PREVALENCE OF AND RISK FACTORS ASSOCIATED WITH DIARRHOEAL DISEASES AMONG UNDER FIVE YEARS OLD CHILDREN IN RWANDA

GASURIRA Sylvestre

College of Medicine and Health sciences

School of Nursing and Midwifery

Masters of Sciences in Nursing (Paediatrics).

2017

PREVALENCE OF AND RISK FACTORS ASSOCIATED WITH DIARRHOEAL DISEASES AMONG UNDER FIVE YEARS OLD CHILDREN IN RWANDA

by

GASURIRA Sylvestre

216340233

A dissertation submitted in Partial Fulfilment of the Requirements for the degree of

MASTERS OF SCIENCES IN NURSING (PAEDIATRICS)

IN THE COLLEGE OF MEDICINE AND HEALTH SCIENCES

Supervisor: Mr. NSEREKO Etienne

Co-supervisor: Prof. ADEJUMO Oluyinka

July 2017

DECLARATION

I,GASURIRA Sylvestre, do hereby declare that this research dissertation titled “Prevalence of and risk factors associated with diarrhoeal diseases among under five years old children in Rwanda” submitted in partial fulfillment of the requirements for the degree of Masters of Sciences in Nursing (Paediatrics) at the University of Rwanda/ College of Medicine and Health Sciences, is my original work and has not previously been submitted elsewhere. Also, I do declare that a complete list of references is provided indicating all the sources of information quoted or cited”.

Signature ……../…../…..

GASURIRA Sylvestre Date

AKNOWLEDGEMENT

I would like to express my sincere acknowledgement to the following people:

The Ministry of Health for the financial assistance in collaboration with HRH.

The college of Medicine and Health Sciences for the devising of the master's Programme

Rwamagana School of Nursing and Midwifery for the support all over my studies

My supervisor Mr. NSEREKO Etienne and Professor ADEJUMO Oluyinka for their unwavering patience and untiring guidance;

My family, my wife UWIMANA Julienne for her encouragement, our children KWIZERA Bruno; NGOGA Brunold; and INEZA Arnold Benedict for their patience.

ABSTRACT

Diarrhoea among under 5 years children and its associated risk factors: A secondary data analysis of Rwanda Demographic and Health Survey, 2014-2015.

Background: Diarrhoea disease is a worldwide public health issue and it was responsible for approximately 751,000 childhood deaths in 2010. Low and middle-income countries (LMIC) of Africa and part of Asia are more affected. Risk factors for diarrhoea have important implications for planning suitable interventions and appropriate strategies to decrease the impact of the disease.

Methods: This is a secondary data analysis from Rwanda Demographic and Health Survey (RDHS 2014-2015) which is a population-based cross-sectional study design that involved 7856 under five years children from 12,793 households and data analysis was done with SPSS. Descriptive statistics were computed to obtain the prevalence of diarrhoeal among under five. Additionally, to identify risk factors associated with diarrhoea, univariate and multivariate analysis were computed.

Results: The two weeks prevalence of diarrhoea occurrence was 12.1% and Children in the age range between 6 – 24 months were more at risk (OR= 2.942; CI=2.392 - 3.617; p<.001). The study found that wealth index plays important roles in childhood diarrhea includes poorest (OR=2.036; CI=1.618-2.562; p<0.001), poorer (OR=1.913; CI=1.510-2.424; p<0.001) and middle (OR=1.459; CI= 1.135-1.874; p<0.003). The more people are poor the more the risk of childhood diarrhea. Access to improved facilities decreased the risk of contracting diarrheic diseases (OR= 0.703, CI=0.607- 0.815, p<0.001)**.** The same applies for child immunization with rotavirus vaccine; immunized children are less likely to develop diarrheic diseases (OR=0.377; CI= 0.317 – 0.488; p<.001). Prevention and control measures are needed to obtain a lasting solution to diarrhea diseases.

Key concepts: diarrhoea, risk factors, prevalence, sanitation, improved source of drinking water, improved toilet facilities, poorest, poorer, middle, richer, and richest.

KEY WORDS DEFINITION

Prevalence is defined as a number of diseases cases a population at risk at a particular point in time or within a specified time (Olweus, 1989) and it is expressed in percentage. In this study, prevalence illustrates the number of children under 5 years who were reported to have diarrhoea in the last two weeks preceding the survey.

Diarrhoea is defined as frequent loose stools resulting from malabsorption of gastrointestinal contents, and the net secretion of fluids and electrolytes into the intestinal lumen (Woods 1990, p. 457; Guandalini, 2015). Over 200 grams of watery stool or over 10 g/kg per day are considered as diarrhoea. (Menkir et al, 2014). In the context of the study, diarrhoea is a condition which can develop to under five children due to poor hygiene practice of their mothers and themselves throughout Milestone development.

A risk factor is a "characteristic or exposure" that once an individual is exposed to it, this will increase the likelihood to develop a disease or injury (WHO. 2003). In this study, risk factors cover environmental and behavioral factors that are likely to contribute to the occurrence of diarrheic diseases among children under 5 years old.

Sanitation is defined as the safe disposal of human excreta and associated hygiene promotion. In our context, this means that the safe toilet will be accompanied by hand washing with soap and it will be effective barrier to diarrheal diseases transmission in under five years old children(Roma and Pugh, 2012 p.2).

An **improved drinking water sources** are defined as one that, by nature of its construction, is adequately protected from outside contamination, in particular from contamination with faecal matter. In our context of the study, households can drink safe or protected water from piped water into dwelling, piped water to yard/plot, public tap or standpipe, borehole, protected dug well, protected spring, and rainwater while an unimproved drinking water sources, members of household can drink unprotected water or unsafe water stored in unprotected spring, in unprotected dug well, in cart with small tank/drum, in tanker-truck, in surface water, and in bottled water (WHO/UNICEF, 2014 p.22). It is defined as those more likely to provide safe drinking water than those characterized as unimproved drinking water sources.

Improved sanitation/toilet facilities are defined as access to sanitary means of excreta disposal. Also, they are those more likely to ensure privacy and hygienic use. Improved sanitation or toilet facilities include connection to a public sewer, connection to a septic system, pour –flush latrine, and ventilated improved pit latrine (WHO, 2015 pp.4-7).

Poorest household is defined as families who do not have own a house and can hardly afford basic needs. In our context, It is a condition characterized by severe deprivation of basic human needs including lack of foods, drinking unsafe water, lack of sanitation facilities, lack of health insurance, lack of housing, lack of basic information, not follow formal education, and lack of means of supplies (NISR, 2014 p.21).

Poorer household is defined as poor family who has little or no moneys, goods, or other means of support. Those who have a dwelling of their own or are able to rent one but rarely get full time jobs (Household and Survey, 2014 p.6).

Middle households are those who have a job and farmers who go beyond subsistence farming to produce a surplus which can be sold. This family is characterized by either having house, salary job, to be cultivator, or farmer, or commercial by professional(Household and Survey, 2014 p.7).

Richer household is a wealthy family or great possession; abundantly supplied with valuable resources; means or funds. The latter also includes those with small and medium enterprises who can provide employment to dozens of people (Household and Survey, 2014 p.8).

Richest household is defined in terms of money, assets, and wealthy. In our context, are families who own large-scale business, individuals working with international organizations and industries as well as public servants (Household and Survey, 2014 p.9).

LIST OF ACRONYMS AND ABBREVIATIONS

AIDs	Acquired Immune Deficiency Syndrome
CDC	Centers for Diseases Control and Prevention
CHWs	Community Health Workers
EDPRS	Economic Development and Poverty Reduction Strategy
HR	Households Recode
IHLCS/EICV	Integrated Household Living Conditions Survey
KR	Children Recode
LIMC	Low Income and Middle Countries
MoH	Ministry of Health
NISR	National Institute of Statistics Rwanda
RDHS	Rwanda Demographic Health Survey
UDDT	Urine-Diverting Dry Toilet
UN	United Nations
UNFPA	United Nations Populations Fund
UNICEF	United Nations International Children's Emergency Fund
USA	United State of America
USAID	United States Agency for International Development
WASH	Water-Sanitation and Hygiene
WHO	World Health Organization

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE: INTRODUCTION

This chapter describes the background, problem statement, significance of the study, research objectives including specific objectives and research questions, and organization of the study. This study is intended to come up with the general picture of the study.

1.1. Background to the Study

Diarrhoea is among top ten killers worldwide and causes 11% of child deaths globally (Services, 2013 P.2). In addition, UNICEF (2016) reported that global diarrhoea mortality in children under five years old accounted for 9% in 2015. According to WHO, 2017 (Factsheet N^{o} 330) diarrhoea deaths in children under five reach 525,000 and children global diarrhoea cases was 1.7 billion every year. In the last decade, global diarrhoea was responsible for 1.7 million deaths per year among children under 5 years (Walker, et al. 2013, p. 4). Many cases are from low and middle-income countries (Ejemot-Nwadiaro, et al. 2015, p. 6) of Africa and part of Asia (Murray, et al. 2012 p. 2).

For example, a study conducted in Tanzania indicated that the incidence of the diarrheal disease was estimated at 6.1% and affected mostly children aged between 12 to 23 months (11.6% to 15.8%) (Mashoto, et al. 2014 p.1). A study conducted in Burundi found that diarrhoea episodes affected 32.6% of children under 5 years old (Diouf, et al. 2014 p. 1). In Uganda, diarrhea affected 32 to 48% of children under 5 years in the two weeks preceding Uganda Demographic and Health Survey (UDHS, 2011 p.400). The situation in Rwanda was documented in the recent DHS 2014-2015 according to the report, 12% of Children under 5 years had diarrhea within two weeks preceding the Rwanda Demographic and Health Survey (RDHS). Numerous cases were identified among those fitting into 12-23 months of age and 6-11 months 22% (NISR, 2015 p.8). Reports from 2010 stated that around 38,000 under five years old children died in Rwanda because of various diseases but diarrhea was among the top ten leading causes of morbidity (NISR, 2010). Additional literature depicted that in a period of 2009 to 2013 around 13,153 and 17,254 children was hospitalized because of non-bloody diarrhea in Rwanda(Ngabo, Mvundura, *et al.*, 2016 pp.1-2)

Diarrheic diseases have many different consequences to childhood development, beside morbidity and death, diarrhoea affects the nutritional status of children through different mechanisms ranging from poor nutrients intake, poor nutrients absorption, and forced micronutrients excretion (Ferdous et al. 2013, p. 223). Poor absorption of nutrients lead to malnutrition which adds to childhood low immunity and this makes the child more prone to complex infectious diseases and inhibits the natural childhood growth (Ngure, *et al.*, 2014). Several concomitant infections in African children cause permanent immunological damage (Immunology, pp.125-132).

Different pathogens like viruses, bacteria, parasites can cause diarrhoea. But many of them are mostly transmitted via faecal-oral route (Ejemot-Nwadiaro *et al.*, 2015). Diarrhoea pathogens that are transmitted through the fecal-oral channel, involve consumption of unsafe food, drinking contaminated water, or interpersonal contact, or through getting in touch with fecal matter. For the water-borne-diarrhea, people are affected when in-house water storage or/and source of water are contaminated with one of the causative agents. The last is transmitted in at least one of the following channels: either it is person to person, environmental contact, animal to human or vice versa via environment (Van den Bold., 2012 pp.7-36).

In the efforts to prevent diarrhoea, governments are struggling to implement effective therapy by establishing treatment guideline (Löfgren et al., 2012 pp. 1-6). Most of the available guidelines are base on rehydration. This strategy is aiming at preventing the serious consequences of diarrhea including death, but it does little in the primary prevention (Lassi *et al.*, 2014 p. 1).

Researchers believe that around 90% of diarrheic diseases among children under five result from inadequate sanitation and poor hygiene (Montgomery et al, 2007, p. 7). Consequently, to address the root causes of the diarrhoea problem there is a need to understand the environmental and behavioral issues that result in diarrheic diseases. From that perspective, it is true that diarrhea has a multi factorial cause and addressing one cause is at risk of registering a little gain. Studies in Rwanda identified biological-socioeconomic and environmental factors that might offer a conducive environment to biological cause's development (Ngabo, Tate, *et al.*, 2016) (Mukabutera, et al. 2016, pp.1-9). In many cases, human contact with faecal matters happens through behavioral factors that include: type of stool disposal, open defecation and inadequate hand washing (Mattioli, et al., 2015 pp.1912-1920). The mentioned connection chain can be

broken down through effective hand washing and the adequate use of toilettes. However, the gain from hand washing and hygiene cannot happen when people do not have access to safe water and adequate sanitation.

Currently, Rwanda is attempting to address all the potential risk factors. The Ministry of health has been working hard to control diarrheic diseases among children under five and policies have been implemented. For example, the Ministry of Health, through a process of task shifting principles, have enabled Community Health Workers (CHWs) to play a pivotal role in identifying cases in early stages, treat them or refer them to health facilities as before it becomes late (Haver, et al. 2015, p. 33). Additionally, the same Ministry initiated further preventive measures by establishing new diarrhoea vaccines (Ngabo et al. 2016, pp. 129-135). Researchers found that Rotavirus accounts for more than a third of diarrhoea deaths in children younger than 5 years worldwide, with more than half of these deaths happening in sub-Saharan Africa (Nguyen *et al.*, 2005). Aware of that, the Government of Rwanda introduced pentavalent rotavirus vaccine to curb diarrhoea burden in the country.

In relation to access to safe water and sanitation, Rwanda has made tremendous progress. For example, the RDHS 2010 demonstrated that around 74 % of Rwandans across the country have access to both water and sanitation, in 2014 the situation improved and figures went to 84% (NISR, 2010, 2015). However, despite these efforts, diarrhoeal diseases continue to be among the top ten leading causes of mortality and morbidity for children under 5 years in Rwanda (MoH, 2013 p.24).

1.2. Problem Statement

Diarrhoeal diseases continue to be a public health issue in developing countries, especially in Sub-Saharan Africa. The diseases have many consequences that include high morbidity/mortality especially among young children (Ejemot-Nwadiaro, et al., 2015 p.6) and can lead to childhood malnutrition which leaves children vulnerable to infections and delayed growth (Ferdous, *et al.*, 2013). Many competing factors might explain the vulnerability of sub-Saharan Africa. These include poverty, socio-political instability and lack of resources, all of these factors constitute an open ground for pathogens to develop (Stewart et al., 2013 p. 1). Finally, the transmission from infected feces to people through poorly prepared food and unsafe drinking water, interpersonal contact, or manipulation of faecal matter, constitutes a major danger in relation to controlling diarrhoeal diseases.

Despite the efforts made by Government of Rwanda including availing water and sanitation from 74% to 84% (NISR, 2010, 2015), diarrhoeal diseases continue to be among the top ten leading causes of mortality and morbidity for children under 5 years in Rwanda (MoH, 2013 p.24). Rwanda demographic and health survey conducted a survey in 2014-2015 to update the information related to burden of disease revealed that diarrhoea prevalence among children under five years of age is 12% (NISR, 2014). This population based survey targeted households of children five years of age. However, though RDHS indicated the prevalence of diarrhoea among children under five, it did not identify the factors associated with this health condition as it was not its focus. It is important to perform a secondary data analysis from the available data in order to identify factors which are associated with diarrhoea diseases among children under five.

1.3. Research Objectives

The purpose of this study is to identify the determinants of diarrheic diseases among children under 5 years old using RDHS, 2014-2015.

1.3.1. Research Objectives

a. To describe the prevalence of diarrhoeal diseases among children under 5 years old.

b. To determine the proportion of the mothers/care givers of children under five years old that practice hygienic measures applied in the prevention of diarrhoeal disease.

c. To identify the Risk factors associated with diarrhoeal diseases among children under 5 years.

1.3.2. Research Questions

a. What is the prevalence of diarrhoeal diseases among children under 5 years old?

b. What is the proportion of the mothers/care givers of children under five years old that practice hygienic measures applied in the prevention of diarrhoeal disease?

c. What are the risks factors associated with diarrhoeal disease among children under 5 years old?

1.4. Significance of the Study

For the effective prevention of diarrhoeal diseases, it is necessary to understand risk factors and pathogens. The available literature emphases the biological causes and environmental factors but the behavioral aspect of the matter is in many cases overlooked. This study focuses on socio-economic and environmental factors, especially the access to water and sanitation as well as on the practices of hygiene as part of the preventive measures that break down the faecal-oral transmission of the diarrhoeal diseases among children under five years old. The results of this study may contribute to the scanty body of knowledge on independent risk factors associated with diarrhoeal diseases among children under five years old in Rwanda.

The results to this study can inform decision makers on factors associated with diarrhoea among children and they may set adequate and suitable strategies to address diarrhoea diseases among children under five years old. Furthermore, the health professionals such as nurses may use results of this study to design and implement responsive health programmes targeting to tackle morbidity and mortality related to diarrhoea disease among children. Moreover, the findings of the current study may be used by nursing education institutions to develop and implement responsive educational programmes aimed at equipping graduates to deliver safe and quality promotive, preventive and curative care to children under years of age and contribute to reduction of diarrhoea related mortality and morbidity rate and achieving sustainable development goals. Finally, the results from the study establish the baseline information which may be used by other researchers to conduct other studies on diarrhoea diseases in children under five years of age.

1.5. Structure / Organization of the Study

This study comprises six chapters. The first chapter provides the review of the general information on the research topic that describes the background, the problem statement, the objectives and rationale of the study. The second chapter deals with the literature review which describing global situation of diarrhoea in worldwide, describing the potential risk factors associated with diarrhoea to under five years children, describing impact of diarrhoea to under five children, outlining the role of open defecation in relation with diarrhoea, and to recommend the prevention and control measures in order to limit the prevalence of diarrhoea.

The third chapter is devoted to the methodology of the study that will be used from research design up to the software used in analyzing the DHS dataset. The fourth chapter focuses on the presentation of results from the data analysis; the data are presented in tables. Clear explanations to understand well the meaning and relevance of the findings are mentioned in discussion. The fifth chapters discusses the findings obtained from second data analysis, and the last chapter is the summary, conclusion and recommendations of the study.

Briefly, this research is coming up with appropriate recommendations for prevention and control measures which guided the planners to elaborate appropriate guidelines, procedures regarding water sanitation and hygiene practices among mothers of children under five years old in order to find stable solution on diarrhoeal diseases.

CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction

This chapter describes the important roles play by five "f" diagram of disease transmission through excreta as first focal point of contamination. The primary barrier to prevent the spread of pathogens is to manage properly the excreta surrounded the environment. This diagram allowed the researcher to identify the factors associated with diarrheal diseases among children under five years old. This chapter covers, conceptual framework, global situation of diarrhoea in children under five years of age, types of diarrhoea, causes of diarrhoea, transmission routes, risk factors and burden of diarrhoea, prevention and control of diarrhoea and finishing with conclusions.

2.2. Conceptual Framework

This study is guided by the F-diagram of disease transmission or commonly known as a fecal-oral model of diseases transmission. The movement of pathogens from the faeces of anyone infected to where they are ingested by someone else can take a lot of pathways (either direct or indirect transmission of pathogens). The diagram mentioned in the following pages illustrates the important pathways of faeco-oral diseases transmission via faeces, fluids, fingers, flies, and field/floor (Wateraids, 2012 p.2).

The faecal-oral infections are spread when a susceptible subject ingests a pathogen that gives him/her the disease. The pathogen multiples within them and is proliferated inside their faeces. Excreta-related water-borne diseases will be transmitted when the faecal matter enters in the mouth of the individual. So the water borne disease is transmitted through the faecal-oral route (Krumkamp,et al.,2015).

The faecal pathogens are first ingested, then they attack a new host (ex: child). This happens either by contaminated water that is also used for drinking or for food preparation. Additionally, in the case of open defecation; this is the origin of pathogens where there are different micro-organisms including virus, bacteria, parasites, fungal. When flies get in contact with the faeces,they will spread pathogens and transmit pathogens for example onto food and other surface (Krumkamp,et al.,2015).

The same theory assumes that open defecation or inappropriate use of toilets will lead to soil contamination and this in return will contaminate new people/host (e.g. children). The new host can get diarrhoea as an infectious disease.

The model assumes that poor hygiene and improper toilet facilities use leads to high levels of foecal matter contact. Similarly, the manner in which fecal matter from babies is handled and disposed of can contribute to the dissemination of diarrheic pathogens.

The human or animal excreta can contain bacterial, viral, protozoan and helminths that are extremely harmful to health of individual particularly children under five years old. These human or animal excreta-related infection are transmitted to a human being (new host) through different ways of contamination include fingers, flies, fluids, and food. The key elements of "fs" diagram are factors contributing to diarrhoea infections to occur in children under five years. Some factors like socioeconomic and demographic, environmental; and behaviour factors may be the source of contamination to different categories of people. The fecal –oral mode of diseases transmission is applied when an insect can transport pathogens to any under five children and result in contamination and subsequent illness (Krumkamp,et al.,2015).

The mentioned below F diagram shows how diarrheal diseases from faeces can be spread—through flies, fluids, fingers, and fields.

Water*:* One way is through water. Pathogen from faeces on the floor/land or soil can get into the water (fluids) and be drunk by an individual in your household.

Fingers: The second mode of transmission is via fingers, or hands that haven't been cleaned or washed after defecation. Through dirty hands, this can be the way of transmitting the germs to foods, which are then eaten by vulnerable children and subsequently results in diarrhoeal diseases.

Flies: The third approach is through flies. Flies can transport germs from feces to food, so food can be infected and can infect anyone in the family, and result in illness either typhoid fever, diarrhoea, cholera, worms, etc.

Field or floors: The last but not least way is through fields or floors. Some households didn't have standardized toilets which will be used in order to manage well human wastes. Some people did open defecation anywhere and faecal matters are not disposed properly. Pathogens from

faecal matter can be infected different areas or environment. Using the products from contaminated environment, people can be contaminated through eating food, vegetables from environment and subsequently results in illness. So, poor hygiene practices among some mothers and other carergivers of children, for example not washing hands after defecation, is another way to contaminate food via pathogens and these pathogens will be ingested through oral route and the new host (child) can be contaminated and contracted diarrhoeal infections as well.

Preventing pathogens from entering the environment (avoiding open defecations on fields/floors) through cleaning and disinfecting latrines, sewers, and burying waste, can limit contamination from the environment to children who are particularly vulnerable during the crawling and oral phase of development. The role of the mother is crucial to the health of children, particularly young children. Therefore, delivering health education to mothers of children around safe practices such as drinking improved water, using appropriate sanitation (toilets) and adoption of the good practice of hygiene can prevent diarrhoea diseases in children under five years old.

Health education and awareness raising can also be a good way to sensitize people in order to change from negative to positive behaviors. Best practices like boiling water, or treating water using appropriate drugs are simple but crucial methods that can break down the fecal –oral transmission of diarrhoea diseases. Frequently diarrhoeal diseases are spread by fecal-oral-route or person-to-person contact, many times by contaminated hands. Hand washing is one method used for prevention of diarrhoeal diseases caused by most germs like bacteria, parasites, and viruses from the hands.

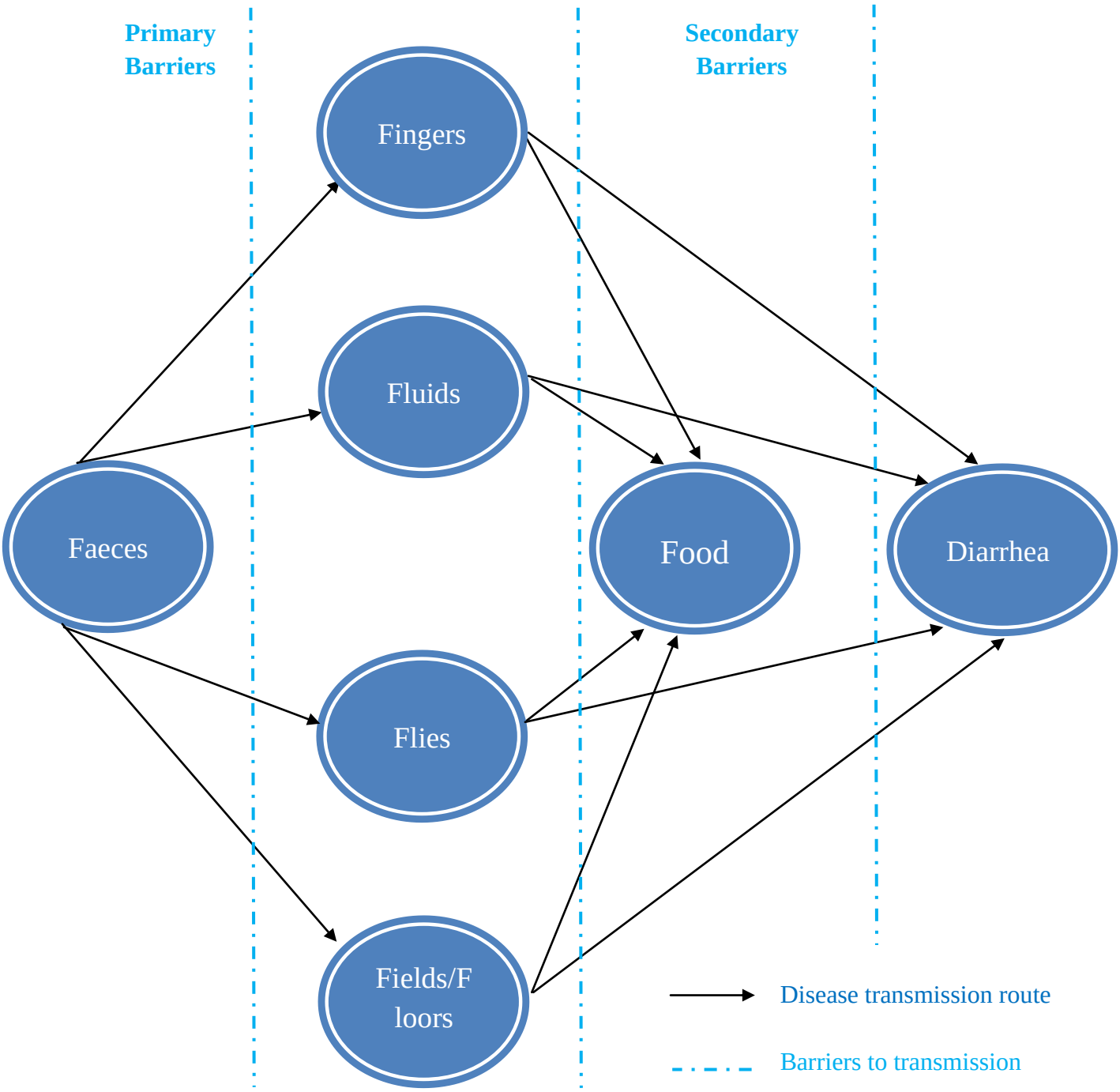

Figure 1: 5F's diagram of disease transmission

Source: Water aids updated, 2012

2.3. Global situation of diarrhoea

Diarrhoea is among top ten killers worldwide and causes 11% of child deaths globally (Services, 2013 P.2). In addition, UNICEF (2016) reported that global diarrhoea mortality in children under five years old accounted for 9% in 2015. According to WHO, 2017 (Factsheet N° 330) diarrhoea deaths in children under five reach 525,000 and children global diarrhoea cases was 1.7 billion every year.

As stated by Services (2015 p.1) every day diarrhoea in Africa is responsible for the death of 2,195 children under five. Therefore, diarrhoea mortality rate is superior to malaria together with measles and AIDs. Global death in young children with diarrhoea accounts 1 in 9 and diarrhoea is classified as the second leading cause of mortality worldwide.

The overall diarrhoea prevalence in Bangladesh among children under 5 years was counted to be 5.71% (Sarker, *et al.*, 2016 p.1). In Philippines, 14% of deaths among children under five were attributed to diarrhoea (Costs, 2015 p.1). In Iran, 10.3% of children experienced significant diarrhoea during the past two weeks with the average number of episodes of 2.8 per child. Half of children studied in the study were ranged between 6-18 months of age.

Global diarrhoeal diseases in Sub-Saharan Africa is a major public health concern, especially in children under five years (Tambe, Nzefa, and Nicoline, 2015 p.1). The prevalence of diarrhoeal cases in Africa is high, accounting for 2.5 billion cases among children under five; the global dehydration is ranged from 25 to 75% of all childhood diseases (Tambe, Nzefa, and Nicoline, 2015 p.1).

In Ghana, diarrhoea deaths were estimated at 0,8million in children below five. The total diarrhoea deaths was 10, 5% all over the country (Krumkamp *et al.*, 2015 p.2). Also, diarrhoea deaths across the following countries like India, Pakistan, Nigeria, China, and Democratic Republic of Congo among children under five was 21% (Vakili *et al.*, 2015 p.809).

In Cameroon, a researcher reported that each year there were around 93,000 diarrhoea deaths in children under five (Tambe, Nzefa, and Nicoline, 2015 p.2). research findings showed that low prevalence of childhood diarrhoea was a result from improved water source through hygiene education (17.9%), as well as water that has been boiled before utilization 19.4% (Tambe, Nzefa and Nicoline, 2015 p.2) .

The study conducted in Mkuranga District (Tanzania) reported that the prevalence of diarrhoea in children under five years old was 32,7% (Kakulu, 2012 p. 38) whereas in Burundi diarrhea prevalence in children under five years old was almost the same 32,6% (Diouf *et al.*, 2014 p.1). The study carried out in Ethiopia reported that the prevalence of diarrhoea among children under five was 22,5% (Mengistie, Berhane and Worku, 2013 p.446).

As stated by Rwanda demographic health survey (RDHS) 2014-2015, mothers reported that diarrhoea prevalence among children under five was 12,1%; and the prevalence was greater in young children between 12-23 months (22%) and those between 6-11 months (18%).

2.4. Types of Diarrhoea

Young children are likely to be affected by diarrhoea. There are many various types of diarrhoea in children including acute watery diarrhoea, dysentery, persistent, and chronic diarrhoea.
Acute watery diarrhoea in children refers to sudden episode of diarrhoea which is characterized by frequent, watery, loose stools without visible blood, ranged within two weeks. Always, acute watery diarrhea episodes are progressively reduced within 72 hours of onset. Acute watery diarrhoea may be accompanied by malaise, abdominal pain, flatulence, nausea, vomiting, and fever (Lindberg *et al.*, 2013 p.12).

Global burden of diarrheic infections was between 3 to5 billion cases. Among the latter, 2 million died each year. 35% of total deaths were attributed to acute diarrhoea, 20 % to dysentery, and 45% to persistent or chronic diarrhoea. Children under five from rural regions of developing countries were more affected and died(Grimwood and Chb, 2009 p.1343). The direct impacts of acute diarrhea in children comprise dehydration, growth faltering, impaired cognitive development, and malnutrition in countries with limited resources (Farthing et al; 2013 p.2). During the past three decades, poor water supply, poor sanitation, and poor personal hygiene

were factors contributing to the occurrence of acute diarrhoeal diseases in developing countries (Farthing et al; 2013 p.2).

Dysentery refers to an acute short period of diarrhoea that lasts at least two weeks .Children pass foul bloody stools that contain mucus. Systemic toxicity and fever are signs of dysentery with infectious origin. That type of dysentery is characterized by abdominal cramps, rectal pain and fever (Pfeiffer et al, 2012 p.374). It can result in persistent diarrhoea, recta1 prolapse, septicemia (blood poisoning), and haemolytic-uraemic syndrome (HUS). The HUS is a condition that affects the kidneys and blood clotting system (Hatz et al; 2015 p.4594).

Evidence showed that about10% of diarrhoeal episodes among children less than five years have observable blood in the stools. This 10% of diarrheal episodes can cause 15% of diarrhoea deaths in children under five. The mortality caused by Shigella dysenteriae type was greater in younger children compared to adult children (Hatz et al; 2015 p.4594). Another evidence showed that the low incidence of dysentery was found in children with age group 0-6months (6,7%). Also, the hospital stay was taken long for dehydrated patients (Rajeshwari *et al.*, 2013 pp.159-160).

Persistent diarrhoea refers to diarrhoeal episodes of reputed gastro-intestinal infection that lasts more than fourteen days. About 10% of diarrhoeal infection in children less than three years in developing countries became persistent. About 35% of deaths among children under five were attributed to persistent diarrhoea (Nadu, 2011 p.37). This diarrhoea causes considerable weight loss among children less than five years. It may be responsible for about one-third to half of all diarrhoea-related deaths. Persistent diarrhea is a major consequence of malnutrition in the developing countries (Muhsen et al; 2012 p.271).

Chronic diarrhoea is recurring or long lasting due to non-infectious etiologies agents. It is due to gastrointestinal conditions, secondary to systemic disease and associated to malabsorption. The mechanism of chronic diarrhoea may be categorized as inflammatory diarrhoea (caused by regional enteritis, ulcerative colitis) (Zella and Israel, 2017).
According to Lamberti, Walker, and Black,(2012 p.1), in a systematic review of diarrhoea duration and severity in children in low and middle-income countries reported that moderate and

severe diarrhea episodes represent a considerable segment of diarrhea among under five years old children (35,2%; about 588 million episodes).

2.5. Main Causes of Diarrhoea

Diarrhoea illnesses in children are due to bacterial, parasitic; viral infections or the noninfectious causes of childhood diarrhoea.(Agustina, *et al.*, 2013 p.3).

Viral gastroenteritis is the main causes of diarrhoea. Among those causes the rotavirus is the most leading cause of severe complication of dehydration especially in developing countries where there is drinking of unimproved water source and poor sanitation. The proportion of diarrhoea cases hospitalized with positive rotavirus is estimated at 40.3% in Sub-Saharan countries (Mwenda et al., 2013 p.6). The study conducted in Ouagadougou Burkina Faso reported that among hospitalized children under five, rotavirus was found in 30% of patients whereas Escherichia Coli was observed in 24%. Both agents were mostly dominant to cause diarrhoea in children under five years. The diarrhoeal infection caused by rotavirus was observed in children less than 2 years whereas Escherichia Coli was found in children with different age groups (Bonkoungou *et al.*, 2013 pp.2-6).

Indonesia reported that in both developed and developing countries, rotavirus incidences were similar. Its ‘mode of transmission is fecal-oral route. Rotavirus may cause 2% of diarrhoea deaths among children under five and sometimes diarrhoea caused by rotavirus is accompanied by seizures. The low incidence was found in children less than 6 months because those children were exclusively breastfed; and in breast milk there is milk mucin which is very important and inhibits the binding and replication of rotavirus. This reduces the incidence of diarrhea to children less than six months. The low incidence was also found in children of more than 2 years old because children of this age present natural antibodies that arise from frequent infections of rotavirus (Sulaksmana *et al.*, 2016 pp.118-123).

Bacterial gastroenteritis: reports from different areas of the world showed that various pathogens were involved in the development of childhood diarrhoea. The study conducted in Nigeria to detect an association between bacterial agents and infantile diarrhoea reported that Escherichia Coli (23.0%), Salmonella species (10.0%), and Shigella species (8.0%) were among pathogens

that cause acute diarrhoea to children with age ranged between 0-12 months. The researcher found that there was a greater association between bacteria and diarrhoea in children less than 12 months. The high incidence of acute diarrhoea was found in children with age ranged between 0-12 months whereas the low incidence decreased with increase in age (Duru, Agbagwa and Umoren, 2014 pp.1-11). Parasites enter in the host through drinking water or eating food and evolve to the digestive system. Most of the parasites that generate diarrhea include Entamoeba histolytica, Cryptosporidium, Giardia lamblia, and Cyclospora cayetanensis.

The study conducted in Kathmandu, Nepal (hospital) to detect parasites which were involved in development of diarrhoea among hospitalized under five children reported that protozoal parasites were found in 10,7% whereas helmintic parasites were 1.3%. The parasitic infection prevalence was higher in children of less than 2 years. Entamoeba histolytica (6, 7%) was the chief cause of diarrhoea in this age group followed by Giardial lambia (3, 4%) (Ansari, *et al.*, 2012 p.1).

Food intolerances or food poisoning: Sometimes children cannot digest correctly some foods such as lactose, gluten found in wheat, sugar found in milk and barley as well as some solid foods. Frequently the food intolerance or poisoning is caused by bacteria in undercooked food or spoiled food.

Many disorders and diseases can cause chronic diarrhoea in young children. Those diseases are connected to common causes like infections, functional gastrointestinal (GI) disorders, food intolerance, allergies, and inflammatory bowel diseases (IBD).They cause chronic diarrhoea along with malabsorption as the small intestine does not absorb nutrients from food. If children do not absorb enough nutrients from the food they eat, they may become malnourished (Turnbull, Adams and Gorard, 2014 p.69).

2.6. Transmission Routes

Diarrhoea infection is acquired via fecal-oral transmission that includes consumption of contaminated water or food, direct contact with person-to-person or direct contact with faecal matter. Considering water-borne-diarrhea, transmission can occur when in-household there is a storage of contaminated water (Access, 2010 p.3658).

There are four routes of transmission of diarrhoeal illnesses through which infectious agents reach human hosts. Among them are person-to-person via the environment; person-to-person multiplying in the environment; human-to-animal-to human via the environment; and animal-to-human via the environment. In situations where faecal matter contamination of the domestic environment is high, the majority of cases of endemic disease probably occur either by person-to-person transmission, or from the person-to-person transmission of pathogenic agents that have multiplied in the environment(Bain *et al.*, 2015 pp.1-2).

Water borne diseases are caused by a pathogenic micro-organism which is direct transmission once the individual consumes contaminated water. According to the World Health Organization, diarrheal disease is responsible for 1.8 million deaths every year. An estimation of 88% of burden is attributable to unsafe water supply, poor sanitation, and poor hygiene conditions (Bodzeway., 2014 pp.2-3).

Many studies revealed that in the developing countries the water-borne diseases with diarrhea have serious impact on the human being like dehydration and it was the important cause of childhood death. The researchers found that the typhoid fever, hepatitis A and Cholera are caused by bacteria, and are among the common diarrhoeal diseases. Other illnesses like dysentery are caused by parasites that live in water contaminated by the feces of sick individuals. The most common cause of mortality in water borne diseases is an outcome of dehydration due to loss of abundant amounts of electrolytes either in diarrhoea or vomiting (Bodzeway, 2014 pp.2-3).

Food borne disease is the main public health concern worldwide. In 2013, a total of 19,056 infections, among them 4,200 were for hospitalizations, and 80 of them died. For most of the infections, reported incidence indicated that it was higher among children less than 5 years. Also, food borne illnesses result from consumption of food containing pathogens such as bacteria, viruses, parasites or the food contaminated by lethal chemicals (Jahan, 2011 p.321). Also, the food-borne infections in developing countries can cause diarrhoeal diseases in young children and it was associated with other factors like lack of access to clean water for food preparation; inappropriate transportation and storage of foods; and lack of awareness regarding safe and hygienic food practices (Jahan, 2011 p.322).

Vectors borne diseases, most of the diseases can be contracted directly via contaminated water, poor hygiene of (food, hands) or via insects or open defecation. The research conducted on preventing diarrhea through better water, sanitation and hygiene (WHO, 2014 p.4) found that people drunk water contaminated by an open defecation (bacteria) predicted to be exposed from 14% in Europe to over 52% in Africa. For example, 502,000 diarrhoeal deaths in LMIC were attributed to inadequate drinking water from different types of water sources (WHO, 2014 p.8).

The research findings from different researchers showed that open defecation was done in the bushes, fields and bodies of water or other open spaces. A billion people worldwide practice open defecation. An estimated 215 million people of Sub Saharan Africa engage in open defecation (Njuguna, 2016 p.1).

In 2015 access to improved sanitation facilities was 68% globally, but 2.4 billion people still do not have latrines or toilets (WHO, 2016 p.1). Each year, 280,000 diarrhoea deaths are caused by poor sanitation. About 30% of Sub-Saharan Africa had access to improved sanitation facilities, and at least 842,000 people who live in low- and middle-income countries die each year (equivalent of 58%) due to poor water, sanitation, and hygiene in 2015 (WHO, 2016 p.1). In Rwanda, access to improved sanitation (toilets) in households increased from 74.5% in 2011 to 83.4% in 2014 (Nivers, 2014p.8).

A systematic review conducted by Freeman et al., (2014 p. 906) on hygiene, hand- washing prevalence worldwide, and health effects of hand washing practices, estimated that only about 19% of the world population washes hands with soap after contact with excreta. The study suggested that hand-washing reduces the risk of diarrhoeal disease by 40%. The results of this study demonstrated that global hand washing after contact with excreta is poorly practiced (Freeman et al., 2014 p.906).

In 2014, WHO estimated that 60% of global deaths from diarrhea were attributed to unimproved WASH. The incidence of diarrhoea each year numbered 1.7 billion cases (Rah et al., 2015); and 9.5% of all child deaths were caused by diarrhoea resulting from poor hygiene (WHO, 2014 p.1).

The impact of poor hygiene, poor sanitation and lack of improved water is very important because around two billion people are infected by soil-transmitted helminths (hookworm, etc) whereas 200 million are infected by schistosomiasis (UNICEF & Brocklehurst, 2011 p.2).
In Africa, it has been estimated that 91% of the population have access to improved water while 663 million people do not have access to safe water (Unicef, 2013 p.2). WASH in Sub-Saharan Africa is still a challenge because around 565 million people do not have access to clean sanitation and 330 million of people do not have access to safe water (Hameeteman, 2013 p.6).

Rwanda National data shows that 94.2% of households use pit toilets, 3.1% of households use ventilated improved pit (VIP) toilets, 0.2% of households use Urine – diverting dry toilet (UDDTs), and 4.5% of households use flush toilets (Ekane et al., 2012 p.9).

Global lack of improved water and sanitation is the single most cause of illnesses, and this problem has a connection to the childhood deaths with about 4,100 children under five dying every day from waterborne diseases (Sales-Ortells et al., 2015 p. 6945). The reason behind is that 1 gram of feces can contain viruses, bacteria, parasite cysts, and parasite eggs. These microorganisms facilitate the transmission of infectious diseases (e.g., diarrhea) especially in under five year old children (Sales-Ortells et al., 2015 p. 6945).

Enabling mothers to access safe water is the single most effective preventive interventions against diarrhea, a leading cause of illness and death among under-five year old children in developing countries (Publishing, 2012 p.3). Koolwal (2010 p.7) argues that access to water in

the household has a positive effect on child health if mothers are more knowledgeable. In addition, by using treated water mothers can reduce 42% of diarrhoea morbidity to under five years children. In addition, good hygiene practices of mothers decreased morbidity from diarrhoeal disease to about 31%. Overall, appropriate sanitation practices among mothers reduced diarrhea morbidity to almost 37% (Bhutta et al., p.1419).

According to Katabarwa, (2012 p.1) safe drinking water can decrease diarrhea to approximately 16% if each individual practices hand washing with water and soap whereas domestic hygiene practice can prevent diarrhea in over 65% of households if hand washing is done correctly.

2.7. Potential Risk Factors of Diarrhoea

Demographic factors: several studies have recognized that the diarrhoea prevalence is increased in younger children especially in children ranged between 6-11months. Several findings showed that the diarrhoea rate was greater in boys than girls. Other demographic factors, like low level of mother's education, mothers' younger age, birth order, and high number of siblings were notably associated with diarrhoea in children below five years (Agustina et al., 2013 p.1).

Socio-economic factors**:** Various studies showed that the association between socio-economic factors, such as crowded conditions, poor housing, low income; and elevated rate of diarrhoea was statistically significant. For example, the socio-economic determinants of health, such as low socioeconomic status, lack of education among mothers or care givers, insufficient safe drinking-water, and inadequate sanitation, are likely to be leading factors of diarrhoeal disease, which continues to affect millions of children below 5 years, in low- and middle-income countries (Agustina et al., 2013 p.1).

Water-related factors: As diarrhoea is acquired through contaminated foods and water, water-related factors are crucial determinants of diarrhoea incidence. This happens when the distance from water sources increases, when there is poor storage of drinking water (for example obtaining water from storage containers by dipping, no drinking water storage facility), when

some household use unsafe water sources (such as rivers, pools, dams, lakes, streams, wells and other surface water sources),water storage in wide mouthed containers and low per capita water used (Gebru, Taha and Kassahun, 2014 p.2). .

Sanitation factors: evidence showed that sanitation plays a major role in reducing diarrhoea morbidity. Some sanitation factors, like improper disposal of children's stool and no existence of latrine or unhygienic toilet, sharing latrine and house without sewage system. These elements were reported as the risk factors for diarrhoea in children under five years (Gebru, Taha and Kassahun, 2014 p.2).

Hygiene practices**:** various studies noticed that children who did not wash hands before eating or after defecation, mothers who don't wash hands before feeding children or mothers who don't clean foods before cooking, children who eat with their hands rather than with a spoon, eating of cold leftovers, dirty feeding bottles and utensils, unhygienic domestic places (kitchen, living room, yard), improper food storage, living with animals inside the house, lack of strategies to limit flies inside the house, were associated with greater risk of diarrhoea occurrence in children (Gebru, Taha and Kassahun, 2014 p.2).

Breastfeeding: the morbidity of diarrhea is lower in exclusive breast-fed children; it is higher in partially breast-fed children, and highest in fully-weaned-children. In addition, a particular risk of diarrhoea is associated with bottle-feeding. Many studies have shown the strong protective effect of breast feeding. A high concentration of specific antibodies, cells, and other mediators in breast milk reduces the risk of diarrhoea following colonization with entering pathogens (Gebru, Taha and Kassahun, 2014 p.2).

Malnutrition: the relationship between diarrhoea and malnutrition is so common in low-income societies that the concept of a vicious circle is appalling, with diarrhoea leading to malnutrition and malnutrition predisposing to diarrhoea. Children whose immune systems have been weakened by malnutrition are the most vulnerable to diarrhoea. Diarrhoea, especially persistent and chronic diarrhoea weakens nutritional status, leading to malabsorption of nutrients or the inability to use nutrients properly to maintain health. A number of studies have reported a higher

incidence of diarrhoea in malnourished children. A tendency of increased incidence of diarrhoea was also found in children with low weight-for-age, or, in particular, in stunted children (Gebru, Taha and Kassahun, 2014 p.2).

Eating habits: Eating with the hands; eating raw foods; or drinking unboiled water, increases the risk of diarrhoea. For example, the inadequate food hygiene practices, resulting in food and water contaminated with pathogens_can increase the risk of having diarrhea up to 70% among children in low socioeconomic status (Augustina et al., 2013 p.2).

The occurrence of diarrhoeal disease among young children below five years old was complex and the factors varied when there was interaction between socioeconomic, environmental, and behavioral variables.

2.8. Impact of Diarrhoea

The global impact of diarrhoeal diseases on children under five years is discussed in various literatures and showed that the mortality and morbidity rate is high. This is illustrated by diarrhoeal diseases that have been classified as the second cause of mortality in children; global deaths estimated at 760,000 children under five each year and 1.7 billion of childhood diarrhoeal cases each year (WHO, 2013 p.1). Diarrhoeal diseases resulted in dehydration, malnutrition, stunting and cognitive impairment (Walker et al., 2013 pp.1405-1406).

2.9. Prevention and Control of Diarrhoea

The prevention of diarrheal disease is first and foremost based on access to safe drinking-water sources; use of improved sanitation; hand-washing with soap; exclusive breastfeeding for the first six months of life; personal and food hygiene. Health professionals like nurses could make more effort in health education talks on how diarrhoeal infections spread, and sensitize all mothers of children under five years to immunize them with rotavirus vaccine (Tate *et al.*, 2016 p.1). All major cases of diarrhoeal diseases in children under five years old can be prevented by proper household practices of water, sanitation and hygiene (Diouf et al., 2014 p.1).

2.10. Conclusion

The chapter of literature reviews indicates that there is high burden of diarrhoea among children under five years of age and it was found that transmission follows oral fecal model and various factors of diarrhoea are linked with poor hygienic measures and practices.

CHAPTER 3: MATERIAL AND METHODS

3.1. Introduction

The chapter 3 of material and methods covers research design and approach, research setting, population, Sampling, data collection, data analysis, ethical considerations, data management, data dissemination, limitations and challenges and conclusion of chapter.

3.2. Study Design and approach

The current study uses secondary data analysis from Rwanda Demographic and Health Survey (DHS, 2014-2015) which was a population-based cross-sectional study design. A cross-sectional study design refers to the observational study in which exposure and outcome are measured at same time (Long and Hart, 2012 p.5). In this study, prevalence of Diarrhoea among children under five years of age in Rwanda and associated factors are simultaneously measured. Cross-sectional analytical study design was used to identify associated factors with this health condition. It follows quantitative research approach as numerical information was collected. According to (Of and Methods, 2011 p.18), in quantitative approach, numerical data are gathered in terms of numbers and statistical tests are used.

3.3. Study setting

The study was conducted in Rwanda as Rwanda Demographic and Health survey in the whole country. Rwanda is landlocked country with about 12 million population composed by 48% of men and 52% of female distributed in five Provinces and 30 districts (NISR, 2014). Rwanda is surrounded by four countries where there is Uganda in North, Tanzania in East, Burundi in South and Republic Democratic of Congo in Ouest. The population of Rwanda is young with average mean of age is 22.7 years (NISR, 2014 p.21).

In Rwanda, 83.5% live in rural areas while 16.5% live in urban areas (NISR, 2014) and about 16.5% of Rwandan population live in extreme poverty (NISR, 2014).

3.4. Study population

The current study used 12,793 household heads that were used in RDHS. It covered all thirty districts of Rwanda.

3.5. Sampling

3.5.1. Sample size and sampling techniques

The sample size was all children under five years old living in selected households. A total of 7,856 children under five years old constituted a sample size of the study. This sample size was considered in RDHS. The study considers the same technique used in RDHS. RDHS used multistage sampling technique where the households were systematically chosen from 492 villages. Every district, 16 households were selected except some districts whereby 17 households were selected. Briefly, the study followed probability sampling methods with strata technique whereby each village constituted strata.

3.5.2. Inclusion criteria

- All women of 15-49 years old either permanent residents or visitors before the night of survey
- All men of 15-59 years old either permanent residents or visitors before the night of survey
- Willing to participate
- Household heads having children of five years of age and below

3.5.3. Exclusion criteria

- Not willing to participate in the survey
- Household heads having children of above five years

3.6. Data Collection, dataset and instrument/ measurements

The RDHS used three questionnaires: household, women and men questionnaires. In this current, household questionnaires which collected information on household characteristics, parents, both mothers and fathers, and children information on their health status especially on Diarrhoea was used . In RDHS, interview was done by trained research assistants using standardized World Health Organization instrument. The instrument has many parts. In this current study, household characteristics, children characteristics and health status on diarrhoea and water and sanitation variables were considered. DHS database has various datasets (e.g. household). This study was primarily focused on children recodes (KR) dataset, which stands for household recodes (HR). However, other dataset including the household one was visited for merging whenever necessary. Demographic and Health Survey children recoded dataset include all necessary

quantitative data pertaining to demographic and socioeconomic characteristics, including data essential to analyze risk factors of diarrheal diseases among children under five.

3.7. Validity and Reliability of instrument

The instrument is valid and reliable as it is World Health Organization standardized instrument and has been used by National Institute of Statistics of Rwanda in collaboration with Ministry of Health through Rwanda Biomedical Centre. Additionally, this instrument has content validity as considered information of the dataset are those related to study objectives and conceptual framework.

3.8. Statistical analysis

The data groundwork is done by recording, identifying and putting the variable of choice using SPSS version 20.0. Categorical variables are presented in a table of frequencies for descriptive statistics. A Bivariate regression analysis with Chi-square test is computed to test the focal research inquiry. We tested personal factors and variables that confound the major predictors (hand hygiene) of the model, as these could influence the odds ratio by 10%. These essential confounders were controlled in multiple logistic regression analysis in the final model. The discontinue point for statistical implication is p-values of at least 0.1 for univariate analysis and 0.05 for the final model.

3.9. Data Management

The study performed secondary data analysis from RDHS. Therefore, the data was kept and will be destroyed after five years.

3.10. Data dissemination

The findings of this study will be presented in School of Nursing and Midwifery at College of Medicine and Health Sciences, University of Rwanda. Furthermore, the results will be submitted to Rwanda Demographic and Health Survey management as requested in authorization. In case authorization is given, the findings will be presented in national and international conferences for dissemination and sharing evidences.

3.11. Limitations and challenges

Due to large dataset, it is not easy to identify all determinants of diarrhoeal disease among under five years old. Also, some information related to causes of diarrhoeal diseases among children

under five years old are not mentioned. Also, the information about validity and reliability are not detailed in the RDHS 2014-2015 report.

The challenge the researcher has been seen, some determinants including pathogens of diarrhoea were not studied because it was not mentioned in DHS dataset 2014-2015.

3.12. Ethical considerations

The study used DHS 2014-2015 databases. Approval for the right to use the databases of DHS will be obtained via online registration. All DHS data are treated anonymously and confidentially, and the user is prohibited to make an effort to identify any household or individual respondent interviewed in the survey. The data set from DHS is not passed to other researchers without the written consent of RDHS. After doing a second data analysis, the researcher is required to submit a copy of any report or publication to the DHS website.

3.13. Conclusion

The chapter 3 provided blueprint of this current study and described methodology that has been used in Rwanda Demographic and Health Survey 2014-2015 and how used methodology was applied in this current study on prevalence of diarrhoea of children under five years and associated risk factors using secondary data analysis from RDHS.

CHAPTER FOUR: PRESENTATION OF RESEARCH FINDINGS

4.1. Introduction

The chapter 4 presents results of the current study. The description of household, children and water and sanitation characteristics of participants along with statistical tests for association (Chi-square and Multiple Logistic regression analysis) are presented and interpreted.

4.2. Household characteristics of the study population

As seen in table.1 below, of the total 7856 of participants were asked about their education level, the results showed that majority of the participants 5078 (64.6%) reported that they have informal education whereas formal education were 2778 (35.4%).

For participants' occupation, results showed that majority of participants have no paying jobs 4933(62.8%), followed by participants with paying job 2400 (30.6%), and Jobless participants equivalent to 521(6.6%). Results on the number of under 5 years old children in the household (HH) was investigated, results showed that a great proportion 7787(99.1%) is between zero to three.

For wealth index, those who reported to be the poorest households were 1893(24.1%), the poorer households were 1643(20.9%), Middle households were 1479 (18.8%) and Richer households were 1340 (17.1%) while the Richest households or category were 1501 (19.1%).

For the type of place of residence, results showed that the higher number of participants 6131(78.0%) are in the rural area than in the urban area 1725 (22.0%).

Table 1:Household characteristics

Characteristics	Frequency	Percentage
Households educational level (N=7856)		
Informal education	5078	64.6
Formal education	2778	35.4
Participants' occupation (N=7854)		
Jobless	521	6.6
Paying Job	2400	30.6
No paying Job	4933	62.8
Number of under five in household(N=7856)		
0-3	7787	99.1
4-6	62	0.8
7 and above	7	0.1
Wealth index category (N=7856)		
Poorest	1893	24.1
Poorer	1643	20.9
Middle	1479	18.8
Richer	1340	17.1
Richest	1501	19.1
Types of place of residence (N=7856)		
Urban	1725	22.0
Rural	6131	78.0

N=7856.

4.3. Characteristics of Children under five years old

The results in table2, describe the characteristics of children under five years. According to the age of children in months, a high proportion of participants 2030 (56.1%) is ranged between 24-59 months followed by those who are between 6 and 24 with 1234 (34.1%), and those who are less than six months were 354 (9.8%). For the sex of the children, results showed that male sex was 3978 (50.6%) nearly equal to female sex 3878 (49.4%).

Table 2: Distribution of sex and age of children under five years

Characteristics	Frequency	Percentage
Age of children in months (N=3615)		
Less than six months	353	9.8
Six to 24 months	1232	34.1
25 – 59 months	2030	56.1
Sex (N=7856)		
Male	3978	50.6
Female	3878	49.4

N=7856. N is changed from 7856 to 3615 because of the missing and don't know in dataset were not considered.

As seen in table 3 below, for children who had diarrhea two weeks preceding survey, the results showed that 12.1% of children under 5 years old had diarrhoea compared to 87.9% who were not having diarrhea. It means that the reported prevalence of diarrhoeal diseases by mothers' of children under five years old is 12.1%.

Table 3: Reported prevalence of diarrhoea among children under five years old.

Characteristics	Frequency	Percentage
Had diarrhea in the past two weeks (N=7474)		
Yes	905	12.1
No	6569	87.9

As seen in table 4 below, results showed that the majority of children under five years old 4389 (62.0%) received rotavirus vaccine 1, 2, and 3 compared to those who did not receive rotavirus vaccine 2710 (38.0%).

Table 4: Received rotavirus vaccine among children under five years of age

Characteristics	Frequency	Percentage
Received rotavirus vaccine 1,2, and 3 (N=7544)		
Yes	4389	62.0
No	2710	38.0

4.4. Water and Sanitation Characteristics

The results on water and sanitation characteristics as presented in table 5 below. According to the Source of drinking water, the higher number of participants 5468 (73.0%) used improved source of drinking water than those who used unimproved source of drinking water 2488 (27.0%). The time taken to fetch water (minutes) was assessed, and those who use zero to thirty minutes (0-30minutes) were 4513 (57.5%) compared to those who use more than thirty minutes were 3339 (42.5%) of participants.

For water usually treated by boiling, the results showed that majority 7630 (60.2%) used boiled water while 5051(39.8%) did not use boiled water. It means that the majority of participants did not use safe drinking water. Water usually treated by chlorine, the results document that the greater proportion of participants 12062 (95.2%) were not using water usually treated by chlorine while 612 (4.8%) of the participants used water usually treated by chlorine.

Table 5:Water Source and Water treatment Practices

Characteristics	Frequency	Percentage
Source of drinking water (N=7856)		
Improved source of drinking water	5468	73.0
Unimproved source of drinking water	2488	27.0
Time taken to fetch water(7852)		
0-30 minutes	4513	57.5
More than 30 minutes	3339	42.5
Water usually treated by boiling (N=12681)		
Yes	5051	39.8
No	7630	60.2
Water usually treated by chlorine (N=12681)		
Yes	612	4.8
No	12069	95.2

N=7856 for children under five years old.

N=12699 for households of children under five years old.

The findings on hand washing practices as presented in table 6 below, showed that more than a half of participants 863 (54.7%) have water at hand washing places whereas 715 (45.3%) participants reported that had no water at hand washing places.

For items used to wash hands, the results showed that participants who washed their hands with soap 855 (54.1%) were nearly equal to those who did not wash their hands with soap 725(45.9%).

For places where household members wash their hands, results document that majority of households observed equivalent to 87.9% did not have places for hand washing while 12.1% of the households observed at time of the study had hand washing places.

Table 6: Hand Washing Practices

Characteristics	Frequency	Percentage
Water at hand washing place(N=1578)		
Available	863	54.7
Not available	715	45.3
Items present: Soap or detergent (N=1580)		
Yes	855	54.1
No	725	45.9
Place for washing hands (N=7856)		
Observed	950.6	12.1
Not observed	6905.4	87.9

The results on sanitation practices summarized in table 7. According to types of sanitation or toilet facilities, findings show that majority of participants uses improved sanitation facilities 5461(70.8%) compared to those who use unimproved sanitation facilities 2253 (29.2%). According to the results on toilet facilities shared with other households showed that above three out of four (3/4) of participants 5776 (77.3%) shared toilet with others while 1698 (22.7%) were not sharing toilet with others at the time of the study.

The results on stool disposal showed that at least three out of four of participants used Put/rinsed in toilet/latrine 5428(71.4%), followed by those who use toilet/latrine 966 (12.7%), Put/rinsed into drain or ditch 615 (8.1%), Left in the open/not disposed of 296 (3.9%),Throw into garbage 178 (2.3%),buried 94 (1.2%),other 24 (0.3%).

Table 7: Sanitation Practices

Characteristics	Frequency	Percentage
Types of toilet facilities (N=7714)		
Improved toilet	5461	70.8
Unimproved toilet	2253	29.2
Toilets facilities shared with others(N=7474)		
Yes	5776	77.3
No	1698	22.7
Stool disposal (N=7601)		
Put/rinsed toilet/latrine	5428	71.4
Used toilet/latrine	966	12.7
Put /rinsed into drain	615	8.1
Left in the open	296	3.9
Throw into garbage	178	2.3
Buried	94	1.2
Other	24	0.3

4.5. Bivariate analysis on diarrhoea and household characteristics

Factors associated to diarrhoea are summarized in table 8 below. Results show that education level of participants was associated ($p<0.001$) with diarrhoea; wealth index of children from poorest family, poorer family, and middle family were associated ($p<0.001$) with diarrhoea, and types of place of residence were positively associated ($p=0.010$) to diarrhoeal disease in dealing with children under five years old.

Table 8: Bivariate analysis between diarrhoea and household Characteristics.

Variables	Ever had diarrhoea			
	Had diarrhoea	No diarrhoea	Chi-square	p-Value
Household Characteristics				
Participants 'education level			14.315	< 0.001
Informal education	634(13.2%)	4180(86.8%)		
Formal education	271(10.2%)	2389(89.8%)		
Participants' occupation			4.156	0.125
Jobless	46 (9.2%)	452(90.8%)		
Paying Job	279(12.3%)	1988(87.7%)		
No paying Job	580(12.3%)	4177(87.7%)		
Households size			0.006	0.937
1-5members	549(12.1%)	3976(87.9%)		
More than 5members	356(12.1%)	2593(87.9%)		
Wealth index category			50.911	<0.001
Poorest	271(15.2%)	1509(84.8%)		
Poorer	226(14.4%)	1339(85.6%)		
Middle	162(11.4%)	1259(88.6%)		
Richer	130(10.2%)	1147(89.8%)		
Richest	116(8.1%)	1315(91.9%)		
Types of place of residence			6.610	0.010
Urban	168(10.3%)	1467(89.7%)		
Rural	737(12.6%)	5102(87.4%)		

p-Value <0.005 is significantly associated with childhood diarrhoea

4.6. Bivariate analysis on diarrhoea and children characteristics

Factors associated to diarrhea are summarized in table 9. Findings show that age of children in months (Chi-square: 132.73, p<0.001); received rotavirus vaccine 1, 2, and 3(Chi-square: 128.941, p<0.001) are significantly associated with diarrhoeal diseases.

Table 9: Bivariate analysis between diarrhoea and children under five years characteristics

Variables	Ever had diarrhea			
	Had diarrhea	**No diarrhea**	**Chi-square**	**p-Value**
Children under five Characteristics				
Age of children in months			132.73	<0.001
Less than six months	21(5.9%)	332(94.1%)		
Six to 24 months	265(21.5%)	967(78.5%)		
25-59 months	173(8.5%)	1857(91.5%)		
Gender			2.009	0.156
Male	476(12.6%)	3290(87.4%)		
Female	429(11.6%)	3279(88.4%)		
Received rotavirus vaccine 1, 2, and 3.			128.941	<0.001
Yes	692(15.9%)	3667(84.1%)		
No	175(6.6%)	2460(93.4%)		

p-Value <0.005 is significantly associated with childhood diarrhoea

4.7. Bivariate analysis on diarrhoea and water characteristics

Factors associated with diarrhea are presented in table 10 below. Results showed that the source of drinking water (Chi-square: 42.037, p<0.001) is strongly significant associated with diarrhoea in dealing with childhood diarrheal diseases.

Table 10: Bivariate analysis on diarrhoea and characteristics of water

Variables	Ever had diarrhea		Chi-square	p-Value
	Had diarrhea	No diarrhea		
Characteristics of Water				
Water source and water treatment				
Source of drinking water			42.037	<0.001
Improved source	608(11.7%)	4602(88.3%)		
Unimproved source	238(12.4)	1681(87.6%)		
Time taken to fetch water (minutes)			1.554	0.213
0-30 minutes	537(12.5%)	3752(82.5%)		
More than 30 minutes	368(11.6%)	2813(88.4%)		
Water usually treated by boiling			2.980	0.239
Yes	560(12.2%)	4026(87.8%)		
No	342(11.9%)	2536(88.1%)		
Water usually treated by chlorine			1.457	0.227
Yes	867(12.2%)	6248(87.8%)		
No	35(10.0%)	314(90.0%)		
Hand washing practices				
Water at hand washing place			1.368	0.242
Available	56(12.5%)	391(87.5%)		
Not available	52(10.1%)	461(89.9%)		
Place for washing hands			3.350	0.187
observed	109(11.2%)	861(88.8%)		
Not observed	794(12.2%)	5702(87.8%)		

4.8. Bivariate analysis on diarrhoea and sanitation facilities characteristics

Factors sanitation facilities associated with diarrhoea are presented in table 11below. The results showed that types of toilet facility (Chi-square: 21.947, p<.001); toilet facilities shared with other households (Chi-square: 6.118, p=.013); and stool disposal (Chi-square: 29.420, p<0.001) are significantly associated with diarrhoea in dealing with children under five years old.

Table 11: Bivariate analysis on diarrhoea and sanitation facilities

Variables	**Ever had diarrhea**			
	Had diarrhea	**No diarrhea**	**Chi-square**	**p-Value**
Sanitation characteristics				
Sanitation practices				
Types of toilet facilities			21.947	<0.001
Improved toilet facilities	569(64.3%)	316(35.7%)		
Unimproved toilet facilities	1818(85.2%)	4662(89.1%)		
Toilets facilities shared with others			6.118	0.013
Yes	215(13.4%)	1385(86.6%)		
No	618(11.2%)	4909(88.8)		
Stool disposal			29.420	<0.001
Put/rinsed toilet/latrine	81(8.6%)	863(91.4%)		
Used toilet/latrine	671(12.7%)	4603(87.3%)		
Put /rinsed into drain	59(9.9%)	534(90.1%)		
Left in the open	17(9.7%)	159(90.3%)		
Throw into garbage	20(22.0%)	71(78.0%)		
Buried	46(16.2%)	238(83.8%)		
Others	2(9.1%)	20(90.9%)		

P<0.005 is significant associated with childhood diarrhoeal disease.

4. 9. Multiple logistic regressions analysis of independent variables associated with diarrhea

To identify the risk factors associated with diarrhoea, the researcher conducted a multiple logistic regression analysis and results are summarized in table 12. The researcher found that some factors are significantly associated with diarrhea. According to the age of children, results showed that a child who was aged between 6 and 24 months were three times risk of having diarrhea (OR=2.942; CI= 2.392 - 3.617; p<0.001) compared to those with age ranged between 24-59 months.

For children under five who receive rotavirus vaccine 1,2, and 3; findings show a remarkable decrease of diarrhoea to those who received rotavirus vaccine 1, 2 and 3 (OR=0.377; CI= 0.317 - 0.448; p<0.001) compared to those who did not receive rotavirus vaccine 1, 2, and 3. The more children under five years were received rotavirus vaccine 1, 2, and 3 the more the risk of having diarrhoea decreased.

With regard to wealth index, the poorest household category was two times risk to develop diarrhoea (OR= 2.036; CI=1.618 - 2.562; p<.001) compared to richest families. The poorer households was two times risk to develop diarrhoea (OR: 1.913; CI: 1.510; 2.424; p<.001) compared to richest household, and the middle was one times likely to develop diarrhoea (OR=1.459; CI=1.135 - 1.874; p.003) compared to richest households. The children under five years from poor family are at high risk of developing diarrhoea compared to those from the richest family because the richest family had sufficient basic needs to build their body and promote healthy.

According to types of toilet facilities, results showed that the risk of developing diarrhoea was decreased among children who used improved toilet facilities (OR= 0.703; CI= 0.607 - 0.815; p<.001) compared to those who did not use it.

Table 12: Multivariate logistic regression analysis of risk factors associated with diarrhoea

Risk factors	OR	95% CI	p-Value
Age of children in months			
Above 24 months	1		
6-24 months	2.942	[2.392; 3.617]	<0.001
Vaccination			
Not received rotavirus vaccine	1		
Received rotavirus vaccine	0.377	[0.317; 0.448]	<0.001
Wealth index			
Richest	1		
Middle	1.459	[1.135; 1.874]	0.003
Poorer	1.913	[1.510**;** 2.424]	<0.001
Poorest	2.036	[1.618**;** 2.562]	<0.001
Type of toilet			
Unimproved toilet facilities	1		
Improved toilet facilities	0.703	[0.607; 0.815]	<0.001

p<0.005 is significantly associated with childhood diarrhoeal diseases of children under five years old.

p<0.001 is strongly significant associated with childhood diarrhoeal diseases.

Briefly, this chapter plays an important role because it describes the analysis, presents the findings, and interprets findings in understandable language. The researcher comes up with factors associated with diarrhoea among children under five years old.

CHAPTER 5: DISCUSSION OF RESEARCH FINDINGS

5.1. Introduction

The study provides detailed information on household, children characteristics; and water and sanitation practices that were interrelated with diarrhea disease of children under five year of age. The key findings from this study show also the factors significantly associated with diarrhea.

5.2. Prevalence of diarrhea among children under five years of age

The prevalence of diarrhoea found during a second data analysis was to be 12.1% equally the same with the prevalence reported by Rwanda demographic and health survey 2014-2015. The prevalence of diarrhoea among under five in Uganda was higher (22.5%) compared to those found in Rwanda. The study conducted in Burundi reported that the prevalence of diarrhoeal diseases in children under five was 32.6%. It was greater compared to those reported by current study through analysis of DHS 2014-2015 dataset. Diarrhoea prevalence in Tanzania was to be 32.7%. It was almost similar compared to those found in Burundi. It is higher than diarrhoea found in Rwanda. The occurrence of diarrhoeal diseases among under five years of age was positively associated with children aged between 6-24 months, household characteristics including practices related to types of toilets facilities, toilets facilities shared with others household, stool disposal, source of drinking water, rotavirus vaccine received young children, wealth index of household (extreme poverty and poverty), education level of household heads/caregivers. The high rate of childhood diarrhoea indicates needs more attention.

5.3. Households treated water

The current study determines the proportion of participants who treat water for drinking using any methods either by boiling and chlorine. It found that water boiled before drinking was to be 39.8% while the water treated by chlorine was to be 4.8%. The results presented in table 5, show that the greater proportion of participants drink unsafe water. The Uganda reported that water treated by boiling was found to be 39.8%, Zambia 15.2% while Tanzania was to be 49.5% while water treated by chlorine reported 17.1% in Latine America, and 24.0% in Mali. The study carried out in Tanzania reported that drinking unsafe water was linked with household's belief. They think that water was safer from source (Kamuhabwa, 2012 pp.49-50). Unsafe drinking water is linked with water-borne disease. Ingestion of unsafe water, lack of water was linked to

poor household and person hygiene (Pruss-Ustun, et al., 2010 p.1). The most water borne diseases caused the diarrhoea among children under five years old (WHO, 2011 p.2). Contrary, using treated water mothers can reduce 42% of diarrhoea morbidity to under five years children. In addition, good hygiene practices of mothers decreased morbidity from diarrhoeal disease to about 31% (Bhutta et al., p.1419).

5.4. Household hand washing practices

The current study determines the proportion of participants who wash their hands with water and soap or detergents. The study findings found that hand washing with water was to be 54.7% while those who wash their hands with soap or detergent had (54.1%) almost the same percentage. The proportions of participants who wash their hands with water were nearly equal compared with the proportion of participants who did not wash their hands with soap or detergent. The researcher did not know the reason behind. The study conducted in Nigeria showed that the risk of diarrhoea was higher among children of the mothers who did not wash their hand with soap before preparing food (Oloruntoba, Folarin and Ayede, 2014 p.1). Koolwal (2010 p.7) reported that access to water in the household has a positive effect on child health if mothers are more knowledgeable.

5.5. Household sanitation practices

This study determines the proportion of participants who use the improved toilet facilities (70.8%). It shows also the proportion of participants who rinse the toilet or latrines (71.4%) after using it. The high number of participants who was shared the toilet facilities with other households (77.3%). The study conducted in India reported that children's stool were managed unsafely at 79%. The researcher stated that unsafe disposed stool increase the risk of developing diarrhea among children under five years old (Bawankule, *et al.*, 2017 pp .1-7). The sanitation facilities are poorly managed. Excreta-related diseases, where sanitation was poorly managed contributed to contamination of food, water, and caused diarrhoea diseases especially to young children (WHO, 2009 p.6). According to Baker, et al., (2011 p.2) reported that the children from developing countries were frequently exposed to excreta contaminated food, water, human hands, and soils. This can result to diarrhoea infection in young children. Contrary, appropriate

sanitation practices among mothers reduced diarrhoea morbidity to almost 37% (Bhutta, et al., p.1419). The sanitation programmes focused on safe disposal of children's stool in Rwanda need to be improved through monitoring.

5.6. Risk factors associated with diarrhoea among children under five years old

5.6.1. Reason for association between child age and diarrhoea

Factor child aged between 6 to 24 months (OR= 2.942; CI=2.392 - 3.617; p<.001), show strong association with diarrhoea among children under five years old. This might happen due to transition from an exclusive breastfeeding to introduction of complementary food like solid food. Regarding the preparation of food, it was unsafe due to poor hygiene of mothers or care givers. Poor hand washing might be the source of food contamination. In this way, the child may ingest some microorganisms and result in diarrhoea (Mohammed and Tamiru, 2014 p.6). Also children considered as too young, they don't have adequate knowledge on hand washing with water and soap in order to prevent pathogens which may be source of diarrhoea. When they play on the bare floor with soil, they don't have capacity to stop the transfer of pathogens from their hands to mouths (Danquah *et al.*, 2015 p.350).

Also, the child is exposed to external environmental condition. For example, the child starts to crawl and to walk; this increases the risk of ingesting contaminated material like food and this favour the transfer of pathogens between hands and mouths, and results in diarrhoea.

Findings didn't find any association among children less than six and above 24 months because the children were limited to micro-organisms and they were exclusively on breastfeeding (Mohammed and Tamiru, 2014 p.6). This protection might be related to different mechanisms including mother antibodies which fight against enteric agents.

Some studies found that the lower prevalence of diarrhoea was found in youngest (less than six months) and oldest children (above 24 months) because the children acquired natural immunity (As *et al.*, 2013 p.381) whereas in this study, researcher does not find an association to children less than six and above twenty four months.

5.6.2. Reasons for association between wealth index and diarrhoea

The key findings show a significant association between the household wealth indexes (status) and diarrhea among children less than five years old. The households categorized as poorest were statistically and strongly significant association (p<.001) with diarrhea (table12). The risk was 2 times likely to develop diarrhoea (OR=2.036, CI=1.618 - 2.562; p<.001) compared to richest. Also, the poorer have 2 times risk (OR= 1.913; CI= 1.510 - 2.424; p<.001) of developing diarrhea compared to richest. This might happen because the children under five from poor family have a greater risk of developing diarrhea compared with children from richest family. The family categorized as middle, the results showed that there was a positive association with diarrhoea. The risk was one times likely to develop diarrhoea (OR= 1.459; CI= 1.135 - 1.874; p<.003) compared with richest.

According to Rwandan context, to be the poorest is failure to own a house and can hardly afford human basic needs while the poorer families was defined as those who have a shelter of their own or are able to rent one but rarely get full time jobs as broadly explained below (NISR, 2013/2014.p21).

The study conducted on Rwanda poverty assessment by World Bank, (2011 p.61) reported that poor families were largely unskilled. About 67% of households head were unskilled. There was a strong association between poverty and diarrhea because living in bad conditions, without incomes, with poor WASH might be linked with childhood diarrhoea. The poorer had less incomes compared to richest and 45% among households heads fall below the poverty line. Otherwise, the poorest and poorer head of households didn't have information on how diarrhoeal diseases can be transmitted and how it can be prevented. Also, the research conducted on integrated household living conditions survey in Rwanda (Nivers, 2014 p.21) found that among the Rwandan population, 39.1% were poorer while 16.3% were poorest (living in extreme poverty). To be poorest and poorer impact the level of family and person hygiene of vulnerable population (As *et al.*, 2013 p.381). Diarrhoea is the result of poor hygiene, poor sanitation, and unsafe water.

5.6.3. Reason of association between diarrhoea and received rotavirus vaccine 1, 2, and 3

The findings showed a significant association between diarrhoea and children received rotavirus vaccine 1, 2, and 3 (P<0.001). The risk of having diarrhoeal disease was decreased (OR=0.377; CI= 0.317 – 0.488; p<.001) compared with children who didn't receive rotavirus 1, 2, and 3. The research conducted in northern Ghana on acute childhood diarrhoea showed that rotavirus was among most causes of paediatric diarrhoea. It showed that the risk of having diarrhoea diseases was higher in children less than one year. In this study, rotavirus was present in more of half of participants (Manuscript, 2014 p.2).

The study conducted in Cameroon (North West and Far North Regions) reported that rotavirus was significantly associated with childhood diarrhoea. When the children increased age rotavirus infection decreased. This showed that rotavirus infection was higher in young children (Ndze *et al.*, 2012 p.7). The study conducted in Indonesia 2016 reported that the human breastfeed milk contains most important components like milk mucin which inhibit the binding and replication of rotavirus. So, children who exclusively breastfeed, the risk of having rotavirus infection decreased compared with children who didn't breastfeed nor receive rotavirus vaccine (Sulaksmana *et al.*, 2016 pp.118-123).

5.6.4. Reason of association between diarrhoea and water and sanitation practices

The results in table 12, showed that types of toilets facilities were associated with diarrhoea (p<.001). It means that the use of improved toilet facilities decreased the risk of having diarrhoea (OR= 0.703, CI=0.607- 0.815, p<0.001) compared with those who used unimproved toilet facilities. This showed that households who used improved toilet facilities lowered prevalence of diarrhoea among children under five years old while the households who used unimproved toilet facilities increased the risk of having diarrhoea.

The study conducted in Kampala-Uganda in urban slum settlement by Tumwebaze, et al (2014 p.1) reported that dirty shared toilet facilities created unsanitary conditions and the households who shared toilet facilities were at health risk factors because it increased the prevalence of diarrhoeal diseases among children under five years old while no-shared toilet facilities among households decreased the prevalence of diarrhoea at 10% (Fuller, et al., 2011 pp173-177).

The study conducted in Ethiopia on environmental factors associated with diarrhoea among under five years old children found the same results (Mohammed.et al., 2016 p.8). The households who used improved toilet facility were 70.8% while the households who used unimproved toilet facility were 29.2%. According to WHO (2014 p.22), improved toilet facilities decreased diarrhoeal morbidity to 32% and ensured hygiene separation of human excreta from human contact. Also, this decreased an open defecation from different field/floors and decreased the risk of having diarrhoeal diseases among children under five years old.

CHAPITER SIX: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1. Introduction

The chapter six covers the summary, conclusion and recommendations of the current study done. It shows the image of this study and describes some required interventions related to hygienic measures to be implemented by different authority levels.

6.2. Summary and Conclusion

In virtue of work, shifting paradigm considering as a solution to address the issue related to the prevalence of diarrhoeal diseases among children under five years old. The diarrhoeal diseases were still public health issue in Rwanda. The results showed that the prevalence of diarrhoeal diseases among children under five was 12.1%.

The proportion of the mothers or care givers of children under five years old that practice hygienic measures applied in the prevention of diarrheic diseases, the results showed that the improved source of drinking water was 73.0%, mothers who washed hands were 54.7%, mothers who washed hands with soap were 54.1%, the use of improved toilet facilities was 70.8%. Some malpractices need to be improved include: water should be always treated by boiling method or by chlorine in order to limit contamination from contaminated water through fecal-oral transmission. The results showed that the high proportion of households used water not usually treated by boiling methods (60.2%) and water usually no treated by chlorine (95.2%). These malpractices impaired the level of prevention of diarrheic diseases among children under five and globally increase the prevalence of diarrhoea disease.

About risk factors associated with diarrheic diseases among under five years old. In multiple logistic regression analysis table 12, results showed that the age of children ranged between 6-24 months was significantly associated (OR: 2.942; [2.392-3.617]; $p<0.001$) with diarrhoeal diseases. Those children in this age group were at high risk of developing diarrhoea compared to others who were above 24 months of age. Also, children who received rotavirus vaccine 1, 2, and 3 were strongly significant associated (OR: 0.377; [0.317-0.448]; $p<0.001$) with diarrhoeal diseases. This decreased the risk of developing diarrhoea among children under five years old. During the process of analysis, the researcher found that wealth index category includes poorest, poorer, and middle families were significantly associated with diarrhoeal disease in dealing with

children under five years old. To be poorest family increased the risk health of developing diarrhoea two times (OR: 2.036; [1.618-2.562]; p<0.001) compared to be richest family. Also, to be poorer household tends to increase the risk two times (OR: 1.913; [1.510-2.424]; p<0.001) of having diarrhoeal diseases in dealing with children under five years old. To be the middle family/household was also significantly associated with diarrhoeal diseases in dealing with children under five years old. The risk of having diarrhoea was likely to increase one times (OR: 1.459; [1.135-1.874]; p<0.003) compared to be richest family. Briefly, those poorest, poorer families were condition characterized by severe deprivation of basic human needs including lack of foods, drinking unsafe water, lack of sanitation facilities, lack of health insurance, lack of housing, lack of basic information, not follow formal education, and lack of means of supplies (NISR, 2014 p.21). Those children under five years old from vulnerable populations were at high risk of having diarrhoeal diseases

However, some barriers related to water and sanitation malpractices need to be improved through continuous training and regular refresher courses to mothers/care givers as required. This requires supply of improved water and sanitation to vulnerable households in order to reduce diarrhoea prevalence and achieve SDGs targets especially end of poverty for all, ensure healthy and well-being for all at all ages, ensure available and sustainable management of water and sanitation for all.

6.3. Recommendations

Recommendations addressed to Ministry of Health (MoH):

- During survey, the researchers did not explore the causes of diarrheal diseases and their impacts among children under five years. This needed to be studied in future research in order to update data on determinants of diarrhea diseases.
- Organize continuous training and regular refresher courses which facilitate mother to gain knowledge on mode of transmission and prevention measures of diarrheic diseases.

Recommendations addressed to Ministry of Infrastructure:

- Supply of improved water sources to vulnerable households should be ensured in order to decrease the prevalence of diarrhoeal disease among children under five years old.

Recommendations to Community Health Workers and Nurses:

- Encourage mothers to wash their hands with water and soap before doing anything, before feeding the child, after going to the toilet/latrine,
- Encourage household members to defecate in the toilets rather than outside as it is known to some household members (contaminate the environment),
- Encourage household members to use improved water source and treated by chlorine or boiling water.
- Encourage mothers/care givers to use improved sanitation facilities for the safety of their children.
- Encourage household heads to vaccinate their children as a way of prevention of diarrheic infections to their children (rotavirus infection)

REFERENCES

Access, O. (2010) 'Water Microbiology . Bacterial Pathogens and Water', pp. 3657–3703. doi: 10.3390/ijerph7103657.

Agustina, R., Sari, T. P., Satroamidjojo, S., Bovee-oudenhoven, I. M. J., Feskens, E. J. M. and Kok, F. J. (2013) 'Association of food-hygiene practices and diarrhea prevalence among Indonesian young children from low socioeconomic urban areas', *BMC Public Health*. BMC Public Health, 13(1), p. 1. doi: 10.1186/1471-2458-13-977.

Ansari, S., Sherchand, J. B., Parajuli, K., Paudyal, B. M., Tandukar, S., Khadka, R., Shreshta, R., Baral, S. K. and Pokhrel, B. M. (2012) 'Pattern of Acute Parasitic Diarrhea in Children under Five Years of Age in Kathmandu , Nepal', 2012(September), pp. 95–100.

Bado, A. R., Susuman, A. S. and Nebie, E. I. (2016) 'Trends and risk factors for childhood diarrhea in sub-Saharan countries (1990 2013): assessing the neighborhood inequalities', 1(1990 2013) p. 4.

Bain, R., Cronk, R., Wright, J., Yang, H., Slaymaker, T. and Bartram, J. (2015) 'Fecal Contamination of Drinking-Water in Low- and Middle-Income Countries : A Systematic Review and', 11(5), pp. 1–23. doi: 10.1371/journal.pmed.1001644.

Bbaale, E. (2011) 'Determinants of diarrhoea and acute respiratory infection among under-fives in uganda', *Australasian Medical Journal*, 4(7), pp. 400–409. doi: 10.4066/AMJ.2011.723.

Bhutta, Z.A., Das, J.K., Walker, N., Rizvi, A., Campbell, H., Rudan, I. and Black, R.E., 2013. Interventions to address deaths from childhood pneumonia and diarrhoea equitably: what works and at what cost? *The Lancet*, *381*(9875), pp.1417-1429.

Bodzeway, F. E. (2014) 'Biosafety & Health Education Prevalence of Water Borne Diseases within Households in the Bamendankwe', 2(3). doi: 10.4172/2332-0893.1000122.

Bonkoungou, I. J. O., Haukka, K., Österblad, M., Hakanen, A. J., Traoré, A. S., Barro, N. and Siitonen, A. (2013) 'Bacterial and viral etiology of childhood diarrhea in Ouagadougou , Burkina Faso'. BMC Pediatrics, pp. 2–7.

Bygbjerg, I.C., 2012. Double burden of non-communicable and infectious diseases in developing countries. *Science, 337*(6101), pp.1499-1501.

Cajacob, N. J. and Cohen, M. B. (2017) 'Update on Diarrhea', 37(8).

CDC.(2012) 'Diarrhea : Common Illness , Global Killer', pp. 1–4. Retrieved from: https://www.cdc.gov/healthywater/pdf/global/programs/globaldiarrhea508c.pdf

Chola, L., Michalow, J., Tugendhaft, A. and Hofman, K. (2015) 'Reducing diarrhoea deaths in South Africa : costs and effects of scaling up essential interventions to prevent and treat diarrhoea in under-five children', p.1 doi: 10.1186/s12889-015-1689-2.

Costs, T. (2015) 'Country Context', *World bank*, (Nutrition at a Glance), p. 2.

Danquah, L., Mensah, C. M., Agyemang, S. and Awuah, E. (2015) 'Risk Factors Associated with Diarrhea Morbidity Among Children Younger than Five Years in the Atwima Nwabiagya District , Ghana : A Cross-Sectional Study', 3(3), pp. 344–352. doi: 10.11648/j.sjph.20150303.17.

Denno, D. M., Shaikh, N., Stapp, J. R., Qin, X., Hutter, C. M., Hoffman, V., Mooney, J. C., Wood, K. M., Stevens, H. J., Jones, R., Tarr, P. I. and Klein, E. J. (2012) 'Diarrhea Etiology in a Pediatric Emergency Department : A Case Control Study', 55, pp. 897–904. doi: 10.1093/cid/cis553.

Diouf, K., Tabatabai, P., Rudolph, J. and Marx, M. (2014) 'behavioural factors at the household level', 1, pp. 1–9.

Duru, E. E., Agbagwa, O. E. and Umoren, F. E. (2014) 'Bacterial Agents Associated With Infantile Diarrhea and Their Antibiotics Susceptibility Pattern in Port Harcourt , South- South , Nigeria', 3(1), pp. 1–12.

Ejemot-Nwadiaro, R. I., Ehiri, J. E., Arikpo, D., Meremikwu, M. M. and Critchley, J. A. (2015) 'Hand washing promotion for preventing diarrhoea.', *The Cochrane database of systematic reviews*, (9), p. CD004265. doi: 10.1002/14651858.CD004265.pub3.

Ekane, N., Kjellén, M., Noel, S. and Fogde, M. (2012) 'Sanitation and Hygiene : Policy , Stated Beliefs and Actual Practice A Case Study in the Burera District , Rwanda'.

Farthing, M., Salam, M.A., Lindberg, G., Dite, P., Khalif, I., Salazar-Lindo, E., Ramakrishna, B.S., Goh, K.L., Thomson, A., Khan, A.G. and Krabshuis, J., 2013. Acute diarrhea in adults and children: a global perspective. Journal of clinical gastroenterology, 47(1), pp.12-20.

Ferdous, F., Das, S. K., Ahmed, S., Farzana, F. D., Latham, J. R., Chisti, M. J., Ud-Din, A. I. M. S., Azmi, I. J., Talukder, K. A. and Faruque, A. S. G. (2013) 'Severity of diarrhea and malnutrition among under five-year-old children in rural Bangladesh', *American Journal of Tropical Medicine and Hygiene*, 89(2), pp. 223–228. doi: 10.4269/ajtmh.12-0743.

Freeman, M. C., Stocks, M. E., Cumming, O., Jeandron, A., Higgins, J. P. T., Bonjour, S., Hunter, P. R., Fewtrell, L., Wolf, J., Pr, A. and Curtis, V. (2014) 'Systematic Review Hygiene and health : systematic review of handwashing practices worldwide and update of health effects', 19(8), pp. 906–916. doi: 10.1111/tmi.12339.

Gebru, T., Taha, M. and Kassahun, W. (2014) 'Risk factors of diarrhoeal disease in under-five children among health extension model and non-model families in Sheko district rural community , Southwest Ethiopia : comparative cross-sectional study', pp. 1–6.

George, C. M., Perin, J., Calani, K. J. N. De, Norman, W. R., Perry, H., Jr, T. P. D. and Lindquist, E. D. (2014) 'Risk Factors for Diarrhea in Children under Five Years of Age Residing in Peri-urban Communities in Cochabamba , Bolivia', 91(6), pp. 1190–1196. doi: 10.4269/ajtmh.14-0057.

Grimwood, K. and Chb, M. B. (2009) 'A c u t e an d P e r s i s t e n t Diarrhea', *Pediatric Clinics of NA*. Elsevier Ltd, 56(6), pp. 1343–1361. doi: 10.1016/j.pcl.2009.09.004.

Hameeteman, E. (2013) 'Future Water (In) security : Facts , Figures , and Predictions Future Water (In) Security : Facts , Figures , and Predictions'.

Hatz, C.F., Bally, B., Rohrer, S., Steffen, R., Kramme, S., Siegrist, C.A., Wacker, M., Alaimo, C. and Fonck, V.G., 2015. Safety and immunogenicity of a candidate bioconjugate vaccine against Shigella dysenteriae type 1 administered to healthy adults: A single blind, partially randomized Phase I study. *Vaccine*, *33*(36), pp.4594-4601.

Haver, J., Brieger, W., Zoungrana, J., Ansari, N. and Kagoma, J. (2015) 'Experiences engaging community health workers to provide maternal and newborn health services: Implementation of four programs', *International Journal of Gynecology and Obstetrics*. Elsevier B.V., 130(S2), pp. S32–S39. doi: 10.1016/j.ijgo.2015.03.006.

Hospital, D. (2013) 'Characterization and factors associated with diarrhoeal diseases caused by enteric bacterial pathogens among children aged five years and below attending Igembe District Hospital, Kenya', 8688, pp. 1–8. doi: 10.11604/pamj.2013.16.37.2947.

Jahan, S. (2011) 'Epidemiology of Foodborne Illness', 1.

Kamuhabwa Kakulu Remedius (2012) 'Ga : 1', Diarrhea among under five children and household water treatement, pp. 49–50.

Krumkamp, R., Sarpong, N., Schwarz, N. G. and Adelkofer, J. (2015) 'Gastrointestinal Infections and Diarrheal Disease in Ghanaian Infants and Children : An Outpatient Case-Control Study', pp. 1–14. doi: 10.1371/journal.pntd.0003568.

Lamberti, L. M., Walker, C. L. F. and Black, R. E. (2012) 'Systematic review of diarrhea duration and severity in children and adults in low- and middle-income countries', BMC Public Health. BioMed Central Ltd, 12(1), p. 276. doi: 10.1186/1471-2458-12-276.

Lassi, Z. S., Mallick, D., Das, J. K., Mal, L., Salam, R. A. and Bhutta, Z. A. (2014) 'Essential interventions for child health', 11(Suppl 1), pp. 1–12.

Lindberg, G., Dite, P., Republic, C. and Khalif, I. (2013) 'Acute Diarrhea in Adults and Children A Global Perspective', 47(1), pp. 12–20.

Löfgren, J., Tao, W., Elin, L., Kyakulaga, F. and Forsberg, B. C. (2012) 'Treatment patterns of childhood diarrhoea in rural uganda: a cross-sectional survey', BMC International Health and Human Rights, 12, p. 19. doi: 10.1186/1472-698X-12-19.

Long, J. and Hart, P. (2012) 'Definition of Design', p. 5.

Manuscript, A. (2014) 'NIH Public Access', 30(1), pp. 25–33. doi: 10.1097/MOG.0000000000000022.Epidemiology.

Mashoto, K. O., Malebo, H. M., Msisiri, E. and Peter, E. (2014) 'Prevalence , one week incidence and knowledge on causes of diarrhea : household survey of under-fives and adults in Mkuranga district , Tanzania', pp. 1–8.

Mengistie, B., Berhane, Y. and Worku, A. (2013) 'Prevalence of diarrhea and associated risk factors among children under-five years of age in Eastern Ethiopia : A cross-sectional study', 3(7), pp. 446–453.

Mohammed, S. and Tamiru, D. (2014) ‘The Burden of Diarrheal Diseases among Children under Five Years of Age in Arba Minch District , Southern Ethiopia , and Associated Risk Factors : A Cross-Sectional Study’, 2014.

Montgomery, M. a and Elimelech, M. (2007) ‘Water and sanitation in developing countries: including health in the equation.’, Environmental science & technology, 41(1), pp. 17–24. doi: 10.1021/es072435t.

Mukabutera, A., Thomson, D., Murray, M., Basinga, P., Nyirazinyoye, L., Atwood, S., Savage, K. P., Ngirimana, A., Hedt-Gauthier, B. L., Hashizume, M., Armstrong, B., Hajat, S., Wagatsuma, Y., Faruque, A., Hayashi, T., Prüss-üstün, A., Kay, D., Fewtrell, L., Bartram, J., Dwight, R., Baker, D., Semenza, J., Olson, B., Huang, J., Dool, H. and Georgarakos, K. (2016) ‘Rainfall variation and child health: effect of rainfall on diarrhea among under 5 children in Rwanda, 2010’, BMC Public Health. BMC Public Health, 16(1), p. 731. doi: 10.1186/s12889-016-3435-9.

Murray, C. J. L., Vos, T., Lozano, R., Naghavi, M., Flaxman, A. D., Michaud, C., Ezzati, M., Shibuya, K., (2012) ‘Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990GÇô2010: a systematic analysis for the Global Burden of Disease Study 2010’, The Lancet, 380(9859), pp. 2197–2223. doi: 10.1016/S0140-6736(12)61689-4\rS0140-6736(12)61689-4 [pii].

Mwenda, J. M., Mihigo, R., Tevi-benissan, C. and Mumba, M. (2008) ‘Rotavirus disease burden in Africa and the need to accelerate introduction of vaccines’, (19), pp. 5–7.

Nadu, T. (2011) ‘Chronic and Persistent Diarrhea in Infants and Young Children: Status Statement’.

Ndze, V. N., Akum, A. E., Kamga, G. H., Enjema, L. E., Esona, M. D., Abena, O. and Therese, M. (2012) ‘Open Access’, 8688, pp. 1–7.

Ngabo, F., Mvundura, M., Gazley, L., Gatera, M., Rugambwa, C., Kayonga, E., Tuyishime, Y., Niyibaho, J., Mwenda, J. M., Donnen, P., Lepage, P., Binagwaho, A. and Atherly, D. (2016) 'The Economic Burden Attributable to a Child ' s Inpatient Admission for Diarrheal Disease in Rwanda', pp. 1–16. doi: 10.1371/journal.pone.0149805.

Ngabo, F., Tate, J. E., Gatera, M., Rugambwa, C., Donnen, P., Lepage, P., Mwenda, J. M., Binagwaho, A. and Parashar, U. D. (2016) 'Effect of pentavalent rotavirus vaccine introduction on hospital admissions for diarrhoea and rotavirus in children in Rwanda: A time-series analysis', The Lancet Global Health. World Health Organization, 4(2), pp. e129–e136. doi: 10.1016/S2214-109X(15)00270-3.

Ngure, F. M., Reid, B. M., Humphrey, J. H., Mbuya, M. N., Pelto, G. and Stoltzfus, R. J. (2014) 'Water, sanitation, and hygiene (WASH), environmental enteropathy, nutrition, and early child development: Making the links', Annals of the New York Academy of Sciences, 1308(1), pp. 118–128. doi: 10.1111/nyas.12330.

Nguyen, T. V., Van, P. Le, Huy, C. Le and Weintraub, A. (2005) 'Diarrhea caused by enterotoxigenic Bacteroides fragilis in children less than 5 years of age in Hanoi, Vietnam', Anaerobe, 11(1–2), pp. 109–114. doi: 10.1016/j.anaerobe.2004.10.004.

NISR (2010) 'Rwanda Demographyic and Health Survey', National Institute of Statistics.
NISR (2014) Rwanda h m e National Institute of Statistics of Rwanda - Youth - a i t e c o p t r National Institute of Statistics of Rwanda Thematic report.

NISR (2015) 'Rwanda Demographic and Health Survey 2014-15', National Institute of Statistics Rwanda. Rockville, Maryland: National Institute of statistics.

Nivers, A. N. (2014a) 'Rwanda Poverty Pro le Report Results of Integrated Household Living Conditions Survey [EICV] National Institute of Statistics of Rwanda National Institute of Statistics of Rwanda Rwanda Poverty Pro ile Report Integrated Household Living Conditions Sur', p. 21.

Oloruntoba, E. O., Folarin, T. B. and Ayede, A. I. (2014) 'Hygiene and sanitation risk factors of diarrhoeal disease among under-five children in Ibadan , Nigeria', 14(4), p. 1.

Olweus, D. (1989) 'Prevalence and Incidence in the Study of Antisocial Behavior: Definitions and Measurements', NATO ASI, 50, pp. 187–201.

Organization., W. H., Diseases., N. and Cluster., M. H. (2003) 'The SuRF Report 1: Surveillance of Risk Factors Related to Noncommunicable Diseases: Current Status of Global Data'.

Publishing, I. W. A. (2012) 'A community-based approach to promote household water treatment in Rwanda Slavea Chankova , Laurel Hatt and Sabine Musange', pp. 116–129. doi: 10.2166/wh.2012.071.

Rah, J. H., Cronin, A. A., Badgaiyan, B., Aguayo, V. M., Coates, S. and Ahmed, S. (2015) 'Household sanitation and personal hygiene practices are associated with child stunting in rural India : a cross-sectional analysis of surveys'. doi: 10.1136/bmjopen-2014-005180.

Rajeshwari, K., Mishra, M., Dubey, A. P., Uppal, B. and Anuradha, S. (2013) 'Spectrum of dysentery in children presenting to a tertiary level teaching hospital in New Delhi', 5(April), pp. 158–162. doi: 10.5897/IJMMS11.117.

Roma, E. and Pugh, I. (2012) 'IN COLLABORATION WITH DOMESTOS', journal, p. 2.

Sarker, A. R., Sultana, M., Mahumud, R. A., Sheikh, N., Meer, R. Van Der and Morton, A. (2016) 'Prevalence and Health Care – Seeking Behavior for Childhood Diarrheal Disease in Bangladesh'. doi: 10.1177/2333794X16680901.

Services, H. (2015) 'Diarrhea : Common Illness , Global Killer', pp. 1–4.

Statisticsbooklet, H. (2013) 'Rwanda Annual Health StatisticsBooklet'.

Stewart CP, Lannotti L, Dewey KG, M. K. & O. A. (2013) 'Childhood Stunting : Context , Causes and Consequences WHO Conceptual framework', Maternal and Chind Nutrition, 9(September), pp. 27–45.

Sulaksmana, W., Parwata, S., Sukardi, W., Wahab, A. and Soenarto, Y. (2016) 'Paediatrica Indonesiana', 56(2), pp. 118–123.

Survey, A. C., Walker, C. L. F., Taneja, S., Lefevre, A. and Black, R. E. (2015) 'Appropriate Management of Acute Diarrhea in Children Among Public and Private Providers in Gujarat , India ':, Global Health: Science and Practice, 3(2), pp. 230–241.

Tambe, A. B., Nzefa, L. D. and Nicoline, N. A. (2015) 'Childhood Diarrhea Determinants in Sub-Saharan Africa: A Cross Sectional Study of Tiko-Cameroon', pp. 229–243. doi: 10.3390/challe6020229.

Tate, J. E., Burton, A. H., Boschi-pinto, C., Parashar, U. D., Health, W., Coordinated, O. and Rotavirus, G. (2016) 'Global , Regional , and National Estimates of Rotavirus Mortality in Children < 5 Years of Age , 2000 – 2013', 62(Suppl 2). doi: 10.1093/cid/civ1013.

Turnbull, J. L., Adams, H. N. and Gorard, D. A. (2014) 'Alimentary Pharmacology and Therapeutics Review article : the diagnosis and management of food allergy and food intolerances'. doi: 10.1111/apt.12984.

Vakili, R., Moghadam, Z. E., Khademi, G. and Vakili, S. (2015) 'Child Mortality at Different World Regions : A Comparison Review', 3(20), pp. 809–816.

Walker C, Rudan I, Liu L, Nair H, Theodoratou E, B. and ZA (2013) 'Global burden of childhood pneumonia and diarrhoea', The Lancet, 381(9875), pp. 1405–16.

WHO (2014) 'Preventing diarrhoea through better water, sanitation and hygiene', journal, pp. 4–12.

WHO (2015) ‘Definitions of Indicators’, pp. 4–7.

WHO/UNICEF (2014) ‘Drinking water 21’, pp. 21–32.

Woods, T. A. (1990) ‘Diarrhea’, CLinical Methods: The history, Physical, and LAboratory Examinations, pp. 457–460.

Zella, G. C. and Israel, E. J. (2017) ‘Chronic Diarrhea in Children’, 33(5).

ANNEX