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ASSOCIATION OF SOCIODEMOGRAPHIC FACTORS WITH DIARRHEA IN CHILDREN UNDER 5 YEARS IN RWANDA

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ASSOCIATION OF SOCIODEMOGRAPHIC FACTORS WITH DIARRHEA IN CHILDREN LESS THAN 5 YEAR IN RWANDA

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DECLARATION

I**, UMUHOZACLAUDINE** i hereby declare that this work entitled **"ASSOCIATION OF SOCIODEMOGRAPHIC FACTORS AND DIARRHEA IN CHILDREN UNDER 5 YEAR IN RWANDA"** is my own work".

Claudine Umuhoza

Date 2019 /09/02

DEDICATION

To my parents, my sisters and brothers and, my friends and my lovely supporting friend

N.H.L.F

To almighty God

I dedicate this work

ACKNOWLEDGEMENT

My special thanks go to Professor **Tai-Soon Yong**, who despite many engagements, accepted to supervise me this work. My thanks are also highly addressed to Dr Eun-Min Kim, my family and my classmates for their support and encouragement during my stay at Yonsei university,

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LIST OF ABBREVIATIONS

WHO	World Health Organization
IHM	Institute for Health Metric
ORS	Oral Rehydration Solution
HIV	Human Immunodeficiency Virus
DHS	Demographic Health Survey
RDHS	Rwanda demographic health survey
OR	Odds ratio
CI	Confidence interval
AIDS	Acquired immunodeficiency syndrome
SPSS	Statistical package for social sciences

ABSTRACT

Background: Diarrheal disease is the second leading cause of mortality and morbidity in children under 5 years worldwide and the most common cause of malnutrition in sub-Saharan Africa. In Rwanda, diarrheal is the third cause of death in children under 5 years.

Methods: This study was a cross-sectional descriptive secondary data analysis of the RDHS (2014-2015), examining the association of socio-demographic factors with diarrhea in children under 5 years. This study analyzed 7856 households. a descriptive statistic, bivariate analysis was done using Pearson's Chi-square analysis and multivariate analysis and binary logistic analysis for finding the associations of variables with diarrhea and the p-value <0.05 was significant.

Results: The overall prevalence of diarrhea was 12.1% in children under 5 years, the rotavirus coverage was 62% and no difference in developing diarrhea between males and females found. Diarrhea was increased with child age 11-23 months [OR=4.415,95%CI (3.047-6.687)]. Low economic status found to increase diarrhea, where the poorer family were at high risk of developing diarrhea compare to children from the richest [OR=1.64,95%CI (1.196-2.249)]. The children from the western province were found at high risk [OR=1.439,95% CI (1.032-2.007)], No education of the mother increased risk of diarrhea [OR=5.163,95%CI (1.163-22.924)], and agricultural activities increased the risk [OR:1.624,95% CI (1.003-2.629)]. Association of knowledge of ORS with mother age, province of origin, living in urban area were found and no association found with mother education status.

Conclusions: Sociodemographic factors affects significantly the risk of developing diarrhea in children under 5 years and the mother knowledge for ORS. Designing and implementing health education, awareness of simple early interventions are essential tools in the Rwandan community. further study for attitudes, knowledge and practices of caregivers towards children with diarrhea is needed.

Keywords: Rwanda, Diarrhea, less than 5 years, children

CHAPTER 1
INTRODUCTION

1.1. Background

Diarrheal disease is the second leading cause of morbidity and mortality in children under five years worldwide and according to WHO report around 1.7 billion of the diarrheal case in children are reported every year and 525000 children death (WHO, 2017a). Mainly diarrheal diseases are caused by contaminated food and lack of clean water. Around the world 780 million people live without clean water and about 2.5 million of people are living in an environment with poor sanitation and most of them are from developing countries mostly South-Asia and sub-Saharan Africa where the majority of children are experiencing at least 3 episodes of diarrhea every year (CDC, 2019)

Since the beginning of measuring the global burden disease in 1990, diarrhea has been reported among the top ten killer global and the recent global burden of disease report of 2017 diarrhea was at 5 places (Murray et al., 2012). According to a study published in 2016 it showed that the burden of diarrhea is still challenging and causing death for both adults over 70 years in children under 5 years(Collaborators, 2018). since 2000 in developing countries only 39% of children receive adequate treatment for diarrhea (WHO, 2017b).

In Africa according to IHM measurement in 2015 reported that 330,000 childhood death was due to diarrhea and the cases of severe diarrhea reported were 30 million and diarrhea is causing the high number of malnutrition in Africa (Munyamaharo, 2017).
In Rwanda, diarrheal disease is ranked as the third cause of mortality in children under 5 years with 18.3% of childhood deaths in 2015(Analysis, 2017). The diarrheal diseases increase the economic burden to the country and family as shown in a study done in Rwanda where the disease burden was one hundred and one dollars and 65% were borne by the family and for poor families the price is 110% compare to the family incomes even

if 93% of the general population are covered by health insurance(Ngabo, Mvundura, et al., 2016).

According to sustainable development goal more than five million children still die before their fifth birthday each year and the children from poor family are vulnerable more than twice compare to children from rich family as those family are not able to live in proper environment with clean water and good sanitation with the target to reduce that preventable child and newborn mortality.

To be able to achieve the sustainable development goals with the target to decrease mortality rate to 12/1000 live births for children under 5 years (U.Nations 2015), it is critical for policy makers, public health experts and clinicians to understand the sociodemographic factors for diarrheal disease in Rwanda, a cluster study done in Rwanda 2013-2014 showed that 59% of child death happen at home(Roder-DeWan et al., 2019),a study done in Rwanda showed that the risk factors of diarrhea in children under 5 years were lack of clean water, inadequate hygiene and sanitation(Hbatu, Nsabimana, & Mureithi, 2017) and there is a need to increase community awareness for prevention measures of diarrhea and homemade simple treatment another to continue decrease the morbidity and mortality in children less than 5 years. The purpose of this study was to assess the sociodemographic factors of diarrhea in Rwandan community.

1.2. Objectives

To determine the sociodemographic factors associated with diarrheal diseases in children under the age of five in rural and urban communities in Rwanda.

Specific obejctives

a. To describe relationship between sociodemographic factors and diarrhea in children under 5 years in Rwanda

b. To determine the associations sociodemographic factors knowledge on ORS package

c. To determine the impacts of coverage of rotavirus vaccination on diarrhea among children under 5 years

CHAPTER 2
LITERATURE REVIEW

2.1. Brief history

Diarrhea is a global public health problem since many two decades is still the second leading cause of death in children under 5 years and WHO in 2018 estimated that around 6.2 million children who was under 15 years died because of diarrhea and among them 5.3 million died within the first 5 years of life(WHO, 2018).

Diarrheal disease has been accounting 1 in 9 child deaths since 1990 worldwide and many efforts have been put in place to reduce the under 5 years mortality from 12.6million in 1990 to 5.4 million in 2017 despite those efforts 1 children in 13 children still die before sees his or her fifth birthday and diarrhea is still among the top killer for the past 30 years and the majority of those case are reported from developing country with limited resources and lack of enough healthcare personnel(Department of Child and Adolescent Health and Development, 2005)(GBD 2016 diarrheal diseases Collaborators 2018).

In children with HIV, diarrhea is more severe and deadly compare to other children without other comorbidities and the mortality rate for children with HIV is 11 times higher than the rate for children without HIV and diarrhea is killing more children than HIV, measles and malaria combined global (CDC, 2012).

Among the top ten diseases which kills children under 5 years half of them are preventable and treatable with simple and cheap interventions and a strong primary healthcare can help the accessibility for those interventions to all children and many lives can be saved. Children with Malnutrition especially those with severe acute malnutrition, have a higher risk of death from common childhood illness such as diarrhea, pneumonia, and malaria and many children in developing countries are facing malnutrition(Africa, Goal, Africa, Asia,

& Africa, 2018). The global mortality of diarrhea disease in children have decreased but the incidence is still the same.

The prevention of diarrhea disease in children require vaccinations against rotavirus and exclusive breastfeeding before 6 months and continue up to 2 years, and use of safe water, quality hygiene and sanitation which still difficult in developing countries but cost effective: every $1 invested yields in safe water, hygiene and sanitation an average return of $25.50 and simple and inexpensive interventions to prevent and treat diarrhea can save the lives of children around the world(CDC, 2012).

2.2. Diarrheal disease situation in Rwanda

In Rwanda, Diarrhea in children is the third cause of morbidity and mortality, according to the report of National Institute of Statistics of Rwanda in 2015, the prevalence of children under 5 years with diarrhea was 12% and this number was higher when compared with other infectious diseases like acute respiratory infections and among the most risk factors 27 percent of households use unimproved sources of water, which are considered unhealthy and 14 percent of households use an unprotected spring as a water source, which increases household members' risk of contracting diarrhea and other waterborne diseases ((Ministry of Health , 2016). In 2012, Rwanda has become the first low-income country to introduce pentavalent rotavirus vaccine in the routine national immunization program and in 2014 the potential benefits for the vaccine were obvious in Rwanda where they were a decrease of 48-49 case of acute gastroenteritis in pediatrics patient(Ngabo,Tate,etal.,2016).

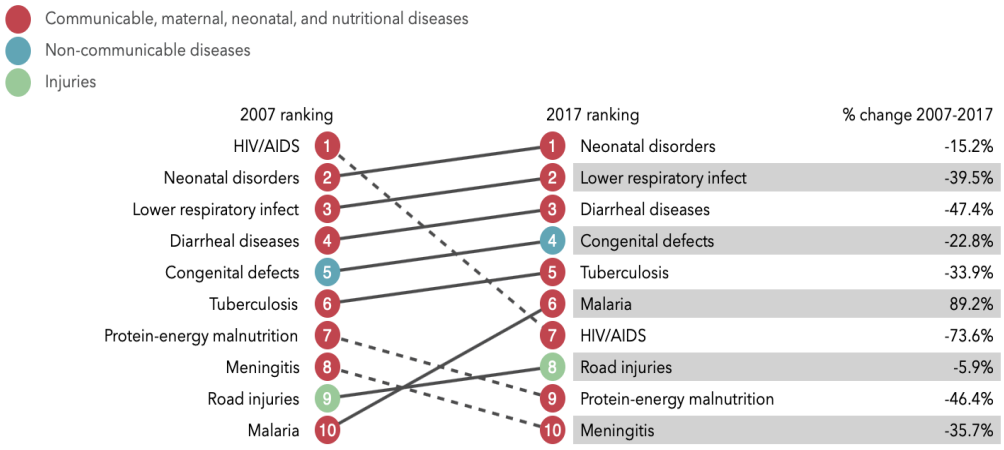

Figure 1: The top ten cause of premature death in Rwanda

Source: http://www.healthdata.org/rwanda

2.3. Clinical situation of diarrheal disease

Definition of diarrheal disease

Diarrheal is the word from Greek dictionary means dia 'through 'and rhien known as 'flow' and diarrhea is defined as the passage of abnormal stool in frequency and consistency, which can be liquid or loose and diarrhea in children under 5 years is defined as the passage of loose or watery stool three or more times per day(WHO, 2017a).

Classification and etiology factor of diarrheal disease

A. Classification according to disease condition

- Mild diarrhea: few diarrheas in frequency and quantity of stool passed by day or few symptoms of diarrhea
- Moderate diarrhea: moderate symptoms of diarrhea but no more than 10 episodes of diarrhea per day
- Severe diarrhea: more than 10 episodes of diarrhea per day.

B. Classification according to disease course

Acute diarrhea

Acute diarrhea is one of the most commonly reported disease in children in developed and developing country in children(WHO, 2017a). As the children is too young, the more the great risk of severe dehydration regardless the cause of diarrhea. The acute diarrhea is a diarrhea characterized by a sudden onset of the disease and can last several hours or days (up 7 to 10 days) and not more than 14 days and it includes the most dangerous type of diarrhea called cholera(Koletzko & Osterrieder, 2009). Mostly acute diarrhea occurs in children until they reach 5 years.

The acute diarrhea causes are considered by 2 phenomena:

- The first is due to gastrointestinal system development according to age because the intestinal mucosa in children is permeable to fluid and electrolyte as the children is younger the impact of diarrhea is more severe with much fluid loss

caused by increased luminal osmolarity and around 80% of fluid absorption in children occur in small bowel.

- The second is based on the 4 principal pathophysiological processes that can contribute individually or collectively to diarrhea disease and those different processes cause different types of diarrhea with varying fluid and electrolyte losses that have significant implications for management(Binder, 1990) (Whyte & Jenkins, 2012)

Chronic diarrhea

Chronic diarrhea is defined as passage of loose stool for at least 4 weeks.

The main cause of chronic diarrhea in divided in 4 pathophysiology processes below:

- **Osmotic diarrhea** results from a failure to absorb a luminal solute in the gastrointestinal tract, as with lactose intolerance and cause the secretion of fluids and net water retention across an osmotic gradient most the time this disorder is either from congenital or acquired disease, lactose is not absorbed but other carbohydrate can be absorbed.
- **Secretory diarrhea** results from substances (e.g., bacterial toxins) that increase secretion of electrolyte and water into the intestinal lumen without compensatory absorption. When children with secretory diarrhea does not stop even with fasting.in secretory diarrhea the children may be having multiple congenital diarrheal disorder associated with an identifiable genetic mutation which affects gut epithelial ion transport and one example is congenital chloride diarrhea.
- **Inflammatory diarrhea** is associated with conditions that cause inflammation or ulceration of the intestinal mucosa (e.g., Crohn disease, ulcerative colitis) and lead to malabsorption of dietary macronutrient and cause a Luminant osmotic

gradient. The resultant outpouring of plasma, serum proteins, blood, and mucous increases fecal bulk and fluid content.

- **Malabsorption** may result from osmotic or secretory mechanisms or conditions that lead to less surface area in the bowel. Conditions such as pancreatic insufficiency and short bowel syndrome and conditions that speed up transit time cause diarrhea due to decreased absorption(Shander & Perrault, 1985).

2.4. Classification according to etiology

Estimation of pathogen-specific causes of child diarrhea deaths is needed to guide vaccine development and other prevention strategies. Despite global success in the reduction of all cause and diarrhea- specific mortality in the past 30 years, diarrhea remains the second leading cause of death due to infections among children under five years of age worldwide(WHO, 2017a). Several organisms have been implicated as important causes of these death the primary causes of diarrheal in children are gastrointestinal infections, mostly viral infections parasites and bacterial, and more rarely food intoxications and other factors.

✓ **Infectious cause**

Around 70% of diarrheal diseases in children are due to viral infections and 40% of acute diarrhea in the first 5 years of the children are due to rotavirus and other 30% are caused by other virus like norovirus and adenovirus and the bacteria like campylobacter jejuni, Yersinia, salmonella, shigella, pathogenic E. coli, or clostridium difficile can be found in children with diarrhea 20% of stool exams and in less than 5% the parasite like lamblia, cryptosporidia, Entamoeba histolytica and others can be found(Koletzko & Osterrieder, 2009)

✓ **Noninfectious**

- Inflammatory bowel disease

- Dietary or nutritional factors like ingestion of poorly absorbable sugars like lactulose and acute alcohol ingestion
- Irritable bowel syndrome
- Partial small bowel obstruction
- Allergic diarrhea to some drugs or food

The study done in Rwanda have shown that rotavirus is the most common cause of diarrhea by 36.9% and shigella is the most common cause of bloody diarrhea in children less than 5 years by 17.5% and characterized by severe symptoms in children(Kabayiza et al., 2014)

2.5. Risk factors of diarrhea

Many studies have done in many countries to show different risk factors for diarrhea in children, those risks factors can be divided in categories

Environment factors like type of lack of water source near the households which can be unsafe like ponds, wells, rivers, lakes and water storage with longterm storage of water at home in many villages in developing countries, sanitations facilities, solid waste disposal system at home and near the home, type of kitchen which play a great role in diarrhea prevalence in many communities, poor water storage, lack of hands washing facilities, unprotected latrines, unsafe toilets with poor sanitation and lack of knowledge on diarrheal diseases(Connell, Quinn, & Scheuerman, 2017)(Kapwata, Mathee, le Roux, & Wright, 2018)

Host risks factors young children as the diarrheal is greatest during the first year of life, male gender, early weaning, child rearing(Mølbak, Jensen, lngholt, & Aaby, 1997)

Nutritional factors in developing countries diarrhea and malnutrition are common and the combination of the two put the children at high risk of dying before their 5 birthdays, the children with malnutrition has long duration of diarrhea compare to other children's and diarrhea kills easily malnourished children and repeated episodes of diarrhea increase the risk of malnutrition and breastfeeding decrease diarrhea and healthcare workers are advised to promote breastfeeding (Brown, 2003).

Others factors, low maternal education, lack of water treatment, rainy season, eating cold food leftover, not being look over by the parents, having pigs at home, low wealth index, young mothers have been shown to have an impact of occurrence of diarrhea in developing country (20).

2.6. Transmission route

Diarrhea is caused by infectious organisms; those organisms are transmitted from one person to another through stool to the mouth and the term is called a fecal-*oral transmission*. Some of the agents that transmitted the disease are well known, others are recently discovered or emerging new agents, and presumably many remain to be identified.

The disease transmission varies in the route from the stool to the mouth and in the required number of microorganisms needed to cause infectious process. For example, for bacteria, the capacity to endure stomach acid is an important factor of the disease determinant of the inoculum size required to cause illness. Like *Shigella* bacteria are unaffected by low pH, and a few thousand organisms are enough, to be transmitted by direct person-to-person contact or through contamination of inanimate objects, such as a cup. In contrast, some bacteria which doesn't resist the acidity of stomach such as *Vibrio cholerae,* need millions of microorganisms to cause diarrhea, and therefore must first proliferate in the food or water to get the necessary infectious dose. Some pathogens, such as rotavirus, display a sharp host species preference, and others have a broad host range. Among *Salmonella* bacteria, certain bio-serotypes are adapted to infect animals and pose no threat to humans, and others are adapted to humans and do not infect animals. The majority, however, are not adapted to a specific host and can infect either humans or domestic animals, thus facilitating transmission of these organisms to humans. Less than a dozen of the more than 2,500 individual *Salmonella* cause the majority of human infections, reflecting the requirement for genes that encode essential virulence factors(Jamison et al., 2006)

The ability to identify the mode of transmission of the virulence organisms have led to epidemiological control and innovative new measures for diagnosis, prevention and treatment of diarrhea in children and in adults

2.7. Pathway for diarrheal disease in children

A. Pathway 1

- Sick people without proper sanitation facilities defecate in or near a water source. Water source is contaminated with feces
- Animals defecate in or near a water source. Water source is contaminated with feces.
- Farmers use contaminated water to irrigate their crops.
- People use contaminated water for drinking and food preparation.
- Crops irrigated with contaminated water are used to prepare meals.
- Families eat and drink contaminated food and water.

B. Pathway 2

- Caregivers change a sick baby's diaper and contaminate their hands OR they touch objects and other people, contaminating surfaces they touch.
- Caregivers prepare foods with unwashed hands, contaminating the food.
- Families eat and drink contaminated food and water

2.8. Diagnosis of diarrheal disease

Diagnosis of any disease depend on the well taken medical history, physical examination of the patient and laboratory diagnosis. If the disease is still not well known the clinician can ask other exams like X-ray of the abdomen, abdominal ultrasound, barium enema, CT-scan of the abdomen, ERCP, proctoscopy, colonoscopy, intestinal absorption test and sometime intestinal biopsy

Laboratory diagnosis

Routine stool examination to identify the pathogenic microorganisms, the consistency of the stool and the presence of the blood or Erythrocytes and leucocyte by microscopic exam is the main step in diagnosis of the cause of diarrhea in developing country where there is lack of resources for advanced exams and most of the cause of diarrhea can be detected in the stool by microscopy or stool culture and some require specific test for molecular diagnostic test such as PCR test to identify the main pathogen causing the disease(Platts-Mills, Operario, & Houpt, 2012)

2.9. Management of diarrhea

A. Clinical Assessment

Fever, vomiting, and loose stools are the common symptoms of acute gastroenteritis. Among infants and children, however, these can be the symptoms of many no gastrointestinal illnesses as well, including meningitis, bacterial sepsis, pneumonia, otitis media, and urinary tract infection.

B. Rehydration

Dehydrating diarrhea and the physiological disturbance were first published in 1830s when they were an epidemics of vibrio cholera and since then, many studies have been called out to show the intravenous fluid and ORS therapy role in restoring the blood volume in the normal state.

C. Oral rehydration solution therapy

In 1970, WHO and UNICEF started the promotion of a single solution (WHO-ORS) containing (in mmol/L): sodium, 90; potassium, 20; chloride, 80; base, 30; and glucose, 111 (2%), since then, ORS solution has been known in treatment of diarrhea in all

patient despite their age's, the cause of diarrhea, the global acceptability of ORS has helped the WHO global diarrheal disease control programs and the reduction of mortality but some clinician in developed countries have been showing resistance and advice the parents to use clear fluid in spite of ORS in developing countries no concern on the use of ORS.

The ORS encompasses the two phases of treatment the first one is rehydration phase and second is replacing the losses for fluid and also electrolytes. The use of ORS is very cheap, noninvasive procedure, easy availability and the reduce the hospitalizations of children.

D. Limitation of ORS

ORS is not sufficient for children with bloody diarrhea like dysentery and those patients need the use of antimicrobial agents by consulting the health facilities.

Children in severe dehydration and shock must be treated initially with IV fluids and ORS should be started when the child is stable

children with intractable vomiting must be treated with IV fluid maintenance and slow nasogastric tube for help in feeding or ORS in small amounts but many times.

Lack of sufficient knowledge for preparation

E. Dietary Therapy

Breast-fed infants should continue nursing on demand. For bottle-fed infants, full-strength, lactose-free, or lactose-reduced formulas should be administered immediately upon rehydration in amounts sufficient to satisfy energy and nutrient requirements

F. Drug Therapy

Neither antibiotics nor nonspecific antidiarrheal agents are usually indicated for acute diarrhea and according to WHO around 90% of diarrhea disease resolve without antibiotics. Antibiotics must be considered with invasive bacteria or a high fever is present, or when watery diarrhea lasts for greater than 5 days, or when stool cultures, microscopy, or epidemic setting indicate an agent for which specific treatment is required.

Watery diarrhea is caused by virus or enterotoxin bacteria in 70% and can be cured spontaneously with the use of homemade solutions or ORS.For many years, the treatment of acute diarrhea has proven that oral therapy, with a fluid-electrolyte solution for rehydration and maintenance, is simple and effective. More recently, the important coprinciple in case management of early refeeding of children immediately upon rehydration has also gained wider acceptance. The combination of oral rehydration and early nutritional support guides a patient through an episode of diarrhea safely and effectively(Camilleri, 2004) and in Rwanda there is national wide program of using home made solution of ORS by mother and every community health workers know the methods of preparation(Mugeni et al., 2014).

G. Treatment of acute diarrheal in children

- The treatment of acute diarrhea in children can be started at home by giving enough liquid for prevention of dehydration as diarrhea cause loss of water and electrolytes.
- Liquid can be:
- Solutions of rice water mixed with salt
- Solutions of sugar and salt
- Orally ORS
- Provide the child with enough food

– If the diarrhea is not decreasing or child not eating as usual, vomiting, presence of fever or bloody in the stool, the caretaker must go immediately to the health facility for further exams and management.

2.10. Preventive methods

- Support and promote the importance of community health workers
- Ensure safe water is provided close to people's homes
- Discourage/eliminate open defecation
- Develop strategies for proper disposal of human waste
- Construct basic sanitation facilities
- Promote handwashing

2.11. Diarrheal disease impact

Diarrheal disease has an impact on child health, many studies have shown that many episodes of diarrheal in preschool children in absence of catch up growth, it's lead to growth faltering causing stunting with long term effects on cognitive development and raise the risk of other infectious diseases like measles, pneumonia.

The study by Christopher and Troeger with his colleagues was the first studies to show the global impact of diarrheal disease using disability adjusted life years (DALYS) and diarrheal disease has short term and long-term sequelae on child health with risk of morbidity and mortality from infectious disease and protein energy malnutrition.

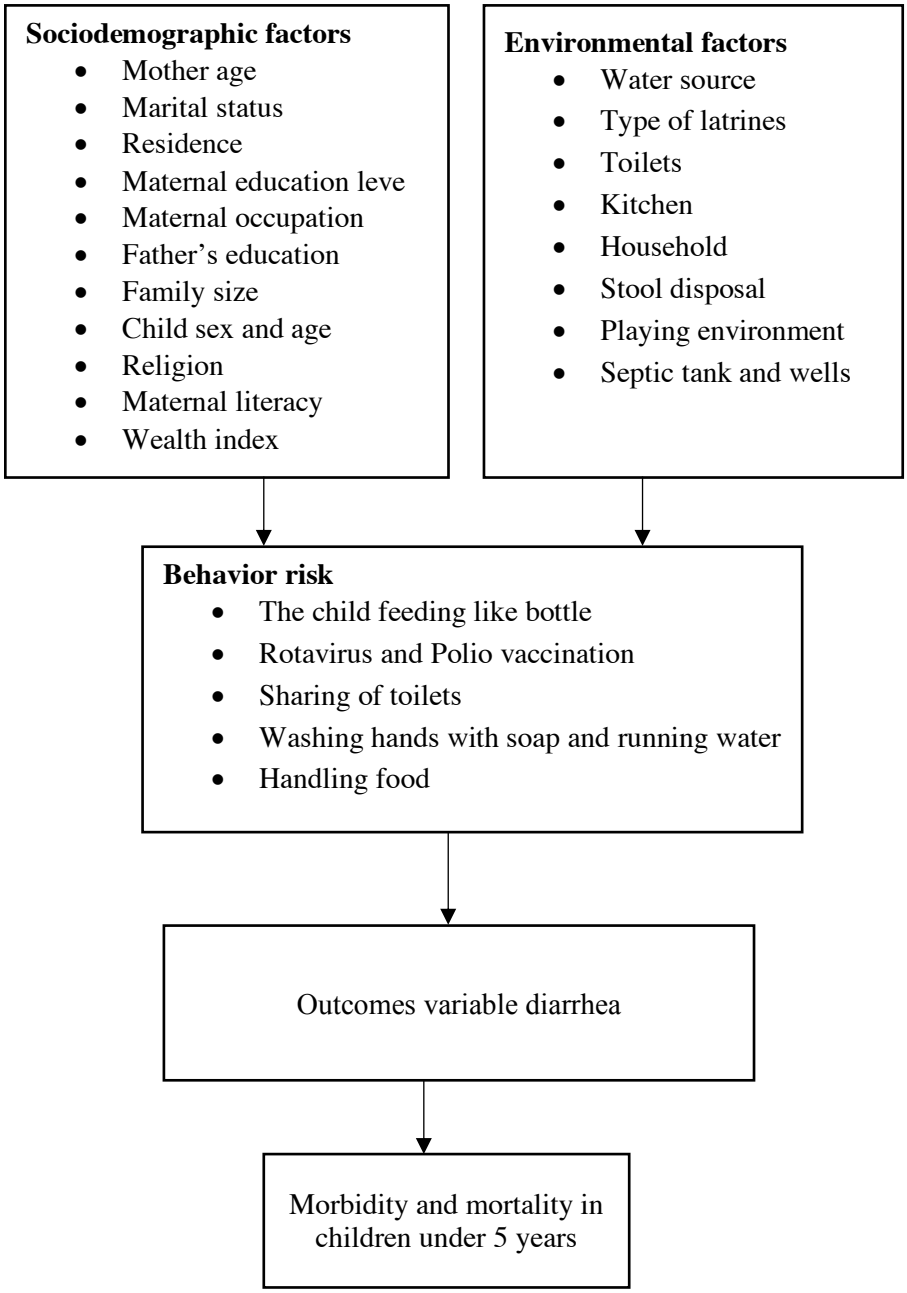

Figure 2:Conceptual framework of risk factors of diarrhea in children

2.12. Rwanda wealth index classes

The government of Rwanda has used Ubudehe category to classify the populations in different wealth index and the first two category benefit from the government by receiving the health insurance,one cow by family, housing and the school fees for their children.According to the ministry of local government of Rwanda and social affairs in Rwanda there is 4 category of wealth index and the first two is comprise the poorest people and fourth category is the wealthiest people of Rwanda society.

CHAPTER 3
MATERIALS AND METHODS

3.1. Study design

This study was a secondary data analysis of demographic health survey of 2014-2015, which is a population-based health survey with marked by the all the population in the country were represented within their geographical, social and economic classes. This study was a cross-sectional descriptive comparing different variable of sociodemographic and diarrheal disease recorded during the survey

3.2. Study site

The study was performed using data from Rwanda.Rwanda is small landlocked country in Central-East Africa with a population of 12.5million and around 45% of rwandan's population are under 18 years and the demographic health survey data were taken in all party of the country rural and urban. Around 85.5% of Rwandan population are living in the rural area(Rwanda - statistical overview, 2018)

3.3. Study population

The 2014-2015 DHS involved 12,793 households' heads from all 30 districts of Rwanda and our target population was households with children under 5 years and the mortality rate for children under 5 years according to world bank in Rwanda was 38,5/1000 births live in 2016.

3.4. Sampling size

A multistage selection technique was used by choosing the households systematically from 492 sector. In Every sector, 16 households were selected except some sector whereby 17 households were selected a total of 7856 households were used in this study.

3.5. Inclusion criteria

- All women with 15-49 years with children under 5 years

3.6. Exclusion criteria

- Women's with children above 5 years old

3.7. Data sets and measurement

Rwanda demographic health survey was conducted using 3 different questionnaires, first was household questionnaire, women's questionnaire and men's questionnaire, children health information was collected on the household's questionnaire with the information of household's characteristics and the information on both parents.

This study was done using the household's data sets recoded on sociodemographic characteristics of households with alive child birth within the 5 years, data on diarrhea and rotavirus vaccinations were also collected and the knowledge of mother's on ORS packets.

3.9. Statitistical analysis

The data was analyzed in relation with 3 dependent variables which was diarrheal, oral rehydration solution knowledge, rotavirus vaccination and independents variables were sociodemographics factors including the age of the mother, age of the children, province, type of residence, province, education attainement, marital status, literacy, religion, occupation, number of children in the households and wealth index. Descriptive statistics, chi-square test and multivariate logistic regression analysis were done.

The data were analysed in 3 different parts :first the frequency of distribution fo dependent and independent variables were analysed.Second bivariate analyses were done between each independent variables and dependent variables or outcome variables.Third a multivariate logistic regression analyses were perfomed to determine the association of sociodemographic factors and the outcome variables and the odds ratio and confidence interval of 95% were measured for showing the association between dependent variable and selected independents variables.

3.10. Data management

This study used secondary data from RDHS 2014-2015 survey and I will keep the data up 5 years.

3.11. Ethical considerations

Before performing the research, the abstract was sent to the DHS progam and the letter of approval to use the data was given. All DHS data are treated anonymously and confidentially, and the user is prohibited to try to identify any household or individual respondent interviewed in the survey and this study did not require ethical clearance by an Ethical Review Board since it consisted of secondary analysis of data, which were released for public use.

CHAPTER 4
RESULTS

4.1. Sociodemographic characteristic of study population

The results of table 1 is showing among 7,658 women with children less than 5 years old, 55.6% of women were between 25-34 years, 17.5% were having 20-24years, 5.8% of women were 25-34 and women with 35-49 were 24.8%. For the mother education level, 50.1% were having incomplete primary education,14.5% were with no education, 21.5% were with primary education level ,7.4% were having incomplete secondary education, 4% were having a completed secondary education level and 2.5% were having higher education level. The province of residence, the women form Kigali city were 11.7%, around 24.7% of women were from South province, 25% of women were from Western province, Eastern province women were 24.7% and women from North province were 13.8%. Type of residence most of the women were from rural area with 78 % and urban area were 22%. The majority of women were protestant with 48.7%, catholic were 35.9%, the Adventist church were 12%, muslim were 2.2% and women with no religion were 0.5%. According to the wealth index category, most of the women were living in the poorest category with 24.1%, followed by the poorer category with 20.9%, those living in middle category were 18.8%, the richer and richest category were 17.1% and 19.1% respectively. The majority of women were able to read the whole sentence with 68%, where 8.7% of women were not able to read the whole sentence abd around 22.5% were not able to read at all.when seeing the marital status, the majority of women were married with 52.9%, those never in union but with kids were 8.8%, those living with partener but not married were 29.2%, widowed women were 2%, divorced women were 2.6% and separated with partener but not divorced were 4.5%.

Table 1. Background characteristics of women with live birth in the five years

Characteristics		Frequency (%)
Women's age group	15-19	157(2.0)
	20-24	1,378(17.5)
	25-34	4,371(55.6)
	35-49	1,950(24.8)
Mother's education level	No education	1,141(14.5)
	Incomplete primary	3,937(50.1)
	Complete primary	1,687(21.5)
	Incomplete secondary	578(7.4)
	Complete secondary	313(4.0)
	Higher	200(2.5)
Province	Kigali city	923(11.7)
	South	1,939(24.7)
	West	1,965(25.0)
	East	1,944(24.7)
	North	1,085(13.8)
Type of residence	urban	1,725(22.0)
	rural	6,131(78.0)
Religion	Catholic	2,822(35.9)
	Protestant	3,823(48.7)
	Adventist	943(12.0)
	Muslim	169(2.2)
	Jehovah witness	50(0.6)
	No religion	41(0.5)
	Other	2(0.0)
Wealth index	Poorest	1,893(24.1)
	Poorer	1,643(20.9)
	Middle	1,479(18.8)
	Richer	1,340(17.1)
	Richest	1,501(19.1)
Literacy	Cannot read	1,769(22.5)
	Able to read only parts of sentence	682(8.7)
	Able to read whole sentence	5,390(68.6)
Marital status	Never in union	693(8.8)
	Married	4,157(52.9)
	Living with partner	2,294(29.2)
	Widowed	155(2.0)
	Divorced	202(2.6)
	Separated	355(4.5)

4.2. Children characteristics

The children charcetristics showed in table 2. Among 7,658 children 50,6% were male and 49,4% were female. The age group of children those <6 months were 11.7 %, 6-11months were 9.8%,12-23 months were 20.7%, 24-35 were 20.9% and 36-59 months were 36.9%. They were 4241 missing data for age of children in the database. The diarrhea was reported in 12.1% and 87.9% didn't have diarrhea. Children who received rotavirus vaccine first dose were 64.1%, second dose 58.7% and third dose were 60.2 %. The total coverage of rotavirus of the 3 vaccines dose was 62% and 38% of children didn't receive vaccine.

Table 2. Children under 5 years health characteristics

Variables		Frequency	%
Age group in months	<6	423	11.7
	6-11	354	9.8
	12-23	747	20.7
	24-35	757	20.9
	36-59	1,334	36.9
Gender of the child	Male	3,978	50.6
	Female	3,878	49.4
Diarrheal	No	6,569	87.9
	Yes	905	12.1
Received rotavirus 1	No	2,710	34.5
	Yes	4,834	64.1
Received rotavirus 2	No	2,933	37.3
	Yes	4,609	58.7
Received rotavirus 3	No	3,130	39.8
	Yes	4,542	60.2
Received all 3 rotavirus doses	Yes	4,389	62.0
	No	2,710	38.0

4.3. Bivariate analysis of diarrhea with sociodemographic factors

There is a significant association between diarrhea with age of the mother's, marital status, the province of residence, type of residence, educational of the mother, wealth index, education level of the husband and occupation with a p-value less than 0.05.no association found between literacy, religion and number of children in the households as shown in table 3 and 4.

Table 3. Association of sociodemographic characteristics of respondents with diarrhea

Variables		Diarrhea		
		Total	Yes (%)	*P*
Wealth index	Poorest	1,780	271(15.2)	<0.001
	Poorer	1,565	226(14.4)	
	Middle	1,421	162(11.4)	
	Richer	1,277	130(10.2)	
	Richest	1,431	116(8.1)	
Number of children 5 and under in household	0	105	12(11.4)	0.840
	1	3,358	399(11.9)	
	2	3,146	391(12.4)	
	3	796	97(12.2)	
	4	53	6(11.3)	
	5	9	0	
	7	7	0	
Husband/partner's education level	No education	1,134	154(13.6)	<0.001
	Primary	4,778	587(12.3)	
	Secondary	619	49(7.9)	
	Higher	270	13(4.8)	
Occupation	not working	498	46(9.2)	0.028
	professional	381	28(7.3)	
	sales	712	90(12.6)	
	agricultural	5,499	703(12.8)	
	domestic	93	9(9.7)	
	Manuel job	289	29(12.1)	

Table 4. Association of sociodemographic characteristics of respondents with diarrhea

Variables		Diarrhea		
		Total	**Yes (%)**	***P***
Age of women's	15-19	142	17(12)	0.028
	20-24	1,281	187(14.6)	
	25-34	4,192	488(11.6)	
	35-49	1,859	213(11.5)	
Marital status	Never in union	642	95(14.8)	0.030
	married	4,009	439(11)	
	Living with partner	2,160	2,71(12.5)	
	widowed	145	18(12.4)	
	Divorced	190	34(17.9)	
	separated	328	48(14.6)	
Province	Kigali city	875	76(8.7)	<0.001
	south	1,841	228(12.4)	
	west	1,879	274(14.6)	
	north	1,039	113(10.9)	
	East	1,840	214(11.6)	
Residence	urban	1,635	168(10.3)	0.010
	rural	5,839	737(12.6)	
Mother's education level	No education	1,067	145(13.6)	<0.001
	Primary	5,355	669(12.5)	
	Secondary	853	86(10.1)	
	higher	199	5(2.5)	
Literacy	Cannot read at all	1,653	231(14)	0.098
	Able to read only parts of sentence	651	73(11.2)	
	Able to read whole sentence	5,155	601(11.7)	
	Visually impaired	6	0	
Religion	catholic	2,683	325(12.1)	0.0698
	protestant	3,636	446(3636)	
	Adventist	898	98(10.9)	
	Muslim	163	21(12.9)	
	Jehovah witness	48	8(16.7)	
	No religion	39	7(17.9)	
	other	2	0	

Chi-square applied

4.4. Association of children characteristic and diarrheal disease

The results of the table 4 below showed that the age of the children and rotavirus vaccine status has an association with diarrhea in children and a p-value of less than 0.05 was considered significant and the sex of children have no association with diarrheal disease with p-value of 0.156.

Table 4. Association of characteristics of children with diarrhea

Variables			**Total**	**diarrhea**	***p***
				YES (%)	
Age of children grouped		<6	423	33(7.8)	<0.001
		6-11	354	60(16.9)	
		12-23	747	181(24.2)	
		24-34	757	109(14.4)	
		35-59	1,334	76(5.7)	
Sex of the child		male	3,766	476(12.6)	0.156
		Female	3,708	429(11.6)	
Rotavirus	1	yes	4,082	727(15.1)	<0.001
		no	2,660	177(6.7)	
	2	yes	4,578	713(15.6)	
		no	2,882	190(6.6)	
	3	yes	4,382	694(15.8)	
		no	2,660	209(6.8)	

Chi-square applied

4.5. Association of rotavirus vaccine and diarrheal disease

A multivariate analysis of diarrhea with the 3 different doses of rotavorus vaccines showed the lack of 3 dose of rotavirus vaccines were more likely associated with diarrheal disease compare to the counterpart's children who taken the rotavirus vaccine with [OR:0.573,95% (0.36-0.911)].

Table 5. Association of diarrhea with rotavirus vaccination

variable			**OR**	**95% C. I**	***p***
Rotavirus vaccination	1	Yes	1		
		No	0.999	0.614-1.627	0.998
	2	Yes	1		
		No	0.654	0.342-1.252	0.200
	3	Yes	1		
		No	0.573	0.36-0.911	0.019

1: First dose of rotavirus vaccine

2: Second dose of rotavirus vaccine

3: Third dose of rotavirus vaccine

4.6. Factors associated with diarrheal disease in children

Multivariate logistic analysis model was done using binary logistic regression to demonstrate the relationship between sociodemographic factors with diarrheal disease in children under 5 years. the variable with p-value less than 0.05 in bivariate analysis were included in multivariate analysis. A confidence interval of 95% were used, odds ratio was calculated and the p-value less than 0.05 were taken as significant.

Children with age range 24-34 months were 2.652 times having risk of diarrhea more than those with 6 months,11-23 months children were 4.514 times more rik of diarrhea compare to their counterparts of 6months [OR:4.514,95%CI (3.047-6.687)] and those ranging between 35-59 months were 2.340 times more rik of diarrhea compare to those with less than 6 months.

Considering the wealth index of the family, Children in the poorest category were having 1.592 times risk to develop diarrhea compared with children from the richest and additionally, the poorer category has 1.64 times more than those in the richest family with [OR:1.64, 95%CI (1.196-2.249)].

Children from western province, their risk of developing diarrhea were 1.439 times risk of diarrhea when compare to children from Kigali city [OR:1.439,95% CI (1.032-2.007)].The occupation of the women in the family was found to have an impact on diarrhea in children and the family who work in agricultural activities had 1.624 times more than those from a family with mothers who are not working and remain at home [OR:1.624,95% CI (1.003-2.629)]. Women with no education their children had five times risk for having diarrhea when compared with children with mother of higher education [OR:5.163,95%CI (1.163-22.924)], the primary education women had more than 4 times risk of diarrhea with reference to higher education mother [OR:4.736,95% CI (1.092-20.546)]

Table 6. Multivariate logistic regression analysis of diarrhea with sociodemographic factors

Variables		Odds ratio	95% CI	*P*
Child age	<6m®	1		
	6-11	1.404	0.855-2.304	0.180
	11-23	4.514	3.047-6.687	<0.001*
	24-34	2.652	2.652-4.236	<0.001*
	35-59	2.340	1.583-3.459	<0.001*
Marital status	No longer living together®	1		
	Married	0.837	0.596-1.176	0.306
	Living with partner	0.869	0.617-1.223	0.421
	Widowed	0.895	0.493-1.624	0.715
	Divorced	1.352	0.820-2.228	0.237
Wealth index	Richest®	1		
	Poorest	1.592	1.152-2.199	0.005*
	Poorer	1.64	1.196-2.249	0.002*
	Middle	1.274	0.921-1.762	0.143
	Richer	1.109	0.804-1.530	0.528
Mother's ducation level	Higher®	1		
	No education	5.163	1.163-22.924	0.031*
	Primary	4.736	1.092-20.546	0.038*
	Secondary	4.098	0.946-17.755	0.059*
Type of residencce	Urban ®	1		
	Rural	0.760	0.529-1.093	0.139
Province	Kigali city®	1		
	South	1.232	0.879-1.726	0.226
	West	1.439	1.032-2.007	0.032*
	North	1.144	0.796-1.644	0.467
	East	1.193	0.852-1.671	0.305
Occupation	Not working®	1		
	Professional	1.007	0.586-1.73	0.979
	Sales	1.316	0.693-2.498	0.401
	Agricultural	1.624	1.003-2.629	0.048*
	Domestic	1.16	0.745-1.806	0.511
	Manuel job	1.317	0.536-3.234	0.548
Husband's education level	No education	1.517	0.759-3.034	0.238
	Primary	1.483	0.760-2.894	0.248
	Secondary	1.059	0.533-2.102	0.870
	higher®	1		

®: reference, *: p-value<0.05

4.7. Oral rehydration solutio knwoledge with sociodemographic factors

The proportion of women with age group range between 25-34 were more to know ORS with 56%. most women with primary education knew about ORS with 71% and most women who were living in rural area more knew about ORS with 76,9%. And the univariate analyses were perfomed among each independent variables and dependent variable the knowledge of ORS were a significant association between ORS knowledge package and the selected sociodemographics factors with p-value <0.05 as showed in the table below.

Table 7. Frequency of women who knew ORS with sociodemographic factors

Variables		**Know about ORS (N=6613)**	**p-value**
		N (%)	
Age group	15-19	119(1.8)	<0.001
	20-24	1,050(15.9)	
	25-34	3,703(56.0)	
	35-49	1,741(26.3)	
Mother's education level	No schooling	921(13.9)	<0.001
	Primary	4,720(71.4)	
	Secondary	789(11.9)	
	Higher	183(2.8)	
Wealth index	Poorest	1,541(23.3)	<0.001
	Poorer	1,296(19.6)	
	Middle	1257(19.0)	
	Richer	1,152(17.4)	
	Richest	1,367(20.7)	
Type of place residence	Urban	1,540(23.2)	<0.001
	Rural	5,073(76.9)	
Province	Kigali City	838(12.7)	<0.001
	South	1,639(24.8)	
	West	1,557(24.8)	
	North	889(13.4)	
	East	1,690(25.6)	

4.8. Association of sociodemographic factors with ORS knowledge

The bivariate analysis showed that the age group show an association with diarrhea and mother with age. The age group of 20-24 years, 25-34 yearsb and 35-49 years were more likey to know more about ORS compare to their counterparts of 15-19 years.the women from Western, North and Eastern province were more likey to know about ORS compare to the counterpartswomen from Kigali city. The poorer, the middle, the richer and richest class were more likely better to know about ORs compare the counterparts of the poorest class.for the education level no association found between education and to know about ORS and the women from urban area were 1,4 times higher to know abour ORS compare to women from the rural area with [OR:1.488,95% (1.231-1.797)].

Table 8. Multivariate analysis of sociodemographic factors with ORS knowledge

Variable		**OR**	**95% CI**	***p***
Age group	15-19	1		
	20-24	0.306	0.211-0.472	<0.001
	25-34	0.337	0.286-0.424	<0.001
	35-49	0.636	0.547-0.767	<0.001
Province	Kigali city	1		
	South	1.110	0.836-1.474	0.985
	West	0.805	0.669-0.969	0.022
	North	0.591	0.496-0.705	<0.001
	East	0.67	0.544-0.825	<0.001
Wealth index	Poorest	1		
	Poorer	0.634	0.477-0.843	0.002
	Middle	0.509	0.383-0.676	<0.001
	Richer	0.731	0.546-0.979	0.036
	Richest	0.742	0.557-0.988	0.041
Education level	No schooling	1		
	primary	0.791	0.452-1.384	0.412
	Secondary	1.043	0.609-1.789	0.877
	Higher	1.312	0.749-2.297	0.342
Type of residence	Urban	1.488	1.231-1.797	<0.001
	Rural	1		

CHAPTER 5
DISCUSSION

Diarrhea prevalence

The prevalence of diarrhea was 12.1% and was slightly low to demographic health survey of 2010 which was 13.1(Connell et al., 2017) and low compared to a study done in Nyarugenge district in Rwanda which showed 26% of diarrhea but that study was a cluster study in the health facilities (District & Nsabimana, 2017), this decrease of diarrhea in Rwanda may be due to increasing access to clean water and sanitation in Rwanda community and increase access to medical services due to increase health insurance coverage in general population and This study finding was slightly lower compared a study done in the nomadic population in Ethiopia showed the prevalence of diarrhea was 26.1 %, as the nomadic populations live moving from one place to another (Woldu, Bitew, & Gizaw, 2016). This study finding was slightly lower compared to a study done in some East Africa country in 2010 using DHS data, Burundi was 24.8% and 13.9% in Tanzania (Connell et al., 2017). lower to northern parts 14.5% and Eastern parts 22.5% of Ethiopia (Mengistie, Berhane, & Worku, 2013)(Gebreyesus et al., 2018)

They were no significant difference between boys' and girls' children concerning for the prevalence of diarrhea which was against the cultural bias in many communities favoring boys than girls. This result was similar to a study done in Bangladesh showe that no gender difference during acute diarrhea in children less than 5 years(Jarman et al., 2018).

Rotavirus vaccination

WHO recommends the rotavirus vaccination in children and it has been introduced in the protection of children less than 2 years old for diarrhea caused by the rotavirus, which is the number one cause of diarrhea in children. The vaccine was introduced in Rwanda in 2012.

Since the introduction of the rotavirus vaccine in Rwanda, the number of cases of non-bloody diarrhea was decreased by 17-29%, and active surveillance of rotavirus showed a reduction of 61-70% of gastroenteritis cases in 2013-2014 in every age group(Ngabo, Tate, et al., 2016) . in this study found the coverage was 62% in 2014-2015 which was lower than the overall coverage of 31 countries of African region 77% in 2016(Mwenda et al., 2017), the low coverage difference might be caused that the rotavirus vaccines were still new with may challenge of new vaccination introduction with some health facilities lack the cold chain for vaccines, lack of system for delivery and unavailability of vaccines, and lack of access to medical care in impoverished communities. During 2016 Rotavirus infection was the cause of more than 258 million episodes of diarrhea worldwide among children younger than 5 years in 2016. Mortality associated with rotavirus has decreased considerably since the introduction of the rotavirus vaccine in Rwanda (Mwenda et al., 2017),(Steele et al., 2019) ,(Troeger et al., 2018).In this study we found an association of lack of third dose of rotavirus and increase risk of diarrhea ,According to WHO the third dose of rotavirus vaccines is the booster dose and it's still uncertain if it reduce mortality due to diarrhea in children compare to placebo who receive only 2 doses (Henschke, Maayan, Mills, Kakourou, & Lutje, 2017).

Assoociation between ORS knowledge and sociodemographic factors

The oral rehydration solution in this study was found to have an association with sociodemographic factors such as the age of the mother, type of residence, wealth index and the province of origin and no association found education level. The age increases with more women heard of ORS and the more the age of the mother, the more the number of birth and the experience of having children with diarrhea and treated using ORS. the results of this

study were same with a study done in the Gambia where the mother with high maternal age and high socioeconomic status scored high in the management of diarrhea by using oral rehydration solution(Sillah, Ho, & Chao, 2013)(Ngabo, Mvundura, et al., 2016) and another study done Ethiopia showed that mother with higher income were more likey to use ORS compare to women from low socioecomic status(Misgna, Ebessa, & Kassa, 2019).The low maternal education is associated with high morbidity and mortality of diarrhea in children less than 5 years as most of the diarrhea cases in children are treated with simple methods and homemade solutions with the same composition as ORS (CDC, 2012).living in the urban area increase access to health information and to health services easily and the socioecomic status of the women in the urban is better compare to rural area

Association of sociodemographic factors and diarrhea

In this study significant association of diarrhea found with children age, between 11-24 months was more than 2 times to have diarrhea compare to children less than 6 months and this result was similar with results of a study done in Pakistan(Irfan, Zaidi, & Waseem, 2017).The young children are protected against different disease by the different mechanisms such as the maternal antibodies, breastfeeding protects against many enteric pathogens and after the child reaches 6 months of the exclusive breastfeeding, they start supplement foods which can cause diarrhea by ingestion of microbes or food intolerance and as child grow the maternal protection decrease and become lost.

The children from the poor family had a higher risk than children from middle, richer and richest family, this may due to inadequate hygiene and sanitation, lack of clean water, lack of knowledge on diarrhea prevention, and inappropriate disposal of stool and living near unsafe ponds and wells(Hbatu et al., 2017). The poor family in Rwanda community, they tend to have many children and live in overcrowded households.

Living in the western province was a high risk of developing diarrhea as this part of Rwanda is near lake Kivu and some families use contaminated water from the lake for drinking and food preparation.

Lack of maternal education increased the risk of developing diarrhea in children as the educated mother has autonomy and she is empowered to take care of her children and the family. Other previous studies have shown high educated mothers their children have a low risk of morbidity and mortality due to diarrhea because of having necessary knowledge in practice sof good hygiene and sanitation(Bado, Susuman, & Nebie, 2016)(Irfan et al., 2017). maternal education is an important determinant of wellbeing and health status of children under 5 years and the important predictor of good development of children(Desmennu, Oluwasanu, John-Akinola, Oladunni, & Adebowale, 2017).

The agricultural family found a high risk of diarrhea as the farmers use contaminated water to irrigate the crops and some time for food preparations and are at high risk of soil-transmitted parasites. A study done in India showed the relationship of irrigation water quality and incidence of diarrhea with farming households were having high diarrhea risk compare to other occupation(Falkenberg & Saxena, 2018).

CHAPTER 6
CONCLUSIONS AND RECOMMENDATION

6.1. Conclusion

Sociodemographic factors increase the risk of developing diarrhea in the Rwanda community and this study found that Child age, low wealth index, education attainment of the mother, province of origin and family of agricultural activities were having a high association with the development of diarrhea in children less than 5 years. the child from a poor family was high compare to the middle, richer richest family and mother with secondary school education found with a high risk of diarrhea. To continue to decrease diarrhea morbidity and mortality, designing and implementing health education, awareness of simple early interventions for the treatment of the child with diarrhea are essential tools in the Rwandan community.

6.2. Recommendations

- Continuous awareness campaigns for hygiene and sanitation measures and education to health caregiver and the general population on diarrhea prevention and management
- Strengthening of integrated community case management (ICCM) of childhood illness nationwide

6.3. Strengths and limitation

Previous studies done in Rwanda have shown the risk factors for diarrheal morbidity and mortality and were interested in household factors mostly hygiene and sanitation and not sociodemographic factors. This study used data from DHS in Rwanda and the use of these data of DHS allowed the researchers first to study the trend of the prevalence of diarrheal morbidity and sociodemographic factors in all parties of the country.

Diarrheal morbidity in the DHS was taken by asking mothers if their children had diarrhea in the 2 weeks preceding the survey and, this methodology, can lead to a deficiency of information of recall (2 weeks), the problems associated with the lack of some variable.

Future study

For decreasing morbidity and mortality of children, less than 5 years who still die because of diarrheal disease further studies on knowledge and attitudes of parents towards children with diarrhea are needed in the Rwanda community and the study on the community health workers' impact in diarrheal management in Rwanda is also needed.

REFERENCE:

1. Africa, S., Goal, S. D., Africa, S., Asia, S. E., & Africa, S. (2018). Children : reducing mortality, (October 2017), 3–6.

2. Analysis, A. S. (2017). Child ren ' s Rights and Sustainable Development in Rwanda, 1–128.

3. Bado, A. R., Susuman, A. S., & Nebie, E. I. (2016). Trends and risk factors for childhood diarrhea in sub-Saharan countries (1990–2013): assessing the neighborhood inequalities. Global Health Action, *9*(1), 30166.

4. Binder, H. J. (1990). Pathophysiology of acute diarrhea. *The American Journal of Medicine*, *88*(6), S2–S4.

5. Brown, K. H. (2003). Diarrhea and malnutrition. *The Journal of Nutrition*, *133*(1), 328S-332S.

6. Camilleri, M. (2004). Chronic diarrhea: a review on pathophysiology and management for the clinical gastroenterologist. *Clinical Gastroenterology and Hepatology*, *2*(3), 198–206.

7. CDC. (2012). Diarrhea : Common Illness , Global Killer. Centers for Disease Control and Prevention, 1–4.avaialble from:https://www.cdc.gov/healthywater/pdf/global/programs/Globaldiarrhea508c.pdf

8. CDC. (2019). Global WASH Fast Facts. *Global Wash Facts*, 21–24. Retrieved from https://www.cdc.gov/healthywater/global/wash_statistics.html

9. Collaborators, G. 2016 D. D. (2018). Estimates of the global , regional , and national morbidity , mortality , and aetiologies of diarrhoea in 195 countries : a systematic analysis for the Global Burden of Disease Study 2016. *THE Lancet Infectious Diseases*, *18*(11), 1211–1228. https://doi.org/10.1016/S1473-3099(18)30362-1

10. Connell, B. J. O., Quinn, M. A., & Scheuerman, P. (2017). Risk factors of diarrheal disease among children in the East African countries of Burundi, Rwanda and Tanzania. *GLOBAL JOURNAL OF MEDICINE AND PUBLIC HEALTH*, *6*(1). Retrieved from 1

www.gjmedph.com Vol. 6, No. 1 2017%0AISSN#- 2277-9604

11. Department of Child and Adolescent Health and Development. (2005). Handbook: IMCI The integrated management of childhood illness. World Health Organization.

12. Desmennu, A. T., Oluwasanu, M. M., John-Akinola, Y. O., Oladunni, O., & Adebowale, S. A. (2017). Maternal education and diarrhea among children aged 0-24 months in Nigeria. *African Journal of Reproductive Health*, *21*(3), 27–36.

13. District, N., & Nsabimana, J. (2017). Factors Contributing to Diarrheal Diseases among Children Less than Five.*Journal of tropical diseases*,*5*(2). https://doi.org/10.4172/2329-891X.1000238

14. Falkenberg, T., & Saxena, D. (2018). Impact of wastewater-irrigated urban agriculture on diarrhea incidence in Ahmedabad, India. *Indian Journal of Community Medicine: Official Publication of Indian Association of Preventive & Social Medicine*, *43*(2), 102.

15. Gebreyesus, A., Id, W., Dejene, T. A., Teferi, M., Negash, L., Yemane, D., & Mcguigan, K. G. (2018). Risk factors for diarrhoea and malnutrition among children under the age of 5 years in the Tigray Region of Northern Ethiopia. PLoS ONE13(11). 32–39.

16. Hbatu, M., Nsabimana, J., & Mureithi, C. (2017). Factors Contributing to Diarrheal Diseases among Children Less than Five Years in Nyarugenge District, Rwanda. *Journal of Tropical Diseases*, *05*. https://doi.org/10.4172/2329-891X.1000238

17. Henschke, T. N., Maayan, N., Mills, I., Kakourou, A., & Lutje, V. (2017). Update of a systematic review and meta-analysis of the safety , effectiveness and efficacy of childhood schedules using Rotavirus vaccines Cochrane Response, 1–231.

18. Irfan, M., Zaidi, S. M. H., & Waseem, H. F. (2017). ASSOCIATION OF SOCIO-DEMOGRAPHIC FACTORS WITH DIARRHEA IN CHILDREN LESS THAN FIVE YEARS: A SECONDARY ANALYSIS OF MULTIPLE INDICATOR CLUSTER SURVEY SINDH 2014. *Pakistan Journal of Public Health*, *7*(2), 85–89.

19. Jamison, D. T., Breman, J. G., Measham, A. R., Alleyne, G., Claeson, M., Evans, D. B., … Musgrove, P. (2006). Disease control priorities in developing countries. The World Bank report.

20. Jarman, A. F., Long, S. E., Robertson, S. E., Nasrin, S., Alam, N. H., McGregor, A. J., & Levine, A. C. (2018). Sex and Gender Differences in Acute Pediatric Diarrhea: A Secondary Analysis of the DHAKA Study. *Journal of Epidemiology and Global Health*, *8*(1), 42–47.

21. Kabayiza, J.-C., Andersson, M. E., Nilsson, S., Baribwira, C., Muhirwa, G., Bergström, T., & Lindh, M. (2014). Diarrhoeagenic microbes by real-time PCR in Rwandan children under 5 years of age with acute gastroenteritis. *Clinical Microbiology and Infection*, *20*(12), O1128–O1135.

22. Kapwata, T., Mathee, A., le Roux, W. J., & Wright, C. Y. (2018). Diarrhoeal Disease in Relation to Possible Household Risk Factors in South African Villages. *International Journal of Environmental Research and Public Health*, *15*(8), 1665. https://doi.org/10.3390/ijerph15081665

23. Koletzko, S., & Osterrieder, S. (2009). Acute Infectious Diarrhea in Children, *Deutsches Arzteblatt international 106*(33). https://doi.org/10.3238/arztebl.2009.0539

24. Mengistie, B., Berhane, Y., & 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), 446–453.

25. Ministry of Health (MOH). (2016). *National Institute of Statistic of Rwanda (NISR) [Rwanda]*. Retrieved from https://dhsprogram.com/pubs/pdf/FR316/FR316.pdf

26. Misgna, H. G., Ebessa, B., & Kassa, M. (2019). Prevalence of oral rehydration therapy use and associated factors among under - five children with diarrhea in Dangure , Benishangul Gumuz Region , Ethiopia / 2018. *BMC Research Notes*, 1–6. https://doi.org/10.1186/s13104-019-4078-6

27. Mølbak, K., Jensen, H., lngholt, L., & Aaby, P. (1997). Risk factors for diarrheal disease incidence in early childhood: a community cohort study from Guinea-Bissau. *American Journal of Epidemiology*, *146*(3), 273–282.

28. Mugeni, C., Levine, A. C., Munyaneza, R. M., Mulindahabi, E., Cockrell, H. C., Glavis-Bloom, J., … Rukundo, A. (2014). Nationwide implementation of integrated

community case management of childhood illness in Rwanda. *Global Health: Science and Practice*, *2*(3), 328–341.

29. Munyamaharo, F. (2017). iMedPub Journals An Empirical Analysis of Death of Children Under Five Years in Rwanda Abstract Under-Five Mortality Rate, Journal of medical research and health eductaion,1(2:7)*2015*, 2015–2018.

30. Murray, C. J. L., Vos, T., Lozano, R., Naghavi, M., Flaxman, A. D., Michaud, C., … Lopez, A. D. (2012). Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990-2010: A systematic analysis for the Global Burden of Disease Study 2010. *The Lancet*, *380*(9859), 2197–2223. https://doi.org/10.1016/S0140-6736(12)61689-4

31. Mwenda, J. M., Burke, R. M., Shaba, K., Mihigo, R., Tevi-Benissan, M. C., Mumba, M., … Zawaira, F. R. (2017). Implementation of rotavirus surveillance and vaccine introduction—World Health Organization African region, 2007–2016. MMWR. Morbidity and Mortality Weekly Report, *66*(43), 1192.

32. Nations, U. (n.d.). Transforming our world: the 2030 agenda for sustainable development. Retrieved September 15, 2019, from https://sustainabledevelopment.un.org/post2015/transformingourworld

33. Ngabo, F., Mvundura, M., Gazley, L., Gatera, M., Rugambwa, C., Kayonga, E., … Atherly, D. (2016). The Economic Burden Attributable to a Child ' s Inpatient Admission for Diarrheal Disease in Rwanda, PLoS ONE 11(2)1–16. https://doi.org/10.1371/journal.pone.0149805

34. Ngabo, F., Tate, J. E., Gatera, M., Rugambwa, C., Donnen, P., Lepage, P., … 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*, *4*(2), e129–e136.

35. Platts-Mills, J. A., Operario, D. J., & Houpt, E. R. (2012). Molecular diagnosis of diarrhea: current status and future potential. Current Infectious Disease Reports, *14*(1), 41–46.

36. Roder-DeWan, S., Gupta, N., Kagabo, D. M., Habumugisha, L., Nahimana, E., Mugeni, C., … Hirschhorn, L. R. (2019). Four delays of child mortality in Rwanda: a mixed methods analysis of verbal social autopsies. *BMJ Open*, *9*(5), e027435. https://doi.org/10.1136/bmjopen-2018-027435

37. *Rwanda - statistical overview*. (2018). https://doi.org/10.18356/5e7afe7d-en

38. Shander, J. E., & Perrault, J. (1985). Chronic Diarrhea in Children. *Mayo Clinic Proceedings*, *60*(1), 68. https://doi.org/10.1016/S0025-6196(12)65296-3

39. Sillah, F., Ho, H.-J., & Chao, J. C. J. (2013). The use of oral rehydration salt in managing children under 5 y old with diarrhea in the Gambia: Knowledge, attitude, and practice. *Nutrition*, *29*(11–12), 1368–1373.

40. Steele, A. D., Victor, J. C., Carey, M. E., Tate, J. E., Atherly, D. E., Pecenka, C., … Kirkwood, C. D. (2019). Experiences with rotavirus vaccines: can we improve rotavirus vaccine impact in developing countries? *Human Vaccines & Immunotherapeutics*, *15*(6), 1215–1227.

41. Troeger, C., Khalil, I. A., Rao, P. C., Cao, S., Blacker, B. F., Ahmed, T., … Colombara, D. V. (2018). Rotavirus vaccination and the global burden of rotavirus diarrhea among children younger than 5 years. *JAMA Pediatrics*, *172*(10), 958–965.

42. WHO. (2017a). Diarrhoeal disease, (May 2017), 1–5. Retrieved from https://www.who.int/news-room/fact-sheets/detail/diarrhoeal-disease

43. WHO. (2017b). Why Children are Still Dying and What can Be Done.

44. WHO. (2018). Children : reducing mortality.

45. Whyte, L. A., & Jenkins, H. R. (2012). Pathophysiology of diarrhoea. *Paediatrics and Child Health (United Kingdom)*, *22*(10), 443–447. https://doi.org/10.1016/j.paed.2012.05.006

46. Woldu, W., Bitew, B. D., & Gizaw, Z. (2016). Socioeconomic factors associated with diarrheal diseases among under-five children of the nomadic population in northeast Ethiopia. *Tropical Medicine and Health*, *44*(1), 40. https://doi.org/10.1186/s41182-016-0040-7.