Hygiene and sanitation risk factors of diarrheal disease among children under five in NYARUGURU District, Rwanda

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Hygiene and sanitation risk factors of diarrheal disease among children under five in NYARUGURU District, Rwanda

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This certifies that the Master's thesis

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Declaration

I, HABYARIMANA Etienne, hereby declare that the research titled "Hygiene and sanitation risk factors of diarrheal disease among children under five in NYARUGURU District, Rwanda" is my original work and has not been previously submitted anywhere. It is submitted in partial fulfillment of the requirements for the Master of Public Health, Global Health Policy and Financing at Yonsei University, Seoul Korea. I further proclaim that a list of references includes all the sources of information cited, with the exception of those that are acknowledged. I further declare that this is my own work, except to the extent that aid from the others' kin thesis' design and notions or in style, presentation, and linguistic expression is acknowledged.

Dedication

I dedicate to Almighty God, my brothers and sisters, my Professors and Classmates Korean friends.

To my true friend and lovely wife: MUKARUGWIZA BEATRICE

To my beloved children: MBABAZI Faith Benitha, AGANZE Beni-Tresor, INEZA Hope Benise, and ATETE KUNDWA Amelia.

To all people who rendered me moral and material supports all along the journey of my studies.

Acknowledgement

I dedicate this study to Almighty God for strengthening me to fulfill this research and to the Republic of Rwanda for cooperating with the Republic of Korea and the Korea International Cooperation Agency (KOICA) for this scholarship to study in Korea. I thank the administration of Yonsei University for the sustainable, supportive effort toward my daily activities to achieve my objectives. This support enabled me to pursue a Master's Degree Program in Global Health Policy and Financing and send my gratitude to my professors (So Yoon Kim, Sang Sook Beck, and Myungken Lee) for their guidance in the preparation of my thesis.

Special thanks to my true friend and lovely wife MUKARUGWIZA Beatrice and my beloved children: MBABAZI Faith Benitha, AGANZE Beni-Tresor, INEZA Hope Benise and ATETE KUNDWA Amelia. I cannot express exactly how grateful I am for their prayers, and physical, moral, and financial support.

May God richly bless all of you!

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List of symbols, abbreviations/acronyms

KOICA: Korea International Cooperation Agency

UNICEF: United Nations Children's Fund

WHO: World Health Organization

WASH: Water, Hygiene, and Sanitation

NTD: Neglected Tropical Diseases

ECC: Early Childhood Caries

ARI: Acute Respiratory Infection

HIV: Human Immunodeficiency Virus

EDPRS: Economic Development and Poverty Reduction Strategy

IHLCS: Integrated Household Living Conditions Survey

EICV: Enquête Intégrale sur les Conditions de Vie des Ménages (Integrated Household Living Conditions Survey)

LMIC: Low- and Middle-Income Countries

Abstract

Background

In developing countries, including Rwanda, the leading cause of preventable death, particularly among children under five, is diarrheal illnesses. Despite efforts to minimize the morbidity and mortality caused by diarrheal diseases, there is little evidence of how well those efforts are working (K. Alemayehu et al., 2021).

There are nearly1.7 million cases of childhood diarrheal infections that account for one in nine child deaths globally, making diarrhea the second leading cause of death among children under five years old (Kefalew Alemayehu et al., 2021).

Diarrhea is ranked as the third leading cause of mortality in children under five years old in Rwanda, a small blocked-in nation with a population of 12.5 million. In 2015, it was responsible for 18.3% of child deaths (Claudine et al., 2021).

Methods

This study was conducted in Nyaruguru District among 950 children aged under five years in 2021. It aimed to assess hygiene and sanitation risk factors of diarrheal disease and related diseases among children under five who consulted Munini hospital January to September 2021. Characteristics of the study population were analyzed using chi-square test for binary variables. The odds ratios (OR), p-value and 95% confidence intervals (CI) for diarrhea were determined using binomial logistic regression analysis. All analyses were

conducted using JAMOVI statistical software, version 2.2.5. A value of p <0.05 was considered statistically significant and applied in binomial logistic regression.

Result

Of the 950 participants included in this study, there were 466 male children (49.1%) and 484 female children (50.9%). The results are presented as OR, p-value (P), and 95% CI for binary variables.

The risk of suffering from diarrhea is high among children who do not have access to soap (p<.001, OR=5.21), whose parents are farmers (p<.001, OR=0.512), who do not have towels (p<.001<0.05, OR =3.64), who do not wear shoes (p<.001, OR =2.18), in unclean environments (p<.001, OR =5.21), who drink untreated water (p=0.013, OR =1.49), whose hands are not washed properly (p<.001, OR =4.26), with dirty bedrooms (p<.001, OR =1.83), without well-lit rooms (p<.001, OR =5.21), and who do not use soap (p<.001, OR =2.69).

Conclusion

The causes of diarrheal illnesses in children under the age of five were identified in this study. These causes included the absence of a hand-washing facility near latrines, lack of hand-washing practice at crucial times, not wearing shoes, parents' occupations, and children's lack of cleanliness. Other causes included the absence of treated water, unclean bedrooms, dark rooms, lack of towels at the washing stations, and lack of soap.

In the region where the study was conducted, most of the risk factors that have been connected to diarrheal disease among young children can be avoided. Supporting the delivery of continuous and customized health information programs for households is essential for reducing the prevalence of diarrheal illness in kids under the age of five.

Keywords

Hygiene, sanitation, child, diarrhea

Chapter I. INTRODUCTION

1.1. Background

In developing countries, including Rwanda, the leading cause of preventable death, particularly among children under five, is diarrheal illnesses. Despite efforts to minimize the morbidity and mortality caused by diarrheal diseases, there is little evidence available on how well these efforts are working (K. Alemayehu et al., 2021).

There are nearly 1.7 million cases of childhood diarrheal infections that account for one in nine child deaths globally, making diarrhea the second leading cause of death among children under five years old (Kefalew Alemayehu et al., 2021).

Despite a rise in the number of children in low- and middle-income nations, the number of children dying from diarrhea between 1980 and 2015 decreased by more than 80%. The factors responsible for this incredible success may help to further reduce the 500,000 child fatalities from diarrhea that still occur each year (Black et al., 2019).

Although the mortality rate from diarrhea has considerably decreased in underdeveloped nations, it still causes around 11% of all deaths among children under five (Agustina et al., 2013).

Despite being preventable and treatable, diarrhea kills 525,000 children under the age of five every year and is the leading cause of malnutrition in this age group (D. Mosisa et al., 2021).

In the Nyaruguru district, the poverty rate is less than 40% (38.4%); it is 35.4% for the severely poor and 26.2% for the poor (excluding the extreme poor). By percentage of people classified as poor or extremely poor, Nyaruguru district ranks fourth among Rwanda's districts (National Institute of statistics of Rwanda, October 2010 and November 2011).

Nyaruguru is ranked between >55 and 73.3%. Less than 25% of the population of Nyarugenge, Kicukiro, and Musanze are classified as poor; Nyarugenge is in second place with 10% of the population (National Institute of statistics of Rwanda, October 2010 and November 2011).

Approximately 66% of Nyaruguru district homes use an upgraded supply of drinking water, according to EICV3 statistics (National Institute of statistics of Rwanda, October 2010 and November 2011).

Protected springs, public standpipes, water piping into a home or yard, boreholes, protected wells, and rainwater collection are examples of improved sources of drinking water (Patunru, 2015).

Protected spring water is used by most families (44%) followed by public standpipes and protected wells (15% and 6%, respectively). However, unimproved water sources are still used by 34% of families in the Nyaruguru district (National Institute of statistics of Rwanda, October 2010 and November 2011).

According to the Economic Development and Poverty Reduction Strategy

, the national target was 85% access to safe drinking water by 2012, however, the district of Nyaruguru has not yet met it (National Institute of statistics of Rwanda, October 2010 and November 2011).

The district of Nyaruguru falls under the category of districts with intermediate to low percentages (interval of >60-70%) of household drinking from an improved water source. District Nyaruguru falls short of the national average (74.4%) (National Institute of statistics of Rwanda, October 2010 and November 2011).

In the Nyaruguru district, only 39% of homes are within 15 minutes of a good water source on foot. In terms of the proportion of families who can travel 15 minutes to a good water source, Nyaruguru district comes in ninth.

It is also crucial to remember that people in 9% of households in the Nyaruguru district still have to walk for thirty minutes or more to get to a good water source. This proportion is lower than the average for the country (12.8%) (National Institute of statistics of Rwanda, October 2010 and November 2011).

In the Nyaruguru district, the average travel time to a good water source is 14.2 minutes, which is virtually on par with the national average (14.4 minutes) (National Institute of statistics of Rwanda, October 2010 and November 2011).

It demonstrates that just 51% of families in Nyaruguru district have access to better sanitation, which is much less than the country average (74.4%) (National Institute of statistics of Rwanda, October 2010 and November 2011).

By 2012, 65% of the nation's population must have access to hygienic sanitation, according to the EDPRS sanitation target. There is little doubt that Nyaruguru district has met this goal (National Institute of statistics of Rwanda, October 2010 and November 2011).

Regarding the percentage of districts that use cement flooring, Nyaruguru is seventh from the bottom overall ranking (8%). The most often utilized material is beaten earth (87%). Additionally, according to the EICV3 statistics, only 17% of all families nationwide use cement flooring, compared to 50% of urban households (National Institute of statistics of Rwanda, October 2010 and November 2011).

In the Nyaruguru district, the primary wall material used by 76% of houses is mud-covered tree trunks, followed by mud bricks (12%) and mud bricks covered in cement (8%).

Tree trunks covered in mud are used as wall material in 35.2% of houses nationwide, compared to 17.1% in urban regions and 38.3% in rural ones.

Concerning upgrading wall construction materials, Nyaruguru district remains well behind the average for rural areas (National Institute of statistics of Rwanda, October 2010 and November 2011).

Nyaruguru district ranks among the districts that consume low levels of electricity, with 0.7% of homes using electricity as their primary source of lighting (between 0.3 and 1.6%) (National Institute of statistics of Rwanda, October 2010 and November 2011).

Compared to only 4.8% in rural areas and 10.8% nationwide, 46.1% of households utilize electricity as their primary source of lighting in urban areas. The district of Nyaruguru ranks third last out of all districts with 30% of households having a mobile phone.

It is less than the average for rural areas (40.6%). On average, 45.2% of homes nationwide and 71.5% of households in urban areas have a cell phone (National Institute of statistics of Rwanda, October 2010 and November 2011).

In the Nyaruguru district, 85% of residents who are 16 years of age or older are employed; there is no unemployment and a 15% incidence of economic inactivity. According to the employment rate, Nyaruguru district ranks thirteenth from the bottom among all districts, with an employment rate of 84% countrywide, an unemployment rate of 0.9%, and an economic inactivity rate of 15% (National Institute of statistics of Rwanda, October 2010 and November 2011).

In the Nyaruguru district, the median amount of time all people aged 16 and older, employed and unemployed, spent on all domestic tasks over the course of the previous

seven days was 19, with men spending 11 hours and women 26 hours. Across the country, women spend an average of 26 hours per week on domestic work, compared to men's nine hours per week, for a total of 19 hours per week (National Institute of statistics of Rwanda, October 2010 and November 2011).

Agriculture accounts for 50% of household income, followed by wages (22%) and rents (9%). Private transfer income makes up only 5% of household income in the Nyaruguru district) (National Institute of statistics of Rwanda, October 2010 and November 2011). Diarrhea is ranked as the third leading cause of mortality in children under five years old in Rwanda, a small blocked-in nation with a population of 12.5 million. In 2015, it was responsible for 18.3% of child deaths (Claudine et al., 2021).

1.2. Problem statement

According to the IHLCS3 findings, 66% of families in the Nyaruguru district have access to good drinking water sources (National Institute of statistics of Rwanda, October 2010 and November 2011).

The research reveals that protected spring water is used in most homes (44%), followed by protected wells (6%), and then public standpipes (15%). However, unimproved water sources are still used by 34% of families in the Nyaruguru area. The EDPRS national target requirement for the water and sanitation sector, which is to improve access to safe drinking water to 85% by 2012, has not yet been met by the Nyaruguru district (National Institute of statistics of Rwanda, October 2010 and November 2011).

Only 39% of Nyaruguru district households, according to the same report, are situated within 15 minutes of good water sources by foot. In terms of the proportion of families who can travel 15 minutes to a good water source, Nyaruguru district comes in ninth from the bottom. It is also crucial to remember that 9% of households in the Nyaruguru district still have to walk for 30 minutes or longer to get to good water sources. This proportion is less than the national average (12.8%). In the Nyaruguru district, the average travel time to a good water source is 14.2 minutes, virtually on par with the national average (14.4 minutes) (National Institute of statistics of Rwanda, October 2010 and November 2011).

Although the government of Rwanda has tried to improve hygiene and sanitation in the community, the factors associated with diarrheal disease of children under five years in the

Nyaruguru district are still unknown. This is a serious issue because children are still dying due to diarrheal disease.

The most common cause of undernourishment in sub-Saharan Africa and the second leading cause of morbidity and mortality among children under the age of five is related to diarrheal illnesses. Diarrhea is the third leading cause of death in children under five in Rwanda (Jean, 2017).

Approximately 8% of all fatalities among children under the age of five worldwide in 2017 were caused by diarrhea, according to UNICEF, making it the leading cause of death in children. Regardless of the accessibility of a simple action-reaction, this translates to more than 1,400 children daily, or nearly 525,000 kids annually (D. Mosisa et al., 2021).

Therefore, this study investigates hygiene and sanitation risk factors of diarrheal diseases among children under five in the Nyaruguru district and provides evidence-based information for health decision-makers to plan for effective intervention.

1.3. Purpose

The research aimed to identify the hygiene and sanitation risk factors of diarrheal disease among children under five in the Nyaruguru District of Rwanda.

1.4. General objective

To assess hygiene and sanitation factors of diarrheal disease among children under five in Nyaruguru District, Southern Rwanda

1.5. Specific objectives

To identify hygiene and sanitation risk factors of diarrhea among children under five in Nyaruguru district.

1.6. Research questions

What are the hygiene and sanitation risk factors of diarrheal disease among children under five in Nyaruguru district?

1.7. Significance of the study

Personal interest

Mothers who have children under five years of age will benefit from this study by receiving sufficient information concerning personal hygiene. This will play an important role in preventing diseases related to diarrhea among their children.

Scientific interest

Future researchers in the relevant field can consult this study. The risk of developing diseases related to poor hygiene and sanitation will be reduced by this study. More research will be conducted to explore the specific issues related to this study.

Social interest

The study's findings can be utilized as a starting point for numerous decision-making processes and intervention activities including sanitation and hygiene.

1.8. Limitation of the study

The study participants included only children who visited the hospital. Data on children who did not visit the hospital are missing. The results of the study, which focused on sanitation and hygiene risk factors of diarrheal disease among children under five in Nyaruguru district, Southern Province of Rwanda, were not generalized to the entire nation.

1.9. Scope of the study

This study is limited in geographical, time, and scope of content as shown below:

Geographical scope

This study, which involved children under five, was conducted in 14 sectors of Nyaruguru District, Southern province in 2021, namely, Cyahinda, Busanze, Kibeho, Mata, Munini, Kivu, Nyabimata, NYagisozi, Muganza, Ruheru, Ruramba, and Rusenge.

Time scope

This study on hygiene and sanitation risk factors of diarrheal disease among children less than five years old and other disorders is evaluated between January and September 2021.

Content scope

The study was conducted in Nyaruguru district (MUNINI Hospital) where sanitation and hygiene risk factors for diarrheal disease among children under five were investigated.

1.10. Definition of key terms

Hygiene: Outlines the procedures for confirming cleanliness and excellent health. The maintenance of health and healthy life is referred to by the scientific term " hygiene." Its origins are in Hygieia, the Greek goddess of sanitation, cleanliness, and health. Another science that deals with enhancing and defending health is hygiene (Patrick L. Anderson (Editor), November 15, 2008).

Sanitation: This term has been used in this study to describe the efficient use of resources and practices that maintain a healthy ecosystem. These include latrines or toilets to manage waste, areas for cooking and washing dishes, efficient drainage systems, and other similar

devices. Additionally, it refers to issues with sewage disposal, treatment of human waste, and access to clean drinking water (/English, Retrieved 2017-11-17).

Child: A person who is under the age of 18, unless the common age is achieved earlier under the law that applies to children.(UNICEF, 20 November 1989 entry into force 2 September 1990). This word has been used in this study to mean human being under 5 years of age

Diarrhea: The passing of three or more liquid or loose stools per day brought on by abnormally high stoma fluid content or an abnormal increase in daily stoma fluidity, frequency, or volume from what is thought to be typical for an individual and is caused by bacterial, viral, protozoal, or parasitic entities. (WHO, 2 May 2017).

Chapter II. LITERATURE REVIEW

Diarrhea involves the passing of three or more liquid or loose stools per day brought on by abnormally high stoma fluid content or an abnormal increase in daily stoma fluidity, frequency, or volume from what is thought to be typical for an individual and is caused by bacterial, viral, protozoal, or parasitic entities(WHO, 2 May 2017).

2.1. Determinants of diarrheal diseases among children under five years of age

The lack of handwashing indicates a nearby restroom and the mother's or caretakers' "history of the last two weeks." The causes of diarrheal infections in children under five include rotavirus vaccination status, unsuitable solid waste collection practices, incorrect latrine use, absence of handwashing during life-threatening situations, and diarrheal diseases themselves (Tarekegn & Enquselassie, 2012).

To reduce the problem of diarrheal illness among children under five, there should be ongoing and improved health information plans for households on the relevance of sanitation, personal cleanliness, and the rotavirus vaccine (OConnell et al., 2017).

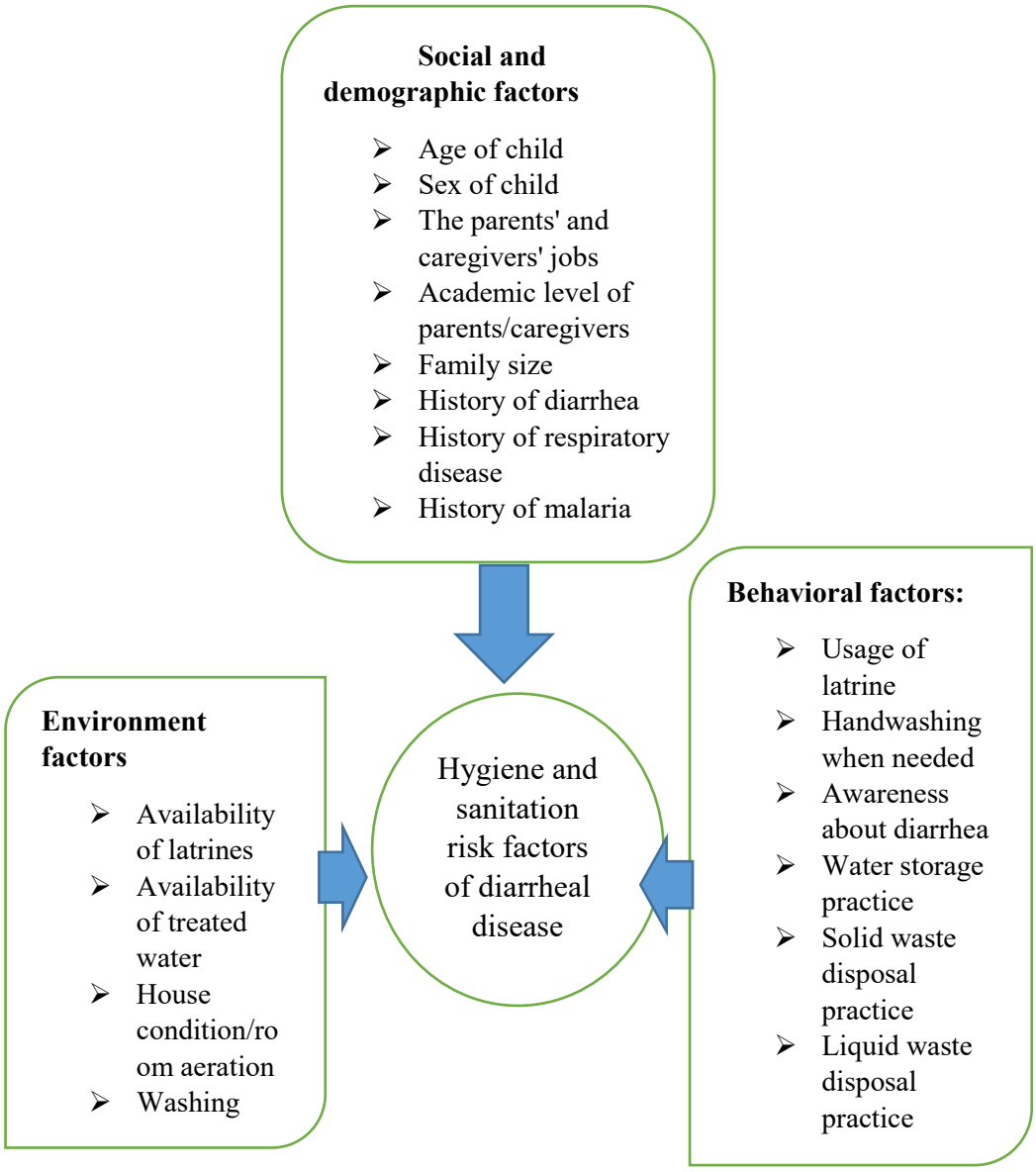

Figure 1: Conceptual framework of risk factors for diarrheal illness among children under five in terms of hygiene and sanitation

2.2. Malaria vs poor hygiene and sanitation

Good hygiene is generally recognized as one of the greatest effectual and forthright measures to avert the spread of diseases, including malaria (Yang et al., 2020).

The WASH component of the approach has thus far gotten only minimal attention, while the spread of malaria and other neglected tropical diseases (NTDs) has largely remained unaffected (Organization, 2018; Yang et al., 2020).

2.3. Dental caries vs poor hygiene and sanitation

Dental caries in children's deciduous teeth is more common due to an unpleasant condition with regard to oral hygiene practices, parental attitudes toward dental care, and behavioral changes (Guan et al., 2021).

To better control children’s oral health behaviors and boost prevention and treatment strategies for caries in children under the age of five, public awareness must be raised. Within the last ten years, dental caries has become one of the most common chronic diseases worldwide, especially in developing nations (Su et al., 2018).

Early childhood caries is an oral disease that is influenced by a variety of factors, including socioeconomic factors, nutritional factors, and organic factors. It is defined as the occurrence of decayed, absent, and filled tooth surfaces in any deciduous dentition in a child younger than 71 months (Kumar et al., 2014).

2.4. Respiratory infection vs hygiene and sanitation

Children's Acute Respiratory Infection morbidity and death are impacted by a variety of social and environmental factors. These include sociocultural beliefs, poor air quality, overpopulation, industrialization, misuse and improper use of antibiotics, the lack of access to basic health facilities, and a lack of awareness (Murarkar et al., 2021).

2.5. Factors associated with different hygiene practices among children under five

High hygiene scores are inversely correlated with maternal smoking during pregnancy, poor parental instructional performance, living in public housing, and increased use of chemical household products (Sherriff et al., 2002).

Higher hygiene ratings are found in more socially isolated groups, indicating that social deprivation has some influence on how cleanliness practices are implemented. The consumption of toxic household goods has increased in more isolating households (Burney et al., 1990).

2.6. The connection between mothers' handwashing habits and young children's health outcomes

Most mothers who are knowledgeable about handwashing do not follow the exact instructions (Taddese et al., 2020).

Children under five who are admitted with diarrhea are affected by their mother's ineffective handwashing habits. Therefore, it is crucial to increase mothers' comprehension of proper handwashing techniques at every level of the community(Bertrand & Walmus, 1983).

Mothers have a crucial influence on children's health because they are often the children's immediate and reliable cares (Reddy B et al., 2017)

Additionally, female parents are responsible for both general housekeeping (cooking meals for the family and feeding the kids) and child hygiene (handling their faces and blowing their nostrils), and poor hygiene practices might increase the risk of illness transfer to children (Reddy B et al., 2017).

2.7. Handwashing practices at critical times

Infections spread mostly through human contact, particularly respiratory and diarrheal illnesses, which are the leading causes of infant and under-five mortality in developing nations (Dagne et al., 2019).

When their own hands, their mothers' hands, or caretakers' hands at home or school touch their nose, mouth, or eyes with pathogen-contaminated hands, many children develop respiratory, gastrointestinal, and skin illnesses (Kruk et al., 2010).

Therefore, one of the best ways to reduce the spread of illnesses is to consistently and properly engage in hand washing. This practice alone can prevent millions of deaths each year. Despite being aware of this fact, many childcare providers still do not wash their hands properly (McMillen & Stern, 2000).

Hand washing with soap and water is one of the most effective ways of reducing the prevalence and incidence of infectious diseases incidence (Zwane & Kremer, 2007).

Some critical times of handwashing with soap

- After using the latrine
- After altering a child's nappy
- Before food preparation, before eating, and after eating
- Before and after nursing a child
- After dealing with animals
- Children like inserting their fingers in their mouths; hence, it is essential for them to wash their hands frequently.

Life-threatening handwashing periods for sick people caregivers and child caregivers-people who are HIV positive and children are at high risk of diarrheal illnesses (Dagne et al., 2019).

Chapter III. RESEARCH METHODOLOGY

3.1. Introduction

This chapter discusses the methods the researcher employed to gather pertinent data for the study. The approach utilized in the study is presented. It outlines the study's constraints, data gathering procedures, sample design, data analysis, and research design.

3.2. Study area, design, and period

A hospital-based cross-sectional study design was conducted in Munini Hospital of Nyaruguru District from January to September 2021.

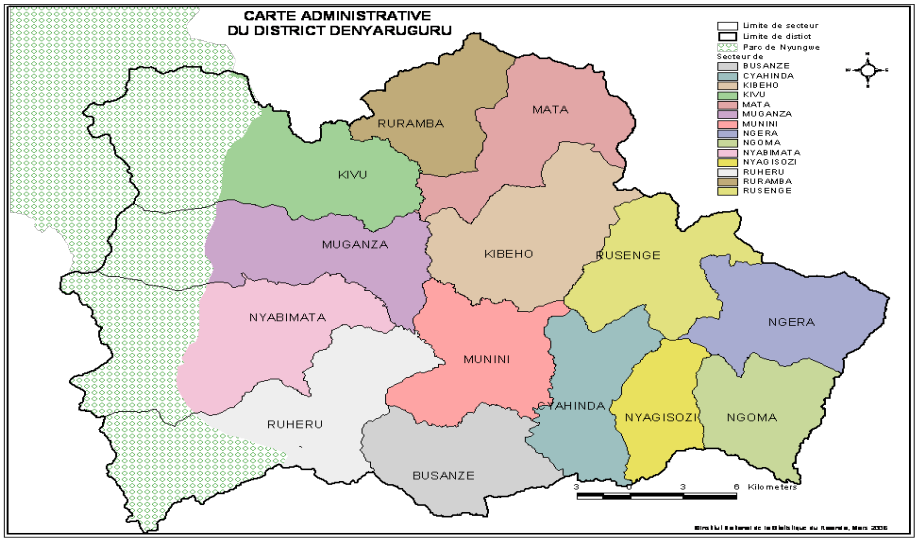

Figure 2: Map of Nyaruguru District

3.3. Research setting

Children under five who visited Munini hospital in 2021 were the participants of this study; it was conducted in the 14 sectors of Nyaruguru District, namely include Cyahinda, Busanze, Kibeho, Mata, Munini, Kivu, Ngera, Ngoma, Nyabimata, Nyagisozi, Muganza, Ruheru, Ruramba, and Rusenge. The Nyaruguru District is found in the Southern Province. According to the 2012 Rwandan census, the district has a total surface area of 1010 km^2, a total population of 294334 people living in 63613 households, and a population density of 291 habitats/km^s

3.4. Source and Study population

All children under five who consulted Munini Hospital of Nyaruguru District with any clinical history of illness were the source population and those who attended without missing information were the study population.

3.5. Inclusion and exclusion criteria

All children under five who attended Munini Hospital in Nyaruguru District with medical records were included in this study, and those without medical records, who did not visit the hospital and who had missing data were excluded from this study.

3.6. Variables

Dependent variables

The dependent variables are all conditions resulting from diarrheal disease in the study population. The researcher focused on diarrhea as the dependent variable

Independent variables

The dependent variables are the following factors related to and associated with diarrheal disease in this study:

Environmental factors: Availability of soap, availability of towels, availability of water, room light, room aeration

Behavioral factors: Wearing of shoes, use of soap, proper hand washing, use of treated water, use of toothpaste, clean bedrooms, hand washing after toilet use, cleanliness of children.

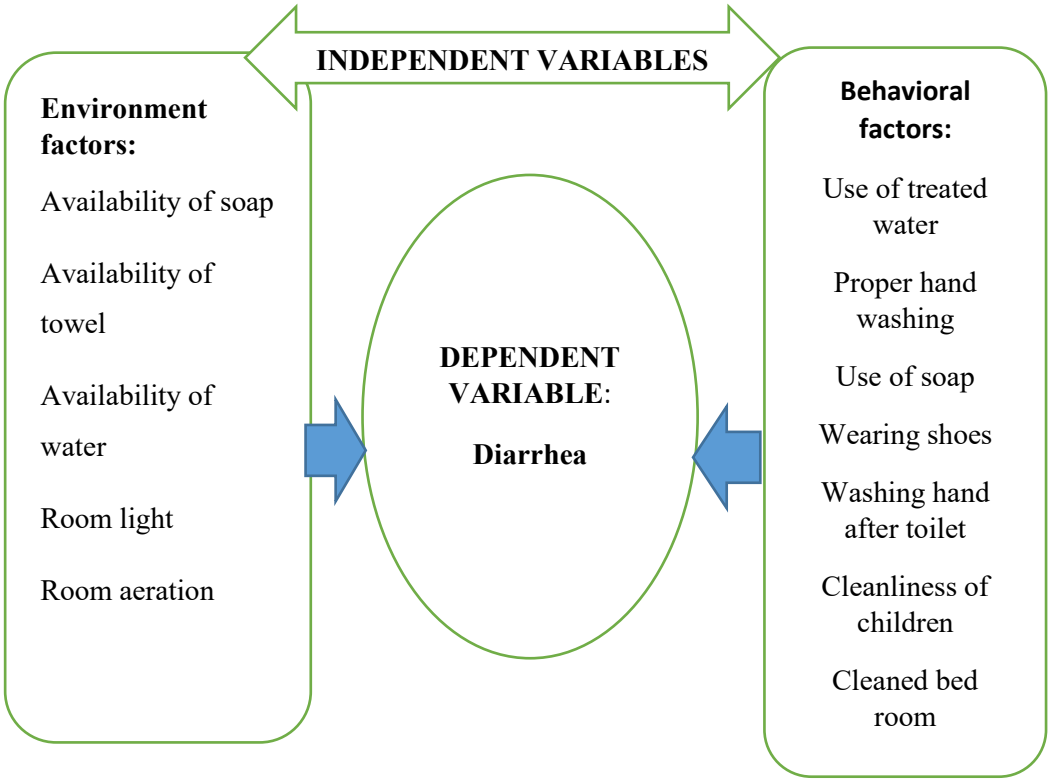

Figure 3: Conceptual framework of the study variables

3.7. Data analysis

Statistical analyses were conducted for the sampling weights to represent the entire children under five in the Nyaruguru district. The characteristics of the study population were analyzed using a pure chi-square test for binary variables. The odds ratios (OR), p-value, and 95% confidence intervals (CI) for diarrhea were determined using binomial logistic regression analysis. To confirm the results, binomial logistic regression models were analyzed in both the general population and the associated factors. The sample size was 950 participants (n = 950). Binomial logistic models were also analyzed to investigate the relationship between diarrhea and its predictors. All analyses were conducted using JAMOVI statistical software, version 2.2.5. $P < .05$ was considered statistically significant and applied in binomial logistic regression, and all statistical tests were two-sided.

Chapter IV. RESULTS AND DISCUSSION

4.1. Results

Table 1 shows the characteristics of the study population.

Of the 950 participants included in this study, there were 466 male children (49.1%) and 484 female children (50.9%). The results are presented as p-value (P) and numbers (percentage) for binary variables. Of the males, 112 (24%) had diarrhea and 354(76.0%) did not have diarrhea. Of the females, 92 (19%) had diarrhea and 392(81.0%) did not have diarrhea. The p-value was 0.059.

Among the 578 participants whose parents were non-farmers (60.8%), 98 (17.0%) had diarrhea and 480 (83.0%) did not. A total of 372 (39.2%) participants had parents who were farmers; among them, 106 (28.5%) had diarrhea and 226 (71.5%) did not. The p-value was <0.001.

Overall, parents of 419 (44.1%) participants did not have soap; among these participants, 110 (26.3%) had diarrhea and 309 (73.7%) did not. Of the participants whose parents had soap (n = 531; 55.9%), 94 (17.7%) had diarrhea and 437 (82.3%) did not. The p-value was 0.001.

Of the participants who had towels 525 (55.3%), 462 (88.0%) did not have diarrhea and 94 (17.7%) had diarrhea. Among participants without towels (n = 425; 44.7%), 284 (66.8%) did not have diarrhea and 141 (33.2%) had diarrhea. The p-value was <.001.

Of the participants who did not wear shores (n = 320; 33.7%), 222 (69.4%) did not have diarrhea and 98 (30.6%) had diarrhea. Of the participants who wore shoes (n = 630; 66.3%), 524 (83.2%) did not have diarrhea and 106 (16.8%) had diarrhea. The p-value was <.001.

The number of participants with cleanliness habits were 566 (59.6%); among them, 507 (89.6%) did not have diarrhea and 59 (10.4%) had diarrhea. Of the 384 participants without cleanliness habits (40.4%), 239 (62.2%) did not have diarrhea and 145 (37.8%) had diarrhea. The p-value was <.001.

Of the 398 participants without abdominal pain (41.9%), 348 (87.4%) did not have diarrhea and 50 (12.6%) had diarrhea. Of the 552 participants with abdominal pain (58.1%), 398 (72.1%) did not have diarrhea and 154 (27.9%) had diarrhea. The p-value was <.001.

Of the 720 participants who were not vomiting (75.8%), 694 (96.6%) did not have diarrhea and 26 (3.6%) had diarrhea. Of the 230 participants who were vomiting (24.2%), 52 (22.6%) did not have diarrhea and 178 (77.4%) had diarrhea. The p-value was <.001.

Of the 566 participants who were using treated water (59.6%), 460(81.3%) did not have diarrhea and 106 (18.7%) had diarrhea. Of the 384 participants who were not using treated water (40.4%), 286 (74.5%) did not have diarrhea and 98 (25.5%) had diarrhea. The p-value was 0.012.

Of the 500 participants who washed their hands properly (52.5%), 447 (96.6%) did not have diarrhea and 53(10.6%) had diarrhea. Of the 450 participants who did not wash their

hands properly (47.4%), 299 (66.4%) did not have diarrhea and 151 (33.6%) had diarrhea. The p-value was <.001.

Of the 522 participants with clean bedrooms (54.9%), 434 (83.1%) did not have diarrhea and 88 (16.9%) had diarrhea. Of the 428 participants without clean bedrooms (45.1%), 312 (72.9%) did not have diarrhea and 116 (27.1%) had diarrhea. The p-value was <.001.

Of the 320 participants with aerated room (33.7%), 257 (80.3%) did not have diarrhea and 63 (19.7%) had diarrhea. The participants without aerated room were 630 (66.3%), 489 (77.6%) did not have diarrhea and 141 (22.4%) had diarrhea. The p-value was 0.339.

Of the 566 participants with well-lit rooms (59.6%), 507(89.6%) did not have diarrhea and 59 (10.4%) had diarrhea. Of the 384 participants with poorly-lit rooms (66.3%), 293 (62.2%) did not have diarrhea and 145(37.8%) had diarrhea. The p-value was <.001.

The number of participants who used soap were 398 (41.9%); among them, 348 (87.4%) did not have diarrhea and 50 (10.4%) had diarrhea. The number of participants who did not use soap were 552 (58.1%); among them 398 (72.1%) did not have diarrhea and 154 (27.9%) had diarrhea. The p-value was <.001.

Table 2. Odds ratios, 95% confidence intervals and p-value of diarrhea from logistic regression analysis (association of diarrhea and predictors)

Of the 950 participants included in this study, there were 466 male children (49.1%) and 484 female children (50.9%). The results are presented as odds ratios (OR), and p-values (P), and 95% confidence intervals for binary variables.

The risk of suffering from diarrhea among female children is 1.35 times higher than among male children, but it is not statistically significant due to p=0.06, OR=1.35.

The children whose parents are in public service suffer from diarrhea less than those whose parents are farmers, and it is statistically significant p<.001, OR =0.512.

The risk of suffering from diarrhea among children who do not have access to soap is 5.21 times higher than among children who have access to soap, and it is statistically significant due to p<.001, OR=5.21.

The children without towels are at risk 3.64 times higher of suffering from diarrhea than those with towels to clean their bodies and it is statistically significant p<.001, OR =3.64.

The children who do not wear shoes are at risk 2.18 times higher of suffering from diarrhea than those who wear shoes and it is statistically significant p<.001, OR =2.18.

The children without cleanliness are at 5.21 times higher risk of suffering from diarrhea than those with cleanliness and it is statistically significant p<.001, OR =5.21.

The children with diarrhea are at 2.69 times higher risk of suffering from abdominal pain than those without diarrhea and it is statistically significant p<.001, OR =2.69.

There is a strong relationship between diarrhea and vomiting as evidenced by p<.001, OR=91.37.

The children who do not drink treated water are at 1.49 times higher risk of suffering from diarrhea than those who drink treated water and it is statistically significant p=0.013, OR =1.49.

The children whose hands are not washed properly are at 4.18 times higher risk of suffering from diarrhea than those with proper hand wash and it is statistically significant p<.001, OR =4.26.

Children with unclean bedrooms are at 1.83 times higher risk of suffering from diarrhea than those with clean bedrooms and it is statistically significant p<.001, OR =1.83.

The children without properly ventilated rooms are at 1.18 times higher risk of suffering from diarrhea than those with aerated rooms and it is not statistically significant p=0.34, OR =5.21

Children without well-lit rooms are at 5.21 times risk higher of suffering from diarrhea than those with well-lit rooms and it is statistically significant p<.001, OR =5.21.

The children who do not use soap are at 2.69 times higher risk of suffering from diarrhea than those who use, and it is statistically significant p<.001, OR =2.69.

Table 1. Characteristics of study participants

Predictors	n=950	Diarrhea				P
		No		Yes		
Sex of child						0.059
M	466(49.1)	354	76.0 %	112	24.0 %	
F	484(50.9)	392	81.0 %	92	19.0 %	
Occupation						<0.001
Non farmer	578(60.8%)	480	83.0 %	98	17.0 %	
Farmer	372(39.2%)	266	71.5 %	106	28.5 %	
Availability of soap						0.001
Yes	531(55.9%)	437	82.3 %	94	17.7 %	
No	419(44.1%)	309	73.7 %	110	26.3 %	
Available towel						<.001
Yes	525(55.3%)	462	88.0 %	63	12.0 %	
No	425(44.7)	284	66.8 %	141	33.2 %	
Wearing shoes						<.001
Yes	630(66.3%)	524	83.2 %	106	16.8 %	
No	320(33.7%)	222	69.4 %	98	30.6 %	

Cleanliness of child						<.001
Yes	566(59.6%)	507	89.6 %	59	10.4 %	
No	384(40.4%)	239	62.2 %	145	37.8 %	
Abdominal pain						<.001
No	398(41.9%)	348	87.4 %	50	12.6 %	
Yes	552(58.1%)	398	72.1 %	154	27.9 %	
use of treated water						0.012
Yes	566(59.6%)	460	81.3 %	106	18.7 %	
No	384(40.4%)	286	74.5 %	98	25.5 %	
Proper hand washing						<.001
Yes	500(52.6%)	447	89.4 %	53	10.6 %	
No	450(47.4%)	299	66.4 %	151	33.6 %	
clean bedrooms						<.001
Yes	522(54.9%)	434	83.1 %	88	16.9 %	
No	428(45.1%)	312	72.9 %	116	27.1 %	
Room aeration						0.339

Yes	320(33.7%)	257	80.3 %	63	19.7 %	
No	630(66.3%)	489	77.6 %	141	22.4 %	
Room light						<.001
Yes	566(59.6%)	507	89.6 %	59	10.4 %	
No	384(40.4%)	239	62.2 %	145	37.8 %	
Use of soap						<.001
Yes	398(41.9%)	348	87.4 %	50	12.6 %	
No	552(58.1%)	398	72.1 %	154	27.9 %	

Table 2. Odds ratios, 95% Confidence intervals and p-value of diarrhea from logistic regression analysis (association of diarrhea and predictors)

Model Coefficients - Diarrhea			**95% Confidence Interval**		
Predictor		**Odds ratio**	**Lower**	**Upper**	**p**
M	466(49.1)	1			
F	484(50.9)	1.35	0.988	1.84	0.06

Occupation					
Non farmer	578(60.8%)	1			
Farmer	372(39.2%)	0.512	0.375	0.701	< .001
Availability of soap					
Yes	531(55.9%)	1			
No	419(44.1%)	5.21	3.71	7.32	< .001
Available towel					
Yes	525(55.3%)	1			
No	425(44.7)	3.64	2.61	5.07	< .001
Wearing shoes					
Yes	630(66.3%)	1			
No	320(33.7%)	2.18	1.59	2.99	< .001
Cleanliness of child					
Yes	566(59.6%)	1			
No	384(40.4%)	5.21	3.71	7.32	< .001
Abdominal pain					
No	398(41.9%)	1			
Yes	552(58.1%)	2.69	1.9	3.82	< .001

use of treated water					
Yes	566(59.6%)	1			
No	384(40.4%)	1.49	1.09	2.03	0.013
Proper hand washing					
Yes	500(52.6%)	1			
No	450(47.4%)	4.26	3.02	6.02	< .001
clean bedroom					
Yes	522(54.9%)	1			
No	428(45.1%)	1.83	1.34	2.51	< .001
Room aeration					
Yes	320(33.7%)	1			
No	630(66.3%)	1.18	0.843	1.64	0.34
Room light					
Yes	566(59.6%)	1			
No	384(40.4%)	5.21	3.71	7.32	< .001
Use of soap					

Yes	398(41.9%)	1			
No	552(58.1%)	2.69	1.9	3.82	< .001

Implication of results

Children who lack proper cleanliness and sanitation have an increased chance of developing diarrhea. These at-risk populations should be the focus of strategies to prevent pediatric diarrhea. By providing proper healthcare, a targeted effort should be initiated to address low health among children. By providing hygiene and sanitation services, policymakers and stakeholders can improve the unfavorable environmental conditions.

4.2. Limitation of the study

Approximately 950 cases were selected, among which a total number of 204 diarrheal cases were used as dependent variables. The remaining were non-diarrheal cases. Among 746 non-diarrheal cases, there were some symptoms such abdominal pain and vomiting which are closely related to diarrhea. In this study, the correlation between abdominal pain and diarrhea was not analyzed. Future studies should consider the relationship between the two.

The findings of this research could not be generalized to whole country. This is because the study of the Nyaruguru area in Southern Province of Rwanda concentrated on hygiene and sanitation risk factors of diarrheal illness among children under five.

Future research should explore how family economic position is related to hygiene and sanitation variables of diarrheal disease in children under the age of five in light of the findings, which indicate that the majority of factors are related to the economic condition of families.

This research is not a case-control study; it involves a hospital-based cross-sectional study design, which cannot show the cause and effect due to the nature of data, which is also a limitation of the study.

Interviews with senior policymakers or administrators were not possible, which is another limitation. The only study participants were children who went to the hospital. Future studies can consider the data of children who did not visit a hospital, which was not done in this study. Nevertheless, the study identified potential sanitation and hygiene factors that increase the risk of diarrheal disease among children under five in the Nyaruguru District.

4.3. Discussion

Similar to the study conducted to determine hygiene and sanitation risk factors of diarrheal disease among under-five children, this study demonstrates that the absence of a hand-washing facilities near latrines, lack of hand-washing practice at critical times, lack of child cleanliness, the absence of treated water, the absence of towels at the washing stations, and

the absence of soap are the factors associated with and related to diarrheal diseases among children under five (Oloruntoba et al., 2014).

This study is similar to one that considered the prevalence of acute diarrhea and WASH-related factors among children under five in Woldia Town, Amhara Region, and northeastern Ethiopia. That study found that acute diarrhea is significantly correlated with poor sanitation facilities, poor handwashing at crucial times, and a lack of soap (Getahun & Adane, 2021).

Poor handwashing habits among children and caregivers after using the restroom, the lack of clean water, and poorly implemented WASH are significantly linked to diarrhea in children under the age of five, according to a study that was conducted to identify the risk factors for water, sanitation, and hygiene in the rural community of Dongila District, Northwest Ethiopia. To decrease the prevalence of under-five diarrhea, rural areas should prioritize improving access to clean water, effective sanitation, and hygiene habits (Hailu et al., 2021).

A cross-sectional study from 2016 found that children who drink untreated water have a higher chance of developing a diarrheal disease, which is similar to the study done to assess the prevalence of and variables related to diarrheal diseases among children under five in Malaysia. These at-risk populations should be the focus of strategies to prevent pediatric diarrhea. Additionally, the Government of Malaysia must work to guarantee that everyone has access to clean, treated water, and the Ministry of Health must concentrate on promoting an understanding of how to prevent diarrhea (Aziz et al., 2018).

To identify the causes of diarrheal diseases among children under the age of five, a case-control study was carried out in Jimma Geneti District, Oromia region, Ethiopia in 2020. The results revealed that improper latrine use, the absence of nearby hand-washing facilities, and a lack of hand-washing practice at critical times were among the causes of diarrheal diseases. This study is comparable to that study. The provision of ongoing and customized health education programs for homes should be encouraged to reduce the prevalence of diarrheal diseases among children under the age of five (Dejene Mosisa et al., 2021).

This study demonstrates that other significant characteristics related to diarrheal infections in children under the age of five include not wearing shoes, the parents' occupations, unclean bedrooms, and poorly-lit rooms.

CHAPTER V. CONCLUSION AND RECOMMENDATION

5.1. Conclusion

In this study, the causes of diarrheal diseases among children under the age of five were determined. These causes included the absence of a hand-washing facility near a latrine, a lack of hand-washing practice at a crucial time, not wearing shoes, parents' occupations, and children's lack of cleanliness. Other causes included the absence of treated water, unclean bedrooms, dark rooms, lack of towels at the washing stations, and a lack of soap.

Most factors that have been linked to diarrheal illness among children under five in the study area can be avoided. Therefore, encouraging the provision of ongoing and modified health information programs for households on the significance of sanitation and personal hygiene (hand-washing facilities and proper hand-washing practices at critical times, wearing shoes, cleanliness, cleaned bedroom, lightening room, and availability of treated water) is essential to reducing the burden of diarrheal disease.

5.2. Recommendations

Nyaruguru District Health Office, the Environmental Health Department, and the Rwanda Ministry of Health should inspire the community to build a hand-washing station near the latrine, motivate the community to use the latrine properly and to wash their hands at crucial times, and emphasize the value of personal hygiene for all children under the age of five. Healthcare professionals should support and educate mothers and caregivers about the importance of having hand-washing facilities close to restrooms, personal hygiene, and

proper latrine usage, as well as the significance of hand-washing techniques during a vulnerable period, proper solid waste disposal techniques, and home water treatment techniques.

To stop the spread of diarrheal disease from mother to child and from one child to another, local NGOs should work with the District Health Office and other stakeholders on personal hygiene practices, the early introduction of hand-washing habits, and the preparation of areas for proper solid waste disposal practices. Mothers are responsible for the personal hygiene of their children by making towels available for them, cleaning them and their bedrooms, installing lights in their rooms, and ensuring that there are windows in children's rooms.

Future research is needed to find out the extent to which parents' occupations affect the personal hygiene and sanitation of children under five.

In this study, the correlation between abdominal pain and diarrhea was not analyzed. Future studies should consider this relationship.

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