data collection was conducted in Machakel district, Northeast Ethiopia from March 20 to April 30, 2014. Quantitative data were collected from mothers who had 12-23 months aged children. Census was done to identify all cases and controls. For quantitative method, a sample of 154 cases and 154 controls were selected using a stratified multistage random sampling technique. Data were collected using a pretested structured questionnaire using interview data collection technique and data were entered into Epi Info software and analysed using Statistical Package for Social Sciences for windows version 16 and logistic regression methods. Results from the study showed that parity is a predictor of defaulting from completion of childhood vaccination.

Lakew, Bekele and Biadgilign (2015) carried out a study to identify factors associated with full immunisation coverage among children aged 12-23 months in Ethiopia. This study used the 2011 Ethiopian Demographic and Health Survey data. The survey was cross-sectional by design and used a multistage cluster sampling procedure. A total of 1,927 mothers with children of 12-23 months of age were extracted from the children's dataset. Mothers' self-reported data and observations of vaccination cards were used to determine vaccine coverage. Vaccination coverage was high among single parity mothers.

Marital Status as a Determinate of Childhood Vaccination

On how marital status determines childhood vaccination, Weiss, Choudhary and Solomon (2013) explored determinants of routine immunisation performance to strengthen routine immunisation services. The researchers conducted a

secondary data analysis of the latest project household immunisation survey in 2011 and compared the findings to reports of past surveys in the Core Group Polio Project (CGPP program area) and at the Uttar Pradesh state level (as measured by children's receipt of DPT vaccinations). This was done to judge if there is any evidence that routine immunisation services are being disrupted. They also model characteristics of survey respondents and respondents' exposure to CGPP, communication activities against their children's receipt of key vaccinations in order to identify determinants of routine immunisation coverage. Results from the study showed that marital status influences immunisation coverage.

Similarly, Lakew, Bekele and Biadgilign (2015) carried out a study to identify factors associated with full immunisation coverage among children aged 12-23 months in Ethiopia. This study used the 2011 Ethiopian Demographic and Health Survey data. The survey was cross-sectional by design and used a multistage cluster sampling procedure. A total of 1,927 mothers with children of 12-23 months of age were extracted from the children's dataset. Mothers' self-reported data and observations of vaccination cards were used to determine vaccine coverage. Results from the study showed that children of never married women were more likely to have full vaccination coverage compared to those who were married.

Finally, Adokiya, Baguune and Ndago (2017) evaluated the immunisation coverage and its associated factors among children aged 12–23 months in Techiman Municipality, Ghana. A cross-sectional cluster survey was conducted among 600 children. Data was collected using a semi-structured questionnaire through face-to-face interviews. Descriptive statistics such as percentages, frequencies and cross-

tabulations were performed to estimate the odds ratio of not being fully immunised. Results showed that children of married couples (AOR = 0.29, 95%CI = 0.13–0.68) were more likely to be fully immunised compared to children of never married/singles mothers.

Religion as a Determinant of Childhood Vaccination

With religion as a determinant of childhood vaccination, Weiss, Choudhary and Solomon (2013 explored determinants of routine immunisation performance to strengthen routine immunisation services. The researchers conducted a secondary data analysis of the latest project household immunisation survey in 2011 and compared the findings to reports of past surveys in the Core Group Polio Project (CGPP program area) and at the Uttar Pradesh state level (as measured by children's receipt of DPT vaccinations). This was done to judge whether there is any evidence that routine immunisation services are being disrupted. They also modelled characteristics of survey respondents and respondents' exposure to CGPP, communication activities against their children's receipt of key vaccinations in order to identify determinants of routine immunisation coverage. Results from the study showed that religion influences immunisation coverage.

Lakew, Bekele and Biadgilign (2015) carried out a study to identify factors associated with full immunisation coverage among children aged 12-23 months in Ethiopia. The study used the 2011 Ethiopian demographic and health survey data. The survey was cross-sectional by design and used a multistage cluster sampling procedure. A total of 1,927 mothers with children of 12-23 months of age were extracted from the children's dataset. Mothers' self-reported data and observations

of vaccination cards were used to determine vaccine coverage. It was found from the study that the coverage of vaccination differed by religion.

Adokiya, Baguune and Ndago (2017) evaluated the immunisation coverage and its associated factors among children aged 12–23 months in Techiman Municipality, Ghana. A cross-sectional cluster survey was conducted among 600 children. Data was collected using a semi-structured questionnaire through face-to-face interviews. Descriptive statistics such as percentages, frequencies and cross-tabulations were performed using SPSS, with bivariate and multivariate logistic regression analysis conducted using Stata 12.1 version to estimate the odds ratio of not being fully immunised. Results showed that children from the Christian religion (AOR = 0.17, 95%CI = 0.06–0.50) were more likely to be fully immunised compared to children from Islam.

Lastly, Asuman, Ackah and Enemark (2018) examined rural-urban inequalities in child immunisations in Ghana. Using data from the recent two waves of the Ghana Demographic and Health Survey, the authors examine the probability that a child between 12 and 59 months receives the required vaccinations and proceed to decompose the sources of inequalities in the probability of full immunisation between rural and urban areas. In terms of religion and vaccination, the study revealed that, compared to children of mothers with no or other religious backgrounds, children with Christian or Moslem mothers are more likely to be fully immunised.

Theoretical Framework

This section reviews the model used to study vaccination. This is the Health Care Services Utilisation Model propounded by Andersen in 1995..

Health Care Services Utilisation Model

The Health Care Services Utilisation Model is a behavioural model which was propounded by Anderson in the 1960s (Andersen, 1995). It has been used widely to explain factors that promote or impede health care utilisation. The core postulation of this framework is that some persons have a higher tendency to utilize health service than others. The propensity to use the services are varied and influenced by three sets of individual characteristics: predisposing factors, enabling factors and need-for-care factors.

Predisposing factors denote the demographic, social structure and health belief characteristics, the individual's demographic characteristics that affect his/her decision not to use or to use a health care service. The characteristics may include the individual's sex, age and marital status. Social structure consists of education, ethnicity and occupation and the health belief factors consist of values, attitudes of health care services providers and knowledge about health care.

Enabling factors are the resources or means which are accessible to an individual to pursue healthcare services. Enabling factors are measured at the household level, thus, the availability of income and the community level, the availability and location of healthcare facilities in the community.

Need-for-care factors refer to how individuals perceives their own general health and functional condition, as well as their familiarity with the signs and

symptoms of ill health, agony and concerns about their health (Andersen, 1995). The need-for-care factors are affected by the predisposing factors and the enabling factors of an individual.

The health care services utilisation model embraces both structural and material factors which are barely taken into consideration in the social-psychological model (Hausamann-Muela, Ribera, & Nyamongo, 2003).

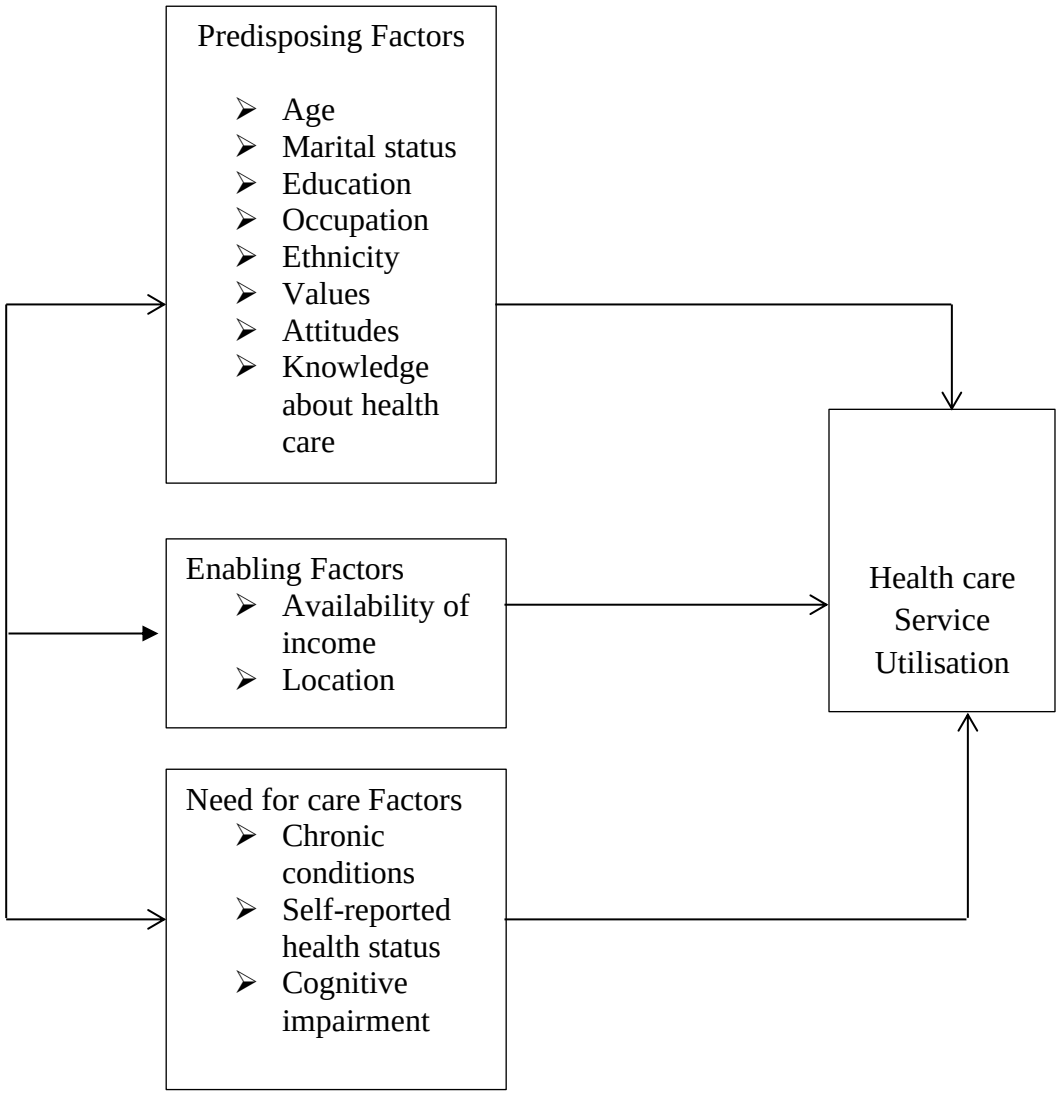

Figure 1: Health Care Utilisation Model
Source: Andersen, 1995

Conceptual Framework

The Health Care Service Utilisation Model by Andersen (1995) was adapted as the conceptual framework for this study. This is because the model best fit considering the objectives, the data availability and focus of the study. The model identifies the interactions among predisposing factors, enabling factors and the need-for-care factors in the utilisation of health care services.

In order to precisely replicate the variables of interest of the study in the adapted model, the framework uses age, occupation, ethnicity, education, region and marital status. The enabling factors were wealth status and place of residence whilst the need-for-care factor was parity. Some variables were excluded because they were not captured in the GDHS data set for which the study was grounded.

The independent variables for the study are predisposing factors which are age, occupation, ethnicity, education, region and marital status; enabling factors are wealth status and place of residence and the need-for-care factor is, parity. The dependent variable for the study is childhood vaccination. It is expected that the interaction of predisposing factors, enabling factions and need for care factor would influence vaccination of children under five years of age. From the framework, each of the three groups of variables individually affect childhood vaccination and collectively they have an influence the outcome variable. That is only the predisposing factors affect the outcome variable, only the enabling factors affect the outcome variable and the need for care only also affect the outcome variable. The combination of the predisposing, enabling and need for care factors also affect the outcome variable.

The strength of the model lies in the fact that it looks at the direct factors that lead to the utilisation of health care services. Specifically, it looks at the individual characteristics and the resources or means available to pursue health care services. The limitation of the model is that it is biased towards the utilisation of healthcare services and does not look at the satisfaction of clients in their utilisation of healthcare services. The second limitation is that it is silent about the healthcare systems and the social network and the influence of culture on the utilisation of health care service.

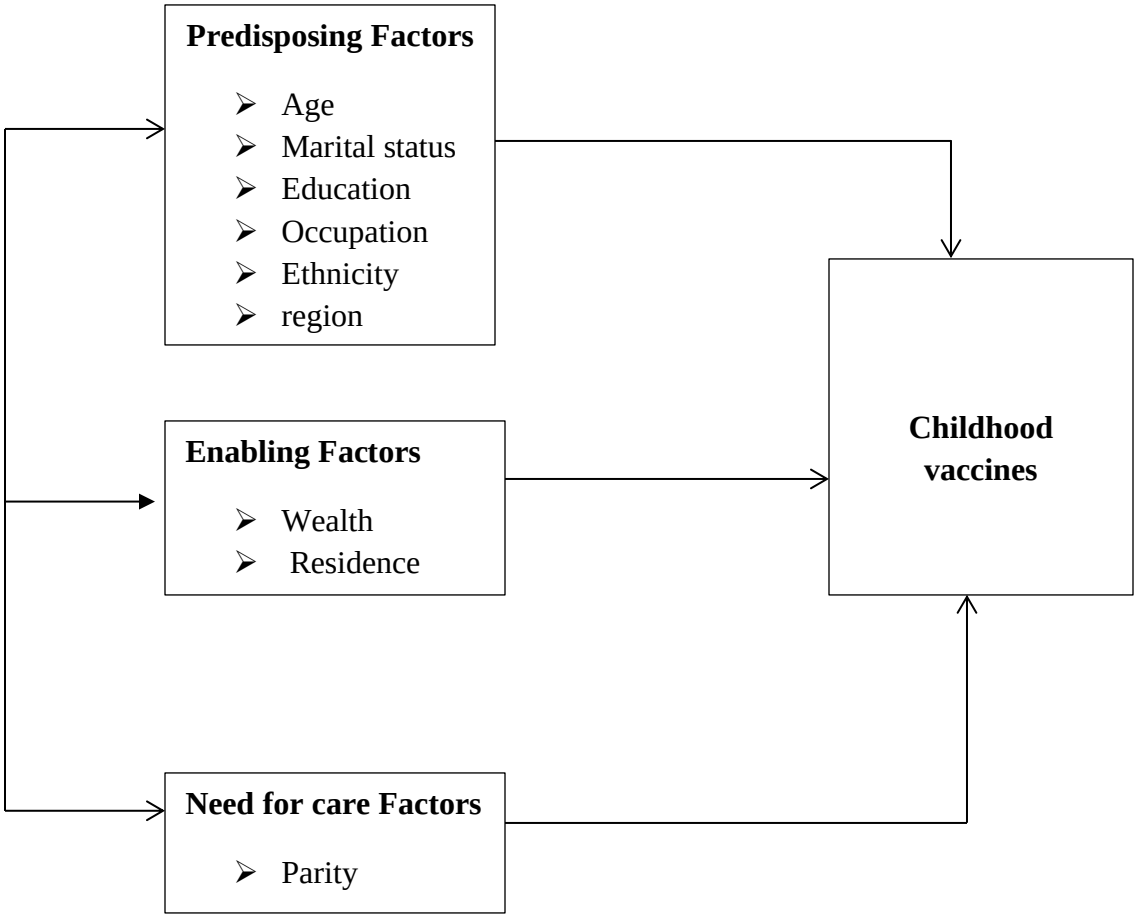

Figure 2: Conceptual framework

Source: Adapted from Andersen (1995).

CHAPTER THREE

METHODS OF DATA COLLECTION AND ANALYSIS

Introduction

This chapter discusses the study area, sources of data, methods of data collection, sampling procedure, data acquisition, definition and description of variables, data processing and management, data analysis as well as the data limitations.

Study Area

The Republic of Ghana, the study area, is located on the West African coast and it has a total land area of 238,533 square kilometers (GSS, 2013). It is bounded by three French-speaking countries (Burkina Faso on the north, Togo in the east and Cote d'Ivory on the west. The south of Ghana lies the 560-kilometers-long Gulf of Guinea. Ghana lies between latitudes 4º and 12ºN and longitudes 4ºW and 2ºE, and the Greenwich Meridian line passes through the sea point of Tema about 24 kilometers to Accra, the capital of the country. Ghana is a low-lying country with a few series of hills on the eastern border and Mountain Afaddjato, the maximum point of 883 metres above sea level which is west of Volta Region.

The population of Ghana, according to the National Population Census conducted in 1960, 1970, 1984, 2000 and 2010 stood at 6,726,815; 8,559,313; 12,296,081; 18,912,079 and 24,658,823 respectively (GSS, 2013). The annual growth rate from 1960 to 1970 was 2.7 percent, 2.6 percent from 1970 to 1984, 2.7 percent from 1984 to 2000 and 2.5 percent from 2000 to 2010 accordingly. The population density based on the 2010 population and housing census was 103

people per square kilometre, with Greater Accra having the highest of 1235.8 people per square kilometer and Northern, the lowest, with 35.2 people per square kilometer. Ghana as at 2000 had a sex ratio of 95 males per 100 females.

The country has been divided into 10 regions. These are Western Region, Central Region, Greater Accra Region, Volta Region, Eastern Region, Ashanti Region, Brong Ahafo Region, Northern Region, Upper East Region and Upper West Region. With these 10 administrative regions, Ashanti Region has the highest population of 19.4%. Greater Accra has the second highest with 16.3% followed by Eastern Region with 10.7%. Northern Region has 10.1%, Western region has 9.6%, Brong Ahafo has 9.4%, Central Region has 8.9% and Volta Region has 8.6%. The Upper East Region and the Upper West Region has the least population of 4.2% and 2.8% respectively (GSS, 2013).

Ghana has about 51 percent of its population living in urban centres and 49 percent in the rural areas. About 3,405,406, representing 13.8 percent of the total population of the country are below age 5 (Ghana Statistical Service, 2010) In relation to economic activities, Ghana has most of the population in the economically active group. About 42 percent of these economically active people are skilled in agriculture, 21 percent are service and sales workers and forestry workers whereas 9.5 percent are professionals, managers and technicians whiles 12.6% are into other occupation. (GSS, 2013).

In terms of education, Ghana has about 26 percent of its population 6 years or older having no education (Never attended school, Nursery, and Kindergarten), with 56.3 percent in primary education (Primary, JSS/JHS, Middle). Secondary

education (SSS/SHS, Vocational/Technical/Commercial, Post Middle/Post-Secondary Certificate and Post-Secondary Diploma) represents 15.6 percent of the population 6 years and older. Higher education (Bachelor Degree and Post Graduate) denotes 2.1 percent of the population 6 years and older (GSS, 2013)

The dominant ethnic groups in Ghana are Akan (47.5%), Mole Dagbani (16.6%), Ga-Adangbe (7.4%), Gruma (5.7%), Guan (3.7%), Grusi (2.5%) with the rest being others which consist of Mande, Hausa and other ethnic groups. With religious affiliation, the majority of Ghanaians (71.2%) are Christians (Catholic, Protestant, Pentecostal/Charismatic and other Christian) followed by Islam (17.6%), Traditionalist (5.2%), No Religion (5.3%) and 0.8% of the population with Other Religion (GSS, 2013).

Research Design

The GDHS uses a repeated cross-sectional research design. Cross-sectional research design helps to study the current behavior, practices, belief and attitudes of a specific group of respondents at a given point in time Creswell (2014). The cross-sectional research design was used because complete coverage of the population was impossible. It addresses the survey population in a short period of time and also produces comparable and equal valid results.

This study employed a cross-sectional study design to assess childhood vaccination in Ghana. This study design was considered suitable because of the nature of the data, the objectives and the hypotheses guiding the study. The philosophical basis for the study was positivist, which asserts that knowledge is attainable and can be quantified. According to Creswell (2014), a respondent's

belief and attitude would be a measure of his/her perception of the problem at hand while the respondent's practices would reflect his/her behaviour in response to the problem at hand. It has an epistemological assumption since human behaviour can be studied through numeric and hard data aimed at measuring and describing the social phenomenon, and these attributes entirely coincide with the focus of this study.

Source of Data

The study used four datasets from the GDHS which were conducted in 1998, 2003, 2008 and 2014. This is because the first and second datasets of the GDHS (those conducted in 1988 and 1993) had a number of inconsistencies. For instance, DPT was not present in the 1988 and 1993. The GDHS is a nationwide survey that is carried out every five years since it began. The survey gathers information on fertility, family planning infant and child mortality, maternal and child health as well as nutrition. The GDHS focuses on child and maternal health and is designed to provide adequate data to monitor the population and health situation in Ghana.

Typically, with the nationwide survey, the GDHS uses sample weights to regulate for effects of under-and-oversampling which have the potential to affect the generalizability of the result. The sample weights are alternation factors used to account for differences in the probability of selection and interview of respondents as a result of the design for the survey or as a result of chance (GSS, GHS & ICF Marco, 2015).

The GDHS was carried out by the GSS with ICF Macro an International company, providing technical support for the survey through Measure DHS. GDHS is funded by United States Agency for International Development (USAID) and the Government of Ghana with support from other donor agencies such as UNICEF, the Global Fund, the International Labor Organization (ILO), the Danish International Development Agency (DANIDA), the United Nations Development Programme (UNDP), and the United Nations Population Fund (UNFPA).

Target Population

The target population for the study was children between the ages of 0-23 months who were usual residents of the selected household. The reason for focusing on children between the ages of 0-23 month was that, according to the vaccination schedule, the last vaccine to be received by children is the third doses of Polio and DPT which is given when the child is 23 months. Mothers of these children therefore were the respondents for the study. This is because children between the ages of 0-23 months could not speak for themselves.

Sampling Procedures

The GDHS uses a two-stage sample design. The first stage involved selecting points or clusters from an updated master sampling frame constructed from the most recent Ghana Population and Housing Census. The 1998 GDHS were based on the 1984 Population and Housing Census and 2003, 2008 and 2014 GDHS were based on the 2000 and 2010 Population and Housing Census respectively.

The second stage of the sampling procedure also involved the systematic sampling of households listed in each cluster and households to be included in the survey were randomly selected from the list. Weights were calculated taking into consideration respective clusters, households and individual no-responses so that there would be representativeness that is proportional at the national level.

Table 2: Sampling Procedure

Round	Sample Frame	Cluster	Household	Women with children less than 5 years	Women with children 0-23 months
6 (2014)	2010 PHC	427	12831	5884	1215
5 (2008)	2000 PHC	412	11778	2978	1198
4 (2003)	2000 PHC	412	6251	3815	1447
3 (1998)	1984 PHC	400	6375	3298	1282

Source: Computed from 1998, 2003, 2008 and 2014 GDHS

Acquisition of Data

The data for the study was acquired from Measure DHS through the internet. A registration form was filed by the researcher after which approval was granted to access the datasets. In addition to the registration, I added a brief proposal which indicated how relevant the datasets are to my research. I was then allowed to download the datasets from Measure DHS when my application was accepted. The datasets are available in SAS, SPSS, STATA and CSPRO formats, however, only the datasets in STATA were downloaded for this work.

The datasets were generated using the standard DHS model questionnaire developed by the Measure DHS program (GSS, GHS & ICF Macro, 2015; GSS, Noguchi Memorial Institute for Medical Research and ORC Marco, 2014; GSS & Marco International, 1999).

Description and Definition of Dependent Variables

The study used four variables as the dependent or outcome variables. These variables were obtained from the questions "Did (NAME) ever received vaccination against Measles?", "Did (NAME) ever receive vaccination against Polio?", "Did (NAME) ever receive vaccination against BCG?" and "Did (NAME) ever receive vaccination against DPT?". These variables were chosen because the study tries to investigate the individual vaccines that are required for children in Ghana. Responses for each of these questions were categorized under 'yes', 'no' and 'don't know'. These responses were re-coded into dichotomous variables (No and Don't Know =0 and Yes = 1). The literature is not consistent on whether 'no' and 'don't know' responses mean the same. One school of thought argue that 'no' and 'don't know' mean different things and should be analysed separately (Waters, Hay, Orom, Kiviniemi & Drake, 2013) others are of the view that they are similar and could be analysed together (Darteh *et. al.*, 2014: Gravningen, Furberg, Simonsen & Wilsgaard, 2012; Groothuis & Whitehead, 2002). For the purpose of this study, I subscribed to the views of the second school of thought that 'no' and 'don't know' are similar and can be analysed together. And also because there were fewer cases for the 'don't know' category.

Independent Variable

The study made use of ten independent variables. These variables are all maternal variables. These were age, region, educational level, wealth index, parity, ethnicity, place of residence, religion and occupation (Asuman et al., 2017; Adokiya et al., 2017; Lakew et al.,2015). The age of respondents was categorised into groups, thus, 15-19, 20-24, 25-29, 30-34, 35-39, 40-44 and 45-49. Region was captured as Central, Western, Eastern, Greater Accra, Ashanti, Brong Ahafo, Volta, Northern, Upper East and Upper West. The educational level was classified into No education, Primary education, Secondary education and Higher education. The place of residences was coded as Rural and Urban settlements.

Marital status was recoded into Married, never married, Widowed, Divorced and Cohabitation. The wealth status is grouped into five quintiles. They are Poorest, Poorer, Middle, Richer and Richest. Parity was coded from a question that assessed the number of children a woman had ever given birth to. Responses were grouped into Null birth (that is, prior to current pregnancy), One birth, Two births, Three births and Four or more births. The occupation was recoded into Working and Not working. In addition, Ethnicity was recoded into Akan (which consists of Asante, Akwapim, Fante and others), Ga-Adangbe, Ewe, Guan, Mole-Dagbani, Grussi, Gruma, Mande and Others. Religion was recoded into Christian, Islam, Traditional, No Religion and Other.

Data Analysis

The data were processed and analysed using STATA version 13 with the use of both inferential and descriptive statistics. The wealth file and the individual

file in the GDHS 1998 dataset were merged together since they were separated in the dataset but with the GDHS 2003, 2008 and 2014, the datasets had wealth as a variable in the individual file. Some variables such as marital status, occupation, parity, etc were recoded, renamed and generated to suit the objectives of this study after which tables and graphs were used for the presentation of the results. All missing values were further dropped to have a clean and consistent dataset The results were weighted with the available sample weight factor (v005) within the GDHS data. Univariate, bivariate, multivariate and binary logistic regression analyses were employed.

Binary logistic was used to assess the effect of the independent variables on a specific outcome variable. It is based on the assumption that the outcome variable will be dichotomous in nature and also has no outliers. The outcome variables are captured in dichotomous variables and so will help to explain their association with independent variables.

The dependent variables were recoded 0= No and 1= Yes. The explanatory variables used in the binary logistic regression were the predisposing factors such as age, marital status, education, occupation, ethnicity and region. Enabling factors include wealth status, residence and the enabling for care factor, parity. Five models were used to help explain the relationship among variables based on the conceptual framework which were grouped into three factors: predisposing factors, enabling factors and the need for care factors.

The first model, Model 0 was a null model. In the Model I, an incomplete model which featured the predisposing factors (age, region, marital status, education, ethnicity and occupation). In the Model II, enabling factors wealth status and residence were added to the variables in Model I. The next model, Model III, was a model which comprised all the variables used in the Model I, Model 11 and the variable in the need for care factors: parity. The final model, Model IV, was a full model where year of survey was controlled for. This sequential modelling was done to determine how much of effect do each of the factors have on the outcome.

Data Limitation

Changes in the sample over time may have effects on the results due to the inherent characteristics. Also, there is also the limitation that comes with self-reporting made by the mother's interview. Questions were asked based on birth history. That is, women were asked questions about themselves three to five years before the round of the survey. This study may be affected by recall bias or deliberate misreporting. Therefore, only women who gave definite responses were concentrated on in the study.

CHAPTER FOUR

RESULTS AND DISCUSSION

Introduction

This chapter report the outcome of the analysis of data from the 1998-2014 Ghana Demographic and Health Survey (GDHS). The analysis focused on the socio-demographic characteristics of the mothers of respondents, trends of vaccination in Ghana and patterns of childhood vaccination in Ghana. Multivariate analysis was conducted using binary logistic analysis. The results are presented in tables and graphs.

Results

Socio-Demographic Characteristics of Respondents

The background characteristics of the respondents are essential in appreciating the dynamics in the group and a good grasp of these helps in understanding the results of the study. This section covers the socio-demographics of the respondents namely; age, residence, region, religion, education, wealth status, occupation, parity, marital status and ethnicity. The respondents for the study were aged 15-49 years. Table 3 shows that respondents were predominately aged 25-29 years. For example, in 1998, about 27 percent of the women were in the 25-29 age group and about 26.6 percent in 2014. Majority of the respondents were from the rural area (74 percent in 1998 and about 55 percent in 2014). Educational level of the respondents varied.

Table 3: Socio-Demographic Characteristics of Respondents

Variables	Years			
	1998 n=1281	**2003** n=1447	**2008** n=1197	**2014** n=1215
Age				
15-19	6.9	6.5	6.8	6.0
20-24	26.6	21.7	23.3	21.1
25-29	27.0	27.1	29.1	26.6
30-34	17.7	21.8	19.3	22.0
35-39	13.6	15.8	14.3	16.3
40-44	6.6	5.1	5.8	6.3
45-49	1.7	2.1	1.4	1.7
Residence				
Rural	74.4	66.5	60.8	54.9
Urban	25.6	33.5	39.2	45.1
Education				
No education	37.1	40.2	31.3	28.5
Primary	21.0	22.4	24.1	18.7
Secondary	41.0	36.5	41.6	48.5
Higher	0.9	1.0	3.0	4.3

Table 3 continued

Marital status				
Never married	2.5	3.4	6.6	8.5
Married	72.3	81.0	69.7	63.1
Cohabiting	18.0	10.1	20.1	24.7
Widowed	0.7	0.6	0.4	0.8
Divorced	6.5	5.0	3.2	2.9
Region				
Western	14.1	9.3	9.7	9.7
Central	11.4	8.6	10.8	10.5
Greater Accra	11.1	10.7	11.3	7.7
Volta	10.6	9.0	9.4	7.7
Eastern	12.8	10.5	8.9	9.0
Ashanti	17.0	12.2	17.7	9.1
Brong Ahafo	7.6	10.9	9.0	11.2
Northern	6.4	14.5	14.9	15.7
Upper East	3.1	3.4	5.4	10.4
Upper West	6.0	5.9	2.9	9.1
Occupation				
Not working	16.1	14.8	11.0	23.0
Working	83.9	85.2	89.0	77.0

Table 3 continued

Ethnicity				
Akan	16.9	44.3	45.7	48.2
Ga-Adangbe	4.1	7.3	4.5	4.7
Ewe	14.4	12.5	13.7	12.4
Guan	17.6	2.6	3.0	2.0
Mole-Dagbani	7.5	17.4	20.2	18.8
Grussi	13.5	2.8	3.7	2.2
Gruma	1.5	4.8	5.0	8.4
Mande	7.7	0.4	0.8	1.1
Others	16.8	8.0	35	2.3
Parity				
One birth	22.7	21.1	21.3	21.4
Two birth	21.2	20.5	23.5	23.2
Three births	15.5	16.6	18.0	16.8
Four or more births	40.6	41.8	37.2	38.6
Wealth quintiles				
Poorest	10.4	26.8	23.9	23.4
Poorer	19.6	22.7	22.0	19.9
Middle	29.1	19.3	19.3	20.6
Richer	27.2	16.4	20.4	19.0
Richest	13.7	14.7	14.4	17.1

Table 3 continued

Religion				
Christianity	74.1	70.8	71.4	74.9
Islam	11.1	18.7	18.9	18.1
Traditionalist	5.1	3.9	5.5	3.3
No religion	9.7	6.5	4.2	3.7
Total	**100**	**100**	**100**	**100**

Source: Computed from GDHS 1998, 2003, 2008 and 2014.

About 37, 40, and 31 percent of the respondents had no education in 1998, 2003 and 2008 respectively whereas in 2014, the highest proportion had secondary education (about 49 percent).

Marital status of the respondents revealed that, the highest proportion of respondents were mothers who were married in all the years under review even though there were variations in the percentages. For instance, in 1998, about 72 percent were married, about 81 percent in 2003, about 70 percent in 2008 and about 63 percent in 2014. There was an increase in the proportion of women not married from 2.5 percent in 1988 to about 8.5 percent while the percentage of divorcees decreased from about 6.5 percent in 1998 to about 2.9 percent in 2014. The region of the respondents varied. In 1998, the highest proportion of the respondents were mothers who were in the Ashanti Region (17 percent) while mothers from the Upper East Region had the least proportion of about 3.1 percent. In 2003, 2008 and 2014, the highest proportion of the mothers of the respondents were in the Northern

Region. The majority of the respondents were mothers who were working for all the years under review (see Table 3).

Respondents in the Guan ethnic groups had the highest proportion in 1998 with about 17.6 percent whereas respondents from the Akan ethnic group dominated in the 2003, 2008 and 2014. Respondents with four or more births had the highest proportion for all the years under review. Wealth quintile showed varying proportions. In 1998, the richer wealth quintile had the highest proportion of about 27 percent. In 2003, 2008 and 2014, the highest proportion were mothers in the poorest wealth quintile. Religious affiliation revealed that, the highest proportion (above 70%) of the respondents were Christians whiles minority of the mothers of the respondents were traditionalists for all the years under review except 2008 where the respondents who had no religion had the least.

Trends of Under Five Vaccination from 1998-2014

Universal vaccination programmes have greatly reduced the burden of infectious diseases in both developing and developed countries (Ethreth, 2003). In the 1960s and 1970s, these reductions led to optimism that a victory in the battle against infectious diseases could be within reach (Cohen *et. al.*, 2000). Unfortunately, even though the benefits of most childhood vaccinations are scientifically unquestioned, vaccination coverage rates are far from 100% in many countries, and show substantial variation (Boven & Lier, 2016). Trends in global vaccination coverage have shown increases with most countries reaching 90% DTP3 coverage in 2008, although under five vaccination continues to persist in parts of sub-Saharan Africa particularly in the urban slums (Aaby & Benn, 2009).

From the study, there was an increase in the proportions of all the childhood vaccines in Ghana. The proportion of children 23 months and below who received the BCG vaccine increased from about 83 percent in 1998 to about 94. percent in 2014. With polio, the proportion of children aged 0-23 months who received the vaccine increased from about 54 percent in 1998 to about 79.3 percent in 2014 (See Figure 5).

Children who received the measles vaccine before the age of 24 months increased from about 43 percent in 1998 to about 50 percent in 2014. The proportion of children under 24 months who received the DPT3 vaccine increased from about 54 percent in 1998 to about 71 percent in 2014. (See Figure 5).

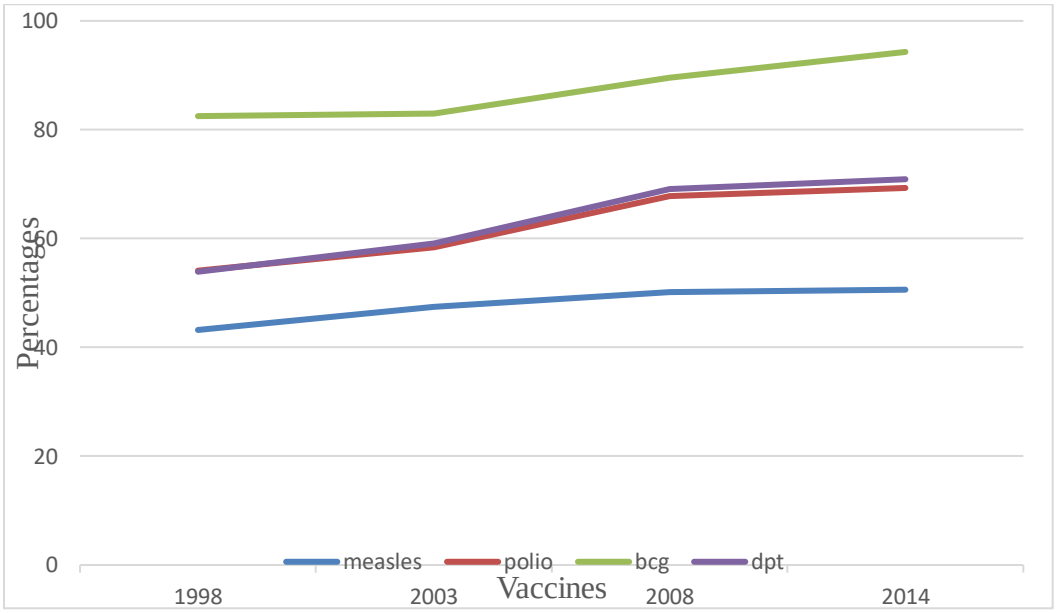

Figure 3: Trends of childhood vaccination from 1998 to 2014

Source: Computed from GDHS 1998, 2003, 2008 and 2014

Prevalence of Childhood Vaccination in Ghana from 1998-2014

Table 4 presents results on the prevalence of childhood vaccination in Ghana from 1998-2014. The results indicate that 47.7% of children received measles from 1998 to 2014, with variations in vaccination coverage in the sub-groups. The prevalence of measles vaccination was high among children born to women aged 45-49 (55.5%), urban women (51.8%), those with secondary education (54%), the widowed (71.4%), women in the Brong Ahafo region (51.3%), working women (49%), Akans (52.2%), women with one birth (51.1%), richest women (53.2%) and Christians (49.8%). The chi-square test results showed significant associations between age, residence, level of education, marital status, region, occupation, ethnicity, parity, wealth status and religion and measles vaccination at 95% CI.

In terms of polio, 62.1% of children received vaccination from 1998 to 2014. vaccination for polio was high among children born to women aged 25-29 (64.6%), urban women (68.4%), those with higher education (71%), the widowed (69.1%), women in the Brong Ahafo region (67.1%), working women (63.1%), Akans (68.8%), women with one birth (64.6%), richest women (68.3%) and Christians (65.3%). The chi-square test results showed significant associations between age, residence, level of education, region, occupation, ethnicity, parity, wealth status and religion and polio vaccination at 95% CI (see Table 4).

With BCG, 87.1% of children had received vaccination from 1998 to 2014. Vaccination for BCG was high among children born to women aged 30-34 (64.6%), urban women (95.3%), those with higher education (97.2%), the widowed (97.6%),

women in the Greater Accra region (93.5%), working women (87.2%), Ga-Adangbes (91.6%), women with two births (88.8%), richest women (91.2%) and Christians (89.3%). The chi-square test results showed significant associations between residence, level of education, region, ethnicity, parity, wealth status and religion and BCG vaccination at 95% CI (see Table 4).

With respect to DPT, 63% of children had received vaccination from 1998 to 2014. Vaccination for DPT was high among children born to women aged 25-29 (65.5%), rural women (70.9%), those with higher education (75.7%), the widowed (69.1%), women in the Ashanti region (69.3%), working women (64.2%), Akans (70.3%), women with one birth (66.1%), richest women (71.4%) and Christians (66.4%). The chi-square test results showed significant associations between age, residence, level of education, region, occupation, ethnicity, parity, wealth status and religion and BCG vaccination at 95% CI (see Table 4).

Table 4: Socio-demographic characteristics of mothers and prevalence of childhood vaccination in Ghana from 1998-2014

	Childhood vaccination			
Variables	**Measles**	**Polio**	**BCG**	**DPT**
Overall	47.7	62.1	87.1	63.0
Age				
15-19	36.1	54.8	85.1	55.1
20-24	47.7	61.0	86.2	62.5
25-29	48.4	64.6	87.6	65.5
30-34	49.2	63.3	89.1	64.6
35-39	50.1	62.5	87.1	62.4
40-44	43.5	59.5	84.7	59.8
45-49	55.5	57.4	83.2	56.4
$\chi 2$ (p-value)	25.0 (0.000)	14.0 (0.029)	9.0 (0.173)	16.8 (0.0010)
Residence				
Rural	45.9	59.3	83.8	70.9
Urban	51.8	68.4	95.3	59.4
$\chi 2$ (p-value)	15.4 (0.000)	38.6 (0.000)	107.8 (0.000)	62.3 (0.000)
Education				
No education	42.8	55.3	82.1	55.6
Primary	46.4	61.3	87.3	61.3
Secondary	54.0	69.9	92.1	71.7
Higher	50.5	71.0	97.2	75.7
$\chi 2$ (p-value)	50.7 (0.000)	93.7 (0.000)	97.7 (0.000)	118.1 (0.000)
Marital status				
Never married	48.3	64.4	89.1	67.8
Married	47.9	62.7	87.0	63.2
Cohabiting	45.9	58.9	87.1	60.2
Widowed	71.4	69.1	97.6	69.1
Divorced	46.0	60.5	83.1	62.0
$\chi 2$ (p-value)	10.8 (0.029)	5.6 (0.227)	7.3 (0.121)	5.7 (0.219)
Region				
Western	47.6	64.4	87.6	65.4
Central	47.4	62.0	88.7	62.2
Greater Accra	49.1	66.7	93.5	69.0
Volta	47.8	61.1	85.3	62.2
Eastern	49.9	61.0	87.2	62.1
Ashanti	49.5	67.0	89.0	69.3
Brong Ahafo	51.3	67.1	87.5	67.3
Northern	41.0	48.7	76.1	47.6
Upper East	46.8	63.7	90.7	65.8
Upper West	49.9	64.6	90.6	64.6
$\chi 2$ (p-value)	19.1 (0.025)	75.7 (0.000)	111.8 (0.000)	100.5 (0.000)
Occupation				
Not working	40.8	56.6	86.5	56.5
Working	49.0	63.1	87.2	64.2

Table 4 continued

$\chi 2$ (p-value)	18.4 (0.000)	12.4 (0.000)	0.3 (0.589)	17.3 (0.000)
Ethnicity				
Akan	52.2	68.8	90.5	70.3
Ga-Adangbe	51.5	65.3	91.6	64.4
Ewe	47.1	60.8	89.2	61.8
Guan	46.6	61.4	82.2	62.8
Mole-Dagbani	47.8	62.9	88.6	64.4
Grussi	48.3	59.1	85.5	60.7
Gruma	37.7	48.3	74.7	48.0
Mande	46.4	56.4	87.2	55.9
Other	39.3	51.4	79.2	50.0
$\chi 2$ (p-value)	40.6 (0.000)	84.5 (0.000)	100.7 (0.000)	107.4 (0.000)
Parity				
One birth	51.1	64.6	88.5	66.1
Two births	47.9	63.8	88.8	64.7
Three births	48.2	63.0	87.4	64.4
Four or more births	45.8	59.1	87.1	59.9
$\chi 2$ (p-value)	7.9 (0.047)	10.0 (0.018)	10.8 (0.013)	15.3 (0.002)
Wealth quintile				
Poorest	46.2	59.6	83.6	60.3
Poorer	45.0	62.1	86.1	61.4
Middle	47.2	60.9	87.6	61.8
Richer	48.9	63.0	89.6	64.3
Richest	53.2	68.3	91.2	71.4
$\chi 2$ (p-value)	11.0(0.027)	15.4 (0.004)	30.3 (0.000)	26.6 (0.000)
Religion				
Christianity	49.8	65.3	89.3	66.4
Islam	46.8	60.6	86.3	61.3
Traditionalist	41.8	47.5	74.9	47.5
No religion	35.3	49.0	78.6	48.4
$\chi 2$ (df) (p-value)	32.9 (0.000)	72.0 (0.000)	80.7 (0.000)	85.1 (0.000)

source: Computed from GDHS 1998, 2003, 2008 and 2014

Determinants of Measles Vaccination

Table 5 presents results on the logistic regression analysis of the determinants of measles vaccination among children in Ghana. The results indicate that the odds of measles vaccination increased with age with children of women aged 45-49 more likely to be vaccinated against measles compared to those aged 15-19 (AOR=3.91, 95% CI= 2.34-6.52). The likelihood of measles vaccination also increased among children born to women with secondary level of education

(AOR=1.37, 95% CI= 1.16-1.63), the widowed (AOR=2.94, 95% CI= 1.39-6.19), the working (AOR=1.43, 95% CI= 1.21-1.68) and children born in the 2014 survey year (AOR=1.25, 95% CI= 1.03-1.52). On the other hand, the odds of measles vaccination was low among children born to women of Gruma ethnic group (AOR=0.68, 95% CI= 0.50-0.93) and those who had no religion (AOR=0.68, 95% CI= 0.53-0.86) and those with four or more births (AOR=0.54, 95% CI= 0.43-0.68). The results further show model IV as the best fit model with a log likelihood ratio of -3457.4, compared to -3557.5 in the null model, -3478.9 in model I, -3474.7 in Model II and -3460.2 in model III.

Table 5: Determinants of vaccination for measles among children under five in Ghana

Variables	Model 0 OR (95% CI)	Model I AOR (95% CI)	Model II AOR (95% CI)	Model III AOR (95% CI)	Model IV AOR (95% CI)
Age					
15-19		1	1	1	1
20-24		1.64***	1.63***	1.92***	1.91***
		(1.26-2.15)	(1.25-2.14)	(1.45-2.53)	(1.45-2.52)
25-29		1.68***	1.64***	2.27***	2.25***
		(1.28-2.21)	(1.25-2.16)	(1.68-3.06)	(1.66-3.04)
30-34		1.70***	1.66***	2.59***	2.55***
		(1.28-2.26)	(1.25-2.21)	(1.86-3.60)	(1.84-3.55)
35-39		1.82***	1.77***	2.89***	2.84***
		(1.35-2.44)	(1.32-2.38)	(2.04-4.08)	(2.01-4.03)

Table 5 continued

40-44	1.49*	1.48*	2.44***	2.39***
	(1.06-2.09)	(1.05-2.08)	(1.65-3.60)	(1.62-3.52)
45-49	2.42***	2.30***	3.94***	3.91***
	(1.51-3.88)	(1.49-3.85)	(2.36-6.57)	(2.34-6.52)
Education				
No education	1	1	1	1
Primary	1.15	1.14	1.13	1.12
	(0.97-1.36)	(0.96-1.35)	(0.95-1.34)	(0.95-1.33)
Secondary	1.52***	1.47***	1.38***	1.37***
	(1.29-1.79)	(1.25-1.74)	(1.17-1.64)	(1.16-1.63)
Higher	1.18	1.04	0.84	0.81
	(0.79-1.77)	(0.69-1.58)	(0.55-1.29)	(0.53-1.24)
Marital status				
Never married	1	1	1	1
Married	0.88	0.88	0.97	1.01
	(0.66-1.19)	(0.65-1.19)	(0.72-1.31)	(0.75-1.36)
Cohabiting	0.76	0.76	0.82	0.84
	(0.56-1.04)	(0.56-1.04)	(0.60-1.13)	(0.61-1.15)
Widowed	2.48*	2.45*	2.84**	2.94**
	(1.18-5.22)	(1.16-5.18)	(1.34-5.98)	(1.39-6.19)
Divorced	0.84	0.84	0.91	0.96
	(0.57-1.24)	(0.57-1.24)	(0.61-1.35)	(0.64-1.43)
Region				
Western	1	1	1	1
Central	0.97	0.96	0.97	0.97
	(0.74-1.26)	(0.74-1.25)	(0.74-1.26)	(0.74-1.26)

Table 5 continued

Greater	1.03	0.93	0.89	0.90
Accra	(0.78-1.35)	(0.70-1.23)	(0.67-1.19)	(0.68-1.20)
Volta	1.20	1.21	1.19	1.16
	(0.900-1.61)	(0.91-1.63)	(0.89-1.59)	(0.86-1.56)
Eastern	1.08	1.08	1.09	1.09
	(0.83-1.40)	(0.83-1.40)	(0.83-1.41)	(0.84-1.42)
Ashanti	1.01	0.99	0.99	1.02
	(0.79-1.29)	(0.78-1.27)	(0.78-1.27)	(0.79-1.30)
Brong Ahafo	1.23	1.21	1.19	1.18
	(0.95-1.59)	(0.94-1.57)	(0.92-1.55)	(0.91-1.53)
Northern	1.01	0.99	0.96	0.95
	(0.77-1.34)	(0.74-1.31)	(0.72-1.27)	(0.71-1.26)
Upper East	1.23	1.21	1.15	1.12
	(0.91-1.65)	(0.89-1.64)	(0.84-1.56)	(0.82-1.52)
Upper West	1.43*	1.43*	1.36*	1.31
	(1.01-1.92)	(1.06-1.93)	(1.01-1.84)	(0.97-1.78)
Occupation				
Not working	1	1	1	1
Working	1.36***	1.38***	1.41***	1.43***
	(1.16-1.60)	(1.18-1.63)	(1.20-1.66)	(1.21-1.68)
Ethnicity				
Akan	1	1	1	1
Ga-Adangbe	0.99	1.00	1.00	1.02
	(0.74-1.34)	(0.74-1.35)	(0.74-1.35)	(0.75-1.38)
Ewe	0.83	0.82	0.81	0.83
	(0.67-1.03)	(0.66-1.02)	(0.65-1.00)	(0.67-1.04)
Guan	0.84	0.85	0.84	0.92
	(0.65-1.08)	(0.65-1.10)	(0.65-1.09)	(0.70-1.22)

Table 5 continued

Mole-	0.87	0.86	0.85	0.87
Dagbani	(0.69-1.08)	(0.69-1.08)	(0.68-1.06)	(0.69-1.09)
Grussi	0.80	0.81	0.80	0.86
	(0.61-1.06)	(0.61-1.07)	(0.60-1.05)	(0.64-1.15)
Gruma	0.69*	0.69*	0.68*	0.68*
	(0.51-0.94)	(0.50-0.94)	(0.50-0.93)	(0.50-0.93)
Mande	0.85	0.85	0.84	0.75
	(0.59-1.22)	(0.59-1.23)	(0.58-1.22)	(0.64-1.43)
Other	0.65***	0.65**	0.65**	0.72*
	(0.50-0.84)	(0.50-0.85)	(0.50-0.84)	(0.54-0.97)
Religion				
Christianity	1	1	1	1
Islam	1.09	1.06	1.08	1.04
	(0.91-1.30)	(0.89-1.28)	(0.90-1.29)	(0.87-1.25)
Traditionalist	0.90	0.91	0.94	0.95
	(0.70-1.17)	(0.70-1.17)	(0.73-1.22)	(0.73-1.23)
No religion	0.65***	0.65***	0.67**	0.68**
	(0.51-0.83)	(0.51-0.83)	(0.52-0.85)	0.53-0.86)
Residence				
Urban		1	1	1
Rural		0.88	0.90	0.93
		(0.76-1.03)	(0.77-1.05)	(0.79-1.08)
Wealth status				
Poorest		1	1	1
Poorer		0.90	0.89	0.91
		(0.75-1.07)	(0.74-1.06)	(0.76-1.08)
Middle		0.91	0.89	0.93
		(0.76-1.10)	(0.74-1.08)	(0.77-1.12)

Table 5 continued

Richer			0.96	0.93	0.97
			(0.78-1.17)	(0.76-1.14)	(0.79-1.19)
Richest			1.07	1.03	1.07
			(0.85-1.36)	(0.76-1.14)	(0.84-1.36)

Table 4 continued

One birth				1	1
Two births				0.69***	0.68***
				(0.57-0.83)	(0.56-0.82)
Three births				0.65***	0.64***
				(0.52-0.80)	(0.51-0.80)
Four or more				0.54**	0.54***
births				(0.43-0.68)	(0.43-0.68)
Survey year					
1998					1
2003					1.10
					(0.91-1.32)
2008					1.19
					(0.98-1.44)
2014					1.25*
					(1.03-1.52)
-2LL	-3557.5	-3478.9	-3474.7	-3460.2	-3457.4
% change in -2LL		0.786	0.042	0.145	0.028
N	5140	5140	5140	5140	5140

*p<0.05, **p<0.01, ***p<0.001

Source: Computed from GDHS 1998, 2003, 2008 and 2014

Determinants of Polio Vaccination

Table 6 presents results on the logistic regression analysis of the determinants of polio vaccination among children in Ghana. The likelihood of polio vaccination increased among children born to women aged 35-39 (AOR=1.95 95% CI= 1.37-2.77), those with secondary level of education (AOR=1.45, 95% CI= 1.21-1.73), those who lived in the Upper West region (AOR=1.38, 95% CI= 1.01-1.90), the working (AOR=1.40, 95% CI= 1.19-1.65) and children born in the 2014 survey year (AOR=1.78, 95% CI= 1.45-2.18). On the other hand, the odds of polio vaccination were low among children born to women of Grussi ethnic group (AOR=0.73, 95% CI= 0.54-0.98) and those who had no religion (AOR=0.68, 95% CI= 0.54-0.85) and those with four or more births (AOR=0.68, 95% CI= 0.53-0.87). The results further show model IV as the best fit model with a log likelihood ratio of -3258.6, compared to compared to -3410.7 in the null model, -3295.4 in model I, -3287.8 in Model II and -3283.1 in model III.

Table 6: Determinants of vaccination for polio among children under five in Ghana

Variables	Model 0 OR (95% CI)	Model I AOR (95% CI)	Model II AOR (95% CI)	Model III AOR (95% CI)	Model IV AOR (95% CI)
Age					
15-19		1	1	1	1
20-24		1.31* (1.02-1.70)	1.31* (1.01-1.70)	1.45** (1.10-1.90)	1.45** (1.10-1.90)
25-29		1.54** (1.19-1.99)	1.50** (1.16-1.95)	1.85*** (1.38-2.49)	1.86*** (1.38-2.51)
30-34		1.45** (1.11-1.89)	1.41* (1.08-1.84)	1.88*** (1.36-2.61)	1.87*** (1.35-2.60)
35-39		1.47** (1.12-1.95)	1.43* (1.08-1.89)	1.96*** (1.39-2.78)	1.95*** (1.37-2.77)

Table 6 continued

40-44	1.44*	1.42*	1.97***	1.90**
	(1.04-1.99)	(1.03-1.97)	(1.33-2.90)	(1.29-2.81)
45-49	1.35	1.33	1.83*	1.86*
	(0.85-2.15)	(0.83-2.12)	(1.10-3.06)	(1.011-3.12)
Education				
No education	1	1	1	1
Primary	1.15	1.14	1.13	1.09
	(0.97-1.37)	(0.96-1.36)	(0.95-1.35)	(0.92-1.30)
Secondary	1.62***	1.57***	1.51***	1.45***
	(1.37-1.92)	(1.32-1.87)	(1.26-1.80)	(1.21-1.73)
Higher	1.54	1.32	1.16	1.01
	(0.98-2.40)	(0.83-2.11)	(0.72-1.86)	(1.21-1.73)
Region				
Western	1	1	1	1
Central	0.87	0.87	0.87	0.87
	(0.66-1.14)	(0.66-1.15)	(0.66-1.16)	(0.65-1.16)
Greater	1.07	0.93	0.91	0.95
Accra	(0.80-1.43)	(0.69-1.25)	(0.67-1.23)	(0.70-1.28)
Volta	1.13	1.15	1.14	1.08
	(0.84-1.53)	(0.86-1.55)	(0.84-1.53)	(0.80-1.45)
Eastern	0.85	0.84	0.84	0.85
	(0.65-1.11)	(0.63-1.10)	(0.64-1.10)	(0.65-1.12)
Ashanti	1.01	0.98	0.98	1.04
	(0.78-1.31)	(0.75-1.27)	(0.75-1.27)	(0.80-1.36)
Brong Ahafo	1.18	1.15	1.14	1.12
	(0.90-1.55)	(0.87-1.51)	(0.87-1.49)	(0.85-1.47)
Northern	0.74*	0.71*	0.70*	0.68*
	(0.55-0.98)	(0.53-0.95)	(0.53-0.93)	(0.51-0.91)

Table 6 continued

Upper East	1.42*	1.38*	1.34	1.28
	(1.04-1.93)	(1.13-2.11)	(0.98-1.84)	(0.93-1.76)
Upper West	1.58**	1.54**	1.51*	1.38*
	(1.16-2.14)	(1.13-2.11)	(1.10-2.06)	(1.01-1.90)
Occupation				
Not working	1	1	1	1
Working	1.31***	1.34***	1.36***	1.40***
	(1.12-1.54)	(1.14-1.58)	(1.15-1.60)	(1.19-1.65)
Ethnicity				
Akan	1	1	1	1
Ga-Adangbe	0.93	0.94	0.94	1.01
	(0.68-1.27)	(0.68-1.29)	(0.68-1.29)	(0.73-1.39)
Ewe	0.74**	0.73**	0.72**	0.78*
	(0.59-0.93)	(0.58-0.91)	(0.57-0.90)	(0.62-0.98)
Guan	0.81	0.83	0.83	1.04
	(0.62-1.06)	(0.64-1.09)	(0.64-1.09)	(0.78-1.38)
Mole-	0.84	0.83	0.82	0.88
Dagbani	(0.67-1.06)	(0.66-1.04)	(0.65-1.04)	(0.69-1.12)
Grussi	0.61***	0.62***	0.61***	0.73*
	(0.46-0.81)	(0.47-0.82)	(0.46-0.82)	(0.54-0.98)
Gruma	0.74	0.72*	0.72*	0.71*
	(0.54-1.01)	(0.53-0.99)	(0.52-0.99)	(0.52-0.98)
Mande	0.70	0.73	0.73	0.98
	(0.48-1.02)	(0.50-1.07)	(0.50-1.07)	(0.65-1.48)
Other	0.54***	0.57***	0.57***	0.75
	(0.42-0.71)	(0.44-0.74)	(0.44-0.74)	(0.56-1.00)

Table 6 continued

Religion				
Christianity	1	1	1	1
Islam	1.15	1.10	1.11	1.03
	(0.95-1.38)	(0.92-1.34)	(0.92-1.34)	(0.85-1.24)
Traditionalist	0.67**	0.67**	0.68**	0.69**
	(0.52-0.86)	(0.52-0.87)	(0.53-0.89)	(0.53-0.89)
No religion	0.65***	0.64***	0.65***	0.68***
	(0.51-0.81)	(0.51-0.81)	(0.52-0.82)	(0.54-0.85)
Residence				
Urban		1	1	1
Rural		0.78**	0.79**	0.86
		(0.66-0.91)	(0.67-0.92)	(0.73-1.01)
Wealth status				
Poorest		1	1	1
Poorer		0.92	0.92	0.96
		(0.77-1.11)	(0.76-1.10)	(0.80-1.15)
Middle		0.82*	0.81*	0.89
		(0.68-1.00)	(0.67-0.98)	(0.73-1.08)
Richer		0.87	0.86	0.95
		(0.71-1.07)	(0.70-1.06)	(0.77-1.17)
Richest		0.98	0.96	1.07
		(0.76-1.25)	(0.75-1.23)	(0.83-1.37)
Parity				
One birth			1	1
Two births			0.83	0.81*
			(0.68-1.01)	(0.66-0.99)
Three births			0.76*	0.74*
			(0.61-0.96)	(0.59-0.94)

Table 6 continued

Four or more births				0.69** (0.54-0.88)	0.68** (0.53-0.87)
Survey year					
1998					
2003					1.13 (0.94-1.36)
2008					1.62*** (1.33-1.97)
2014					1.78*** (1.45-2.18)
-2LL	-3410.7	-3295.4	-3287.8	-3283.1	-3258.6
% change in -2LL		1.153	0.076	0.047	0.245
N	5140	5140	5140	5140	5140

*p<0.05, **p<0.01, ***p<0.001

Source: Computed from GDHS 1998, 2003, 2008 and 2014

Determinants of BCG Vaccination

Table 7 presents results on the logistic regression analysis of the determinants of BCG vaccination among children in Ghana. The likelihood of BCG vaccination increased among children born to women with secondary level of education (AOR=1.66, 95% CI= 1.27-2.18), those who lived in the Upper East region (AOR=2.40, 95% CI=1.48-3.90) and children born in the 2014 survey year (AOR=3.25, 95% CI= 2.29-4.62). On the other hand, the odds of BCG vaccination was low among children born to women who were Traditionalists (AOR=0.58, 95% CI= 0.42-0.81) and those who lived in rural areas (AOR=0.47, 95% CI= 0.35-0.62).

In terms of model fitness, the results show model IV as the best fit model with a log likelihood ratio of -1791.8, compared to compared to -1979.9 in the null model, -1858.6 in model I, -1829.5 in Model II and -1829.0 in model III.

Table 7: Determinants of vaccination for BCG among children under five in Ghana

Variables	Model 0 OR (95% CI)	Model I OR (95% CI)	Model II OR (95% CI)	Model III OR (95% CI)	Model IV OR (95% CI)
Education					
No education		1	1	1	1
Primary		1.25 (0.99-1.58)	1.18 (0.93-1.50)	1.20 (0.94-1.52)	1.12 (0.88-1.43)
Secondary		2.07*** (1.61-2.66)	1.78*** (1.37-2.30)	1.82*** (1.39-2.37)	1.66*** (1.27-2.18)
Higher		5.43** (1.68-17.71)	3.32 (0.99-11.18)	3.47* (1.03-11.72)	2.62 (0.77-8.92)
Region					
Western		1	1	1	1
Central		0.96 (0.63-1.47)	0.94 (0.62-1.44)	0.95 (0.62-1.45)	0.93 (0.61-1.43)
Greater Accra		1.63 (1.00-2.67)	1.01 (0.59-1.71)	1.02 (0.60-1.73)	1.18 (0.66-1.90)
Volta		0.94 (0.61-1.45)	0.96 (0.62-1.48)	0.96 (0.62-1.48)	0.92 (0.59-1.43)
Eastern		0.82 (0.55-1.23)	0.81 (0.54-1.21)	0.80 (0.53-1.21)	0.84 (0.56-1.27)
Ashanti		0.95 (0.65-1.40)	0.89 (0.60-1.31)	0.89 (0.60-1.32)	1.02 (0.69-1.52)
Brong Ahafo		1.02 (0.69-1.50)	0.98 (0.66-1.45)	0.98 (0.66-1.46)	0.97 (0.65-1.45)
Northern		0.67* (0.45-1.00)	0.68 (0.46-1.02)	0.69 (0.46-1.02)	0.68 (0.46-103)

Table 7 continued

Upper East	2.25***	2.40***	2.41***	2.40***
	(1.41-3.57)	(1.49-3.86)	(1.50-3.88)	(1.48-3.90)
Upper West	2.29***	2.47***	2.49***	2.35***
	(1.44-3.64)	(2.47-3.96)	(1.56-3.99)	(1.45-3.82)
Ethnicity				
Akan	1	1	1	1
Ga-Adangbe	1.16	1.22	1.23	1.39
	(0.68-1.96)	(0.72-2.08)	(0.72-2.09)	(0.82-2.37)
Ewe	1.00	0.99	1.00	1.11
	(0.69-1.43)	(0.69-1.43)	(0.69-1.44)	(0.77-1.59)
Guan	0.61**	0.65*	0.66*	0.87
	(0.42-0.87)	(0.45-0.95)	(0.46-0.95)	(0.58-1.30)
Mole-	0.94	0.91	0.92	0.98
Dagbani	(0.65-1.34)	(0.64-1.31)	(0.64-1.32)	(0.68-1.42)
Grussi	0.58*	0.61*	0.61*	0.76
	(0.38-0.88)	(0.40-0.93)	(0.40-0.93)	(0.49-1.19)
Gruma	0.77	0.80	0.81	0.72
	(0.50-1.18)	(0.52-1.24)	(0.53-1.26)	(0.47-1.12)
Mande	0.94	0.94	0.95	1.28
	(0.54-1.64)	(0.53-1.64)	(0.54-1.66)	(0.69-2.38)
Other	0.48***	0.50***	0.50***	0.68
	(0.34-0.69)	(0.35-0.72)	(0.35-0.72)	(0.45-1.03)
Religion				
Christianity	1	1	1	1
Islam	1.18	1.04	1.04	0.95
	(0.90-1.55)	(0.79-1.36)	(0.79-1.36)	(0.72-1.26)
Traditionalist	0.56***	0.58***	0.57***	0.58**
	(0.41-0.77)	(0.42-0.79)	(0.42-0.78)	(0.42-0.81)

Table 7 continued

No religion	0.64**	0.64**	0.64**	0.68*
	(0.47-0.85)	(0.48-0.86)	(0.47-0.86)	(0.35-0.62)
Residence				
Urban		1	1	1
Rural		0.40***	0.40***	0.47***
		(0.30-0.53)	(0.30-0.53)	(0.35-0.62)
Wealth status				
Poorest		1	1	1
Poorer		0.98	0.78	1.06
		(0.76-1.25)	(0.76-1.25)	(0.83-1.37)
Middle		0.96	0.97	1.13
		(0.73-1.27)	(0.73-1.28)	(0.86-1.50)
Richer		1.09	1.09	1.33
		(0.80-1.48)	(0.80-1.49)	(0.97-1.82)
Richest		0.96	0.96	1.20
		(0.65-1.41)	(0.65-1.41)	(0.83-1.75)
Parity				
One birth			1	1
Two births			1.13	1.10
			(0.85-1.49)	(0.83-1.46)
Three births			1.08	1.05
			(0.81-1.44)	(0.78-1.40)
Four or more births			1.13	1.08
			(0.88-1.44)	(0.85-1.98)

Table 7 continued

Survey year					
1998					1
2003					1.08 (0.83-1.41)
2008					1.74*** (1.30-2.33)
2014					3.25*** (2.29-4.62)
-2LL	-1979.9	-1858.6	-1829.5	-1829.0	-1791.8
% change in -2LL		1.213	0.291	0.005	0.372
N	5140	5140	5140	5140	5140

*p<0.05, **p<0.01, ***p<0.001

Source: Computed from GDHS 1998, 2003, 2008 and 2014

Determinants of DPT Vaccination in Ghana from 1998-2014

Table 8 presents results on the logistic regression analysis of the determinants of DPT vaccination among children in Ghana. The results indicate that the odds of measles vaccination increased among children born to aged 30-34 (AOR=1.90, 95% CI= 1.36-2.65), women with higher level of education (AOR=1.45, 95% CI= 1.22-1.74), the working (AOR=1.52, 95% CI= 1.28-1.80) and children born in the 2014 survey year (AOR=1.96, 95% CI= 1.60-2.41). On the other hand, there was a decrease odd of DPT vaccination among children born to women who lived in the Northern region (AOR=0.60, 95% CI= 0.45-0.81), those who belonged to 'other' ethnic groups (AOR=0.70, 95% CI= 0.52-0.94), those with no religion (AOR=0.65, 95% CI= 0.51-0.82), those who lived in rural areas

(AOR=0.80, 95% CI= 0.68-0.94) and those with four or more births (AOR=0.67, 95% CI= 0.53-0.86). In terms of model fitness, the log likelihood of -3193.2 in model IV makes it the best fit model, compared to the null model (-3388.2), model I (-3242.9), model II (-3228.4) and model III (-3223.5).

Table 8: Determinants of vaccination for DPT among children under five in Ghana

Variables	Model 0 OR (95% CI)	Model 0 OR (95% CI)	Model 0 OR (95% CI)	Model 0 OR (95% CI)	Model 0 OR (95% CI)
Age					
15-19		1	1	1	1
20-24		1.38* (1.06-1.79)	1.36* (1.05-1.77)	1.52** (1.16-2.00)	1.53** 1.16-2.01)
25-29		1.55*** (1.20-2.01)	0.50** (1.15-1.94)	1.86*** (1.37-2.50)	1.87*** (1.38-2.53)
30-34		1.49** (1.14-1.95)	1.43* (1.09-1.87)	1.91*** (1.37-2.66)	1.90*** (1.36-2.65)
35-39		1.42* (1.07-1.88)	1.35* (1.02-1.79)	1.87*** (1.31-2.66)	1.85*** (1.30-2.65)
40-44		1.43* (1.03-1.99)	1.41* (1.02-1.95)	1.96*** (1.32-2.90)	1.89** (1.27-2.81)
45-49		1.29 (0.81-2.04)	1.25 (0.78-2.00)	1.74* (1.04-2.90)	1.77* (1.05-2.97)
Education					
No education					
Primary		1	1	1	1
Secondary		1.10 (0.93-1.31)	1.09 (0.92-1.30)	1.08 (0.91-1.29)	1.04 (0.87-1.24)
Higher		1.67*** (1.41-1.98)	1.58*** (1.33-1.88)	1.52*** (1.27-1.81)	1.45*** (1.22-1.74)
Region		1.86* (1.16-2.97)	1.45 (0.89-2.37)	1.27 (0.77-2.09)	1.09 (0.65-1.82)
Western		1	1	1	1

Table 8 continued

Central		**0.83**	**0.83**	**0.83**	**0.83**

	(0.63-1.10)	**(0.63-1.10)**	**(0.63-1.11)**	**(0.6-1.11)**
Greater	1.16	0.94	0.92	0.96
Accra	(0.87-1.56)	(0.69-1.27)	(0.68-1.25)	(0.70-1.31)
Volta	1.17	1.19	1.18	1.10
	(0.86-1.57)	(0.88-1.61)	(0.87-1.59)	(0.81-1.49)
Eastern	0.87	0.86	0.87	0.88
	(0.66-1.14)	(0.66-1.13)	(0.66-1.14)	(0.67-1.16)
Ashanti	1.06	1.03	1.02	1.10
	(0.82-1.38)	(0.79-1.34)	(0.78-1.33)	(0.84-1.44)
Brong Ahafo	1.14	1.10	1.09	1.06
	(0.87-1.50)	(0.84-1.45)	(0.83-1.43)	(0.81-1.40)
Northern	0.66**	0.63**	0.62**	0.60***
	(0.50-0.88)	(0.48-0.85)	(0.47-0.83)	(0.45-0.81)
Upper East	1.50*	1.46*	1.42*	1.33
	(1.10-2.05)	(1.06-201)	(1.03-1.95)	(0.96-1.85)
Upper West	1.54**	1.52**	1.48*	1.34
	(1.14-2.10)	(1.11-2.09)	(1.08-2.03)	(0.98-1.85)
Occupation				
Not working	1	1	1	1
Working	1.39***	1.44***	1.47***	1.52***
	(1.18-1.64)	(1.22-1.70)	(1.24-1.73)	(1.28-1.80)
Ethnicity				
Akan	1	1	1	1
Ga-Adangbe	0.81	0.83	0.82	0.90
	(0.59-1.11)	(0.60-1.13)	(0.60-1.13)	(0.65-1.23)
Ewe	0.72**	0.70**	0.70**	0.78*
	(0.58-0.91)	(0.56-0.88)	(0.55-0.87)	(0.61-0.97)

Table 8 continued

Guan	**0.83**	**0.85**	**0.85**	**1.11**
	(0.63-1.08)	**(0.65-1.12)**	**(0.65-1.12)**	**(0.83-1.48)**
Mole-	0.87	0.85	0.84	0.92
Dagbani	(0.69-1.10)	(0.67-1.08)	(0.67-1.07)	(0.72-1.17)
Grussi	0.60***	0.61***	0.61***	0.75
	(0.45-0.80)	(0.46-0.82)	(0.46-0.81)	(0.55-1.01)
Gruma	0.74	0.73	0.73*	0.72*
	(0.54-1.02)	(0.53-1.00)	(0.53-1.00)	(0.52-0.99)
Mande	0.66*	0.68	0.68*	0.97
	(0.45-0.97)	(0.46-1.00)	(0.46-1.00)	(0.64-1.48)
Other	0.49***	0.51***	0.51***	0.70*
	(0.37-0.63)	(0.39-0.66)	(0.39-0.66)	(0.52-0.94)
Religion				
Christianity	1	1	1	1
Islam	1.18	1.12	1.13	1.03
	(098-1.43)	(0.93-1.46)	(0.94-1.37)	(0.85-1.25)
Traditionalist	0.67**	0.68**	0.69**	0.70**
	(0.52-0.87)	(0.53-0.88)	(0.54-0.90)	(0.54-0.90)
No religion	0.62***	0.62***	0.63***	0.65***
	(0.49-0.78)	(0.49-0.78)	(0.50-0.79)	(0.51-0.82)
Residence				
Urban		1	1	1
Rural		0.72***	0.73***	0.80**
		(0.61-0.84)	(0.62-0.85)	(0.68-0.94)
Wealth status				
Poorest		1	1	1
Poorer		0.86	0.85	0.90
		(0.72-1.03)	(0.71-1.03)	(0.75-1.08)

Table 8 continued

Middle			**0.81***	**0.80***	**0.89**
			(0.72-1.03)	**(0.65-0.97)**	**(0.73-1.08)**
Richer			0.87	0.86	0.97
			(0.70-1.07)	(0.69-1.06)	(0.78-1.20)
Richest			1.06	1.03	1.18
			(0.82-1.36)	(0.80-1.33)	(0.91-1.52)
Table 4 continued					
One birth				1	1
Two births				0.80*	0.78*
				(0.65-0.98)	(0.64-0.96)
Three births				0.77*	0.75*
				(0.61-0.97)	(0.59-0.94)
Four or				0.68**	0.67**
more births				(0.53-0.87)	(0.53-0.86)
Survey year					
1998					1
2003					1.19
					(0.99-1.43)
2008					1.74***
					(1.43-2.12)
2014					1.96***
					(1.60-2.41)
-2LL	-3388.2	-3242.9	-3228.4	-3223.5	-3193.2
% change in		1.453	0.145	0.049	0.303
-2LL					
N	5140	5140	5140	5140	5140

*p<0.05, **p<0.01, ***p<0.001

Source: Computed from GDHS 1998, 2003, 2008 and 2014

Discussion

This section seeks to discuss the findings of the study in relation to the existing literature on childhood vaccination. It touches on the trends of childhood vaccination, pattern of childhood vaccination as well as the determinants of childhood vaccination.

Trends of Childhood Vaccination

It was found in the study that the childhood vaccination over the years has increased. From the study, children who received the BCG vaccine increased from about 83 percent in 1998 to about 94 percent in 2014. Similarly, the percentage of children who received the polio vaccine increased from about 54 percent in 1998 to about 69 percent in 2014. The percentage of children who received the measles vaccine increased from about 43 percent in 1998 to about 51 percent in 2014. Children who received the DPT vaccine increased from about 53 percent in 1998 to about 71 percent in 2014. A study by Singh (2013) confirms this finding. According to Singh, vaccination coverage in India had increased from 35% in 1992 to 44% in 2006. Also, from the findings of Ushie, Fayehun and Ugal (2014), more vaccination coverage was reported in the 1990 survey, followed by 2008, 1999 and 2003. Which shows that there was an increase in the vaccination coverage over the years under review.

Pattern of Childhood Vaccination

From the study, children born by mothers aged 20-24 and 25-29 years had the highest proportion of children who received all four vaccinations. This can be explained that, women who are aged 20-29 years hold the majority of married

women (GSS, 2013). With the influence of the husbands, these women are more likely to avail their children for vaccination. This is in line with the findings of a study conducted by Adokiya et. al. (2017) which states that children of women above 20 years receive vaccination than children of women below 20 years.

Also, children of women with secondary education showed a higher proportion of children who received all four of the vaccinations under study. The possible explanation for this finding is that women with secondary education may have knowledge and information about immunization and child welfare and may avail their children to vaccination. This finding can be confirmed by the results of a study conducted in Senegal by Mbengue et al. (2017). According to them, children of mothers with secondary school education received vaccination more than those of mother with less than secondary level education.

From the study, children born by Akan women had the highest proportion of all of vaccinations for the years under study. According to GSS (2013), Akan is the most dominant ethnic group in Ghana and from the study by Islam, Islam and Banowary (2009), it was observed that women from the major ethnic groups are likely to receive antenatal care which makes them more knowledgeable to why they are supposed to avail their children for vaccination. Again, children born to mothers in rural areas also showed higher proportion of vaccination uptake than their counterparts who have mothers in urban areas. Urban areas are argued to have more health facilities and health care professionals than rural areas (Tsawe and Susuman, 2014), and this could possibly explain why the highest proportion of children who received vaccination had mothers in the urban areas. This finding

contradicts the results of the study by Murtaza *et. al.*, (2016). According to them, children of mothers in the urban areas showed a greater proportion of children who received vaccination in that year.

Again, children of working mothers were the children who had the highest proportion of vaccination. This is in line with the results of the study conducted by Adenike and colleagues (2017) which states that, children of women who work had the highest proportion of children who received vaccination in the North of Nigeria. From the study, children whose mothers have four or more births were seen to have the highest proportion of vaccine uptake. This could be as a result of the experiences and knowledge gained from their previous children. This disputes the findings of Russo et al. (2015) that, vaccination uptake is dominated by children who are third or less born child in the family. Also, according to Bekele and Biadgilign (2017), children to women who are in the poorest wealth quintiles received vaccination the most. This can be said to confirm the findings of this study that, children with mothers with middle and poorest wealth quintiles had the highest proportion of vaccination uptake. This could be as a result of the fear of complications that might occur to the children and considering their wealth status, they want to prevent future cost. Lastly, children of Christian mothers received vaccination the more for the years under review. According to GSS (2013), majority of women in Ghana are Christians and this could be a possible explanation for children of women who are Christians having the highest proportion of vaccination. This confirms the findings of the study conducted in the Techiman Municipality, Ghana by Adokiya, Baguune

and Ndago, (2017). According to them, children of Christian mothers had the highest percentage of children who received vaccination.

Determinates of Childhood Vaccination

From the study, there were factors that influenced a child being vaccinated with the measles vaccine. From the study, maternal age was found to be a significant factor that determined whether or not a child will receive the measles vaccination. This finding is in line with a study which was conducted in Mathare Valley which revealed that age is a significant determinant of immunization (Kamau & Esimai, 2001). Also, occupation was found from the study to have a significant relation with measles vaccination among children. Russo *et. al.*, (2015) showed that vaccination coverage was associated with mother's employment status. Education, from the study, is a factor that influences measles vaccination among children in Ghana. This confirms the finding of Hu *et. al.,* (2013) where it was revealed that the likelihood of a child receiving vaccination rise with mother's educational level.

Religion was seen to be one of the factors that determine the uptake of measles vaccination among children in Ghana. This is in accordance with the findings of a study by Adokiya, Baguune and Ndago (2017) that, children from the Christian religion were more likely to be immunised compared to children from the Islam religion. Also, parity was seen to be a factor that influenced measles vaccination among children in Ghana. From a study conducted in Varansi in India, parity was seen a determinant of immunisation (Awashi et al., 2015).

From the study, there were factors that influenced a child being vaccinated with the polio vaccine. From the study, maternal age was found to be a significant factor that determined whether or not a child will receive the polio vaccination. This confirms the finding of study by Russo *et. al.,* (2015) that incomplete immunisation status was associated with younger mothers. Occupation was seen to be a factor that influences the uptake of polio among children. This confirms the findings of Tagbo *et. al.,* (2014) which revealed that, in Enugu Metropolis, mother's occupation status is a determinant of vaccination. From the study, education was identified to be a significant determinate of polio vaccination in Ghana. This is in line with the findings of a study which was conducted by Kamau and Esimai in Mathare Valley in 2001. According to this study, education is significant determinant of immunisation.

Also, religion was seen to be a factor that influenced polio vaccination among children in Ghana. In a study conducted by Adokiya, Baguune and Ndago (2017), religion was seen to be a factor that influenced the uptake of vaccination in Techiman Municipality, Ghana. Parity was seen to be a factor that influenced polio vaccination among children in Ghana. This confirms the findings from a study conducted in Zimbabwe, where it was found that parity was associated with full vaccination coverage (Mukungwa, 2015).

From the study, there were factors that influenced a child being vaccinated with the BCG vaccine. From the study, region was found to be a significant factor that affect the BCG vaccination uptake among children in Ghana. From the results of a study by Mbengue *et al.*, (2017), among Senegaliese children aged 12-23

months, it was confirmed that, region has a statistically significant effect on immunisation. Education was seen as a factor that influenced vaccination in Ghana. This is in accordance with the results from a study conducted by Kamau and Esimai (2011) in Mathare Valley, where it was revealth that education is a significant determinant of immunisation. Religion was seen as a factor that influenced vaccination among children in Ghana. According to Adokiya, Baguune and Ndago (2017), religion was found to a determinant of vaccination. Place of residence was seen to be the factors that influenced measles vaccination among children in Ghana. In a study by Abshoko (2016), it was revealed that, residence is an important determinant factor affecting child vaccination in Ethiopia, which confirms the findings of the present study.

From the study, there were factors that influenced a child being vaccinated with the DPT vaccine. From the study, age was identified as one of the determinants that can be used to explain the uptake of the DPT vaccine among children. This confirms the results of a study conducted in Techiman, Ghana. The results from this study showed that, maternal age was a significant factor the influenced vaccination of children (Adokiya, Baguune & Ndago, 2017). Region was seen to be a factors that influenced measles vaccination among children in Ghana. This confirms the findings of the study conducted in Zimbabwe by Mukungwa (2015). The study revealed that, there is a significant association between region and variations in immunisation. Occupation was identified as one of the determinants that can be used to explain the uptake of the DPT vaccine among children. Russo *et al.,* (2015) confirmed this finding. According to him, vaccination coverage was

associated with mother's employment status. Ethnicity was seen to a factors that influenced measles vaccination among children in Ghana. Duah-Owusu in his study conducted in 2010 confirms this finding. According to his study, being fully immunised was associated with ethnicity.

Education was identified as one of the determinants that can be used to explain the uptake of the DPT vaccine among children in Ghana. Findings from a study conducted by Kamau and Esimai in Mathare Valley in 2011 showed that education is a significant determinant of immunisation. Place of residence was identified as one the determinates that can be used to explain the uptake of the DPT vaccine among children. In a study by Abshoko (2016), residence is an important factor affecting child vaccination in Ethiopia. Religion was seen to be a factor that influenced DPT vaccination among children in Ghana. According to Mbengue *et al.*, (2017), in a study conducted in Senegal, religion was found to be a factor that affects vaccination. Parity was also seen to be a factor that influenced DPT vaccination among children in Ghana. From the findings of a study conducted in Varansi in India, parity was seen as a determinate of immunisation (Awashi *et al.*, 2015).

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

This chapter presents an overview of the study, methods of the study, summary of the main findings, providing conclusions and some recommendations including areas for further research. The study assessed the determinants of childhood vaccinations in Ghana from 1998 to 2014. Specifically, the study sought to analyse the trend of childhood vaccination coverage, to examine the patterns of childhood vaccination from 1988 to 2014 and to assess the determinants of childhood vaccination from 1998 to 2014.

The conceptual framework for the study was the health care service utilisation model by Andersen (1995). It defines the interplay of predisposing factors, enabling factors and the need-for-care factors in the utilisation of health care services.

The study used data from four rounds of the Ghana Demographic and Health Service (GDHS), thus 1998, 2003, 2008 and 2014. The GDHS utilized a two-stage sample design, first selecting clusters of a sample frame and second selecting households systematically from the clusters. The target population was children between the ages of 0-23 months who belong to mothers who were either usual residents of the selected household or visitors present in the selected household on the night before the survey.

Key Findings of the Study

The study revealed that, even though there was an increase in the proportion of all the childhood vaccines, BCG is the most received vaccine among the childhood vaccine during the period of 1998 to 2014. On the other hand, the least received vaccine is the polio vaccine. Children who received the BCG vaccine increased from about 83 percent in 1998 to about 94 percent in 2014. Similarly, the percentage of children who received the polio vaccine increased from about 54 percent in 1998 to about 69 percent in 2014, and the percentage of children who received the measles vaccine increased from about 43 percent in 1998 to about 51 percent in 2014. Children who received the DPT vaccine increased from about 53 percent in 1998 to about 71 percent in 2014.

The study revealed that the greater proportion of children who received vaccination for measles are children born to women aged 45-49, urban women, women with secondary education, the widowed women in the Brong Ahafo region, working women, Akans, women with one birth, richest women and Christians. From the study, the greater proportion of children who received vaccination for polio are children born to women aged 25-29, urban women, with higher education, the widowed, women in the Brong Ahafo region, working women, Akans, women with one birth, richest women, and Christians.

The study revealed that the greater proportion of children who received vaccination for BCG are children born to women aged 30-34, urban women, those with higher education, the widowed, women in the Greater Accra region, working women, Ga-Adangbes, women with two births, richest women and Christians. The

study revealed that the greater proportion of children who received vaccination for DPT are children born to women aged 25-29, rural women, those with higher education, those with higher education, women in the Ashanti region, working women, Akans, women with one birth, richest women and Christians.

Findings from the study showed that children of women aged 20-24, 25-29, 30-34, 35-39, 40-44 and 45-49 years were more likely to be vaccinated against measles as compared to children of women aged 15-19 years. Children of women with secondary education were more likely to receive the measles vaccine as compared to children of women with no education. Children of women who are widowed were more likely to receive measles vaccine compared to children of never married women. Children of working women were more likely to be availed for the measles vaccination. Children of women from the Gruma and Other ethnic groups were less likely to receive the measles vaccine compared to children of Akan ethnic group. Children of women who are affiliated to No religion had less likelihood to receive the measles vaccination than women with Christian religion. Children of women with two births, three births and four or more births showed less likelihood of receiving the measles vaccine as compared to children of women with one birth. Children of women in the 2014 survey year were more likely to receive measles vaccine than children of women in the 1998 survey year.

Again, children of women aged 25-29, 30-34, 35-39, 40-44 and 45-49 years were more likely to be vaccinated against polio as compared to children of women aged 15-19 years. Children of women with education up to secondary level showed a higher likelihood of receiving the polio vaccine as compared to children women

with no education. Children of women in the Northern region were less likely to receive the polio vaccine whiles children of women in the Upper West region were more likely to receive the polio vaccine compared to children of women in the Western region. Furthermore, working women's children were more likely to receive the polio vaccine than children of women who were not working. Children of women with Ewe, Grussi and Gruma ethnic background were less likely to receive the polio vaccine compared to children of Akan women. Children of women who are Traditionalists and children of women who do not belong to any religious group had a less likelihood to receive the polio vaccine as compared to children of women with Christian religion. Children of women with two births, three births and four or more births were less likely to be availed to receive the polio vaccine as compared to children of women with one birth. Lastly, children of women in 2008 and 2014 showed higher odds of being availed for the polio vaccine as compared to children of women in 1998.

Also, with BCG vaccination, children of women who have secondary education were more likely to receive the BCG vaccination. children of women in the Upper West and Upper East Regions of Ghana showed higher odds of being availed for BCG vaccination, compared to children of women in Western Region. Children of women with Traditional Religion and No religion were less likely to receive the BCG vaccination than children of women who are Christians. Children of women from the rural areas were less likely to receive BCG vaccination compared to children of women in the urban areas. With the survey wave years,

children of women in 2008 and 2014 showed higher odds of receiving BCG vaccination than children of women in 1998.

Lastly, findings from the study on DPT vaccination in Ghana showed that, children of women aged 20-24, 25-29, 30-34, 35-39, 40-44 and 45-49 years showed a higher likelihood of receiving the DPT vaccination than children of women age 15-19 years. Children of women with higher educational level were more likely to receive DPT vaccine compared to children of women with no education. The study also revealed that children of women in the Northern Region showed less likelihood of being availed to receive the DPT vaccine compared with children of women from Western Region. Children of women who are working showed higher likelihood to receive the DPT vaccine than children of women who are not working. Children of women from Ewe, Grussi, Gruma and Other ethnic groups showed a less likelihood to be availed for the DPT vaccination. Children of women who were traditionalist and women with no religious affiliation were less likely to receive the DPT vaccination than children of women who were Christians. Children of women in rural areas also showed a less likelihood of receiving the DPT vaccine, compared to children of women in urban areas. Children of women with parity two, three and four or more also showed a lower likelihood of being availed to receive the DPT vaccine compared to children of women with one birth. Children of women in 2008 and 2014 were more likely to receive the DPT vaccine, compared to children of women in 1998.

Conclusions

Childhood vaccination over the period 1998-2014 has increased with BCG being the highest received vaccine among them while polio is the least received vaccine. Over the years under study, thus from 1998 to 2014, for measles vaccination, polio vaccination, BCG vaccination and DPT vaccination, uptake was predominated by children whose mothers were older than 20-24 years, living in the urban areas, have secondary education, widowed, from Western and Ashanti Regions, working, Akans, having one birth, in the richest wealth quintiles and are Christians.

From the study, it is concluded that the age of the mother of the children determines whether the child will receive vaccination or not. Place of residence of the mother is also a determinant of childhood vaccination in Ghana. Maternal level of education is a determinant of childhood vaccination. Mothers region of residence is also a key determinant of vaccination among children in Ghana. Also, the occupation status of the money also determines whether a child will receive vaccination or not. Mother's ethnic group also influence the vaccination coverage of children in Ghana. Parity is a key determinant of vaccination among children in Ghana. Wealth status of the mother is a key factor that determines the vaccination coverage of children. Finally, religion of mothers affects the vaccination of children in Ghana.

Recommendation

1. The Ghana Health Service and Ministry of Health should encourage young women who are aged 15-19 years especially those who are not working to avail their children for vaccination through behavioural change communication campaigns.
2. Women should be encouraged to further their education to the secondary and higher educational levels to get the appropriate information about vaccination and its importance.
3. The MoH should strengthen available interventions to ensure that mothers, especially those who are never married especially those who are not working to avail their children for vaccination and immunisation.
4. The Ghana Health Service and Ministry of Health should design messages targeting mothers especially those who have had two or more births on the importance of vaccination and immunisation for their children.
5. Traditional leaders and authorities should encourage women, especially those from the Northern ethnic groups, to avail their children for vaccination through community gatherings and durbars.

Areas for Future Studies

1. It was observed that some women did not avail their children for any of the childhood vaccines. It may be worthwhile to conduct an in-depth study to know why women do not avail their children for vaccination.

2. It was observed that there was a national dropout for polio vaccination. It will, therefore, necessary to conduct a study to identify the factors for the drop out.

REFERENCES

Aaby, P., & Benn, C. S. (2009). Assessment of childhood immunisation coverage. *The Lancet*, *373*(9673), 1428-1430.

Abshoko, A. D. (2016). Determinants of full child immunization; Evidence from Ethiopia. *Science*, *4*(3), 155-164.

Adenike, O. B., Adejumoke, J., Olufunmi, O., & Ridwan, O. (2017). Maternal characteristics and immunization status of children in North Central of Nigeria. *The Pan African Medical Journal*, *26* (14), 620-631.

Adokiya, M. N., Baguune, B., & Ndago, J. A. (2017). Evaluation of immunization coverage and its associated factors among children 12–23 months of age in Techiman Municipality, Ghana, 2016. *Archives of Public Health*, *75*(1), 28-42.

Armah, G., Fuentes, S., Korpela, K. E., Harris, V. C., Parashar, U., Victor, J. C., & Lewis, K. D. (2016). Significant correlation between the infant gut microbiome and rotavirus vaccine response in rural Ghana. *The Journal of Infectious Diseases*, *215*(1), 34-41.

Asamoah, B. O., Agardh, A., Pettersson, K. O., & Östergren, P. O. (2014). Magnitude and trends of inequalities in antenatal care and delivery under skilled care among different socio-demographic groups in Ghana from 1988–2008. *BMC pregnancy and childbirth*, *14*(1), 295-330.

Asuman, D., Ackah, C. G., & Enemark, U. (2018). Inequalities in child immunization coverage in Ghana: Evidence from a decomposition analysis. *Health Economics Review*, *8*(1), 9-12.

Ataguba, J.E., Ojo K. O. & Ichoku H. E. (2016). Explaining socio-economic inequalities in immunization coverage in Nigeria. *Health Policy Plan.* 31(9):1212–24.

Awasthi, A., Pandey, C. M., Singh, U., Kumar, S., & Singh, T. B. (2015). Maternal determinants of immunization status of children aged 12–23 months in urban slums of Varanasi, India. *Clinical Epidemiology and Global Health*, *3*(3), 110-116.

Barata, R. B., de Almeida Ribeiro, M. C., de Moraes, J.C., Flannery, B. (2012). Socioeconomic Inequalities and vaccination coverage: results of an immunisation coverage survey in 27 Brazilian capitals, 2007–2008. *J Epidemiol Community Health*. 66(10):934–41.

Binka, F. N., Steele, A. D., Esona, M. D., Asmah, R. H., Anto, F., & Hall, A. (2003). Changing patterns of rotavirus genotypes in Ghana: Emergence of human rotavirus G9 as a major cause of diarrhea in children. *Journal of Clinical Microbiology*, *41*(6), 2317-2322.

Bruce, K. (2017). *Assessment of the implementation of expanded program on Immunization (EPI) in the Kintampo north municipality*. Unpublished Doctoral dissertation, University of Ghana, Accra.

Centers for Disease Control and Prevention (CDC. (2006). Vaccine preventable deaths and the global immunization vision and strategy, 2006-2015. *MMWR. Morbidity and Mortality Weekly Report*, *55*(18), 511-513.

Centers for Disease Control and Prevention (CDC. (2013*). Prevention and control of seasonal influenza with vaccines. Recommendations of the Advisory Committee on Immunization Practices-United States, 2013-2014. MMWR. Recommendations and reports: Morbidity and mortality weekly report. Recommendations and reports*, *62*(RR-07), 1. USA, CDC.

Chan M (2014). Beyond expectations: 40 years of EPI. *Lancet*. 383 (9930):1697-8

Chang, Y., Brewer, N. T., Rinas, A. C., Schmitt, K., & Smith, J. S. (2009). Evaluating the impact of human papillomavirus vaccines. *Vaccine*, *27*(32), 4355-4362.

Cohen, S. A., Mendelson, I., Altboum, Z., Kobiler, D., Elhanany, E., Bino, T & Barak, R. (2000). Attenuated nontoxinogenic and nonencapsulated recombinant Bacillus anthracis spore vaccines protect against anthrax. *Infection and immunity*, *68*(8), 4549-4558.

Coleman, M. A., Levison, J., & Sangi-Haghpeykar, H. (2011). HPV vaccine acceptability in Ghana, West Africa. *Vaccine*, *29*(23), 3945-3950.

Cynthia, L. K., Ranee, S., Kayla, C., Seth, M., Ashley, T., Stacie, M. G., Vance, D. (2014). *Vaccination Coverage Among Children in Kindergarten-United States, 2013-2014 School Year*. 64, 33, 14-19. USA, Centre for Disease Control & Prevention (CDC).

de Figueiredo, A., Johnston, I. G., Smith, D. M., Agarwal, S., Larson, H. J., & Jones, N. S. (2016). Forecasted trends in vaccination coverage and correlations with socioeconomic factors: a global time-series analysis over 30 years. *The Lancet Global Health*, *4*(10), e726-e735.

Duah-Owusu, M. (2010). *Social determinants and immunisation in Ghana: Is there an association?* Master's thesis, The University of Bergen.

Duru, C. B., Iwu, A. C., Uwakwe, K. A., Diwe, K. C., Merenu, I. A., Emerole, C. A., ... & Ihunnia, O. (2016). Assessment of Immunization Status, Coverage and Determinants among under 5-Year-Old Children in Owerri, Imo State, Nigeria. *Open Access Library Journal*, *3*(06), 1-14.

Ekouevi, D. K., Gbeasor-Komlanvi, F. A., Yaya, I., Zida-Compaore, W. I., Boko, A., Sewu, E., ... & Landoh, D. E. (2018). Incomplete immunization among children aged 12–23 months in Togo: a multilevel analysis of individual and contextual factors. *BMC public health*, *18*(1), 952-954.

Elder, R. G., & Bullough, B. (1990). Nurse practitioners and clinical nurse specialists: Are the roles merging? *Clinical nurse specialist CNS*, *4*(2), 78-84.

El-Zein, M., Conus, F., Benedetti, A., Menzies, D., Parent, M. E., & Rousseau, M. C. (2017). Association between bacillus Calmette-Guerin vaccination and childhood asthma in the Quebec Birth Cohort on Immunity and Health. *American journal of epidemiology*, *186*(3), 344-355.

Enweronu-Laryea, C. C., Boamah, I., Sifah, E., Diamenu, S. K., & Armah, G. (2014). Decline in severe diarrhea hospitalizations after the introduction of rotavirus vaccination in Ghana: a prevalence study. *BMC infectious diseases*, *14*(1), 431-445.

Fatiregun, A. A., & Etukiren, E. E. (2014). Determinants of uptake of third doses of oral polio and DTP vaccines in the Ibadan North Local Government Area of Nigeria. *International health*, *6*(3), 213-224.

Fernandez, R. C., Awofeso, N., & Rammohan, A. (2011). Determinants of apparent rural-urban differentials in measles vaccination uptake in Indonesia. *Rural & Remote Health*, *11*(3), 15-23.

Fine, P., Eames, K., & Heymann, D. L. (2011). "Herd immunity": a rough guide. *Clinical infectious diseases*, *52*(7), 911-916.

Fiore, A. E., Bridges, C. B., & Cox, N. J. (2009). Seasonal influenza vaccines. In *Vaccines for Pandemic Influenza* (pp. 43-82). Springer, Berlin, Heidelberg. from rural India. *Review of Economics of the Household* , 3:171-197.

Ghana Health Services (GHS) (2012). *Immunisation and Vaccination coverage in Ghana*. Ghana, Ghana Health Service.

Ghana Statistical service (1999). *Vaccination and EPI Implementation Policy*. Ghana, Ghana Statistical Service.

Ghana Statistical Service (GSS), Ghana Health Service (GHS), and ICF Macro (2015). *Ghana Demographic and Health Survey 2014: Key Findings*, GSS, GHS, and ICF Macro, Calverton, Md, USA.

Gross, C. P., & Sepkowitz, K. A. (1998). The myth of the medical breakthrough: smallpox, vaccination, and Jenner reconsidered. *International journal of infectious diseases*, *3*(1), 54-60.

Healthy people 2020 (2017). Immunization and Infectious Diseases. *Office of Disease Prevention and Health Promotion.* Retrieved from http://www.healthypeople2020.com.

Hu, Y., Li, Q., Chen, E., Chen, Y., & Qi, X. (2013). Determinants of childhood immunization uptake among socio-economically disadvantaged migrants in East China. *International journal of environmental research and public health*, *10*(7), 2845-2856.

Iseman, M. D. (2002). Tuberculosis therapy: past, present and future. *European Respiratory Journal*, *20*(36 suppl), 87S-94s.

Jamison, D. T., Summers, L. H., Alleyne, G., Arrow, K. J., Berkley, S., Binagwaho, A., & Ghosh, G. (2013). Global health 2035: a world converging within a generation. *The Lancet*, *382*(9908), 1898-1955.

Jamison, D. T., Summers, L. H., Alleyne, G., Arrow, K. J., Berkley, S., Binagwaho, A., ... & Ghosh, G. (2013). Global health 2035: a world converging within a generation. *The Lancet*, *382*(9908), 1898-1955.

Kamau, N., & Esamai, F. O. (2001). Determinants of immunization coverage among children in Mathare Valley, Nairobi. *East African Medical Journal*, *78*(11), 590-594.

Lakew, Y., Bekele, A., & Biadgilign, S. (2015). Factors influencing full immunization coverage among 12–23 months of age children in Ethiopia: evidence from the national demographic and health survey in 2011. *BMC public health*, *15*(1), 728-741.

Liu, L., Oza, S., Hogan, D., Perin, J., Rudan, I., Lawn, J. E., Cousens, S., Mathers, C., Black, R. E. (2012). Global, regional, and national causes of child mortality in 2000-12, with projections to inform post-2015 priorities: an updated systematic analysis. *Lancet*, 184, 721-762.

Mbengue, M. A. S., Sarr, M., Faye, A., Badiane, O., Camara, F. B. N., Mboup, S., & Dieye, T. N. (2017). Determinants of complete immunization among senegalese children aged 12–23 months: evidence from the demographic and health survey. *BMC public health*, *17*(1), 630-702.

McCoy, D., Kembhavi, G., Patel, J., & Luintel, A. (2009). The Bill & Melinda Gates Foundation's grant-making programme for global health. *The Lancet*, *373*(9675), 1645-1653.

Mckee, A. E. (2016). *Modelling Management for the Maintainable of Measles Elimination.* Unpublished doctoral thesis, The Pennsylvania University

Mckee, A. E. (2016). Modelling Management for the Maintenance of Measles Elimination.

McNair, D. T., Mears, J., & Shapcott, D. (2014). *Vaccination in the United States. U.S. Patent No. 8,839,350*. Washington, DC: U.S. Patent and Trademark Office.

Mehmed, M., & Basri, M. (2016). History of vaccines. In *Varna Medical Forum*, 5, 140-143.

Muiru, Z. N. (2009). *"Determinants of utilization of immunization services in the low and high under five mortality regions of Kenya"* (Doctoral dissertation, University of Nairobi, Kenya).

Mukungwa, T. (2015). Factors Associated with full Immunization Coverage amongst children aged 12–23 months in Zimbabwe. *African Population Studies*, *29*(2), 1761-1774.

Murtaza, F., Mustafa, T., & Awan, R. (2016). Determinants of nonimmunization of children under 5 years of age in Pakistan. *Journal of family & community medicine*, *23*(1), 32-61.

Needham, B. D., Carroll, S. M., Giles, D. K., Georgiou, G., Whiteley, M., & Trent, M. S. (2013). Modulating the innate immune response by combinatorial engineering of endotoxin. *Proceedings of the National Academy of Sciences*, *110*(4), 1464-1469.

Offit, P. A. (2007). *Vaccinated: one man's quest to defeat the world's deadliest diseases*. Harper Collins.

Plotkin, S. A., & Plotkin, S. A. (2008). Correlates of vaccine-induced immunity. *Clinical infectious diseases*, *47*(3), 401-409.

Russo, G., Miglietta, A., Pezzotti, P., Biguioh, R. M., Mayaka, G. B., Sobze, M. S., ... & Rezza, G. (2015). Vaccine coverage and determinants of incomplete vaccination in children aged 12–23 months in Dschang, West Region, Cameroon: a cross-sectional survey during a polio outbreak. *BMC Public Health*, *15*(1), 630-671.

Schwartz, J. L., (2013) "Model" patients and the consequences of provider responses to vaccine hesitancy, *Human Vaccines & Immuno-therapeutics,* 9 (12) 2663-2665.

Sebastian, L., & Weiser, G. (1979). Electric field modulated spectra of po lydiacetylene single crystal (PTS). *Chemical Physics Letters*, *64*(2), 396-400.

Semali, I. A. (2010). Trends in immunization completion and disparities in the context of health reforms: the case study of Tanzania. *BMC health services research*, *10*(1), 299-301.

Singh, P. K. (2013). Trends in child immunization across geographical regions in India: focus on urban-rural and gender differentials. *PloS one*, *8*(9), e73102.

Tagbo, B. N., Eke, C. B., Omotowo, B. I., Onwuasigwe, C. N., Onyeka, E. B., & Mildred, U. O. (2014). Vaccination coverage and its determinants in children aged 11-23 months in an Urban District of Nigeria. *World Journal of Vaccines*, *4*(04), 175-200.

Tao, W., Petzold, M., & Forsberg, B. C. (2013). Routine vaccination coverage in low-and middle-income countries: further arguments for accelerating support to child vaccination services. *Global health action*, *6*(1), 20343.

UNICEF. (2002). *The state of the world's children*. UNICEF, Oxford University Press.

UNICEF. (2013). *The State of the World's Children 2009*. from http://www.unicef.org/sowc09/docs/SOWC09-FullReport- EN.pdf

United Nations Children's Fund (UNICEF). (2015). *The State of the World's Children 2014: Child survival.* UNICEF. New York

United Nations Children's Fund. (1983). *The State of the World's Children, 1984*. New York, ERIC Clearinghouse.

Ushie, B. A., Fayehun, O. A., & Ugal, D. B. (2014). Trends and patterns of under-5 vaccination in N igeria, 1990–2008: what manner of progress?. *Child: care, health and development*, *40*(2), 267-274.

van Boven, M., & van Lier, A. (2016). Global trends in vaccination coverage. *The Lancet Global Health*, *4*(10), e670-e671.

Weiss, W. M., Choudhary, M., & Solomon, R. (2013). Performance and determinants of routine immunization coverage within the context of intensive polio eradication activities in Uttar Pradesh, India: Social Mobilization Network (SM Net) and Core Group Polio Project (CGPP). *BMC international health and human rights*, *13*(1), 25-53.

WHO (2005). *Global Immunization Vision and Strategy 2004-2015*. Retrieved from http://www.who.int/vaccinesdocuments/Docs PDF05/GIVS Final EN .pdf

WHO (2012). Pneumococcal vaccines WHO position paper–2012–Recommendations. *Vaccine*, *30*(32), 4717-4718.

WHO (2012). *Weekly epidemiological* record.*Wkly Epidemiol Rec*, 87: 421-436.

WHO and UNICEF (2012). *Estimation of national infant immunization coverage: methods and processes*. Retrieved from http:/www. who.int/I mmuneization/monitoring-surveillance/en

WHO. (1996). *State of the world's vaccines and immunization*. Retrieved from http://www.who.int/vaccines documents/DocsPDF/www9532.pdf

Woods, D. D., & Shattuck, L. G. (2000). Distant supervision–local action given the potential for surprise. *Cognition, Technology & Work*, *2*(4), 242-245.

World Bank. (1993). *Investing in health*. World Bank. Switzerland.

World Health Organization. (2014). WHO statement on the meeting of the International Health Regulations Emergency Committee concerning the international spread of wild poliovirus. Geneva, Switzerland: World Health Organization Available at http://www.who.int/mediacentre/news/statements/2014/polio-20140505/en/.

World Health Organization. (2015). *Improving influenza vaccine virus selection: Report of the 4th WHO informal consultation, Hong Kong SAR, China, 18-20 November 2015*(No. WHO/OHE/PED/GIP/2016.4). World Health Organization, USA.

Wujastyk, D. (1995). Kenneth G. Zysk: Asceticism and healing in ancient India: medicine in the Buddhist monastery [viii], 200 pp. New York and Oxford: Oxford University Press, 1991.£ 30. *Bulletin of the School of Oriental and African Studies*, *58*(3), 573-573.

Yenit, M. K., Assegid, S., & Abrha, H. (2015). Factors Associated with Incomplete Childhood Vaccination among Children 12–23 Months of Age in Machakel Woreda, East Gojjam Zone: A Case-control Study. *Journal of Pregnancy and Child Health*, *2*(4), 180-191.