UNIVERSITY FOR DEVELOPMENT STUDIES, TAMALE

ROTAVIRUS VACCINE COVERAGE AND ITS CONTRIBUTION IN REDUCING DIARRHOEA AMONG CHILDREN UNDER FIVE YEARS IN THE WA MUNICIPALITY

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SIMON AABALEKUU (B.Sc. in Public Health)

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APRIL, 2019

DECLARATION

Student

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

Candidate's Signature:……. Date:……...……

Name:…….……

Supervisor

I hereby declare that the preparation and presentation of the thesis was supervised in accordance with the guidelines on supervision of thesis laid down by the University for Development Studies.

Supervisor's Signature:……Date…….....……

Name:…….……

ABSTRACT

The burden of diarrheal diseases among children is by far more in low and middle-income countries where it is the second leading cause of deaths in children under 5 years. In Ghana, it is among the leading cause of childhood morbidity and mortality where it counts for 10% of deaths. The purpose of this study is to determine the contributions of rotavirus vaccine in reducing diarrhoea among children under-five years in the Wa municipality.The study was a cross sectional design ,retrospective and prospective (secondary data) analysis of secondary data on the trends of rotavirus vaccine coverage and diarrhoea prevalence.Multi stage sampling technique whereby 6 health facilities were selected purposefully. Three hundred and ninety-six respondents were selected systematically. Structured questionnaire was used to obtained the quantitave data. SPSS version 22.0 was used to analyzed the data. Pearson's chi-square test ($p<0.05$) and marginal effect with corresponding 95% confidence interval were used to establish the association between the dependent variables and independent variables.It was found that, more than 90% coverage of rotavirus vaccination among children under-five years of age with some disparities in rota 1 and rota 2. The results showed that children who took two doses had less diarrhoea infection than those who took the rotavirus vaccination only once. Prevalence of diarrhoea cases however, was found to be higher than immunization coverage. Rotavirus vaccination had led to a dramatic reduction in diarrhoea among children who have taken the complete dose. The study therefore strongly advocate for households' awareness creation through public education on the need to have a complete dosage of rotavirus vaccination, and also ensuring adequate sanitation.

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DEDICATION

This thesis is dedicated to my mother, Aabalekuu Domegure who inspired me to achieve greater heights in life and my senior brother, Mr. Aabalekuu Nurudo, whose finacial support has enabled me come this far in life.

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LIST OF ABBREVIATIONS

AIDS	Acquired Immune Deficiency Syndrome
ATE	Average Treatment Effect
AGE	Acute Gastroenteritis
ART	Anti-Retroviral Therapy
CDC	Center for Disease Control
CHPS	Community –Based Health Planning and Services
CHO	Community Health Officer
DHIMS	District Health Information Management Systems
DPT	Deptheria Pertussis Tetanus
DALY	Disability Adjusted Life Years
EPI	Extended Programme on Immunization
FIFO	First In First Out
FEFO	First to Expire First Out
GVAP	Global Vaccine Action Plan
GSS	Ghana Statistical Service
GDHS	Ghana Demographic Health Survey
GSK	Glaxo Smith Kline
GHS	Ghana Health Service
GAVI	Global Alliance for Vaccine and immunization
HIV	Human Immunodeficiency Virus
IOM	International Organization of Migration
ICF	International Classification of Functioning, Disability and Health
IDIs	In-depth Interviews
IQR	Inter-Quartile Range
LLR	Lanzhou Lamb Rotavirus
MMR	Maternal Mortality Ratio
MHA	Municipal Health Administration
MICS	Multiple Indicator Cluster Survey
NHRC	Navrongo Health Research Centre
NGO	Non-Governmental Organisation

ORS	Oral Rehydration Solution
OPD	Orthodox Protestant Denominations
OPV	Oral Poliovirus Vaccine
PLWHA	People Living With HIV/AIDS
PAED	Programme for the Awareness and Elimination of Diarrhoea
SPSS	Statistical Package for Social Science
SDG	Sustainable Development Goal
UDS	University for Development Studies
UNICEF	United Nations International Children Emergency Fund
VVM	Vaccine Vial Monitor
WHO	World Health Organization
WASH	Water Sanitation and Hygiene
WMA	Wa Municipal Assembly

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Diarrhoea is one of the dangerous diseases that is very prevalent in different countries (Frida, Atiena, & Habtu, 2017). Globally, there are about 4 billion incidents of diarrhoea, and this accounts for about 20% of deaths in children less than five years (Akwasi & Joshua, 2015). A child in a developing country can be predicted to have 3–5 episodes of diarrhea per annum, resulting in an estimated 800,000 annual deaths among children under-five years (Dorota, Agnieszka, Renata, & Malgorzata , 2016). Specifically, an estimated 5.9 million children under 5 years died in 2015, constituting a mortality rate of 42.5 per 1000 live births (WHO, 2016). It has further been reported that child mortality is highest in sub-Saharan Africa, where one out of every 12 children dies before age five, followed by South-East Asia where one in 19 dies before reaching 5 years. The rate of reduction in under-five mortality per annum was 3.9% between 2000 and 2015 with 79 countries having their under-five mortality rates above the Sustainable Development Goals (SDG) target of 25 under-five deaths per 1000 live births, and 24 countries have rates that are three times higher than that (WHO, 2016).

In Ghana, under-five mortality is still high even though there has been a continued decline as reported by the Ghana Statistical Service (GSS, 2014). The Ghana Demographic and Health Survey (GDHS) reported a pattern of decreasing under-five mortality since its inception in 1988 to 2014 (GSS, 2014). The results show a decline in infant mortality rate from 64 per 1,000 in 2003 to 41 per 1,000 in 2014 . Similarly, under-5 mortality rate decreased from 111 per 1,000 in 2003 to 60 per 1,000 in 2014. Despite these improvements, the under-five mortality rate in Ghana is still far above the SGDs target (GSS, 2014).

Globally, diarrhoea is one of the leading causes of under-five mortality, accounting for 11 per cent of all deaths among children under-five years annually (UNICEF, 2012). In Africa, it is responsible for approximately 19% of childhood deaths (WHO, 2009). Taken Ghana into perspective, diarrhoea is also among the leading causes of death in children under-five years of age with 25% (GHS, 2012). Diarrhoea is a common disorder of the gastrointestinal system experienced by people sometime in their lives (UNICEF, 2012). According to WHO (2017) diarrhoea is usually a symptom of an infection in the intestinal tract, which is caused by infectious organisms, including viruses, bacteria, protozoa, and helminths. The contribution of these germs to the cause of diarrhoeal illness may differ due to geographical location, season and disease severity (CDC, 2015). The incidence of diarrhoeal disease among under-five children is multifaceted and the relative contribution of each factor also differs as a function of interaction between socioeconomic, environmental, and behavioral variables (WHO, 2009). In many developing countries such as Ghana, socio-demographic characteristics are some of the determinant factors that influence the incidence of diarrhoeal diseases (Kuitunen & Boadi, 2005). These socio-demographic characteristics include maternal and child age, the availability of sanitary facilities, hygienic practices, flies infestations and regular consumption of street foods (Kuitunen & Boadi, 2005). The incidence of diarrhoea is also higher in the second half of the infant's life when inborn immunity is weak and exposure to contaminated weaning foods increases (Bako, Egwuda, & Terru, 2017).

With improvements in environmental hygiene and sanitation, the burden of diarrhoeal diseases due to bacterial and parasitic infections have decreased while there is an increasing proportion of diarrhoea hospitalizations attributed to virus (Black & Cousens, 2010). However, very few viruses are responsible for most acute cases of

childhood diarrhoea of which rotavirus is the leading cause of acute diarrhoea, and is responsible for about 40% of all hospital admissions due to diarrhoea among children under-five world wide (GHS, 2012). It accounted for approximately one-third of the 1.34 million diarrhoea deaths and nine million hospitalizations worldwide among children aged 59 months and younger (WHO, 2004).

Rotavirus is a virus that causes diarrhoea, mostly in babies and young children of which the diarrhoea can be severe, and lead to dehydration (CDC, 2015). According to the Centre for Disease Control (2016), rotavirus is a contagious virus that can cause gastroenteritis (inflammation of the stomach and intestines) and characterized by severe watery diarrhoea, often with vomiting, fever, and abdominal pain. Infants and young children are more likely to get rotavirus diseases (CDC, 2015). It is estimated that nearly all children will be exposed to rotavirus before 3-5 years of age, regardless of where they are born (WHO, 2013). Children in low-income countries acquire the infection early during their first year of life accounting for 80% of infants < 1year old. However, this is the reverse in the high-income countries, where the first occurrence may be delayed until the age of 2–5 years, though the majority still occurs in infancy accounting for 65% (WHO, 2013).

According to WHO (2006), rotavirus infection is a vaccine-preventable cause of childhood deaths. It is against this background that, WHO (2006) recommended including two species of “A” rotavirus (RVA) vaccines in to the national immunization programmes in America and Europe, when both vaccines were found to show increase in efficacy and safety in clinical trials in those regions (Taste et al., 2012). After the evidence shown by these vaccines to be efficacious, WHO (2009) recommended that

all countries introduce rotavirus vaccination into their national expanded programmes for immunization to control severe rotavirus disease.

Rotavirus vaccine is an oral vaccine given as two doses for babies aged two and three months on monthly interval alongside their other routine vaccines. The rotavirus vaccine use in Ghana is Rotarix® manufactured by GlaxoSmithKline (GSK) Biologicals (GHS, 2012). Rotarix® according to GHS 2012 report, is a live attenuated vaccine of human and/or animal origin that replicate in the human intestine and offers cross-protection against multiple strains. Rotarix® is very efficacious hence its recommendation by WHO to be included in all national immunization programmes to offer protection against rotavirus and this should go alongside improved hygiene and sanitation, and oral rehydration therapy (WHO, 2009). Globally, significant gains have been made in increasing access to vaccines and immunization including rotavirus vaccination resulting in an estimated 2.5 million child deaths being prevented every year (WHO, 2009).

In Ghana, the expanded programme on immunization (EPI) was introduced in the 1970s as a strategy to improve child health and this has really proved to be very effective (GHS, 2012). The proportion of fully immunized children has improved from 69% in 2003 to 79% in 2008 while the proportion of children who received no vaccinations has declined from 5% to 1% over the same period (GSS, 2009). According to the 2011 Multiple Indicator Cluster Survey (MICS) results, 77% of children aged 12-23 months were fully immunized before their first birthday (GSS, 2011). The survey further revealed that the coverage rate for all vaccination for children aged 12-23 months was 84%, while less than 1% of children have not received any vaccinations. In addition, the GHS (2014) annual reports also assess equity in

vaccination coverage by districts based on Penta valent (deptheria, pertussis, tetanus, hepatitis B and haemophilus influenza B) -3 coverage. The report covered 216 districts but only 153 (71%) achieved Penta-3 coverage of 80% and above. Although all the districts fell short of the target of 80%, there has been a continuous improvement in the number of districts achieving this target.

1.2 Problem Statement

Globally, effors aimed at preventing diarrhoeal diseases among children under-five years of age through various interventions such as immunization, breastfeeding and safe drinking water has not yielded there desired results. Under-five mortality continues to increase in the poorest regions especially among children in poor families (UNICEF, 2012). In Ghana, rotavirus vaccine has been introduced to help reduce diarrhoeal disease among under-five children. However, some study maintained that despite the potential gains rotavirus vaccine interventions has in diarrhoea prevention, there remains multiple gaps and challenges in terms of its coverage and access (Bosomprah et al., 2016).

A study conducted to assess the efficacy and impact of the rotavirus vaccine as well as the prevalence of rotavirus infections saw a reduction in diarrhoea cases after the introduction of rotavirus vaccine (diarrhoea) (Enweronu et al., 2014). Additionally, the prevalence of severe diarrhoea hospitalizations after the introduction of rotavirus vaccination in Ghana showed a declined in diarrhoea hospitalization among children under-five (Ameyaw, Ameyaw, Acheampong, & Appiagyei, 2017). A similar study was also carried out on the impact of rotavirus vaccination on childhood deaths from diarrhoea in Brazil (Lanzieri et al., 2010). In addition, a systematic review was carried out in South- East Nigeria on global causes of diarrheal disease mortality in children

under-five years of age (Claudio, Dalet, & Pierre, 2013). The study revealed that, more than half of severe diarrhoea episodes, were most likely to result in death among children under the age of 5 years in 2011 and could be attributed to rotavirus. Furthermore, a study conducted on the knowledge of rotavirus disease among health care providers and their acceptance of rotavirus vaccines in South-East, Nigeria, revealed that, participants were aware of rotavirus disease, especially as a high priority child health issue (Tagbo, 2014).

A critical review of these studies reveals various research gaps that need to be filled. These include gaps in the study approach, geographical location of the studies, coverage of the targeted children with the rotavirus vaccine and socio-economic characteristics of households. The study approach used in all the studies was quantitative in nature. In terms of geographical location, they were conducted in Nigeria (Tagbo, 2014) and Southern part of Ghana (Enweronu, 2012). These studies did not also take into consideration the socio-economic status of mothers/care takers as well as cold chain management of the rotavirus vaccine by the health worker providing immunization services.

In this regard, very little is known about the extent of rotavirus vaccine coverage and its contribution in reducing diarrhoea among children under-five years in the Wa Municipality of the Upper West Region. Considering the grave consequences of diarrhoea among children under-five years and intervention (the introduction of rotavirus vaccine) put in place by the government of Ghana, it is therefore important to investigate the contribution of the vaccine in reducing diarrhoea among the children under-five years in the Wa Municipality as this will help enhance the programme in eradicating the disease completely in the municipality.

1.3 Research Questions

1. What is the rotavirus vaccination coverage from 2012 to 2016 among children under-five years?
2. What is the prevalence of diarrhoea from 2007 to 2016 among children under-five years?
3. What is the association between rotavirus vaccine coverage and the prevalence of diarrhoea among children under-five years?
4. What is the association between the sociodemographic characteristics of respondents and diarrheal incidence among children under-five years who were immunized rotavirus vaccine?

1.4 Objectives of the Study

1.4.1 Main Objective

To study rotavirus vaccine coverage and its contribution to reducing diarrhoea among children under-five years.

1.4.2 Specific Objectives

1. To assess rotavirus vaccination coverage from 2012 to 2016 among children under-five years.
2. To assess the prevalence of diarrhoea from 2007 to 2016 among children under-five years.
3. To determine the association between rotavirus vaccine coverage and incidence of diarrhoea among under -five children.

4. To determine the association between the sociodemographic characteristics of mothers and the incidence of diarrheoa among children covered with rotavirus vaccine.

1.5 Significance of the Study

Diarrhoea is negatively affecting the health of children and young people the world over especially in developing countries. This study assessed the the contribution of rotavirus vaccine coverage in reducing diarrhoea among children under-five years and the basic characteristics of mothers/caretakers that influences diarrhoea prevalence. It is hoped that findings from this study will help fill the gaps in diarrhoea prevention and address the barriers to service use. Also, information from this study adds to the existing knowledge in the field of health, especially on child health and immunization services.

The findings and recommendations of this study will help policy makers to come out with effective approaches to reduce diarrhoea prevalence among under-five children in Ghana. Above all, the study offered up-to-date baseline information on rotavirus vaccine coverage, its effectivness and management. It will has also added to the literature on immunization services in Ghana and the world at large.

1.6 Scope of the Study

This study on the contribution of rotavirus vaccination coverage in reducing diarrhoea prevalence is limited to the Wa Municipal Assembly. It focused on the trend of rotavirus vaccination coverage among children under-five years from 2012-2016, trend of diarrhoea prevalence among children under-five years from 2007 -2016, association between rotavirus vaccine coverage and incidence of diarrhoea among under-five

children, association between the basic characteristics of mothers and the incidence of diarrheoa among children covered with rotavirus vaccine and the cold chain management of rotavirus vaccine. Various immunizational programmes have been implemented in the Wa Muncipality but the scope of this study is however limited to only rotavirus immunization exercise among under-five children.

1.6 Organization of the Study

The study is organized in six (6) chapters. Chapter one dealt with the introduction to the study which contains the study background, statement of the problem, research questions, objectives of the study, significance of the study and scope of the study. Chapter two contained the pertinent literature on the study topic which sought relevant materials from journal articles, books, websites and other sources. The chapter further captured the philosophy under which the rationale of the study is built on and the conceptual framework that shows linakages of the major concepts used in the study. Chapter three of the study focused on the research methodology which covered the study area, study approach/design, study population, sample size and sampling technique. The rest are: data sources, study variables, instruments for data collection, data collection procedure, data analysis and presentation of results, training and pre-testing, quality control, ethical considerations and limitations of the study. Chapter four presented the study results whereas chapter five discussed the results. Chapter six which is the last chapter presented the conclusion and recommendations of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of related studies on rotavirus vaccination and diarrhoea prevalence among children under-five years. Several concepts have been reviewed with much focus on the objectives under investigation. First, the chapter presents literature on child motality, diarrhoea, and immunization. Other sections presented related literature on the contribution of rotavirus vaccine in reducing diarrhoeal disease with much emphasis on the socio-economic factors contributing to diarrhoea prevalence, cold chain management of rotavirus vaccine, coverage of rotavirus vaccination and the prevalence of diarrhoea among under-five children.

2.2 Concept and forms of child mortality

Child mortality is the death of a child before the child's fifth birthday (WHO, 2015). Globally, 9.2 million children die each year before their fifth birthday; more than 60% of these deaths are seen as being avoidable with low-cost measures such as continuous breast-feeding, vaccinations and improved nutrition (WHO, 2015). According to CDC (2012), child mortality have been categoried in to seven (7) however this study focuses on two (2), such as infant mortality and postneonatal mortality.

Infant mortality is defined as the death of young children under the age of one year (CDC, 2012). This death toll is measured by the infant mortality rate (IMR), which is the number of deaths of children under one year of age per 1000 live births (CDC, 2012). The under-five mortality rate is also an important statistic, considering the infant mortality rate which focuses only on children under one year of age (UNICEF, 2017). Premature birth is the biggest contributor to the IMR including birth asphyxia,

pneumonia, congenial malformations, preterm birth complications such as abnormal presentation of the foetus umbilical cord prolapse, or prolonged labor, neonatal infection, diarrhoea, malaria, measles and malnutrition (CDC, 2013). Infant mortality is commonly caused by smoking during pregnancy including other factors such as mother's level of education, environmental conditions, political will in health care and medical infrastructure (Shah et al., 2011). Postneonatal mortality is the number of resident newborns dying between 28 and 364 days of age in a specified geographic area (UNICEF, 2011).

2.3 Global Trend of Child Mortality

Child mortality has seen significant reduction world wide over the years and this has translated globally into a drop in the under-five mortality rate from 93 deaths per 1,000 live births in 1990 to 41 in 2016 (UNICEF, 2017). According to the report (UNICEF, 2017), progress in reducing child mortality has been enhanced from 2000–2016 period compared with the 1990s global rate which has seen a tremeduous annual rate reduction in the under-five mortality. The remarkable progress in improving child survival since 2000 has saved the lives of 50 million under-five children who would have died had under-five mortality remained at the same level as in 2000 in each country (UNICEF, 2017). In 2016, infant mortality rate for Ghana was 41.2 deaths per 1,000 live births and fell gradually from 120.4 deaths per 1,000 live births in 1967 to 41.2 deaths per 1,000 live births in 2016 (WDA, 2017).

In sustaining gains made so far, child health programme needs to focus on the first five years of life as this is the most vulnerable period of childhood, which sets the tone for child growth and development thereafter (GHS, 2016). The GHS (2016) report observed that, there have been a progress been made over the years in reducing

childhood morbidity and mortality, however there are still several challenges that need to be addressed in term of newborn deaths which are an vital element of child mortality and currently represents over 40% of all under-five deaths. The report further noted that there exist varation in the mortality between geographic areas and a number of other factors including the age and level of education of the mother and household incomes, with the most deprived having higher mortality rates.

According to UNICEF (2017), majority of the regions in the world 142 out of 195 countries at least divvy up their under-five mortality rate and all countries, more than one third (67) cut their under-five mortality by two-thirds. Twenty eight (28) of these countries are low- or lower-middle-income countries, signifying that improving child survival is possible even in resource-constrained settings. However, there are great differences in under-five mortality across regions and countries and Sub-Saharan Africa remains the region with the highest under-five mortality rate in the world. It shows that, risk of dying for a child born in the highest mortality country is about 60 times higher than in the lowest mortality country. The burden of under-five deaths remains unevenly distributed, 80 per cent of under-five deaths occur in two regions, sub-Saharan Africa and South Asia. While six countries accounted for half of the global under-five deaths, which include; India, Nigeria, Pakistan, the Democratic Republic of the Congo, Ethiopia and China. India and Nigeria alone account for almost a third (32 per cent) of the global under-five deaths (UNICEF, 2017).

2.4 Main Causes of Child Mortality

There are various causes of child deaths. However, these cause have been grouped in to two main categories: endogenous deaths and exogenous deaths (Sornette, 2000). According to the study endogenous child deaths are deaths caused by congenital

malformations, genetic diseases, malnutrition and childbirth-related problems. They further noted that endogenous child deaths has a close relationship with social economic and cultural factors and can be prevented and controlled by public health measures such as immunization, and antibiotic treatment. According to this classification, infectious diseases, parasitic diseases, digestive diseases, injury and poisoning, neonatal tetanus are roughly attributed to exogenous child deaths (Bhatta et al., 2014).

Endogenous child deaths are difficult to prevent and control, so reducing exogenous child deaths mortality should be more focused (United Nation, 2013). The report further stated that the low level of child deaths, are most caused by the congenital and hereditary factors which are endogenous child deaths. Again, the united nation report in 2010 indicated that the exogenous child deaths caused by the postnatal environment and external factors are almost controlled.

According to Singh *et al*. (2013), the influencing factors of child mortality are mainly socio-economic factors, demographic factors and biological factors. Demographic factors affect both of the endogenous and exogenous deaths, like problems at birth which are difficult to prevent and control and exogenous deaths which can be prevented by the public health measures, immunization, and antibiotic treatment. Singh *et al.* (2013) further noted that biological factors mainly refer to the mother's fertility information and the total number of children born which are concerned at the family level rather than children level.

2.5 The concept of Diarrhoea

The Ghana Ministry of Health's Standard Treatment Guidelines (2010) defines diarrhoea as passing frequent, loose, watery stools three or more times in a day and is often accompanied by vomiting which is very common in children. It has been further described by the the treatment guide as a condition of abnormal increases in stool weight and liquidity. An increase in stool water excretion above 150 to 200 ml every 24-hour is an objective parameter for acute diarrhoea (Hogue, 2010). WHO (2000) defines diarrhoea as the passage of 3 or more loose or liquid stools per day, or more frequently than is normal for the individual. Again WHO (2000) further defines diarrhoea as a symptom of gastrointestinal infection, which can be caused by a variety of bacterial, viral and parasitic organisms. Infection is spread through contaminated food or drinking-water, or from person to person as a result of poor hygiene (Akwasi & Joshua, 2015). Diarrhoea could also be defined as the passage of more than 200gm of stool daily and the measurement of stool volume is sometimes helpful in patient evaluation (Scallan et al., 2011). The most severe symptom in many patients is the urgency of defaecation, and faecal frequency is a common event in acute and chronic diarrhoeal illness (Haslett et al., 2009). Diarrhoea can be acute or chronic.

Acute diarrhoea can be defined as the passage of a greater number of stools of decreased form from the normal lasting <14 days (Scallan et al., 2011). Additionally, some definitions require an individual to present with an abrupt onset 3 or more loose or liquid stools above baseline in a 24-hour period to meet the criteria of acute diarrhoea. Persistent diarrhoea is typically defined as diarrhoea lasting between 14 and 30 days, with chronic diarrhoea generally considered as diarrheal symptoms lasting for greater than a month (Kosek, Ben, & Guerrant, 2016). The study further noted that, acute diarrhoea of infectious etiology is generally associated with other clinical features

suggesting enteric involvement including nausea, vomiting, abdominal pain and cramps, bloating, flatulence, fever, passage of bloody stools and fecal urgency.

2.6 Epidemiology of Diarrhoea

Diarrhoeal diseases remain the major cause of childhood morbidity and mortality in developing countries, especially in African countries (Mokomane et al., 2017). According to WHO (2011) report, diarrhoeal diseases are still leading causes of mortality and morbidity in children under-five years of age. Furthermore, WHO (2011) indicates that each child in the Africa region has five episodes of diarrhoea per year and 800,000 children die each year from diarrhoea and dehydration. Diarrhoea which is characterized by an increased in water evacuations or some watery evacuation with blood or 6 mucus relative to the usual pattern of each individual, has been found to be a major contributor to illness and death, particularly among children in sub-Saharan Africa (Holtz et al., 2014; Kirkwood, 2009). An estimated 1,000 million episodes occur each year in children under 5 years of age in Africa (Kirkwood, 2009). Diarrhoea causes an estimated 5 million deaths in children less than 5 years of age per year and about 80% of these deaths occur in children in the first 2 years of life (Sow et al., 2016). Approximately one third of deaths among children less than 5years are caused by diarrhoea and most diarrhoeal illnesses are acute, usually lasting not more than 3-5 days and are secondary to infectious causes-bacterial, viral, and parasitic (Synder & Merson, 2011). Infectious agents that cause diarrhoeal diseases are usually spread by the faecal-oral route, specifically by ingestion of contaminated food or water and contact with contaminated hands (Synder & Merson, 2011). WHO (2006) worldwide report also confirms that acute diarrhoea incidence is 5 percent to 7 percent annually; and at least 5 million deaths per annum is reported in children less 5 years. In Africa

acute diarrhoea is a leading cause of death among children (WHO, 2012). Noticeably, in Ghana, the incidence of diarrhoea obtained from hospitals represent only a small proportion of all illnesses probably because many cases do not seek medical attention or patronize community pharmacy service but may be drawn to the common use of herbs and other belief practices (Akwasi & Joshua, 2015).

2.7 Risk Factors/Causes of Diarrhoea

The prevailing environmental condition and logistics available in the setting; educational level of parents and or care takers are major factors to be considered (Akello, 2010). Again the study noted that, complains of diarrhoea are matters of concern and should not be taken casually because many factors can cause diarrhoea especially in children. Mills *et al*. (2016) also noted in their study findings that poor hygiene practices, lack of adequate sanitation and unsafe or limited water supplies can contribute to the spread of preventable diseases such as cholera, diarrhoea or typhoid. They further noted that,understanding how pathogens (organisms that cause disease) are transmitted allows public health workers to intervene in appropriate ways to break the chain of transmission cycle, saving lives and reducing unneeded suffering.

A study conducted noted that breastfeeding, especially if this is the only source of nutrition, has been shown to protect children against the development of diarrhoea in Nigeria (Sharon et al., 2016). In contrast, foods given for complementary feeding probably contribute to diarrhoea in infants (Barrell & Rowland, 2009). Early introduction of milk-formula or solid food is often considered to increase exposure to enteropathogens and has been associated with increased rates of acute diarrhoea. Studies in The Gambia in the 1970s demonstrated heavy contamination of gruels used as complementary foods in breast-fed infants (Barrell & Rowland, 2009). Methods of

food handling and storage, source, and use of safe water, and personal hygiene all contribute to the potential risk of developing acute diarrhoea. Ponds, rivers, standing waters and unprotected springs tend to be more heavily contaminated than protected spring source of drinking water and have been significantly associated with an increased risk of diarrhoea in a number of studies (Ekanem et al., 2008). Two more studies have found an increased risk of diarrhoea associated with the consumption of maize-based weaning foods (Tagbo et al., 2014; Ekanem et al., 2008). However, in one of these studies, this association was only significant in children living in rural communities (Ekanem et al., 2008). Also, there is an increased risk of diarrhoea in households lacking the habit of frequently washing hands with soap, storage of food in proximity to household defaecation sites was evaluated in one study in Nigeria and found to be significantly associated with acute diarrhoea (Tagbo et al., 2014).

Habitual teaching of washing hands with soap, and using running waters are ideal. Weaker association with diarrhoea includes presence of flies in the latrine area and visible stool around the latrines (Tagbo et al., 2014). The use of improper means of faecal and solid waste disposal and improper refuse disposal were also found to be associated with an increased prevalence of diarrhoea (Olufemi, Kayode, & Olusile, 2013).

Metabolic diseases like hyperthyroidism, diabetes mellitus and pancreatic insufficiency are risk factors for acute diarrhea (Thea et al., 2013). Similarly, surgery procedures like colonostomy, gastrectomy, vagotomy, renal failure, anaemia and gall bladder removal and cancer of the colon are same (Thea et al., 2013). Malnutrition causes diarrhoea which in turn also causes malnutrition, setting up a vicious cycle. Although no much study has systematically evaluated the relationship between malnutrition and persistent

diarrhoea, at least one report found a longer duration of diarrhoea in malnourished children (Tomkins, 2008). Deficits in nutritional status appear to contribute to an increased incidence of persistent diarrhoea in other regions of the developing world as well (Goodgame & Greenough, 2010).

2.8 Prevalence of Diarrhoea in Children

In 2011, diarrhoea accounted for 700,000 deaths in children under-five years of age (U5s) worldwide making it the second leading cause of child mortality (Bhutta, 2013). The study observed that, the highest rates of child mortality were in Sub-Saharan Africa and Southeast Asia. An estimated 1.7 billion episodes of diarrhoea, approximately 2.9 episodes per child per year, created health system costs of about 7 billion US dollars (Hutton & Haller, 2009). The majority of diarrhoeal diseases can be prevented by implementing water, sanitation and hygiene (WASH) programmes, which all aim at interrupting faecal oral transmission pathways, commonly referred to as the five ‘‘Fs’’ (fluids, fields, flies, fingers and food) (Wagner & Lanoix, 1958). Quite a lot of studies have attempted to evaluate the effects of combined or single water, hygiene and sanitation interventions on diarrhoea as an outcome variable. In their review, Fewtrell *et al.* (2011) provided valuable information about the effect of WASH interventions on diarrhoea prevalence, updating an earlier review by (Enweronu et al., 2014; Esrey, Potash, Roberts, & Shiff, 2009). Even though diarrhoea morbidity and mortality has decreased since the 1990s, the overall disease burden remains unacceptably high, particularly in low- and middle-income countries (Walker et al., 2011). To achieve sustainable progress in overcoming such unmet health needs, programme planning and implementation needs to be adjusted to the specific requirements and needs of a local setting (IOM, 2009). Acute diarrheal infection is one of the leading cause of outpatient

visits, hospitalizations, and lost quality of life occurring in both domestic settings and among those traveling abroad. Centers for Disease Control and Prevention has estimated 47.8 million cases of diarrhoea occurring annually in the United States given an an estimated upwards cost of US$150 million to the health-care economy (Scallan, 2011).

2.9 Diarrhoea Prevention in Under-five Years

Diarrhoeal disease control programs have helped most countries which have employed WHO-endorsed case-management strategy emphasizing Oral Rehydration Therapy (ORT) (WHO, 2017). Additional measures including improved nutrition with a focus on breast-feeding and safe weaning foods, better personal and domestic hygiene, and the provision of safe water supplies are being gradually introduced (WHO, 2017). Community intervention programmes should be put in place to train health workers to provide health education to mothers during home visits especially specifying programmes for good water supply use, improvement in health and stressing on other public education. The Imo State Drinking Water Supply and Sanitation Project in Nigeria, a collaborative effort involving several state governments with UNICEF assistance, evaluated the effects of improved water source (The Imo state evaluation team, 1889), ventilated improved pit latrines, and supportive hygiene and health education on the prevalence of diarrhoea and malnutrition (Huttly et al., 2008). These interventions did not appear to have an impact on diarrhoeal prevalence but did lead to a progressive decline in the proportion of children aged less than three years with weight-forheight below the 80% reference value. A case-control approach was used to study the effect of improved water and sanitation facilities on diarrhoeal morbidity in Malawi (Briscoe et al., 2007). The risk of attending a clinic because of acute diarrhoea

was reduced by 20% in children with access to improved sanitation and water supplies. This effect was not statistically significant, perhaps because of the small study sample size. However, a similar estimate of the reduction in diarrhoeal morbidity (22%) was obtained from a review of worldwide studies of the impact of sanitation (Esrey et al., 2009). These findings were reasonably inspiring; however, assessing the effect of sanitary, water, and public health education interventions on morbidity and mortality from diarrhoeal diseases remains a challenge for investigation (Mills & Cumming, 2016). The study also revealed that mass communication techniques which incorporate local perceptions of diarrhoeal disease management, together with increased availability of ORS and educational efforts to teach proper ORS preparation and use, can stimulate increased use of ORT to manage diarrhoea.

2.10 Evolution of Immunization

History of immunization dates back to many centuries, where prophylactic inoculation against smallpox was practiced in China, India and Persia (Riedel, 2005). It was introduced to England from Turkey and in 1754 it was recommended by the Royal College of Physicians (WHO, 2010). The first successful scientific inoculation was done by Edward Jenner on 14th May 1796 against small pox. Motivated by Jenner's work, Louis Pasture worked on weakening of viruses and preventive vaccination of viruses other than small pox (WHO, 2010). Even though Jenner was the founder of vaccinations, it was Louis Pasture who coined the term "Vaccine" (Riedel, 2005).

Expanded Program on Immunization (EPI) was initiated by WHO in 1974 through a resolution passed at World Health Assembly, with the aim of eradicating small pox and also targeting six infectious diseases; namely – tuberculosis, poliomyelitis, diphtheria, pertussis, tetanus and measles (WHO/UNICEF, 2015). Substantial vaccination

campaigns were conducted by the World Health Organization (WHO) for the eradication of Small pox from 1967 to 1977 (WHO, 2010). Small pox had claimed the lives of many for about two centuries and still was a threat to about 60% of the population, killing every fourth victim out the population infected. The disease was eradicated with the use of vaccines on 9th December 1979 (The Expanded Program on Immunization, 2014). As time goes on, the emphasis in immunization shifted from the containment of epidemics to prevention of the disease (Streefland, 2003).

Over the course of time, new vaccines were developed and WHO introduced various vaccines like Hepatitis B, H. influenza, Rotavirus vaccines in EPI which were adopted by the WHO member countries in a tailored manner. After these vaccines were added, globally, vaccines prevent more than 2.5 million child deaths annually. Introduction of new vaccines like Pneumococcal vaccine and Rotavirus vaccine can prevent additional 2 million deaths in children under-five years of age (WHO,UNICEF & World Bank, 2009). In 2010, The Decade of Vaccines was launched with the goal "to extend, by 2020 and beyond, the full benefits of immunization to all people, regardless of where they are born, who they are, or where they live". With this initiative, vaccines against diseases like Malaria, Hepatitis C, E, Dengue fever are in the pipeline for development, which will aim at reducing morbidity and mortality due to vaccine preventable diseases (WHO, 2014).

In the commencement of EPI, only 5% of newborns were vaccinated against tuberculosis, poliomyelitis, diphtheria, pertussis, tetanus and measles. This coverage accounted for mostly developed countries. By 1990, the global vaccination rate reached 80% and this rise in global immunization rate however has been taking a slow progress over the last century with an estimated coverage of 83% (WHO, 2010). According to

the report currently, 100 million children under one year of age are vaccinated against the third dose of diphtheria-pertusis-tetanus (DPT) vaccine; mostly residing in the developed regions and their regional coverage is over 90%. However, immunization fails to reach about 20 percent of children born in a year which amounts to 24 million globally, of which majority reside in developing countries (WHO, 2010). This shows that the trend which was present at the inception of EPI still being carried on and the children of developing countries are still far from the reach of vaccination (WHO, 2014).

According to WHO, "Immunization" is a process whereby a person is made immune or resistant to an infectious disease, typically by the administration of a vaccine. Immunization is one of the most cost-effective strategies to prevent millions of infectious disease episodes and deaths (Desai & Temsah, 2015). Vaccines are preparations which when given evoke immune responses, which lead to the production of antibodies that help combat infectious agents (Saroja, Lakshmi, & Bhaskaran, 2011) . Accornding to Plotkin *et al.* (2008), "Vaccines with the exception of safe water, no other modality, not even antibiotics, has had such an effect on mortality reduction." Vaccination is one of the top ten achievements in the field of public health in the twentieth century as it provide "herd immunity", to protects individual and the community and thus hinders circulation of the infectious agent (CDC, 2013). In doing this, effects of vaccination are seen much rapidly, as evident by the eradication of small pox and also helps healthy individuals stay healthy and therefore aids to human development. Vaccines are the most effective tools available for prevention and control of infectious diseases as its widespread use has prevented millions of premature deaths, paralysis, blindness, and neurologic damage (Miller & Sentz, 2006).

Despite their public health benefit, vaccination programmes face obstacles of which one of them is public perception of the relative risks of vaccination (Reluga et al., 2009). In addition, Reluga *et al*. (2009) states that, scarcity of vaccine and constant increase in vaccine demand remind us that the effectiveness of mass vaccination programs is governed by the public perception of vaccination. Each individual and family weigh perceived risks and benefits, reflect on the value of participation, and consider potential consequences of vaccination (Desai & Temsah, 2015).

2.11 State of of Immunization

According to most of the medical establishments, childhood immunisation constitutes one of the great success stories of American public health in the 20th century, the British led the way in introducing formal clinical trial methodology in the field of immunisation development, the Americans excelled in the rapid translation of laboratory knowledge into strategies suitable for mass application (Baker, 2000). To achieve its "aim" of eradicating infectious diseases WHO launched the Expanded Programme on Immunisation in 1974 (WHO,UNICEF & World Bank, 2009). At the time only 5 per cent of the world's children under one were immunised against six target diseases: diphtheria; tetanus; whooping cough; poliomyelitis; measles; and tuberculosis (WHO,UNICEF & World Bank, 2009). The world's poorest regions are still suffering a heavy toll of premature death and disability from infectious diseases for which vaccines do not exist or else need to be improved (GAVI, 19990). Infectious diseases are responsible for a third of all deaths in the developing world, killing at least 15 million people a year. The health disparity between rich and poor countries results in average life spans of 77 and 52 years respectively, the deaths attributable to infectious diseases contribute most to the disparity, more than 5 million are children under-five

(WHO, 2010). According to the WHO (2008) "The most effective way to reduce disease and death from infectious diseases is to vaccinate susceptible populations". Sainsbury (2005) stated that, Cuba is one of the world's poorer countries but when Fidel Castro came to power in 1959, he has developed an excellent health care service that boasts of 95 per cent immunisation coverage, low infant mortality rates and life expectancy much higher than other developing countries.

A vaccine is a biological preparation that improves immunity to a particular disease (CDC, 2012). According to the vaccine safety tool-kit vaccine typically contains an agent that resembles a disease-causing microorganism, and is often made from weakened or killed forms of the microbe, its toxins or one of its surface proteins (CDC, 2012). Unlike natural infection it is usually injected into a muscle and goes into the blood stream, the theory of immunisation programmes works mainly in two ways: on an individual basis to protect specific persons at risk; and on a population basis to provide "herd immunity" to protect individuals who can not be vaccinated because of health reasons (Fallet, 2017). In both ancient Greece and China it had been noted that people who recovered from smallpox never had subsequent attacks of the disease. The study further noted that girls milking cows did not seem to get smallpox and that cowpox inoculation reduced incidence of later infection with smallpox (WHO, 2010). This was the start of a new science, which is the "coin of the realm" for WHO programme for preventing disease.

The advent of modern medicine, the discovery and invention of vaccines and antibiotics and the establishment of public health agencies promised to make recurring epidemics a thing of the past. The smallpox chapter of the history of immunisations was closed in 1980 when WHO declared the disease officially eradicated Diphtheria,

tetanus and pertussis may seem distant to young parents living in the UK, but they can still strike fear into the hearts of people living in the third world. During the nineteenth century and the early part of the twentieth, diphtheria and pertussis each infected more than 100,000 people a year in the UK, mostly children and tens of thousands died as a result Tetanus (WHO, 2003).

2.12 Immunization Efficacy

Immunisation programmes are globally recognised as the most effective type of health intervention (Ngcobo, 2008). Since the launch of the EPI in 1974, millions of deaths have been prevented every year by delivery of infant immunisation through national immunisation programmes. In 2005 the World Health Organization (WHO) and the United Nations children's Fund (UNICEF) endorsed the Global Immunisation Vision and Strategy (GIVS) (Wolfson et al., 2008). The primary objective of GIVS is to reduce vaccine-preventable disease mortality and morbidity by two-thirds by the year 2015. This was aligned with the achievement of Millennium Development Goal Four (4), which calls for a two thirds reduction of under-five mortality rate by the year 2015. The effectiveness of immunisation programs is related to the quality of the practice of those who implement them (WHO, 2010). Thus, vaccines can be maintained perfectly from the time they are manufactured to the time they are administered through adequate cold chain infrastructure, compliance to national guidelines, and effective management of cold chain. However, in most countries the delivery of potent vaccines and the practice of quality vaccine maintenance remains a challenge.

2.13 Burden of Rotavirus Disease (Diarrhoea)

Diarrhoeal disease has extensively been recognised as a major contributor to the global public health burden, with descriptions of diarrhoea dating back to ancient Greek civilisations and featuring prominently during the modern centuries (Weekly Epidemiological update on rotavirus vaccines, 2009). Children are particularly susceptible to diarrhoeal disease, which remains an leading cause of morbidity and mortality in children under-five years of age worldwide, accounting for approximately 9% of the 6.3 million deaths in this age group in 2013 (Ruiz-Palacios et al., 2015). The burden of diarrhoeal disease is greatest in low- and middleincome countries with the highest incidence rates found among children <12 months of age (Vesikari et al., 2008) . In South Africa, diarrhoea has been identified as one of the leading causes of death in children and accounted for 18% of all deaths in children under-five years in 2009 according to official statistics, but the true burden of disease is not accurately defined (Madhi et al., 2010). Diarrhoea can be caused by a number of viral, bacterial and parasitic enteropathogens but rotavirus remains the most important cause of severe diarrhoea in infants and young children globally (Armah et al., 2010).

Acording to Yen *et al.* (2014), rotavirus-diarrhoea resulted in an estimated 453 000 deaths annually – 37% of all diarrhoeal deaths in children under-five years of age worldwide, with the greatest burden of disease in Africa and Asia. The study also argued that, incidence of rotavirus disease was similar in children in low- and high-income countries. However, children from less-developed countries were more likely to die due to poorer access to health care and comorbidities like malnutrition. The rotavirus, a genus of the Reoviridae family, comprises an 11-segment double-stranded RNA genome surrounded by an outer capsid, an inner capsid and an internal core. Based on the inner capsid protein (VP6), rotaviruses are classified into seven groups

A–G, three of which occur in humans. Group A rotaviruses are responsible for almost all of the disease in humans and are very important from a public health point of view (Rennels, 1996). Two structural proteins in the outer capsid. In South Africa, prior to rotavirus vaccine introduction, rotavirus was associated with approximately 25% of diarrhoeal hospitalisations, with the greatest burden of disease (75%) in children <12 months of age (Goveia et al., 2008).

2.14 Prevention of Rotavirus Disease

Interventions which have been successful against bacterial and parasitic enteropathogens causing diarrhoeal disease, for example administration of ORS with Zinc supplement, have observed improvements in the management of diarrhoea cases (Moon et al, 2013). Furthermore, Moon *et al.* (2013) also observed also that, the transmission of rotavirus occurs through person-to-person contact, thus improvements in sanitation and hygiene have also had limited impact on its prevention, with similar incidence of rotavirus infection, although differing severity reported in children from high-income and lower income countries. It further observed that,vaccination was one of the most cost-effective health interventions available that can help prevent the prevalence of diarrhoeal diseases.

Rotavirus vaccines have the potential to substantially reduce the burden of diarrhoeal disease in young children and in so doing have a tremendous public health impact on children's health, especially in Africa and Asia (Rimer et al., 1992). Natural infection with rotavirus was publicized to offer protection against subsequent severe acute and frequent rotavirus diarrhoea, as well as cross protection against multiple circulating strains, and this observation led to development of the currently licenced liveattenuated vaccines, in order to copycat natural infection and develop comprehensive heterotypic

(i.e. against many strains) protective immunity (Rimer et al., 1992). In view of this, two oral rotavirus vaccines, Rotarix® - a monovalent human-derived vaccine (GlaxoSmithKline Biologicals, Rixensart, Belgium) and RotaTeq® − a pentavalent bovine-derived vaccine (Merck Vaccines, Whitehouse Station, NJ), are licenced in many countries worldwide and recommended by WHO for global use in children (Steele et al., 2013) . Pre-licensure clinical studies of these vaccines demonstrated very good protective efficacy (85-98%) against severe rotavirus disease in middle- and highincome countries in Latin America, Europe and the United States (Rivera et al., 2011). Lower efficacy and immunogenicity have however, been observed in clinical studies of rotavirus vaccines in low- and middle-income countries in Africa and Asia, including South Africa (Rivera et al., 2011). These countries have been shown to have poorer socio-economic conditions, high mortality from diarrhoeal diseases, high rates of malnutrition, high maternal human immunodeficiency virus (HIV) prevalence and vaccine schedules with co-administration of oral polio vaccine (OPV) and rotavirus vaccine.

2.15 Rotavirus vaccines in Developing Countries

The African study of either two doses (given at 10 and 14 weeks of age) or three doses of themonovalent rotavirus vaccine, Rotarix® (given at 6, 10 and 14 weeks of age) reported vaccine efficacy against severe rotavirus gastroenteritis of 77% (95% confidence interval (CI) 56−88) in South Africa and 49% (95% CI 19−68) in Malawi during the first year of life (Mrukowicz et al., 2008). The pentavalent rotavirus vaccine (RotaTeq®) was evaluated in Ghana, Mali and Kenya, demonstrating a vaccine efficacy of 64% (95% CI 40−79) against severe rotavirus diarrhoea in the first year of life (Payne et al., 2008). This is in keeping with the poorer performance observed in

lower-income countries of other live oral vaccines such as those targeting poliomyelitis, typhoid and cholera, as well as previous rotavirus vaccine candidates (Yen et al., 2014). However, vaccine efficacy does not always accurately reflect a vaccine's public health value as it does not account for background disease incidence (Ruiz-Palacios et al., 2006). Although vaccine efficacy was lower in these countries compared to higher income countries, the high incidence of severe rotavirus disease resulted in a considerable vaccine-attributable decrease in severe rotavirus diarrhoea i.e. the number of episodes of severe diarrhoea prevented by rotavirus vaccination was greater (Versikari, 2012).

Regional differences in immunogenicity to rotavirus vaccine have also been observed, with infants in low-income countries found to have significantly lower rotavirusspecific immunoglobulin A (IgA) titres and rates of seroconversion compared to infants in high-income countries (Patel et al., 2009). Locally manufactured oral rotavirus vaccines are available in China (Lanzou lamb rotavirus vaccine; Lanzou Institute of Biological Products), Vietnam (Rotavin-M1; POLYVAC) and India (Rotavac; Bharat Biotech International, Ltd) but the vaccines are only licenced for use within these countries and there are limited efficacy data (Fu et al., 2012).

Since 2006, 2 rotavirus vaccines have been licensed and used globally that is Rotarix (GlaxoSmithKline) and RotaTeq (Merck and Co., Inc.). Rotarix is a live, attenuated vaccine containing a single G1P[8] human rotavirus strain. It is administered orally to infants starting at a minimum age of 6 weeks, with a minimum 4 weeks interval between doses (2 doses per Rotarix course, 3 doses per RotaTeq course) (WHO, 2013). Previous WHO administration recommendations for upper age limits of 15 weeks for the first dose of rotavirus vaccine and 32 weeks for the last dose of the rotavrus vaccine

were removed in 2013. According to WHO (2013) report, the vaccine was clinically tried in high and upper-middle-income countries in the Americas, Asia, and Europe and it demonstrated efficacy rate of 72–100% in preventing severe rotavirus disease during 1- to 3-years follow-up periods, while trials conducted in lower income countries in Africa and Asia demonstrated vaccine efficacy rate of 49–72% (Armah et al., 2010). Although definite reasons for this lower efficacy are unknown, reasons proposed include factors that can result in interference of uptake of a live, oral vaccine, such as breast milk, stomach acid, maternal antibodies, and co-administration of oral poliovirus vaccine (OPV), and factors that may cause an impaired immune response to vaccine, such as malnutrition, and other infections such as human immunodeficiency virus, malaria, and tuberculosis (Patel et al., 2009).

Monitoring of disease trends and vaccine effectiveness studies is very paramount as it help to provide timely information necessary to evaluate the impact of vaccine introduction on disease burden. Findings generated from Rotarix and RotaTeq impact assessments, mostly in Australia and countries in Europe and the Americas, have demonstrated substantial declines of 22–50% in diarrhoea-related mortality and17–55% in diarrhoea-related hospitalizations (Beyard et al., 2012). A smilar study on reduction in gastroenteritis with the use of pentavalent rotavirus vaccine in a primary practice among children revealed that 49–91% in rotavirus-specific hospitalizations were among children <5 years of age (Begue & Perrin, 2010).

Some other studies have also reported that they were potential indirect benefits for unvaccinated older children and young adults, with reductions of 6–51% in diarrhoea-related hospitalizations and 20–92% in rotavirus-specific hospitalization (Clarke et al., 2011). Further more, another study in South Australia have demonstrated vaccine

effectiveness in preventing rotavirus hospitalizations similar to vaccine efficacy observed in clinical trials. High and upper-middle-income countries including Australia (certain regions), Taiwan, Austria, Belgium, France, Germany, Northern Israel, Spain, Mexico, Brazil (certain regions), and the US have reported rotavirus vaccine effectiveness estimates of 79–100% (Field et al., 2010).

2.16 Factors Affecting Vaccine Efficacy in Low- and Middle-Income Countries

Differences in the behaviour of live oral vaccines in the digestive tracts of infants in lower income settings may have an impact on their efficacy (Armah et al., 2010). Immune response and efficacy of oral rotavirus vaccine are dose dependent and factors decreasing the dose of the vaccine may impact its immunogenicity and efficacy (Vesikari et al., 2008). Rotavirus immunity is not completely understood and there is not an established correlate of protection, but a strong correlation was found between serum rotavirus IgA titres and efficacy after rotavirus vaccination (WHO, 2009). This suggests that serum rotavirus IgA titres are an important measurable predictor of protection,albeit not the only immunonological determinant of the defense mechanism protecting infants from rotavirus-associated diarrhea.

Immune responses in the infant may be decreased by conditions that lower the effective titre of vaccine delivered to the intestine such as the amount of gastric acid present in the infant's gut, and interference by high levels of rotavirus antibodies acquired transplacentally from the mother during pregnancy or during breastfeeding. Micronutrient deficiency (zinc, vitamin A), malnutrition, interfering microbiota present in the gut, enteric viral and bacterial co-infections and concomitant disease in the infant such as diarrhoea, tuberculosis, malaria or HIV infection as well as co-administration with OPV may also contribute to sub-optimal immune responses among infants in

lower-income settings (Parashar et al., 2006). Rotavirus vaccine tends to be administered at a younger age in many lower income countries, where the rotavirus disease burden is high and infection at a young age is more common than higher income countries. The earlier administration of the vaccine is advised to prevent early rotavirus infection but the ability to induce neutralising antibodies against rotavirus is dependent on age, and immunogenicity might be reduced when vaccination occurs at a very young age (Yen et al., 2014).

2.17 Trend of Rotavirus Vaccination Coverage among Children Under-five Years

Rotavirus vaccine has been used in eighty-four (84) countries in cluding Ghana, however, global coverage remains low at 23% (WHO/UNICEF, 2015). It is also observed by WHO/UNICEF (2015) that, new vaccine introduction is especially lagging in middle income countries because these countries are often not able to finance introduction with national resources, because they generally don't have access to external funding sources. Low income countries have largely been able to close the gap in coverage with high income countries with assistance from Gavi, the Vaccine Alliance.

Rotavirus vaccination coverage rate was investigated in a study in Belgium, 874 families participated in the study. Of these, a good percentage (92%) of the families had a vaccination document at home. Medical files and vaccination database showed that 94% of children between 18 & 24 months had proof of administration of at least one dose of the vaccine, 92.2% of the children had a second dose and 12.2% a third dose (Braeckman et al., 2014).

A study by Qing He *et al*. (2013) on rotavirus vaccination coverage among 8400 children (2-59months), 2122(25.3%) had received at least one dose of Lanzhou lamb rotavirus (LLR). Among those who received the LLR vaccination, 89.7% received one dose, 9.8% and 0.5% received 2 or 3 doses respectively. This study was performed in China (Qing He et al., 2013). Additionally, rotavirus vaccine was introduced in 81 countries and global coverage reached 23% in 2015 (WHO/UNICEF, 2016). The WHO/UNICEF (2016) study shows under-performance in middle income countries, where vaccination coverage only reached 16% with 44 out of 104 middle income countries using the vaccine; compared to 44% vaccination coverage in low income countries with 18 out of 31 countries using the vaccine, mainly with Gavi's support; and 40% vaccination coverage in high income countries with 19 out of 57 countries using the vaccine. WHO/UNICEF (2016) further stated that data on global immunization coverage was 86% of the world's children who received the required 3 doses of diphtheria-tetanus-pertussis containing vaccines (DTP3) in 2015, a coverage level that has been sustained above 85% since 2010. This has resulted in a dropped of the number of children who did not receive routine vaccinations to an estimated 19.4 million, down from 33.8 million in 2000. This however, falls short of global immunization targets of the Global Vaccine Action Plan (GVAP) for achieving 90% or more DTP3 and rotavirus vaccination coverage at both districts and the national level by 2015. Gaps in immunization coverage was identified among 194 WHO Member States of which 126 countries achieved and sustained the 90% immunization target for DTP3, up from 63 in 2000 (WHO/UNICEF, 2016).

The number of countries using new vaccines such as rotavirus and pneumococcal conjugate vaccine has increased, but challenges remain among the 128 countries which introduced pneumococcal vaccine in national immunization programmes, global

coverage for three doses of the vaccine reached just 37% in 2015 (WHO/UNICEF, 2016).

2.18 Prevalence of Diarrhoea among Children Under-Five Years

Diarrhoeal disease kills an estimated 2.2 million people each year (WHO, 2009). Among infectious diseases, Diarrhoea is ranked as the third leading cause of both mortality and morbidity (UNICEF, 2008). Young children are especially vulnerable bearing 68% of the total burden of diarrhoea disease (WHO/UNICEF, 2007). Among children less than five years, diarrhoea accounts for 17% of all deaths (WHO/ UNICEF, 2009). The infectious agents associated with diarrhoea disease are transmitted chiefly through the faecal oral route (Ameyaw et al., 2017). The wide variety of bacteria, viral and protozoa pathogens excreted in the faeces of humans and animal are known to cause diarrhoea. Among the most important of these are Escherichia coli (E. coli), Salmonella sp; Shigella sp; Campylobacter jejuni, Vibrio cholera, Rotavirus, Norovirus, Giandia lamblia, Cryptosporidium sp; and Entamoeba Histolytica (WHO/UNICEF, 2009).

The prevalence of diarrhoea was significantly lower among children of educated mothers than children of uneducated mothers (Tagbo et al., 2014). The study further noted that, education of mothers is essential in the prevention of diarrhoea in children. This could probably because education provides mothers the knowledge of the rules of hygiene, feeding and weaning practices, the interpretation of symptoms enhances timely action to childhood illness.

A comparative study of urban areas of Ghana, Egypt, Brazil and Thailand clearly indicates that a child's health is affected by environmental conditions and economic

status of the household (Timaeus & Lush, 2010). According to these authors, children from better-off households have lower diarrhoeal morbidity and mortality in Egypt, Thailand, and Brazil. Such differentials in diarrhoeal diseases by households, economic status is probably due to differences in child care practices, for instance preparation of weaning foods and personal hygiene. Worldwide, diarrhoea causes the death of 2,195 children every day more than AIDS, malaria and measles combined. This illness can be fatal because it depletes body fluids and causes profound dehydration (UNICEF & WHO, 2009). Diarrhoea is the second leading cause of child mortality worldwide and low and middle-income countries are particularly burdened with this both preventable and treatable condition (Katharina, 2014). The study further noted that, targeted interventions such as the provision of safe water, the use of sanitation facilities and hygiene education, if implemented in various localities could prevent the prevalence of diarrhoea.

It is estimated that, on average, each child under 5 years of age in developing countries suffers from three episodes of diarrhoea per year and in Africa, a child experiences five episodes of diarrhoea per year and 800,000 children die each year from diarrhoea and dehydration which account for 25 to 75% of all childhood diseases (Ayuk, Leonie , & Nchang , 2015). The study further observed that, the number of childhood deaths only decreased by 4% in Africa from 2000 to 2008, due to inadequate interventions and high poverty rate.

Globally, 500,000 children die every year from diarrhoea caused by a lack of safe water, sanitation and hygiene (Tandoh, 2014). Out of this figure, Africa is the most affected losing 277,794 children each year. South Asia follows with 181,155 while East Asia and the Pacific accounts for 9,669 deaths. The rest of the world loses 39,589

children annually. In 2011, diarrhoea accounted for 700,000 deaths in children under-five years of age (U5s) worldwide making it the second leading cause of child mortality. The highest rates of child mortality are in Sub-Saharan Africa and Southeast Asia. An estimated 1.7 billion episodes of diarrhoea, equaling approximately 2.9 episodes per child per year, created health system costs of about 7 billion US dollars (Katharina, Patrik, Jochen, & Michael, 2014). Over 3,000 children in Ghana die annually from diarrhoea caused by lack of safe water, sanitation and hygiene (WASH) services, says WaterAid Ghana (Tandoh, 2014). Another study conducted in Ghana revealed that among 3963 children who were under surveillance showed that there was a significant decline from 84 inter-quartile range (IQR) during the 52 months before vaccination to 46 IQR in the 22 months after vaccination in all-cause diarrhea hospitalization (Enweronu et al., 2014). The study concluded that the implementation of rotavirus vaccination not excluding other factors could have resulted in the decline of severe diarrhea hospitalization. Similarly, in South Africa, there was a temporary association found between sustained decline in all-cause diarrhea hospitalization and rotavirus vaccine introduction in children less than 2years. The study further revealed that from the year 2010- 2014, among children less than 12 months diarrhoea cases reduced from 54.5 to 30.0, 23.6, 20.0, 18.8 and 18.9 through the respective years (Michelle et al., 2016). In a retrospective study conducted on a cohort of children (250 601) born after the rotavirus vaccination was licensed in U.S (CDC, 2006). 74.4% of these children were fully vaccinated with rotavirus vaccine while 25.6% were not. It was found that a full course of rotavirus vaccination was significantly associated with 18% to 20% reduction in of diarrhoea compared to those children who were not vaccinated (Payne et al., 2015).

In Northern Ghana, a study found that Rotavirus vaccination had the potential of significantly reducing rotavirus associated mortality. Using hospital laboratory surveillance data, all deaths due to acute diarrhea among children during 1998–2004 were identified, and the number of deaths due to rotavirus disease was estimated. Rotavirus infections had caused 131deaths of 381 deaths due to diarrhea. A 90% efficacious complete dose of rotavirus vaccination would have prevented 70% of the rotavirus related deaths that is on the basis of current diphtheria, tetanus and pertussis vaccine coverage and timing (Arvay et al., 2009).

2.19 Rotavirus vaccine Coverage and Incidence of Diarrhoea

Diarrhoea disease is the second leading cause of death in children under-five years and causes an annual mortality in 760 000 children world wide (Gebru et al., 2014). In Ghana, it accounts for 25% of mortality in children under-five years of age, with more than 9 million episodes occurring annually (Binka et al., 2011). Although diarrhoea is common among children under-five years in Ghana, there is disparity between the prevalence in the urban (10.5%) and rural areas (12.8%) (Child Health and Early Development, 2015). In Ghana, diarrhoea greatly affects children under-five years in specific risk groups with the highest prevalence occurring among children aged 12–23 months (16.8%) and it is higher among males (13.1%) than in females (10.2%) (Child Health and Early Development, 2015).

Diarrhoea has a short and long term effect on children, their families and the nation. It is a major cause of malnutrition, dehydration and even death in children under-five years (Gebru et al., 2014). In addition diarrhoea affects the physical and cognitive functioning of children under-five years later in their development (UNICEF & WHO, 2009).

Diarrhoea creates an indirect cost in that mothers' absence from work and stay in the hospital for days caring for sick children and also, the family income is spent on drugs, accommodation and transportation to the hospital (Walker et al., 2013). Many researches have been done on rotavirus vaccine coverage and its contribution in reducing diarrhoea among children under-five years. A study conducted by Bosomprah *et al.* (2016) in Lusaka, Zambia assessed the impact of Programme for the Awareness and Elimination of Diarrhoea (PAED) on under-5 mortality. This programme aimed to reduce post-neonatal, all-cause under-five mortality by 15 % in Lusaka Province, which lead to the introduction of the rotavirus vaccine, improved clinical case management of diarrhoea, and a comprehensive community prevention and advocacy campaign on hand washing with soap, exclusive breastfeeding up to 6 months of age, and the use of oral rehydration solution (ORS) and Zinc. The study adopted a pre-post evaluation design, a Demographic and Health Survey style population-based two-stage approach. Data was collected at the beginning of the intervention and 3 years following the start of intervention implementation in Lusaka province. Analysis of the data was done with the help of the Survival-time inverse probability weighting model was used to estimate Average Treatment Effect (ATE) and The Kaplan-Meier time to event analysis was used to estimate the probability of death. The study came out that the percentage of children under age 5 who had diarrhoea in the last 2 weeks preceding the survey declined from 15.8 % (95 % CI: 15.2 %, 16.4 %) in 2012 to 12.7 % (95 % CI: 12.3 %, 13.2 %) in 2015.

Another study conducted by Lumbwe *et al.* (2015) to aid in reducing diarrhoea deaths in South Africa. The study modeled the cost and impact of scaling up 13 interventions to prevent and treat childhood diarrhoea in South Africa. The model estimates 13 million diarrhoea cases at baseline. Scaling up intervention coverage averted between 3

million and 5.3 million diarrhoea cases. Scaling up 13 essential interventions could have a substantial impact on reducing diarrhoeal deaths in South African children, which would contribute toward reducing child mortality in the post-mellenium development goal (MDG) period (Vesta et al., 2009). A similar study conducted to assessed the effect of vaccination on deaths from diarrhoea among Mexican children in 2008 and 2009. The study obtained data on deaths from diarrhea, regardless of cause, from January 2003 through May 2009 in Mexican children under 5 years of age. Data was analized by comparing the diarrhoea-related mortality in 2008 and during the 2008 and 2009 rotavirus seasons with the mortality at baseline (2003–2006), before the introduction of the rotavirus vaccine. Vaccine coverage was estimated from administrative data. The study revealed that in December 2007, an estimated 74% of children who were 11 months of age or younger had received one dose of rotavirus vaccine. Also in 2008, there were 1118 diarrhea-related deaths among children younger than 5 years of age, a reduction of 675 from the annual median of 1793 deaths during the 2003–2006 period. Diarrhea-related mortality fell from an annual median of 18.1 deaths per 100,000 children at baseline to 11.8 per 100,000 children in 2008 (rate reduction, 35%; 95% confidence interval (CI), 29 to 39; P<0.001). Among infants who were 11 months of age or younger, diarrhea-related mortality fell from 61.5 deaths per 100,000 children at baseline to 36.0 per 100,000 children in 2008 (rate reduction, 41%; 95% CI, 36 to 47; P<0.001). As compared with baseline, diarrhea-related mortality was 29% lower for children between the ages of 12 and 23 months, few of whom were age-eligible for vaccination. Mortality among unvaccinated children between the ages of 24 and 59 months was not significantly reduced. The reduction in the number of diarrhea-related deaths persisted through two full rotavirus seasons. The study concluded that after the introduction of a rotavirus vaccine, a significant decline in diarrhoea-related

deaths among Mexican children was observed, suggesting a potential benefit from rotavirus vaccination.

2.20 Basic Characteristics of Mothers and Rotavirus Vaccination Coverage among Under-Five Children

Demographic characteristics can refer to age, sex, place of residence, religion, educational level and marital status. Sociological characteristics are more objective traits, such as membership in organizations, household status, interests, values and social groups. Sociodemographic characteristics has a greater influence on the lives of mothers and caregivers since each persons in the society belong to a particular social group and is bond to the rules and regulations of that particular group (Angelillo et al., 1999). Geographic area, mother's characteristics, antenatal care and access to health care services were associated with full immunization among children aged 12–23 months (UNICEF, 2012).

A study conducted in Bangladesh showed that the proximity of health center/vaccination site from the residence was a contributory factor to the vaccination coverage (James et al., 2009). Another study conducted in Uganda also showed that, rural areas are disadvantaged due to poor road networks, especially during rainy seasons resulting in low vaccination coverage (Bbaale, 2013). A similar study conducted in China also showed that vaccination coverage was reduced in inaccessible areas where it was hard to reach the health services and parents encountered more barriers in reaching the health center/vaccination site (Han et al., 2014). Another study conducted in India and Pakistan to study the Polio Eradication Initiative in these two countries also showed that some of the hard to reach areas have low vaccination coverage (Obregon et al., 2009). A recurring concern among parents in Mozambique

was the distance to vaccination services, the long queue when they arrived, and the hours of service and that it had an inverse relation with the parents' intention to vaccinate their children (Bingham et al., 2012). A study conducted in India showed that children dwelling in urban areas had higher percentage of being fully immunized in comparison to the children dwelling in rural areas (Choi & Lee, 2006).

Another study conducted by Vassiliki *et al*. (2014) among 1,667 infants to determine vaccination coverage and adherence to the Greek national immunization programme among infants aged 2-24 months at the beginning of the economic crisis (2009-2011) established that less than 5% of parents admitted omitting or postponing vaccination tributary to their beliefs. Although vaccination coverage according to the study was acceptable for most vaccines, lower rates of immunization were found for some newer vaccines such as hepatitis A and rotavirus vaccines. A multiple regression analysis indicated that parental age, occupational, educational statuses and family size were independently associated with immunization coverage at 6 and 12 months (Vassiliki et al., 2014).

The job of mothers have a positive impact on the family and also could be detrimental to children's health due to their unavailability to provide adequate care (Nguefack et al., 2016). A number of factors have been suggested to explain the absence or incomplete vaccination of children, amongst them, family reasons ranked top on the list (Rainey et al., 2011). It is also observed that most families abandoned the responsibility of vaccination of children totally to the woman who, due to her subordination to the duties of the home, is often not allowed to make use of health services (Topuzoglu et al., 2007).

However, it is also noted by another study that, low financial status of women is one of the obstacles to access of health services of children (Rahman, 2013). In a similar study conducted in Managua, it was observed that, mothers who have been employed and are paid in developing countries, have proven to be detrimental to the health of their children (Rodgers, 2011). In addition, the study also observed that mothers' involvement in income generating activity, coupled with their workload, impede them from taking care of their children's health, and from respecting vaccination schedules (Sohn et al., 2011).

Furthermore, in respect to this assertion are studies that have shown that remunerated maternity leave contributed to increase in vaccination coverage (Hajizadeh et al., 2015). However, maternal occupation was noted not to be the only factor influencing vaccination loophole; others included socio-demographic factors, and perception which negatively influenced children's vaccination (Russo et al., 2015). It is therefore important that health personnel, instead of limiting themselves to the provision of information, also motivate parents/care takers to appreciate the necessity of vaccination. Mothers who works often abandoned their children at home because of theirs occupations which often have a detrimental effect on the health of the children which lead growth stagnation and premature death (Lisa et al., 2010).

Another study which looked at the maternal educational level and age at the birth of the child and their knowledge on the required vaccines in Italy showed that knowledge about the protective effects of vaccination was higher in mothers with higher educational level and who were of older age (not teenage) and mandatory vaccination were complete in the children of these mothers (Angelillo et al., 1999). This was also observed in developing countries too. A study conducted in Bangladesh revealed that

mothers with at least 11 years of formal education were more likely to vaccinate their children completely rather than those with less than 11 years of education or no education at all (Breiman et al., 2011). Likewise, a study conducted in India showed that the likelihood of children being fully vaccinated was higher for children born to literate mother and the presence of literate father made little difference in children receiving full immunization (Borooah, 2009). Another study conducted in India showed a direct relationship between childhood immunization and maternal education (Choi & Lee, 2006). Similar trend was seen in Nepal, where the dropout rates in children decreased with increase in maternal education (Basel & Shrestha, 2012). It is also observed that, immunization coverage is lower among poor populations and in peripheral areas mainly due to inability to afford transportation to bring the child to immunization site (Han et al., 2014). Furthermore, a study conducted by Bardenheier *et al*. (2004) showed that, parents of low socio-economic status (low annual income, low level of education) were less likely to be updated with newer vaccines and hence their children were less likely to be vaccinated with these vaccines. A study conducted in the United States also revealed that children from low socio-economic background and low paternal education level were less likely to be vaccinated as the parents were less up-to-date with the vaccines (Smith et al., 2010). Similarly, children of mothers having an asset score above the poorest had complete DPT immunization status by 9 months of age in Bangladesh (Breiman et al, 2011). It is weath noting that, study conducted in Nepal also showed that children of lower socio -economic status were more likely to have higher dropout rates (Basel et al., 2012). On the other hand, children born to mothers of higher socio- economic status were more likely to be fully vaccinated (Choi & Lee, 2006). Similarly, another study showed that mothers with a

better socio-economic status, such as having occupations and a stable income improved the fully immunization coverage (Hu et al., 2013).

2.21 Basic Characteristics of Mothers and Incidence of Diarrheoa among Children Under-five Years

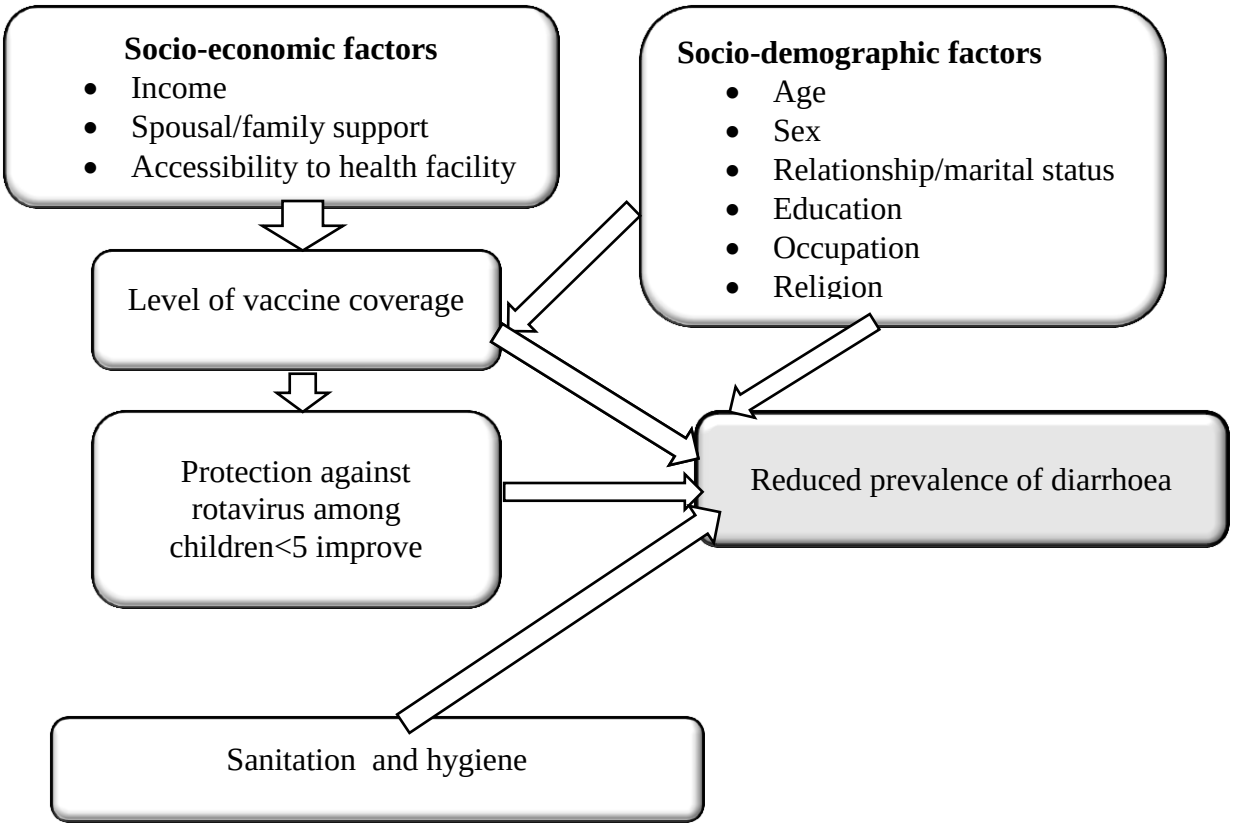
Diarrheal disease was significantly associated with maternal education, child age, and maternal hand washing practices (Shikur & Dessalegn, 2014). According to Akwasi & Josua, 2015 incidence of diarrhoea is slightly higher in rural dwellers as compared to those in the urban communities. It is therefore important to note that there are lower incidence of diarrhoea cases among children of the richest households than cases among children in the poorest households. The greatest risk of diarrhoea is observed among children between 12 and 24 months as compared to children within the ages of 48–59 months. Children living in households with improved water supplies have a lower risk of incidence of diarrhoea than those living in households with unimproved water supplies (Akwasi & Joshua, 2015).

Religion and devoutness are essential components of socio-demographics and this has an influence perceived susceptibility to infection as well as perceived severity to infection (Harold, 2012). When religion is in support of a vaccination programme it leads to high coverage there by reducing the incidence of diseases such as diarrhoea as in the case of rotavirus vaccination. Religious leaders are highly influential, and their authority can persuade members of their congregations to accept or reject vaccination (Ruijs et al., 2013). Studies conducted in India showed that although religion at the individual level did not play any significant role, residents of predominantly Hindu communities were more likely to participate in the vaccination programs compared to residents of predominantly Muslim communities (Desai & Temsah, 2015). Similarly,

study conducted in Bangladesh showed that children of Non-Muslim religion were related with full deptheria pertussis tetanus (DPT) immunization by nine months of age (Breiman et al., 2011).

2.22 Conceptual Framework

The conceptual framework for this study consist of interrelationships of several variables as discussed in the review of empirical literature. Figure 2.1 shows the conceptual framework which indicates that prevalence of diarrhoea among children is influenced by several factors; both direct and indirect. First, prevalence of diarrhoea is directly influenced by level of rotavirus vaccination coverage, protection of rotavirus vaccines, and sanitation and hygiene practices of households. Figure 2.1 further shows that level of rotavirus vaccination coverage is intend influenced by the socio-demographic, scoio-economic factors of households, and the knowledge and skills of staff on rotavirus vaccination.



Source: Author's Construct

Figure 2. 1: A conceptual framework showing the relationship between explanatory variables and diarrhoea prevalence

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter presents the general procedure employed to carry out the study. This chapter contains detailed explanations on the various methods and techniques used in the selection of the sample, the sample size, the tools/instruments for data collection and the data analysis procedure. It also contains the study area/setting, study design, study population, study variables, presentation of results, training and pre-testing, quality control, ethical considerations and limitations of the study.

3.2 Study Area

3.2.1 Location and Size

This research was conducted in the Wa Municipality of the Upper West Region. The Municipality is located in the northern savannah part of the country between Latitudes 8^0 30" - 10o N and Longitude 0^0 30" – 2^0 30" W (GSS, 2004). The municipality shares common boundaries with Wa East district to the East, Wa West District to the South and West, and Nadowli district to the North. The Municipal Administrative Capital is Wa, which also doubles as the Upper West Regional Capital. Wa has 132 communities with one paramouncy, four area councils and one urban council (Municipal Health Administration, 2016). It has a landmass area of approximately 234.74 square (kilo) meters, which is about 6.4% of that of the region (GSS, 2004). This makes it the largest urban centre in the region.

3.2.2 Population

According to the 2010 population and housing census, the Municipality has a population of 127,287 (GSS, 2010) , representing 17.3% of the regional population. The 2010 Population and Housing Census showed that 80.4 percent of the people in the Wa Municipality belong to the Mole-Dagbani group which comprises the Waalas who are the indigenous people.

3.2.3 Religion and Cultural Structure

The way of life of the people of Wa Municipality is unique with considerable inter-marriages between the Waalas, Dagaabas and the Sissalas. This has removed language barriers to a matter of linguistical and semantic variations especially between the Waalas and the Dagaabas (GSS, 2014). Peaceful co-existence is further enhanced by commerce. However, the adoption of Islam by the Waalas on one hand and Christianity by the Dagaabas on the other remains a factor of value differences between the two groups. Nevertheless, education and the continuous influence of technology and information is fast promoting tolerance and eroding the dividing forces. Other ethnic groups found in the Municipality include the Grushe, Akan, Ewe, Ga, Dagomba, Gonja, Sissala and Moshies who are engaged in secular work and commercial activity. The role of the peace and security agencies, NGOs (Non-Governmental Organisation), the Municipal Security Council, the Regional House of Chiefs, Family Tribunals, Imams, Juvenile court have helped to maintain the needed social cohesion to support development.

3.2.4 Education

There are a total of 110 primary, junior and secondary/technical schools and four higher institutions; the University for Development Studies (UDS), the Wa Polytechnic, a Teacher Training College, and a Nurses'Training College. These impact on the burden of health service delivery when students are on campus. It is estimated that only about 15% of the adult population of the Municipality are literate (GSS, 2010).

3.2.5 Water and Sanitation

There is poor access to portable water in some section of the Municipality (MHA, 2015). MHA (2008) further shows that pipe-borne water supply is just around central Wa, where the reticulation network was laid many years back. The under ground source of water supply and boreholes are yielding lesser and lesser quantities of water, which is not enough to meet the current water demand of a rapidly growing population (4.0% for Wa town). The proportion of the population with access to sanitary facilities is about 13% (MHA, 2015). There are inadequate public household and institutional toilets. There is pressure on the existing facilities and water closet facilities are limited due to the poor pipe water system. Also, refuse containers are very limited with inefficient waste/refuse collection and disposal.

3.2.6 Economic Structure

The structure of the economy of the Municipality was dominated by agriculture sector in previous years (WMA, 2015). However, the situation changed in the year 2010 when the Population and Housing Census was undertaken, with the service sector employing about 51.3 percent of the working population, agriculture 30.2 percent and industry

18.4 percent (GSS, 2010). Agricultural production is mainly rain fed during a short spell of rainy season (May – October) followed by a prolonged dry season. Under the agriculture sector, most of the farmers are engaged in peasant farming and the main crops grown include millet, sorghum, maize, rice, cowpea, yam and groundnut. However, soya beans, groundnuts, bambara beans are produced as cash crops. Commercial activity like Shea butter extraction, local soap manufacturing, pito brewing, weaving, dress/smock making, carpentry, masonry etc. are on small scale and mainly done around Wa (WMA, 2015). The formal sector offers employment for public/civil servants, teachers, nurses etc. Construction and hostel/hotel services are other source of economic activity for a few. The unemployment rate especially among the youth is unacceptably high and this accounts for a lot of out migration to the commercial towns in the south. There is high poverty rate in the municipality, at the individual, household and community levels. There is empirical evidence that the Upper West Region has a high incidence of poverty, 86% of the population fall below the World Bank accepted poverty line of 1.25 dollars per day (WMA, 2015). There is low job market, employable skills, and income ventures.

3.2.7 Health Infrastructure

The Municipality has been sub-divided in six Sub Municipality with a total of 37 government health facilities including one hospital which also double as the regional hospital, six health centres, one adolescent health centre and 26 Community –Based Health Planning and Services (CHPS) and five private health facilities such as four (4) health centres, and one (1) hospital (MHA, 2016). In reality, most of these health facilities are not adequately equiped with modern medical equipment and also under supplied making people to move to other neigbouring districts for health care (MHA,

2016).The Municipality also has 264 Community -Based Agent who helps the health staff to carry out community based activity such as immunization, health promotion and disease surveillance.

3.2.8 Health Personel

The number of medical doctors has been increasing continuesly since 2013 to 2016. The Municipality has 32 qualified doctors, 8 house officers, 11 physician assistants, 30 community health officers (CHO), 53 midwives, 85 general nurses, 105 enroll nurses and 12 community health nurses (MHA, 2016). However, these doctors are only concentrated in the Regional hospital to the neglect of the peripheral health facilities, there by creating differences in health care delivery within the Municipality. These human resource are expected to provide various health care services for the population but due to the inbalances in the distribution of these personel, most of the population do not get adequate quality of health care. Population service access is less than 8 kilometres while Doctor-patient ratio and Nurse-patient ratio is 1:3,183 and 1: 240 respectively (GSS, 2010).

3.3 Study Design

A cross sectional study was carried out among children under-five years of which their mothers were interviewed to ascertain the association between basic characteristics of mothers and prevalence of diarrhoea among children covered with rotavirus vaccine in the Wa Municipality. A retrospective analysis of secondary data on the trends of rotavirus vaccine coverage and diarrhoea prevalence was also done.

3.4 Study Population

The study population comprised children under-five years and their mothers/caretakers. Mothers/caretakers were considered because they take decisions regarding whether or not to immunize their children or represent the household in accessing immunization services for their children.

3.5 Sample Size Determination

The determination of the sample size for the study was in two parts. The first part that was objective 1-3 which relied on secondary data on prevalence of diarrhoea among children under-five years from 2007-2016 and rotavirus vaccination coverage from 2012 to 2016 was obtained by extracting data from District Health Information Management System (DHIMS) and review of Immunization registers covering all children under-five years within the study area. The part two which deals with objective 4 of the study was calculated using Cochran (1963) sample size determination to arrive at the desire sample size for children under-five years.

According to Cochran (1963), the following logical arithmetic procedure $N= \{Z^2 *(PQ)/d^2\}$ was used to compute the desired sample size for the study where *N* is the desired sample size, *Z* is the confidence level of 95% (1.96), *P* is the mean prevalence rate which is unknown and hence set at 50% (0.5) of diarrhoea in the Wa Municipality, *Q* is a constant computed as 1-P (1-0.5), and *d* (5% = 0.05) the set of margin of error.

Thus, $N = \frac{Z^2 \times PQ}{d^2}$, (Cochran, 1963)

$= \{(1.96)^2 *(0.5(1-0.5)\}/0.05^2$

$= 0.9604/0.0025 = 384.16$

From the above, the study was expected to cover a sample size of 384 children of which their mothers/caretakers were selected as respondents but the researcher added a non-response rate of 5% making the actual sample size to be 404 for mothers/caretakers. However, 396 mothers/caretakers accepted to participate and hence responded to the questionnaire.

3.6 Sampling Technique

Multi stage sampling was used. The Wa Municipality of the Upper West Region of Ghana has already been divided into six sub municipalities by the health directorate for easy administration and allocation of health resources. These sub municipalities are Wa central, Kambali, Charia, Busa, Bamahu and Charingu. Therefore, the stage one (1) made use of these existing sub-municipalities. Secondly, simple random sampling was done at each sub-municipality to select three (3) communities given a total of eighteen communities for the study. At stage three (3) a systematic sampling technique was used to select houses within each community where every second house was selected (from a random start). The first house was selected through simple random sampling followed by the selection of every other second house in that order. This was done by putting pieces of paper numbering one to four in a container with a lid and shaking it vigorously to ensure fair mix and selecting one number at random, which was then used in the systematic random sampling. To qualify for selection and to be mapped, a house had to have at least one mother/cataker with a child less than five years. At the house level within the selected communities, respondents were selected based on the proportionate distribution of respondents in the communities. Purposive sampling techniques were adopted in selecting eligible respondents whose had children or child less than five years.

3.7 Data Sources

The data sources were primary and secondary. The primary data source was gotten from mothers/caretakers with children under-five years through the administration of structured questionnaire. On the other hand, the secondary data source was obtained from existing sources such as annual reports and district health information management system (DHIMS) with the use of data extraction sheet.

3.8 Study Variables

The study variables included dependent and independent variables. The dependent variable was prevalence of diarrhoea while the independent variables included level of rotavirus vaccine coverage, age, educational status, religion, marital status, rural/urban residence, exposure to information, occupation, income level, and source of information on rotavirus vaccination, area of residence.

3.9 Methods and Instruments for Data Collection

3.9.1 Records Review

Records on diarrhoea and rotavirus immunization were reviewed/assessed from child health record card, immunization register and the District Health Information Management System (DHIMS). An account was created in order for me to be able to assess the secondary data. A data extraction sheet was designed in line with objective 1&2 and use to collect data on diarrhoea prevalence and rotavirus vaccination coverage from DHIMS2 (district health information management system). It serves as the database for the Ghana Health Service where all health data are stored.

3.9.2 Survey

A structured survey questionnaire was used to solicit information from mothers/caretakers with children under-five years. A questionnaire is a document containing questions and other types of items such as statements designed to solicit information from (Kumekpor, 2002). It consists of a set of well-formulated questions to probe and obtain responses from respondents (Panneerselvam, 2011). A questionnaire containing pre-coded with both closed and open-ended questions were used for mothers/caretakers of children under-five years. Questionnaires are relatively quick and easy to understand by using codes. Besides, the researcher was also able to contact a large number of respondents quickly, easily and efficiently using a questionnaire, once the targeted group was identified. The questionnaire was used to collect data on the association between rotavirus vaccine coverage and incidence of diarrhoea, association between the basic characteristics of mothers and the rotavirus vaccination coverage status of their children and the association between the basic characteristics of mothers and the incidence of diarrheoa among their children respectively. The questionnaire also covered background information of both mothers and children in areas such as age, sex, immunization status, education, religion and access to health facility. It also contained questions on water and sanitation which served as confounders in this study. Data collectors administered the questionnaires. In each selected community the purpose of the study was first explained to each participant and consent from each participant sought before the administration of the questionnaire.

3.10 Quality Control

3.10.1 Training

The study involved four research assistants who were recruited and properly trained on the study instrument and data collection procedures. These were health staffs that were fluent in the local languages (Waale/Dagaare). They were also trained on how to build a good rapport with the study participants, how to translate technical terminologies from English into the local language, and how to get verbal consent from respondents. The principal investigator supervised the data collection. The structured questionnaire was mainly in English.

3.10.2 Pre-testing of Research Instruments

The instruments of this study were pre-tested in one of the community in Nadowli/Kaleo District with the characteristics similar to those of the communities that were to be studied in the Wa Municipality. The research assistants used this opportunity to get use to the questionnaire and gain more interview skills. It also gave opportunity to check whether the instruments generate the intended data. Errors noted in the pre-test exercise were corrected before actual data collection was done.

3.11 Ethical Considerations

Ethical clearance was obtained from the Ethics Committee of the Navrongo Health Research Centre (NHRCIRB290). An introduction letter was taken from the University for Development Studies, and access approval obtained from the Upper West Regional Health Directorate as well as the Municipal Health Directorate. Also, an informed consent was obtained from all respondents. The significance of the study was explained in the language the participant understood better. They were made aware that

they have the option of opting out of the study if they fill uncomfortable and also had the option of declining to answer any question. Respondents were assured of maximum confidentiality.

3.12 Data Analysis and Presentation

Data captured in the questionnaire was checked for completeness and enter into a computer database using MS Excel. The final dataset was transferred to SPSSversion 22.0 where all analysis were done. Descriptive analysis was done using proportions, frequencies, cross tabulations, correlation, mean and standard deviation and charts to describe respondents characteristics. To establish any association between diarrhoea and level of rotavirus vaccine coverage, a line graph was used.

Besides, bivariate analysis as well as a regression analysis was performed to identify the basic characteristics of mothers that are associated with the incidence of diarrhoea. The bivariate analysis uses chi-square test of independence while the regression framework considered was binary logistics. The incidence of diarrhoea was measured using a dummy variable that takes a value of 1 if a respondents child had been affected with diarrhoea in the past six months and 0 if not affected. This makes the response variable binary hence a logistic regression was used. Following Gujarati *et al*. (2009), the cumulative logistic distribution function is specified as:

$$P_i = \frac{1}{1+e^{-Z_i}} = \frac{e^{z_i}}{1+e^{z_i}} \qquad (3.1)$$

Where: P_i = the probability of a respondent child having diarrhoea infection. This means that the probability of no infection is$1 - P_i$.

$$Z_i = \beta_0 + \beta_i X_i$$

(3.2)

Where: X_i = Vector of explanatory variables

β_0 = Vector of constant term

β_i = Vector of logistic regression coefficient

As Z ranges from $-\infty$ to ∞, P_i ranges from 0 to 1.

The relative effect of each explanatory variable on the likelihood that an individual child will be infected with diarrhoea is given by the marginal effect as:

$$\frac{\partial(P_i)}{\partial(X_i)} = \beta_i[\bar{P}(1-\bar{P})] \quad (3.3)$$

Where $\bar{P}$ is the mean of the dependent variable? The empirical estimation of the model for diarrhoea infection and no infection is specified as:

$$ln\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \beta_1 Perm - residence + \beta_2 Age + \beta_3 Marital + \beta_4 No.Chidren + \beta_5 Education + \beta_6 Income + \beta_7 Child\ sex + \beta_8 Dosage\ 2 + \beta_9 Source\ of\ water + \beta_{10} Toilet\ facility + U$$

The variables definition, measurement and hypothesized relationships are shown in Table 3.1. Data were presented in a tabular form and charts.

Table 3. 1: Variable labeling, measurement and expected signs

Variable Name	Label	Measurement	Expected Sign
Perm-residence	Permanent residence	Dummy; 1 = Yes; 0 = No	+/-
Age	Age of respondents	Years	-/+
Marital	Marital status	Dummy; 1= currently in a marital relationship, 0 = currently single	-
No. Children	Number of children	Count	-
Education	Educational status	Dummy; 1 = Primary/secondary/Tertiary, 0= Never attended school	-
Income	Income level	Monthly earnings (continuous)	-
Child sex	Child sex	Dummy; 1 = male, 0 = female	+/-
Dosage 2	Taken two dosages	Dummy; 1 = two; 0 = one	-
Source of water	Source of domestic water	Dummy; 1 = pipe, 0 dugout/spring	-
Toilet facility	Toilet facility	Dummy; 1 = pit latrine, 0 = Open defaecation	-

CHAPTER FOUR

RESULTS

4.1 Introduction

This chapter presents the results of the study. The results on several variables have been presented with much focus on the objectives of the study. First, results on the background information of respondents are presented. The other sections contain results on the trend of of rotavirus coverage among children under-five, the trend and prevalence of diarrhoea among children under-five, the association between rotavirus vaccine coverage and incidence of diarrhoea, the association between basic characteristics of mothers and the incidence of diarrhoea, and the quality of cold chain management of rotavirus vaccine.

4.2 Background Information of Mothers/Care Givers

This section presents socio-demographic characteristics of the respondents as shown in Table 4.1. The results show that nearly all the respondents (97.5%) were females. The respondents within the age category of 25-34 years dominated over the other categories. In terms of marital status, majority (92.7%) indicated they were married. The findings on level of formal educational attainement showed that majority of the respondents (45.5%) had attained primary/secondary education while few (26.0%) had attained tertiary education.

The results indicated that, 26% of the respondents were employed in the formal sector, 46.5% were employed in the informal sector whilst 27.5% of them were unemployed. Further, results indicated that 66.2% earned monetary income while 33.8% did not earn any monetary income income within the past six months. In term of location, 38.4% were found to have been living in urban areas, 11.2% live in semi-urban areas,

and 50.5% live in rural areas. The results in Table 4.1 also shows that 42.7% of the respondents were Christians, 46.5% were Muslims and the remaining 10.9% belong to the African Traditional Religion. Majority of the respondents were Waalas (54.6%) followed by Dagaaba (41.9%) and other (3.5%). It was also discovered that 49.5% of the children of the respondents were females and the remaining 50.5% were males. The children age 0-11 months represent 53.3% while those between 12-23 months represent 46.7%.

Table 4. 1: Background Characteristics on Respondents (n=396)

Variable	Frequency	Percent
Sex of respondents (mothers/caretakers)		
Male	10	2.5
Female	386	97.5
Age group of respondents(mothers/caretakers)		
15-24years	109	27.5
25-34years	221	55.8
>35	66	16.7
Marital status of mothers/caretakers		
Married	367	92.7
Never married/single	29	7.3
Level of education of mothers/caretakers		
None/never attended school	113	28.5
Primary/Secondary	180	45.5
Tertiary	103	26.0
Religious affiliation of mothers/caretakers		
Christianity	169	42.7
Muslim	184	46.5
Traditionalist	43	10.8
Occupation of mothers/caretakers		
Formal	103	26

Informal	184	46.5
Unemployed	109	27.5
Monthly income earnings		
No monetary earnings	134	33.8
Monetary earnings	262	66.2
Residence of mothers/caretakers		
Urban	152	38.3
Semi-urban	44	11.2
Rural	200	50.5
Ethnic group of mothers/caretakers		
Dagaaba	166	41.9
Waala	216	54.6
Other	14	3.5
No. Children under 5yrs under the care of respondents		
One	257	64.9
>one	139	35.1
Sex distribution of under-fives		
Male	200	50.5
Female	196	49.5
Age distribution of under-fives (In completed months)		
0-11 months	211	53.3
12-23 months	185	46.7

Source: Field survey, 2017. Data presented in absolute figures and percentages

4.3 Trend of Rotavirus Vaccination Coverage

4.3.1 Rotavirus vaccine Coverage, 2012-2016

The results in Figure 4.1 shows the trend of rotavirus vaccination coverage from the year 2012 to the year 2016. From Figure 4.1, rota1 vaccination coverage was higher (93%) in 2012 than rota2 (81%) however, the coverages were all below the national target of 95%. In 2013 rota1 falls (94%) compared to rota2 (96%) which was above the national target. The coverage of both rota1&2 in 2014 (96%,98%) and 2016

(97%,96%) were high compared to the national target of 95%. In 2015, the percentage coverage declined to 95% which was same as the national target as shown in Figure 4.1 below.

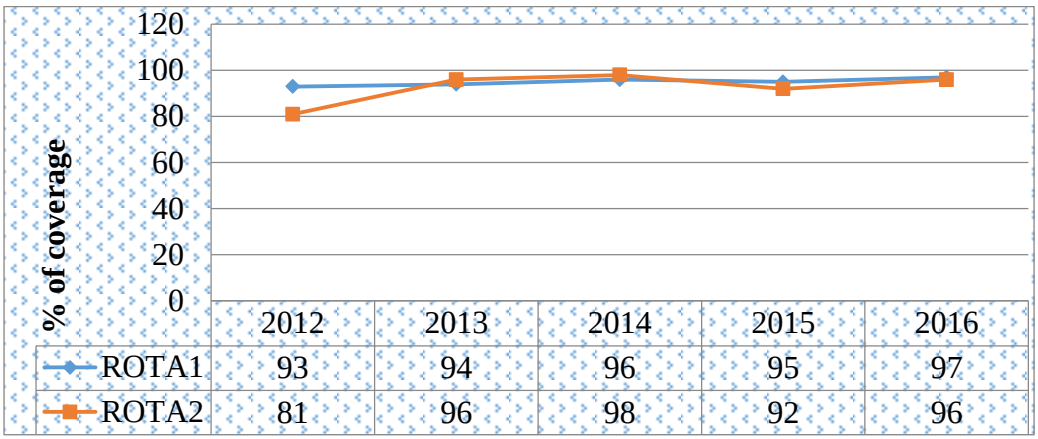


Figure 4. 1:Trend of rotavirus vaccine coverage in Wa Municipality (2012-2016)

Source: DHIMS (2017). Data presented in percentages

4.3.2 Trend of Rota 1 Coverage by Sub-municipal Assembiles (2012-2016)

Further analysis of the trend of rotavirus vaccination was done by considering the performance in the sub-areas in the Wa Municipality. The areas considered include Bamahu, Busa, Charia, charingu, kambali and Wa Central. The results on rota 1 coverage are shown in Figure 4.2. The results showed a variation in rota 1 coverage across the submunicipalities. For example, those located in the hinterlands such as Busa and Charingu recorded low coverage. On the other hand, those found in the Urban areas such as Wa central, and Kambali show higher rota 1 coverage.

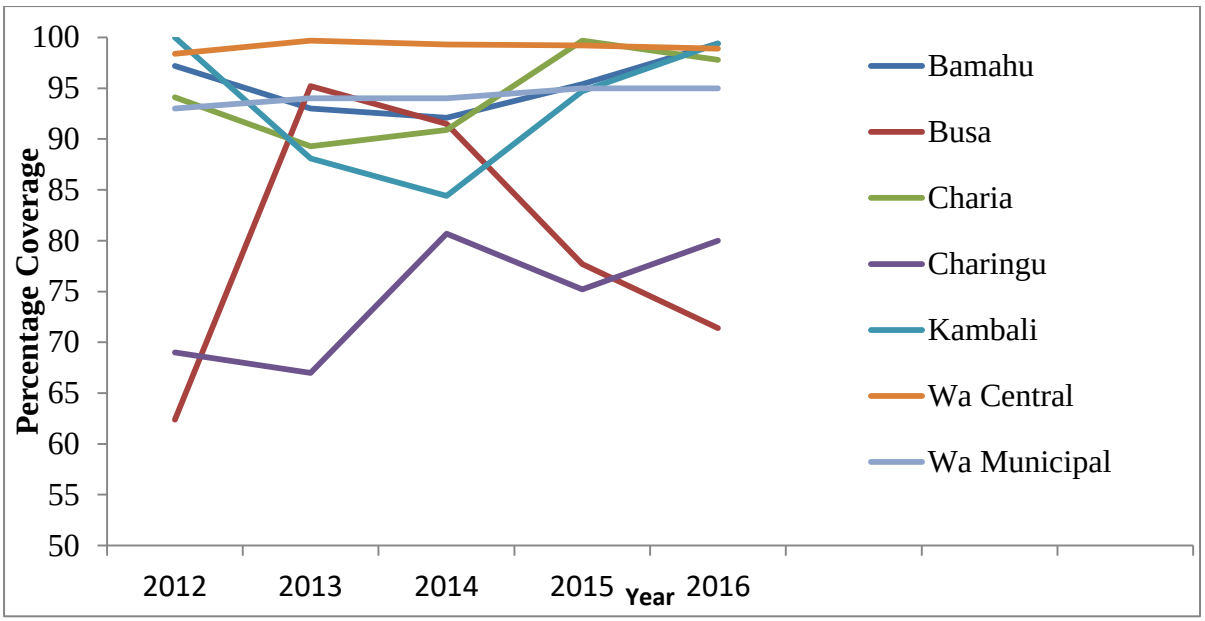


Figure 4. 2: Trend of Rota 1 Coverage by Submunicipal (2012-2016)

Sourece: DHIMS, 2017

4.3.3 Trend of Rota 2 Coverage in Submunicipal (2012-2016)

The trend in rota 2 coverage in the Wa municipality shows an improved performance as shown in Figure 4.3. The fact is that there is little variations among the coverage of sub-municipalities. The rural areas such as Charingu and Busah still show low performance because their graphs fall below those of the urban centers. These rural centers scored below 60% in 2012 with no score up to 90% over the years between 2012 and 2016. However, the variation in rota 2 coverage among the urban sub-municipals is smaller because their line graphs are almost parrel compared to that of rota 1 in figure 4.2. Their scores fall between 80 to 100% in the period between 2012 and 2016.

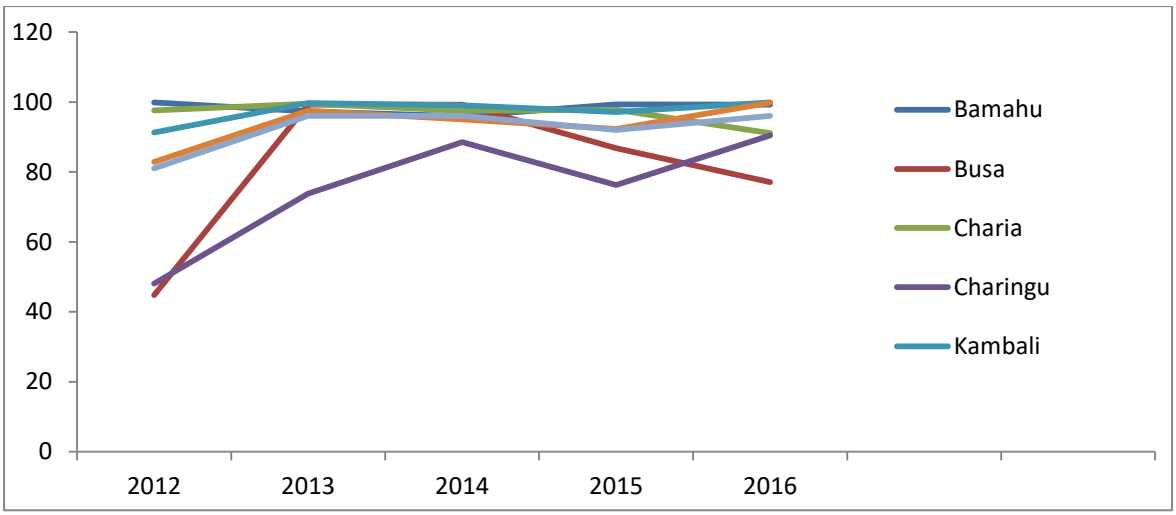


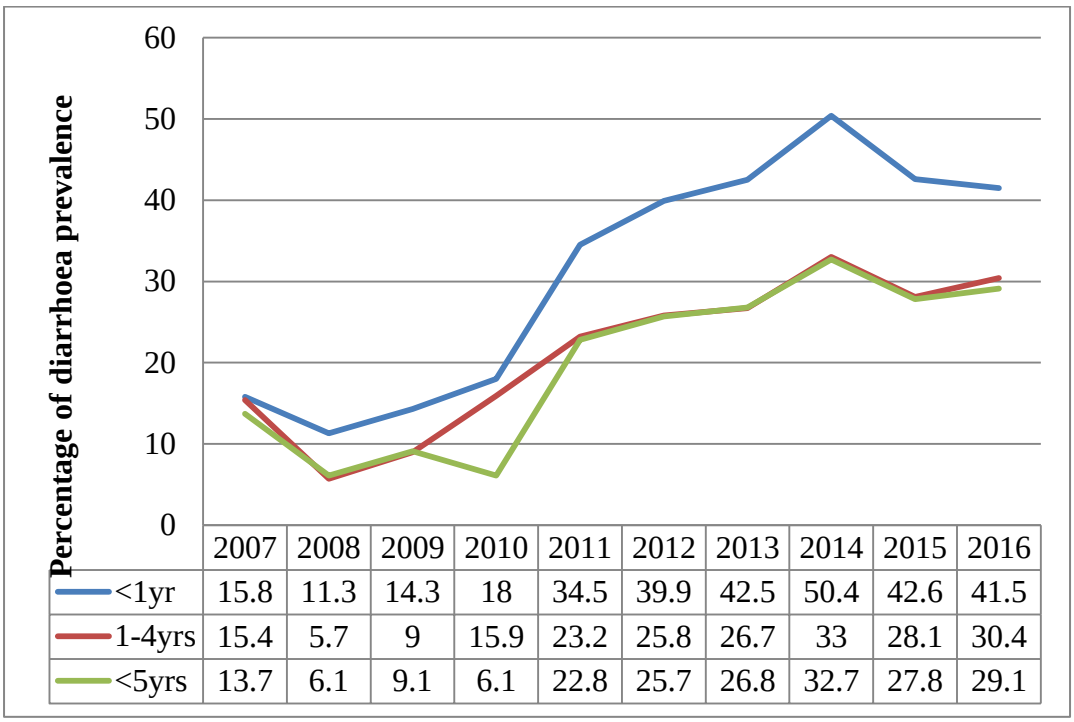
Figure 4. 3: Trend of Rota 2 Coverage in Submunicipal (2012-2016)

Sourece: DHIMS, 2017

4.4 Trend of Diarrhoea Prevalence among Children –five years from 2007-2016

As shown in Figure 4.4 below, there has been a continues increase of diarrhoeal cases from 2007-2016 among all the age categories; <1year,1-4years and below 5years. The figure shows that percentage of diarrhoea cases were high in 2007 with children less than 1 year representing 15.8% while those within 1-4 years and less than 5 years recorded a percentage of 15.4 and 13.5 respectively. In 2008, the prevalence of diarrhoea in the Wa Municipality reduced among all the age caetgories of children. However, in 2009, the prevalence of diarrhoea started rising with those less than 1year (14.3%) leading the other age cohorts. In 2014, the rate of diarrhoea among children less than 1 year reached a peack with a percentage of 50.4 and begin to decline slowly in 2015 (42.6%) and 2016 (41.5%). However, 1-4 years and less than 5 years have dropped stipply from 2007-2008 at almost the same percentage and start to rise at the same pace in 2009. In 2010, children less than 5 years percentage dropped significantly from 9.1% in 2009 to 6.1%. From 2010-2011 the percentage of less than 5 years children has increased significantly from 6.1% to 22.8% respectively. Figure 4.4 shows

a trend The percentage in diarrhoea cases among children below 1 year recorded the highers number than the other age groups from 2007 to 2016. . The variances of diarrhoea prevalence in these groups of children continue to increase over time.



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
<1yr	15.8	11.3	14.3	18	34.5	39.9	42.5	50.4	42.6	41.5
1-4yrs	15.4	5.7	9	15.9	23.2	25.8	26.7	33	28.1	30.4
<5yrs	13.7	6.1	9.1	6.1	22.8	25.7	26.8	32.7	27.8	29.1

Figure 4. 4: Trend of diarrhoeal cases 2007-2016

Sourece: DHIMS, 2017. Data presented in percentages

4.5 Relationship between Diarrhoeal Cases and Rotavirus Immunization Coverage

4.5.1 Graphical Illustration of the Relationship between Rotavirus Vaccination Coverage and Diarrhoea Cases

There exists a wider variation between rotavirus vaccination coverage and diarrhoea prevalence among children under-five years of age that were found in the Wa Municipality. The results shown in Figure 4.8 reveals that the prevalence of diarrhoea is lower than that of immunization coverage in the years: 2012, 2013, 2014, 2015 amd 2016. However, percentage of diarrhoea cases continue increase from 2012-2016 at the

time rota coverages were also increasing which was not expected. The line graph for rota 1 and rota 2 suggests that there is little variation in rota 1 and rota 2 coverage for the whole Municipality especially from 2013 to 2015. There is small differences in the 2012 and 2016 coverages. In 2012 and 2016, the graph of rota 1 is a little above that of rota 2. Generally, the immunization coverage rose in 2013 from the 2012 figure and maintain a constant rate (see slope) till 2016.

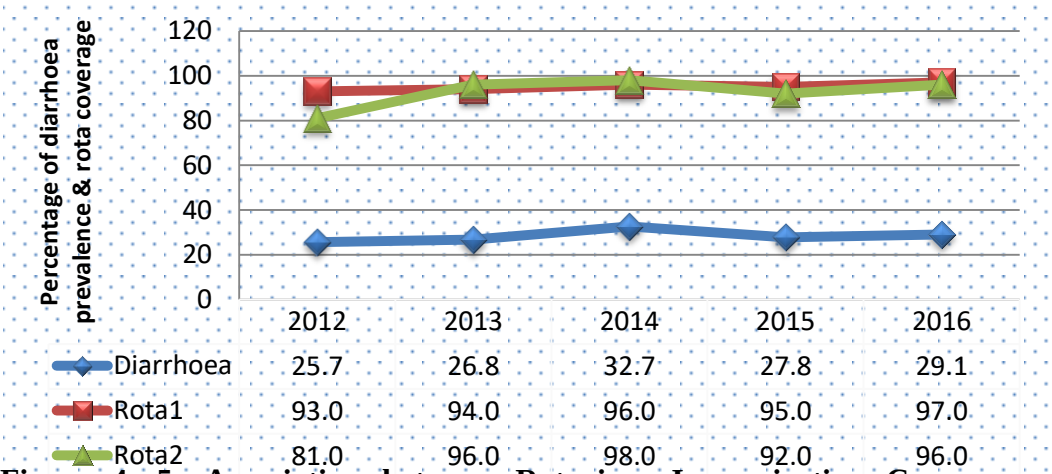


Figure 4. 5: Association between Rotavirus Immunization Coverage and Diarrhoea Prevalence

Sourece: DHIMS, 2017

4.5.2 Correlations among Rota 1, Rota 2, and Diarrhoea Cases

The associations between immunization and diarrhoea prevalence among different age cohorts were estimated and reported in Table 4.3. Specific variable under consideration include rota 1, rota 2, incidence of diarrhoea in children less than 1 year, incidence of diarrhoea in children with 1-4 years, incidence of diarrhoea in children less than 5 years, and incidence of diarrhoea in the combine age cohorts. Pearson correlation coefficients were generated with their p-values (figures in parenthesis) and presented in Table 4.3.

Table 4. 2: Pearson Correlations for Rotavirus Coverage and Inccidence of Diarrhoea in Different Age Cohort of Children Under-five Years

Variables	Rota 1	Rota 2	Diarrhoea (< 1 year)	Diarrhoea (1 - 4 years)	Diarrhoea (<5 years)	Diarrhoea (all ages)
Rota 1	1					
Rota 2	0.972**	1				
	(0.006)					
Diarrhoea (< 1 year)	0.706	0.684	1			
	(0.183)	(0.202)				
Diarrhoea (1 - 4 years)	0.627	0.695	0.868	1		
	(0.258)	(0.193)	(0.057)			
Diarrhoea (<5 years)	0.666	0.711	0.928*	0.990**	1	
	(0.220)	(0.178)	(0.023)	(0.001)		
Diarrhoea (all ages)	0.666	0.711	0.928*	0.990**	1.000**	1
	(0.220)	(0.178)	(0.023)	(0.001)	(0.000)	

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Source: Field Survey, 2017

Some varibales show strong and significant positive correlations at 1% and 5% levels. From Table 4.3, the correlation coefficient between rota 1 and rota 2 is significant at 5%. Besides, the incidence of diarrhoea among the different ages show strong and significant correlations at various levels. This means that diarrhoea cases rises at the same time among the various age categories.

4.6 Association between the basic characteristics of mothers/households and the Incidence of diarrheoa among their children vaccinated with rotavirus vaccine

4.6.1 Diarrhoea incidence among children vaccinated with rotavirus vaccine

All the 396 mothers/caretakers reported that their children had received atleast one dosage of rotavirus vaccine. The respondents were asked to indicate whether their children have ever suffered diarrhoea in the past six months. It was discovered that

195(49.2%) responded affirmed that their wards have ever suffered diarrhoea while 201 respondents denoting 50.8% responded in disagreement that their wards have not suffered from diarrhoea in the last six months. Further results were generated on the frequency of diarrhoea cases recorded per child in the past six months among the children who recorded cases of diarrhoea. It was discovered that 9.1% experienced diarrhoea once, 18.4% experienced it twice, 17.9% experienced diarrhoea thrice in the past six months, 2.5% maintained tht their child/children have been infected with diarrhoea four times and 1.3% had diarrhoea five times in the past six months. The frequency of responses and their relative percentages are shown in Table 4.2.

Table 4. 3: Diarrhoea Episode

Prevalence	Frequency	Percent
No Diarrhoea	201	50.8
Once	36	9.1
Twice	73	18.4
Three times	71	17.9
Four times	10	2.5
Five times	5	1.3
Total	**396**	**100.0**

Source: Field Survey, 2017

The results suggests that there is high prevalence of diarrhoea among children despite the rotavirus vaccination. The evidence is that some children were infected several times even after the rotavirus immunization

4.6.2. Bivariate analysis of the association between basic characteristics of mothers/caretakers and incidence of diarrhea among their children vaccinated with rotavirus vaccine

From Table 4.4, there were statistically significant ($p<0.05$) associations between marital status, sex of the child, and number of dosage of rotavirus vaccine on one hand and the incidence of diarrhoea on the other. The remaining variables in Table 4.4 which were also tested produced no statistically significant associations since the ($p>0.05$).

From Table 4.4, interm of residential location, 48% respondents in rural areas, 47.5% from urban areas and 55.5% in peri-urban areas have had diarrhoea in the past six months. However, the chi-square test value (1.38) was not significant at 5% (P-value > 0.05). Similar observation were recorded for ethnicity, age, education, occupation, source of drinking water, and toilet facility used because their respective P-values are more that than 5% (0.05).

It was however, discovered that people who are currently in their marital relationships dominatedthe sample and 171 of them were found to have experienced diarrhoea among their children. Besides, those who remained single were 37 and 24 of them have their children experienced diarrhoea in the past six months. Respondents with other marital status (widows and divoiced) were 58 and 30 of them had experienced diarrhoea among their children. The chi-square test value (3.98) is significant at 5% (P-value < 0.05) and this suggests a significant association between marital status and diarrhoea prevalence.

Child sex was also tested to see whether it has a significant association with prevalence of diarrhoea. The chi-square value reported was significant at 5% (P-value < 0.05).

This means that, prevalence of diarrhoea differs among boys and girls under-five years. The number (1 dose or 2 doses) of rotavirus vacine a child has received was also tested to ascertain whether there is a significant association with diarrhoea prevelance. The results in Table 4.4 report a chi-square value of 18.7 which is significant at 1% (P-value <0.01) and this means a strong association between dosage of rotavirus vaccine and prevalence of diarrhoea.

Table 4. 4: Association between basic characteristics of mothers and prevelance of diarrhoea

Variable	Category	Diarrhea		Total	Chi^2	P-value
		Yes(%)	No(%)			
Residential status	Urban	58(47.5)	64(52.5)	122		
	Peri-urban	41(55.5)	33(44.5)	74		
	Rural	96(48.0)	104(52.0)	200	1.38	0.449
Ethnicity	Dagaaba	64(52.5)	58(47.5)	122		
	Waala	101(47.0)	115(53.0)	216		
	Others	30(51.7)	28(48.3)	58	1.18	0.554
Age	15-24	35(40.2)	52(58.8)	87		
	25-34	113(50.9)	109(49.1)	222		
	35 +	47(54.0)	40(46.0)	87	3.86	0.146
Marital status	Married	171(47.6)	188(52.4)	359		
	Single	24(64.8)	13(35.2)	37		
	None	90(47.3)	100(52.7)	190	3.98	**0.046**
Education	Primary/Secondary	79(41.6)	73(58.4)	152		
	Tertiary	26(48.1)	28(51.1)	54	0.74	0.68
Occupation	Formal	44(42.7)	59(57.3)	103		
	Informal	96(52.1)	88(47.9)	184		
	Unemployed	55(50.5)	54(49.5)	109	2.45	0.29
Child sex	Female	86(43.8)	110(56.2)	196		
	Male	109(54.5)	91(45.5)	200	4.46	**0.035**
Dosage	Zero	1(100)	0(0.0)	1		
	One dosage	31(81.5)	7(18.50	38		
	Two dosages	163(45.6)	194(54.4)	357	18.7	**0.00**
Source of water	Dug well/spring	19(48.7)	20(51.3)	39		
	Piped water	176(49.2)	18150.8)	357	0.005	0.94
Toilet facility	Flush to pit (latrine)	83(50.3)	82(49.7)	165		
	VIP	71(51.8)	66(48.2)	137		
	Open defecation	41(43.6)	53(56.38)	94	1.63	0.44

***=significant at 1%; **=significant at 5%

Source: Field Survey, 2017

4.6.3. Logistic regression on the association between basic characteristics of mothers/caretakers and the incidence of diarrhea among their children vaccinated with rotavirus vaccine

The association among the basic characteristics of households and incidence of diarrhoea was analysed using a logistic regression framework. The purpose of this model was to establish the direction of association and the relative probability of a child being affected with diarrhoea. Incidence of diarrhoea was measured using a binary response variable that takes a value of 1 if a child from a household was infected with diarrhoea in the past six month and 0 if otherwise. The dependent variable was regressed on ten independent variables that consist of socio-demographic and other households characteristics. The independent variables include residence, age, marital status, number of children, education, income, child sex, dosage, source of water, and toilet facility. Five out of the ten independent variables were found to have a statistically significant influence on diarrhoea cases. They include residential status, marital status, child sex (male), rotavirus dosage, and accessibility to toilet facilities. The variables, their coefficients standard errors of the coefficients P-values (probability values) confident intervals, and marginal effects are shown in Table 4.5.

Table 4. 5: Logistic regression estimates of basic characteristics of households and incidence of diarrhoea

Variable	Coef.	Standard Error	P>z	[95% Conf.	Interval]	Marginal Effect
Perm_residence	1.2440*	0.7432	0.094	-0.2127	2.7007	0.278
Age	0.0188	0.0165	0.253	-0.0135	0.0511	0.005
Maried	-0.8747**	0.3909	0.025	-1.6409	-0.1084	-0.209
No. Chidren	0.0682	0.1709	0.69	-0.2669	0.4032	0.017
Atleast basic education	0.0499	0.2163	0.817	-0.3740	0.4739	0.012
Income	-0.0004	0.0005	0.416	-0.0013	0.0006	0.000
Child sex (male)	0.5028**	0.2140	0.019	0.0834	0.9223	0.125
Dosage 2	-1.8598***	0.4619	0.000	-2.7651	-0.9544	-0.389
Source of water (Piped & dug well)	-0.0121	0.3587	0.973	-0.7151	0.6910	-0.003
Type toilet facility	0.5116**	0.2577	0.047	0.0065	1.0167	0.127
Constant	0.0267	1.0448	0.98	-2.0209	2.0744	

Observation = 396, LR chi^2(10) = 36.68, Prob > chi^2 = 0.0001, Pseudo R^2 = 0.066, Log likelihood = -256.09

***, **, * Correspond with 0.01, 0.05 and 0.1 signifcance level.

Source: Field Survey, 2017

From Table 4.5, the coefficient of age of respondent is positive but insignificant even at 10%. This means that there is no enough evidence to conclude that increase in age is associated with the likelihood of diarrhoea infection. Besides, the coeffienct of number of children in a household yielded a positive coefficient but not significant. The sign of the coefficnet however, suggests that more children in a household will lead to the likelihood of diarrhoea infection as expected but the evidence is not sufficiently large. Education which was measured to see whether a respondents have at least a basic education or otherwise was expected to have a negative relationship with diarrhoea

infection because of its likelihood of increasing awareness of preventive measures. However, its positive coefficient suggests that a respondent with at least a basic education qualification is associated with the likelihood of her child infected with diarrhoea in the past six months. The coefficient of education however, neither conform with the a priori expectation nor was not significance at even 10%. The coefficient of income was negative as expected because higher income can increase the household ability in meeting the cost of medical expenses and hence prevent diarrhoea among children under-five years. However, income has no significant relationship with diarrhoea incidence. Source of water; which was measured by whether an individual household get its domestic supply of water from pipe or dug out well/springs was included in the model predicting determinants of diarrhoea. Its coefficient is in conformity with the a priori expectation because drinking from pipe water is considered safe than water from dug out and springs and hence can be inversely related to diarrhoea infection. However, source of water was found insignificant in the model. The variables with significant relationship at 1%, 5% and or 10% are discussed as follows.

Respondents permanent residence (Perm_residence) was included in the model predicting diarrhoea incidence. It was measured as a dummy variable; taking a value of 1 if a respondents was in his/her permanent resident during the time of this survey and 0 if otherwise (not permanent). The coefficient of this variable was found to be positive and significant at 10%. Its marginal effect was also estimated at 0.278 and this means that respondents who were found in their permanent residence were associated with 27.8% likelihood of being infected with diarrhoea than those not found in their permanent residence.

Marital status which was considered as a dummy variable and measured on whether a respondents is currently in a marital relationship or otherwise was included in the model predicting diarrhoea incidence. The coefficient of this variable was found to be negative and significant at 5%. This means that respondents that are currently in a marital relationship with their spouse are less likely to have diarrhoea infection among their children than those currently staying as single. The marginal effect of this variable is -0.209 which means that people in a marital relationship have 20.9% likelihood of not getting diarrhoea than those that are single.

It was revealed that child sex has a significant relationship with diarrhoea infection in the Wa Municipality. Child sex was measured as a dummy variable; which takes a value of 1 if the child of mother was male and 0 if female. The coefficient of this variable in Table 4.5 was positive and significant at 5%. This means that boys are more likely to have diarrhoea than girls. The marginal effect is 0.125 and this means that the probability of boys getting a diarrhoea is 12.5% more than girls.

The immunization scheduled requires all children under-five years to take two (first and second) dosage of the rotavirus vaccine at regular intervals. However, all children were not able to complete the dosage and this can influence the risk of a child getting diarrhoea. The number of dosage taken was therefore, considered as a dummy variable which takes a value of 1 if a respondents child has taken the required (two) dosage and 0 if not (otherwise). From Table 4.5, the coefficient of this variable was found to be negative and significant at 1%. This means that rotavirus vaccination has a strong negative influence on diarrhoea infection. The marginal effect suggests that children who has completed the two dosages are less likely to get diarrhoea than those that have

not taken the two dosages. The risk of those who have not completed the dosage was 38.9% higher than those who have completed it in getting diarrhoea.

Access to toilet facility included in the model predicting diarrhoea. It was measured as a dummy variable with a value of 1 if an individual households use modern toilet facilities such as pit latrine and 0 if the household resort to open defecation. From Table 4.5, the coefficient of this variable was found to be positive and significant at 5%. This means that households with access to modern toilet facilities are more likely to get diarrhoea than those resorting to open defecation. Access to pit latrine is associated with 12.7% probability of getting diarrhoea infection than those resorting to open defecation. This observation is not in conformity with the priori expectation.

CHAPTER FIVE

DISCUSSION OF RESULTS

5.1 Introduction

This chapter presents the discussions of the results presented in Chapter four. The results are discussed in line with study objectives covering the trend of rotavirus coverage among children under-five, trends in diarrhoea coverage, the relationship between diarrhoea cases and rotavirus immunization coverage. Other results discussed include the association between rotavirus vaccination coverage and prevalence of diarrhoea, the association between basic characteristics of mothers and diarrhoea incidence, and the quality of cold chain management of rotavirus vaccines.

5.2 Trend of Rotavirus Coverage among Children under– five years

In expanded program on immunization (EPI) policy, it is noted that, coverage of rota2 should be equal to rota1, however, it was observed in this study that in 2013 and 2014, rota2 coverages were 96% and 98% as against 94% and 96% of rota1 respectively. Greater variation in coverage occurred in the years 2012, and 2015 where rota 2 fall below that of rota 1. The possible causes of the varance of rota2 against rota1 may be as a results of poor documentation, children travelling in from other districts and rotavirus vaccine availability (Regional Health Administration, 2012 & 2015). However, the low coverages attained in these years may be attributed to various reasons including ill health of children, children travelling out, poor data documentation, shortage of rota vaccine and inadequate supply of other resources such as motor bikes, fuel among others for outreach services.

Rotavirus vaccination is an important immunization exercise in the Wa Municipality to both health institutions and households as well. The staff of Ghana Health Service have made effort to reach various households and this resulted in all the respondents indicating that they have at least immunized their children under-five years on rotavirus vacines. Generally, rotavrus vaccination coverage in the Wa Municipality is wide (over 90%) and this improves over the years as suggested by the slope of the lines graphs in Figure 4.1. This means that rota coverage in the Wa Municiapality shows improvement of the global figure reported by WHO/UNICEF (2016) as 86%. However, there is a disparities between rota 1 and rota 2 coverage. The fact that 9.8% of the respondents have not completed their dosage means that they are still at risk of diarrhoea infection. This means, despite the wide coverage, children will still at risk of diarrhoea because of the disparities in rota1 and rota 2. In some developed countries such as Belgium, Braeckman *et al.* (2014) reported that 94% gross coverage of at least one dosage and 92% for a least the second dosage. A similar study in China by Qing et al. (2013) reported 89.7% coverage in rota 1 with 9.8% and 0.5% rota 2 and rota 3 coverage respectively. This means that, the Wa Muncipality (Ghana) showed improved performance in rotavirus vaccine coverage than some developed countries. Rotavirus vaccination coverage in middle income countries have been low relative to the results of this study. WHO/UNICEF (2016) reported a coverage of 16% with 44 out of 104 middle income countries using the vaccine. This means that the Wa Municipality over the years has been showwing a relatively beter performance in terms of coverage.

Further results suggest that the variation in rota 1 and rota 2 coverage has reduced over the years. The evidence is that rotavirus coverage improved from 2012 towards 2016 with rota 1 sustaining its values while rota 2 improved faster to cover the diference. This means that households are becoming incereasingly aware of the need to take both

rota 1 and rota 2 at some specified intervals (4 weeks). While majority of the respondents (99%) have completed the first dose in 6 weeks, the second dose was taken in different intervals such as 10th week, 11th week and the 14th week and this was found to be in conformity with the recommended practices in Africa (WHO, 2016).

5.3 Trend of Diarrhoea Prevalence among Children under–Five Years from 2007-2016

The results of the study indicate that 49.2% of the respondents have their children having at least once diarrhoea infection in the past six months prio to this survey. Further evidence on the frequency of diarrhoea infection are that some respondents children under-five had diarrhoea onces, twice, thrice, four times, and some five times in the past six months prio to the survey. This means that diarrhoea cases are still evident in the Wa Municipality despite the wider coverage of rotavirus vaccination. A similar study reported that incidence of rotavirus disease was similar in children in low- and high-income countries (Yen et al., 2014) just as the case of Wa Municipality where different submunicipal health centers recorded similar trend in diarrhoea cases. The trends were expected to see a decline from 2012 to 2016 when the rotavirus vaccine was introduced in to the national immunization schedule as many studies have come out with. However, this is not the case in the Wa municipality.

Considering the view of Armah *et al.* (2010), diarrhoea can be caused by a number of viral, bacterial and parasitic enteropathogens but rotavirus remains the most important cause of severe diarrhoea in infants and young children globally. However, children in the Wa Municipality were immunized against this virus yet cases of diarrhoea were observed in this study. This brings to the controversy on the effectiveness of rotavirus vaccination among infants in the Wa Municipality.

The results further indicate that diarrhoea among different age cohorts of children continues to rise from 2008 to 2016. Besides, children under-five had high prevelance rate, next by those between 1-4 years and finally those under 1 year of age. This means that diarrhoea prevalence in the Wa Municipality does not only increase over time but also directly related to the age category as one move from a lower age bracket to another. This observation was not expected given the increasing trend of rotavirus immunization coverage against diarrhoea infection. A possible justification for this rising trend of diarrhoea as observed in this study is that rotavirus vaccination is not expected to fully prevent diarrhoea. Other associated factors are needed to complement the effectiveness of rotavirus vaccines.

5.4 Association between Rotavirus vaccine Coverage and prevalence of Diarrhoea among Under-five Children

The graph of diarrhoea prevalence in the results chapter shows a positive trend as it rises from 2012 to 2016. However, there is a sharp increase in diarrhoea cases in 2014 (50.4%) at a time that immunization coverage was also increasing. Later in 2015, prevalence of diarrhoea decreased (42.6%) and further decreased in 2016 (41.5%). The general picture however, is that all the variables in Figure 4.8 rises but that of diarrhoea rose above immunization and this suggests that increases in immunization coverage does not reduce diarrhoea significantly. In other words, the rotavirus vaccination coverage is not sufficiently large enough to have eliminated diarrhoea since the diarrhoea curve lies far above that of rotavirus vaccination coverage. This means that some factors besides immunization are responsible for diarrhoea infection in the Wa Municipality.

From Table 4.2, all the correlation coefficients are positive and this suggests that there is a direct relationship among all the variables presented in the table. For example, increase in rota 1 is associated with an increase in diarrhoea among all the age cohorts. Besides, increase in rota 2 coverage is associated with increase in diarrhoea among all the age cohorts. A negative correlation between rotavirus vaccination coverage and diarrhoea incidence was expected to mean that, increase in immunization reduces diarrhoea but the results suggests otherwise. This means that increase in immunization coverage does not coresponds with a decrease in prevalence of diarrhoea. Hence other factors such as quality of cold chain management of the rotavirus vaccines or household factors need to be examined on their influence on diarrhoea cases in the Wa Municipality.

Empirical studies such as Michelle *et al.* (2016) in South Africa also observed that there was a temporary association found between sustained decline in all-cause diarrhoea hospitalization and rotavirus vaccine introduction in children less than 2years and this suggests that rotavirus vaccination is among the effective ways of controlling diarrhoea among children. Further empirical evidence that are in support of the results of this study include the work of Payne *et al.* (2015). They observed in the United States of America that 74.4% of children were fully vaccinated with rotavirus vaccine while 25.6% were not. It was found that a full course of rotavirus vaccination was significantly associated with 18% to 20% reduction in diarrhoea compared to those children who were not vaccinated (Payne, et al., 2015).

Despite the fact that a complete dosage of rotavirus vaccines is belief in this study to have an significant control over diarrhoea, the results of Katharina *et al.* (2014) suggests that other targeted interventions such as the provision of safe water, the use of

sanitation facilities and hygiene education, if implemented in various localities could prevent the prevalence of diarrhoea. This means that socio-cultural and economic factors also explains diarrhoea infection and not necessarily the defficiecy of rotavirus vaccination. A similar agurment advanced by Tandoh (2014) in Ghana also explains the unexpected results observed in this study (higher rota coverage with higher diarrhoea cases). He associated the death of 500000 children globally in a year to diarrhoea caused by the lack of safe water, sanitation, hygiene and not necessarily limited access to rotavirus vaccination. Hence the conclusion of Enweronu *et al.* (2014) relates with this study that the implementation of rotavirus vaccination not excluding other factors could have resulted in the decline of severe diarrhoea hospitalization.

From the forgoing discussions, some households receive only rota 1 and failed to add rota 2 and hence lacking the required dosage. This is partly the reason for the positive correlations found among rotavirus coverage and diarrhoea infecton. This was observed among all the age categories and hence implies that it is a common characteristic for households to give their children rota 1 and ignore rota 2. Incomplete dose will invariably not lead to diarrhoea reduction. Emperical finsings of Arvay *et al.* (2009) indicate that a 90% efficacious complete dose of rotavirus vaccination would have prevented 70% of the rotavirus related deaths that is on the basis of current diphtheria, tetanus and pertussis vaccine coverage and timing. Therefore, the conclusion of empirical literature is that the effectiveness of rotavirus vaccination depends on complete dose.

5.5 Association between the Basic Characteristics of Mothers/Households and the Incidence of Diarrhoea

The section presents the discussion of the findings on the association between the basic characteristics of mother/households and diarrhoea indicence. The use of the logistic regression framework aided in the identification of determinants of diarrhoea infection among children vaccinated with rotavirus vaccine in the Wa Muncipality. Five factors consisting of the basic characteristics of households were identified as determinants of diarrhoea infection. They include residential status, marital status, child sex, rotavirus dosage, and accessibility to toilet facilities.

The study was conducted on households who were either permandent or non-pamernnet resident at their homes during the survey period. It was discovered that 27.8% of the children of non perment resident mothers/caregivers were more likely to be infected with diarrhoea compared to that of the permanent residence. This implies that the respondents who were not found in their permenent residence would have been free from the environmental conditions that could have resulted in diarrhoea. Such factors may include the sanitation and hygiene of the people in their new environment. On the other hand, people in their permanent residence are living with such environmental conditions and are not exposed to new conditions that otherwise could have been environmental friendly. Past studies however, have been silent on the effect of residential status on diarrhoea incidence among children.

Respondents that are currently in a marital relationship with their spouse are less likely to have diarrhoea infection among their children than those currently staying as single. It was also found that people in a marital relationship have 20.9% likelihood of not getting diarrhoea than those that are single. These results met the researcher priori

expectation because people in a marital relationship are more likely to have attention for the child health. It was also observed that most families abandoned the responsibility of child care totally to the woman who, due to her subordination to the duties of the home, is often not allowed to make use of health services (Topuzoglu et al., 2007). Such explanation will be the case of single parents as observed in this study. This means that a single parent will play the role of both mother and a father and hence will be over burden. This can consequently lead less attention on the child especially in the area of diarrhoea control.

It was also revealed that child sex has a significant relationship with diarrhoea infection in the Wa Municipality and that, boys are more likely to have diarrhoea than girls. The marginal effect is 0.125 and this means that the probability of boys getting a diarrhea is 12.5% more than girls. Literature does not have a specific stand on the influence of gender on diarrhoea. As a result, the possible explanations should be associated with socio-cultural activity. In the Wa Municipality, children are often left for their mothers to take care of especially in issues relating to their children. Mothers are often capable of detecting early symptoms of diseasessuch as diarrhoea. It is a cultural norm that girls are often considered to be at risk to diseases by their mothers than boys. Hence, mothers with children that are girls pay more attention quickly on their health than when they are boys.

Rotavirus vaccination has a strong negative influence on diarrhoea infection. The marginal effect suggests that children who has completed the two dosages are less likely to get diarrhoea than those that have not taken the two dosages. The risk of those who have not completed the dosage is 38.9% higher than those who have completed it in getting diarrhoea. This observation agreed with literature in different settings.

Empirical evidence that are in support of the results of this study include the work of Payne *et al.* (2015). They observed in the United States of America that 74.4% of children were fully vaccinated with rotavirus vaccine while 25.6% were not. It was found that a full course of rotavirus vaccination was significantly associated with 18% to 20% reduction in of diarrhoea compared to those children who were not vaccinated (Payne et al., 2015). This suggests that rotavirus vaccinationis an important immunization activity with the potential of reducing diarrhoea significantly among children.

Households with access to modern toilet facilities are more likely to get diarrhoea than those resorting to open defecation. Access to pit latrine is associated with 12.7% probability of getting diarrhoea infection than those resorting to open defecation. This observation is not in conformity with the priori expectation. This means that pit latrines in the Wa Municipality does not contribute significantely to diarrhoea reduction. The possible justification for the finding of this study is that many of the households in the Wa Municipality are accessing public toilets outside their homes. The conditions of some of the facilities are unhygienic and does not support health safety.

Several other empirical literature ague that mothers' involvements in income generating activity, coupled with their workload, impede them from taking care of their children's health, and from respecting vaccination schedules (Sohn et al., 2011). Job of mothers have a positive impact on the family and also could be detrimental to children's health due to their unavailability to provide adequate care (Nguefack et al., 2016). In this study income of mothers was considered as a proxy to their job status. The results was negative but notsignificant. This means that the researcher's expectation has been met. Diarrheal disease was significantly associated with maternal education, child age, and

maternal hand washing practices (Shikur & Dessalegn, 2014). In this study, mother's education was found not to be a significant determinant of diarrhoea as argue by literature. However, it was found to be positive and this means that educated mothers would have become aware of the consequences of diarrhoea and hence take steps to control it among thier children. Children living in households with improved water supplies have a lower risk of incidence of diarrhoea than those living in households with unimproved water supplies (Akwasi & Joshua, 2015). However, the results of this study did not provide enough evidence for this propostion and this means that despite the relative influence of access to improved water system on the reduction of diarrhoea prevalence, it is not much an issue in the Wa Municipality because households have access to good sources of drinking water.

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter presents a summary of major finding, the conlusion and recommendations. The conclusions draws issues that emanates from the findings of the study and the recommendations are the set of policies and strategies for major stakeholders of Ghana Health Services for implimemnation towards sustainable immunization of rotavirus vaccines to prevent the incidence of diarrhoea among children in the Wa Municipality.

The study was conducted on rotavirus vaccine coverage and incidence of diarrhoea among children under-five years in the Wa Municipality. The specific objectives were to determine: the trend of rotavirus coverage among children under-five years from 2012-20116; the trend of diarrhoea prevalence among children under-five years; the association between rotavirus coverage and the incidence of diarrhoea among children; the association between the sociodemographic (basic) characteristics of mothers/households and the incidence of diarrhoea among children vaccinated with rotavirus. Both primary and secondary data were collected to achieve the study obectives. The results were analysed using both descriptive and inferential statistics.

6.2 Summary of key findings

6.2.1. Trend of Rotavirus Coverage among Children

- Secondary data established a continues rise in rotavirus coverage from 2012 to 2016.
- There were coverage variations between urban and rural households. Urban households were observed to have received the vaccines more than those in the rural areas.

- Variation in rota 1 and rota 2 coverage, with some households who have received rota 1 have not proceeded to receive rota 2.
- Incomplete vaccination coverage was observed more in the rural submunicipalities such as Busa and Charingu than the urban areas such as Bamahu and Wa Central.
- Variations between rural and urban areas as well as between rota 1 and rota 2 begun to narrow as the years increases.

6.2.2 Trend of Diarrhoea Prevalence among Children

- Cases of diarrhoea continues to rise in the Wa Municipality from the period of 2007 to 2014.
- Children less than one year suffered more with diarrhoea
- Decline in diarrhoea cases among all age categories in 2015 and 2016
- Diarrhoea incidence decreases with a corresponding increase in child age.

6.2.3 Association between Rotavirus Coverage and Diarrhoea Prevalenace

- Children who took the recommended two doses of rotavirus vaccination have less diarrhoea infection than those who took the rotavirus vaccination only once.
- Diarrhoea cases were found to be higher than that of immunization coverage in the years: 2012, 2013, 2014, 2015 amd 2016.
- Significant positive correlation coefficienst were observed among rota 1 rota 2 and episode of diarrhoea in different age cohorts of children under-five years.

6.2.4 Association between Basic Characteristics of Mothers/Households and the Incidence of Diarrhoea among children vaccinated with rotavirus vaccine

- Respondents currently in a marital relationship have their children less likely to contract diarrhoea after being vaccinated with rotat virus vaccine than those who are currently single.
- The results revealed that male children who are vaccinated with rota vaccine are more likely to contract diarrhoea than their female counterpart.

- Children who have taken the required two dosages of rotavirus vaccine were less likely to contract diarrhoea than those who have not completed the dosage.
- Access to public toilet facilities was also found to have a strong influence on diarrhoea incidence though its effect was not expected.

6.3 Conclusion

Diarrhoea is one of the common disease that kills many children under-five years of age. One of the key measures taken to control it in different parts of the world is immunization of the children with rotavirus vaccine. Over the years there has been a sustained effort in the coverage of rotavirus vaccination in the Wa Municipality. However, rural areas are lacking behind in term of percentage coverage. The results of the study also imply that households are very keen in giving their children the first dose of rotavirus vaccine but reluctant in comepleting the second dosage. This means that the vaccine will not be very effective in darrhoea control. The recorded 49.2% of diarrhoea cases among children already vaccinated with rotavirus means that incidence of diarrhoea is high in the Wa Municipality and has previously established a rising trend over the years (2007 -2016). This implies that the over 90% rotavirus vaccination

coverage did not translate into the expected reduction in diarrhoea among children under-five. Further evidence imply that high prevalence of diarhhoea occurs among children with more years of age than those below 1 year. This suggests that low incidence of diarrhoea occurs during the period of exclusive brestfeeding while high incidence corresponds with the period the child begins to consume households meals. The results of this study therefore, agree with theoretical literature that some factors besides rotavirus vaccination also influence diarrhoea infection. This made it imperative to investigate the basic households charateistics influencing diarrhoea and also how the rotavirus vaccines have been managed in the cold chain process by health personel. The results however, imply that staff of the Ghana Health Service in the Wa Municipality do not only have the required knowledge in the management of the vaccines but have equally implemented the required procedures in handling the vaccines along the lines of production, distribution, and utilization.

6.4 Recommendations

- Households' awareness creation through public education on the need to have a complete dosage of rotavirus vaccination should be carried out by the Wa Municipal Health Directorate.
- Management of the Municipal Health Directorate should intensify its compaingns through radio programmes, the use of posters, and face-to-face contacts during antenatal services on the need to have a complete dosage of rotavirus vaccination as this exercise will improve gross rotavirus vaccination coverage and minimize the risk of incomeplete dosage.

- The general public should also be educated on the need to protect and prevent their children from infections as diarrhoea through strong marital tides and relationship.
- Besides, mothers together with all household members should note that boys are at relatively higher risk of diarrhoea and should be given proper care.
- The Municipal Directorate of Health should collaborate with the Environmental Health unit of the Municipal Assembly, to take actions against the public toilet facilities in the Wa Municipality. This is necessary because households using these services are at high risk of diarrhoea than even those resorting to open defecation in the hinterlands.

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APPENDICES

A- QUESTIONNAIRE

SCHOOL OF ALLIED HEALTH SCIENCE, UNIVERSITY FOR DEVELOPMENT STUDIES, TAMALE

STUDY ON ROTAVIRUS VACCINE COVERAGE AND ITS CONTRIBUTION IN REDUCING DIARRHOEA AMONG CHILDREN UNDER-FIVE YEARS IN THE WA MUNICIPALITY

DATE …….. Form No. ……

QUESTIONNAIRE FOR INTERVIEWS

_____ Respondent's Signature

_____ Interviewer's Signature

_____Name of community

INFORMED CONSENT

Hello, my name is ---------- a student at the University for Development Studies reading MPhil in Community Health and Development. I am conducting a survey on **THE CONTRIBUTION OF ROTAVIRUS VACCINE COVERAGE IN REDUCING DIARRHOEA AMONG CHILDREN UNDER-FIVE YEARS IN THE WA MUNICIPALITY**. The purpose of the survey is to help me complete the research component of my programme and also to gather valuable information for the Wa Municipality that can be used to improve upon child health and therefore avert the mortality due to diarrhoea among children under -five years. This information you provide will help the Municipality to plan and improve health services. The questionnaire will take about 20 minutes to complete.

I would very much appreciate your participation in this survey. Whatever information you provide will be kept confidential and will not be shown to other persons.

Participation in this survey is voluntary and you can choose not to answer any individual question or all of the questions. However, I hope that you will participate in this survey since your views are important.

At this time, do you want to ask me question about the survey? YES [ ] NO [ ]

Do you agree to participate in this survey? YES [ ] NO [ ]

If no, mark as a refusal [ ]

THANK YOU

Section 1: Mother's/care taker's Background (socio-economic/demographic characteristics)

1. Are you a permanent resident in this community? 1. Yes [ ] 2. No

If yes to question 1 above move to question 3

2. Where do you currently reside? Name the community [……]
3. How would you describe the residential status of the place you live
    1. Urban [ ] 2. Semi-urban 3. Peri-urban [ ] 4. Rural [ ]
4. Which ethnic group do you belong?
    1. Dagaaba [ ] 2. Waala [ ] 3. Lobi [ ] 4. Others (specify) […….]
5. How old were you at your last birth day? [……] years
6. Your sex is: 1. Male [ ] 2. Female [ ]
7. What is your present marital status? 1. Married [ ] 2.Single [ ].
8. How many children under-five years do you have? [ ]
9. What is the highest educational level you have attained? 1. None [ ] 2. Primary [ ] 3. Secondary [ ] 4. Tertiary [ ]

10. What kind of work do you do for most of your life?

1. Formal [ ] 2. Informal [ ] 3.Unemployed [ ]

11. How much do you earn in a month? 1. No earnings [ ] 2. < GH¢100.00 [ ]

3. GH¢ 100 and above[ ]

12. Which religion do you belong to? 1. Christianity/Traditionalist [ ] 2.

Islam [ ]

Section 2: Child's Background/demographic characteristics

13. What is the sex of the child? 1. Male [ ] 2. Female [ ]

Now I would like to ask you some questions about the health of child (ren).

14. In what month and year was your child born?

Date of Birth: Day ……Month……Year……

PROBE: WHAT IS HIS / HER BIRTHDAY?

IF THE MOTHER/CARETAKER KNOWS THE EXACT BIRTH DATE.

MONTH AND YEAR MUST BE RECORDED.

15. How old is the child? **Age (In Completed Years/Months)**

……Years/Months

PROBE:

HOW OLD WAS THE CHILD AT HIS / HER LAST BIRTHDAY?

RECORD AGE IN COMPLETED YEARS.

RECORD '0' IF LESS THAN 1 YEAR.

16. Have your child been vaccinated with rotavirus vaccine? 1. Yes [ ] 2. No [ ]

CHECK CHILD HEALTH RECORD CARD

17. If yes to 16 above how many doses has your child received? a.1dose [ ] b.2doses [ ]

CHECK CHILD HEALTH RECORD CARD

18. If your child has received rotavirus vaccination when was that?

1.1st dose…….weeks

2. 2nd dose……weeks

19. Have your child ever run diarrhoea for the past six months? 1. Yes [ ] 2. No [ ]

CHECK CHILD HEALTH RECORD CARD

20. If yes how many times? a.1 [ ] b.2 [ ] c.3 [ ] d.4 [ ] e.5 and above [ ]

Section 3: Water supply

21. What is the main source of drinking water for members in your household?

TICK ONLY ONE RESPONSE

1. Piped water [ ]

2. Dug well/spring water [ ]

Section 4: Latrine Usage

22. What is the main type of toilet facility used by members of your household?

TICK ONLY ONE RESPONSE

1. Flush to pit (latrine) [ ]
2. Ventilated improved pit latrine (VIP) [ ]
3. Open defecation [ ]

Record the time the interview ENDS	……. Hour …… Minutes

THANK YOU FOR YOUR PARTICIPATION

C- ETHICAL CLEARANCE

In case of reply the number and date of this letter should be quoted.

My Ref. App/rotavirus/01/2018
Your Ref:

Navrongo Health Research Centre
Institutional Review Board
Ghana Health Service
P. O. Box 114
Navrongo, Ghana
Tel: +233-382-22380

Email: irb@navrongo-hrc.org

22nd January, 2018

Mr. Simon Aabalekuu

Upper West Regional Health Directorate

P. O. Box 298

Wa, UWR

ETHICS APPROVAL ID: NHRCIRB290

Dear Mr. Aabalekuu,

Approval of protocol titled *'Contribution of rotavirus vaccine coverage in reducing diarrhea among children under five years in Wa Municipality'*

I write to inform you that the Navrongo Health Research Centre Institutional Review Board (NHRCIRB) has reviewed the above named protocol and finds the study relevant considering the objectives outlined.

The following documents were reviewed and approved:

- Completed New Protocol submission form
- Summary of Protocol
- Study protocol Version II, dated 02/01/2018
- Informed Consent forms – English Version II, dated 02/01/2018
- Assessment tools and Survey Checklists
- Interview guide for Key Informant Interview

Please note that any amendment to these approved documents must receive ethical clearance from the NHRCIRB before implementation.

Page **1** of **2**

The Board would expect a report on your study, annually or at the close of the study, whichever comes first. Should you require a renewal of your approval, a progress report should be submitted two (2) months before the expiration date. This approval expires on **21st January, 2019.**

The Board wishes you all the best in this project.

Sincerely,

Dr. (Mrs.) Nana Akosua Ansah
(Vice Chair, NHRCIRB)

Cc: The Director, NHRC

In case of the reply the number and date of this letter should be quoted.

My Ref. No GHS/UWR/TP-5 /
Your Ref. No.....

Tel: +233 07 56 22 204 or 22 016
Fax: +233 07 56 22 471
Email: ghs-uwr@africaonline.com.gh

GHANA HEALTH SERVICE
REGIONAL HEALTH ADMIN
P. O. BOX 298
WA UWR
GHANA

MAY 4, 2017

LETTER RECEIVED
07 JUN 2017
REGIONAL HOSPITAL, WA

THE MDHS

THE MEDICAL DIRECTOR, UW REG HOSPITAL

INTRODUCTORY LETTER: MR SIMON AABALEKUU

The above named is a final year student in the Department of Community Health at the University for Development Studies, Tamale-Campus. He is seeking to conduct a research in your facility on the topic: **"Assessing the contribution of rota virus vaccine in reducing diarrhea disease among children under five in Wa municipality, Upper West Region".**

He has duly complied with all the procedures and regulations pertaining to the conduct of research in the health sector. I therefore implore you to kindly accord him the necessary support and cooperation and take the necessary steps to ensure that the privacy and confidentiality of our staff and clients who will be participating in the study are guaranteed.

Thank you.

RICHARD BASADI
DEPUTY CHIEF HEALTH RESEARCH OFFICER
FOR: REGIONAL DIRECTOR OF HEALTH SERVICES

(2) PHCI Incharge
Kindly assist the bearer who is a staff of the facility to do this research.
Ibrahim Fabah
7/06/17

Cc:

1. Research file
2. Mr Simon Aabalekuu