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Variables That Impact Incidence of Diarrhea Amongst Under-Five in Uganda

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Abstract

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MPH, University of Nairobi, 2006

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Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Diarrhea in children remains a major public health problem in Uganda and other countries in the region and acts as one of the leading contributors to child mortality. Most of the risk factors for diarrhea in children are preventable. This study, guided by the socioecological model, was conducted to investigate the association between the occurrence of diarrhea in children and length of breastfeeding, coinfection with acute respiratory infection (ARI), and vaccination status of the child. These variables were identified in the literature as risk factors for diarrhea that had not been investigated in Uganda. The source of the data for this study was the Uganda Demographic and Health Survey 2011 dataset. Data analyses included descriptive statistics of all variables, bivariate analysis using binary logistic regression and multivariable logistic regression. Findings indicated that longer breastfeeding duration was associated with lower incidence of diarrhea. This was particularly significant when breastfeeding was continued beyond 24 months of age. Children who had ARI were twice as likely to have diarrhea as compared to children without ARI. Vaccination status was not significantly associated with occurrence of diarrhea. Increasing age of the child as well as higher age and higher education level of the mother were found to be associated with less occurrence of diarrhea in the child. This study may contribute to positive social change through recommendations that could reduce the burden of diarrhea in children. These recommendations include longer breastfeeding periods up to at least 3 years, integrated management of ARI and diarrhea, and policy support for women in this region to attain higher education levels and engage in less early childbearing.

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Dedication

I dedicate this dissertation to my children, Ashley, Ryan, and Justin: Let your dreams outgrow the shoes of your expectations.

Acknowledgments

The process of designing and completing this dissertation has been a long journey, but it has been worth it. A lot of important people have made this dream come true, and I am eternally grateful to all of them. First, I would like to thank God, for He made this possible. I would like to extend my gratitude and appreciation to my chair, Dr. Donald Goodwin, for his guidance and support, as well as for challenging me to think deeper. My deep gratitude goes to Dr. Leslie Elliott for providing expert direction, guidance, and feedback. I also am sincerely grateful to Dr. Simone Salandy for providing expert advice. Finally, my deepest appreciation and gratitude go to my husband, Pius Muli, for his unwavering support and patience all the way. I can never thank you enough.

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Chapter 1: Introduction to the Study

Background

Childhood diarrhea is one of the leading causes of morbidity and mortality in children under 5 years of age and is estimated to account for over 600,000 deaths globally annually (Liu et al., 2015), making it the second most common cause of childhood mortality after pneumonia (Liu et al., 2012; Walker et al., 2013b). According to Liu et al. (2015), of the 6.3 million deaths that occurred in children under the age of 5 worldwide in 2013, 10% were attributed to diarrhea. In effect, 2,195 children die from diarrhea every day, which is more deaths than AIDS, malaria, and measles combined (Liu et al., 2012). The majority of these childhood deaths occur in South Asia and Africa (Bhutta & Das, 2013), including Uganda (United Nations International Children's Emergency Fund [UNICEF], 2009). Child morbidity and mortality studies and reports in Uganda show that diarrhea is a major public health problem (UNICEF, 2009). In 2008, 16% of all under-5 deaths in Uganda were attributed to diarrhea (Walker et al., 2013b). The 2011 Uganda Demographic and Health Survey (UDHS) reported that 23% of the children in Uganda had diarrhea in the 2 weeks preceding a national survey (UDHS, 2011).

Childhood diarrhea is caused by numerous factors. Kotloff et al. (2013) found that moderate to severe diarrhea in children was mostly attributed to *Cryptosporidium*, enterotoxigenic *Escherichia coli*, *Shigella*, and rotavirus pathogens in a study carried out in multiple sites in sub-Saharan Africa and Asia. In other studies (Bonkoungou et al., 2013; Nakawesi, Wobudeya, Ndeezi, Mworozi, & Tumwine, 2010), rotavirus was found to be the predominant pathogen associated with diarrhea in children. Infection with these pathogens that cause childhood diarrhea has been commonly associated with low-resource settings coupled with low levels of sanitation, lack of or inadequate treatment of water in the household, and lack of piped water (Chandra Mouli Natchu & Bhatnagar, 2013), which results in increased transmission of disease pathogens through consumption of contaminated food or water. Another cited risk factor is low education level of the mother/caregiver (Mbugua et al., 2014; Mihrete, Alemie, & Teferra, 2014). However, as noted from these studies, risk factors for childhood diarrhea may vary by population, with some factors being more important than others in particular settings; thus, there is a need to understand the risk factors for childhood diarrhea in Uganda, which has an impact on children's nutrition, development (Kotloff et al., 2013; Weisz et al., 2011), and survival.

Another risk factor that may impact childhood diarrhea is lack of or suboptimal breastfeeding of children. The World Health Organization (WHO, 2017dc) has recommended that children be exclusively breastfed for the first 6 months of life because exclusive breastfeeding in the first 6 months of life is known to protect the child against childhood diarrhea (Lamberti, Walker, Noiman, Victora, & Black, 2011). This is due to maternal antibodies that offer a natural immunological mechanism against diarrheal disease and reduced exposure of the child to utensils, food, and fluids that may be contaminated and may thus cause diarrhea. However, the benefits of continued breastfeeding past 6 months in terms of diarrheal disease are not well established.

Other studies have also drawn a correlation between breastfeeding and decreased incidence of diarrhea in children (Bhutta & Das, 2013; Das, Salaam, & Bhutta, 2014; Lindsay et al., 2015). However, these studies concentrated on exclusive breastfeeding in the first 6 months of a child's life without exploring the effect of longer breastfeeding periods. Studies on childhood diarrhea that included a breastfeeding period beyond the child's first 6 months include a study by Das et al. (2012) that revealed that incidence of persistent diarrhea in children aged 12 to 59 months decreased with increases in maternal literacy, breastfeeding practices, measles immunization, and vitamin A supplementation in that population. Similarly, Leung et al. (2015) showed that breastfeeding was protective against moderate to severe diarrhea in children less than 60 months of age. In contrast, the work by Wobudeya et al. (2011) among children in Uganda did not demonstrate a relationship between the incidence of diarrhea caused by rotavirus infection which is a common cause of diarrhea in children and breastfeeding status of the child. In this study, a majority of participants were over 6 months of age and on complementary feeding, and the intensity of breastfeeding was not assessed. More research is needed to understand the association between continued breastfeeding beyond the first 6 months of life and occurrence of diarrhea.

Childhood diarrhea commonly presents together with acute respiratory infection, which is often a sign of pneumonia (Walker et al., 2013a), and these two diseases together are the leading causes of death in children under 5 years of age, as described earlier. There is a paucity of studies that describe the relationship between the two diseases. A few studies have assessed how diarrhea impacts acute respiratory infection, but the reverse has not been investigated. For instance, Ashraf, Huque, Kenah, Agboatwalla, and Luby (2013) indicated that children under 5 years of age were at an increased risk of pneumonia following a recent diarrheal illness. Leung et al. (2015)

emphasized the need for further research to determine if the presence of diarrhea predisposes a child to concurrent or subsequent respiratory disease. Statistics from a national survey indicated that 15% of the children under 5 years of age in Uganda had signs of acute respiratory infection while 23% had diarrhea (UDHS, 2011). The impact of pneumonia on childhood diarrhea has not been well addressed; thus, it is useful to evaluate the association between the two diseases among Ugandan children, which could provide information useful in reducing morbidity and mortality associated with childhood diarrhea.

Childhood vaccinations are a lifesaving public health initiative and have made a tremendous contribution in controlling infectious diseases in children (Rappuoli, Pizza, Del Giudice, & De Gregorio, 2014), but few epidemiological studies have investigated the association between diarrheal disease and vaccination status of the child. Pinzón-Rondón, Zárate-Ardila, Hoyos-Martínez, Ruiz-Sternberg, & Vélez-van-Meerbeke (2015), in a multilevel study on acute diarrhea, showed that children with incomplete immunization status were 33% more likely to develop diarrhea than children with complete immunizations. The potential of childhood routine vaccines to have an impact beyond the expected association with the specific disease was demonstrated by a randomized controlled trial by Aaby et al. (2010), which indicated that measles vaccine administration contributed to a 22% reduction in all-cause mortality yet prevention of measles infection itself contributed to only a small part of this change in all-cause mortality. The International Vaccine Access Center (IVAC, 2014) has stated a need to explore the broader value of vaccines, given that vaccines are known to be effective in preventing morbidity and mortality in children. Equally, information specifically pertaining to how routine vaccinations affect the incidence of diarrhea, especially in children in Uganda and the sub-Saharan region, is lacking.

Childhood diarrhea can have grave consequences, but it is a preventable disease. Three decades ago, diarrheal disorders were the largest causes of child mortality, responsible for 4.6 million deaths annually worldwide (Black et al., 2013). These numbers have been reduced due to improvements in prevention and treatment. Chopra et al. (2013) posited that the reduction of preventable deaths due to diarrhea is achievable globally by upscaling interventions such as coverage of oral rehydration salts and zinc for treating diarrhea. This is further supported by the work of Löfgren, Tao, Larsson, Kyakulaga, and Forsberg (2012), which emphasized that diarrhea case management can be improved by increasing effort in oral rehydration salts and zinc usage. Both treatments are recognized to reduce mortality from diarrhea, and zinc offers additional protection by lowering the incidence of diarrhea months after the initial episode (Walker & Black, 2010).

As described above, childhood diarrhea is treatable, and deaths associated with with diarrhea are preventable. Though morbidity and mortality have reduced in recent decades, numbers remain unacceptably high. In the post-2015 Millennium Development Goals era, country targets to reduce child deaths were set. These included the “A Promise Renewed” target of 20 or fewer under-5 deaths per 1,000 live births by the year 2035 in all countries (UNICEF, 2013). Thus, intensified effort is needed to reduce morbidity and deaths from childhood diarrhea, which is the second largest contributor to these mortalities. One of the efforts to accelerate this decline involves characterizing risk factors. In the face of the research that has been carried out on childhood diarrhea, there is a paucity of evidence from the literature on the association of length of breastfeeding, presence of acute respiratory infections, and vaccination status of the child on the incidence of childhood diarrhea. These factors formed the focus for this study. This study is needed, in that it contributes to the literature by providing evidence on factors that could impact the incidence of diarrhea among children in Uganda. This has potential social change implications, in that the evidence derived could contribute to reducing childhood diarrhea incidence and mortality in the country.

This introductory chapter is organized into 12 key areas. The first section has presented the background of the study. The second section contains the problem statement. The third section addresses the purpose of the study. The fourth section consists of the study questions and related hypotheses. In the fifth section, I discuss the theoretical framework of the study. In the sixth section, the nature of the study and a brief discussion of study methods are presented, followed by definitions of terms and study assumptions, scope and delimitations, limitations, and significance, concluding with a summary and transition.

Problem Statement

Globally, in 2015, 5.9 million children under the age of 5 years died, and the majority of these children were in the African region (WHO, 2017a). Most of these mortalities occurred as a consequence of diarrhea and acute respiratory infections (Bhutta & Das, 2013; Walker et al., 2013b;). Childhood diarrhea is a preventable disease, and

Uganda is among the countries where the burden of childhood diarrhea is heavily concentrated (IVAC, 2014). In 2008 in Uganda, 16% of all under-5 deaths were attributed to diarrhea (Walker et al., 2013b). This study addresses the impact of length of breastfeeding, completion of childhood immunization status of the child, and presence of acute respiratory infection on the occurrence of diarrhea in children in Uganda by analyzing secondary data from the UDHS 2011 dataset.

Exclusive breastfeeding of children under 6 months of age contributes to reduction in morbidity and mortality (Black et al., 2013), which includes reduction in episodes of diarrhea (Haile & Biadgilign, 2015; Hanieh et al., 2015). The benefit of breastfeeding beyond this age in terms of reducing diarrhea is not clear, and while UNICEF (2015) recommended continued breastfeeding for up to 2 years, the effect of a longer breastfeeding period in terms of the potential to reduce the occurrence of diarrhea needs to be explored. There is also a paucity of information on the benefits offered by routine immunizations, specifically as protection from diarrhea. Yet routine immunization has been seen to reduce all-cause morbidity and mortality in children (Girma & Berhane, 2011). The impact of acute respiratory infection on diarrheal disease has not been fully explored, although it is an equally common disease in childhood. These risk factors will be studied with respect to their potential to have an impact on the incidence of diarrheal episodes. If associations are established, they could provide important evidence for guiding the design of prevention strategies that would help in reducing morbidity and mortality due to childhood diarrhea in Uganda and areas with similar settings.

Purpose of the Study

The purpose of this study was to assess how selected variables impact the incidence of diarrhea among children in Uganda through a quantitative study methodology. This was done by assessing the association between the dependent variable, incidence of diarrhea in children, and the independent variables: length of breastfeeding, presence of acute respiratory infections, and completion of immunization status of the child. The assessment of these associations was done to provide evidence of how the independent variables are related to the occurrence of diarrhea in children and whether they predict the outcome.

Research Questions and Hypothesis

Research Question 1

Is there an association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the length of breastfeeding of the child (as determined by the number of months a child has been breastfed)?

H_0: There is no association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the length of breastfeeding of the child (as determined by the number of months a child has been breastfed).

H_A: There is an association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the length of breastfeeding of the child (as determined by the number of months a child has been breastfed).

Research Question 2

Is there an association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the presence of acute respiratory infection (as determined by the presence of cough accompanied by short, rapid breathing within the past 2 weeks)?

H_0: There is no association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the presence of acute respiratory infection (as determined by presence of cough accompanied by short, rapid breathing within the past 2 weeks).

H_A: There is an association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the presence of acute respiratory infection (as determined by the presence of cough accompanied by short, rapid breathing within the past 2 weeks).

Research Question 3

Is there an association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the vaccination status of the child (as determined from the vaccination card and/or mother's verbal report)?

H_0: There is no association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the vaccination status of the child (as determined from the vaccination card and/or mother's verbal report).

H_A: There is an association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the vaccination status of the child (as determined from the vaccination card and/or mother's verbal report)?

Theoretical Framework

The theory applied in this study was the socioecological model (SEM). The theory identifies the environmental systems that shape individuals' growth, development, and behavior. This theory was developed by Bronfenbrenner (1979), who argued that human development can only be understood by considering the entire ecological system. Bronfenbrenner (1979) acknowledged the interaction between living things and their environment and that the environment has an impact on whether people will live with a disease or not.

The SEM was used in this study to test the proposed hypotheses in the context of environmental influences on the incidence of diarrhea in children. In an environment where a disease is prevalent (e.g., diarrhea among children in Uganda), prevalence may result from the microsystem, which encompasses the individuals who immediately impact a child's health (i.e., the child's caregivers). There is also the influence of the mesosystem, exosystem, macrosystem, and chronosystem. These are the larger social systems that could influence whether a child presents with a disease or not. For example, the state of the health system in the community influences whether children receive immunizations or not, as well as whether they receive timely care for other diseases, which would influence whether they will acquire diarrhea and whether (if they do) they recover or die. Within the context of the incidence of childhood diarrhea, these levels of the environment in Bronfenbrenner's SEM are used to explain the occurrence of the disease.

Nature of the Study

The research approach was a quantitative study that used secondary data from the Uganda Demographic and Health Survey (UDHS) 2011, conducted from May through December 2011 (UDHS, 2011). The data were accessed through the Demographic & Health Surveys [DHS] Program, (n.d.). The DHS Program collects nationally representative data on health and population every 5 years from large samples. This study used only the latest survey data, drawn from the fifth comprehensive survey done in Uganda as part of the worldwide demographic and health surveys (DHS Program, n.d.).

Data for the survey were collected by administering a questionnaire to collect information on the household level, a questionnaire targeted to males in the household, and a questionnaire administered to women to collect information pertaining to women and children. The UDHS 2011 dataset was representative at the national and regional levels and comprised 9,003 households and 8,076 women in the age bracket of 15-49 years who provided data on children born in the 5 years prior to when the survey was conducted (UDHS, 2011). The database is available online with permission from the DHS Program.

An assessment was made of the association between the incidence of diarrhea, which was the dependent variable, and the independent variables, including length of breast feeding; concurrent morbidity with acute respiratory infections; and the immunization status of the child. Diarrhea was determined in the survey by asking the mother if the child had passed loose, watery stools three or more times in a day in the 2 weeks preceding the survey (UDHS, 2011). Incidence of acute respiratory infection was determined by asking the mother if the child had a cough accompanied by short, rapid breathing in the 2 weeks preceding the survey (UDHS, 2011), while immunization status was determined through examination of the health card and through verbal report from the mother when the card was unavailable (UDHS, 2011). A multivariable logistic regression analysis was used to identify the associations and to predict the impact of the independent variables on the dependent variable. Potential confounders considered were age and sex of the child; age, education level and religion of the mother; number of children in the family; and location (urban or rural). Data were analyzed using Statistical Package for the Social Sciences (SPSS).

Definition of Terms

Acute respiratory infection: In the DHS, acute respiratory infection in children is identified by the presence of a cough accompanied by short, rapid breathing (UDHS, 2011).

Complete immunization/vaccination: Children are considered fully immunized when they have received the following immunizations against vaccine-preventable diseases by the time they reach 1 year of age: a dose of Bacille Calmette-Guerin (BCG) vaccine; three doses of diphtheria, pertussis, tetanus, hepatitis B, *Haemophilus influenza* type b (DPT-HepB-Hib); oral polio vaccine; and measles vaccine (UDHS, 2011).

Diarrhea: The passage of loose, watery stools three or more times in the previous 24 hours (WHO, 2017b).

Exclusive breastfeeding: Feeding an infant from birth to 6 months of age only with breast milk without giving any other liquids or solids, including water, with the exception of oral rehydration solution or drops of medicine (WHO, 2017c).

Under-5: Under-5 and *children* are used interchangeably in this study and refer to children aged between 0 and 59 months of age.

Assumptions

It was assumed that the data in the secondary data set were collected in a valid manner and that the instruments used in collecting the data were valid and reliable. It was also assumed that the sampling techniques did not contain errors and that the data coding and entry done by the DHS Program research assistants were accurate. It was also assumed that the study participants responded in an honest and accurate manner.

Scope and Delimitations

The scope of this study involved the use of the UDHS data set to examine the associations between the incidence of diarrhea and the length of breastfeeding of a child, the presence of acute respiratory infections, and vaccination status of the child among children under 5 years of age in the population of Uganda. The study was delimited to children in Uganda. Another delimitation was the use of the Demographic Health Surveys, a well-established source of reliable population data with a large, nationally representative sample, which added strength to the validity of the findings. The data was available and accessible to researchers who have been granted permission to use this information.

Limitations

The dependent and independent variable definitions were limited by the information collected by the DHS Program. The presence of diarrhea and acute respiratory infection was classified based on the experience of signs and symptoms reported by a child's mother, and this information was not validated by medical personnel. Additionally, the mothers were asked about past events, which introduced the possibility of recall bias. However, the recall period was within the 2 weeks before data collection. The cross-sectional nature of the survey limited inferences about causality from the analysis.

Significance of the Study

This study makes an original contribution by providing information on factors/variables regarding associations with diarrhea that have not been explored fully among children in Uganda. Information on these factors may be of value to public health efforts toward reducing the incidence of diarrhea in children. Because diarrhea is preventable, findings from this study may support positive change by providing evidence that helps in the prevention of childhood diarrhea, thus also reducing associated mortality within this population.

Summary and Transition

Childhood diarrhea is a significant public health problem, as it is the second largest killer in children. Childhood diarrhea is costly to families and to the entire nation, yet it is a disease that can be prevented. In this study, I quantitatively examined the association between incidence of diarrhea and length of breastfeeding, concurrent morbidity due to acute respiratory infections, and the immunization status of the child using the 2011 UDHS dataset.

The theoretical framework for this study was based upon the socioecological model. This chapter has been broken down into sections addressing the background of the study; the problem statement; the purpose of the study; the research questions and hypotheses; the theoretical framework; the nature of the study; definitions of terms; assumptions, scope and delimitations, and limitations of the study; and the significance of the study. A detailed review of the literature on childhood diarrhea and its association with length of breastfeeding of the child, acute respiratory infections, and immunization status of the child is presented in Chapter 2, followed by the research methodology in Chapter 3, a presentation of the results in Chapter 4, and thereafter a summary, discussion, and conclusions in Chapter 5.

Chapter 2: Literature Review

Introduction

Diarrhea in children is the second most common cause of morbidity and mortality among children under 5 years of age (Chopra et al., 2013; Liu et al., 2012) globally, and the majority of these cases are found in sub-Saharan Africa and South Asia (Black et al., 2010). Uganda is ranked ninth among the 15 countries in the world with the highest burden of diarrhea in children (UNICEF, 2009), as shown in Table 1. It is estimated that every year, close to 1 million children worldwide lose their lives before their fifth birthday due to the disease (Liu et al., 2015).

Diarrhea in children is caused by a wide array of pathogens, which include bacteria, viruses, and protozoa (Kotloff et al., 2013), and the disease is particularly dangerous because of the profound dehydration it causes, which can result in death (Farthing et al., 2013; WHO, 2017b). The disease is attributed to risk factors such as poor sanitary practices (Chandra Mouli Natchu & Bhatnagar, 2013; Nhampossa et al., 2015), lack of adequate safe water (Mbugua et al., 2014), suboptimal breastfeeding practices (Girma & Berhane, 2011; Strand et al., 2012), living in a rural area (Mengistie, Berhane, & Worku, 2013), two or more siblings in the house (Mengistie et al., 2013), lack of, or incomplete vaccination of children (Santos et al., 2014), and age of the child (Strand et al., 2012). Although diarrhea in children in Uganda and other developing countries is a significant public health problem, it is preventable through efforts to address risk factors (Rudan, Nair, Marušić, & Campbell, 2013), and it can be controlled easily through administration of oral rehydration salts to counteract extreme fluid and electrolyte loss

(Chandra Mouli Natchu & Bhatnagar, 2013; Löfgren et al., 2012) and therapeutic zinc supplementation, which is known to reduce episode duration and improve diarrheal disease outcome (Lamberti, Walker, Chan, Jian, & Black, 2013).

Table 1

Countries With the Highest Numbers of Annual Child Deaths Due to Diarrhea

Rank	Country	Numbers
1	India	386,000
2	Nigeria	151,700
3	Democratic Republic of Congo	89,900
4	Afghanistan	82,100
5	Ethiopia	73,700
6	Pakistan	53,500
7	Bangladesh	50,800
8	Chad	40,000
9	Uganda	29,300
10	Kenya	27,400
11	Nigeria	26,400
12	Burkina Faso	24,300
13	Tanzania	23,900
14	Mali	20,900
15	Angola	19,700

Note. Adapted from *Diarrhoea: Why Children Are Still Dying and What Can Be Done* (p. 7), by UNICEF, 2009 (http://www.unicef.org/media/files/Final_Diarrhoea_Report_October_2009_final.pdf). Copyright 2009 by UNICEF. Adapted with permission.

There is a gap in knowledge on the length of breastfeeding, the presence of acute respiratory infections, vaccination status of the child (routine vaccinations), and how these variables are associated with the occurrence of episodes of diarrhea in children. In this literature review, I discuss the current literature regarding these factors while addressing the gap in literature. The literature review chapter is organized into sections covering the introduction, search strategy used to generate literature for the literature review, theoretical framework for the study, analysis of diarrhea in children and risk factors which are, breastfeeding and length of breastfeeding in children, acute respiratory infections, and routine immunizations among children, as well as how these variables relate to childhood diarrhea.

Literature Search Strategy

The literature research strategy was organized to provide literature that would answer the research questions and underscore the theoretical framework. The literature search was achieved by reviewing published peer-reviewed literature available in online academic databases provided by Walden University. The search was mostly limited to materials published from the years 2010 to 2016. An exception was literature describing the origin and development of the theoretical framework used for this study. Websites of specialized agencies such as the WHO and UNICEF were also reviewed to provide recent information.

The online academic databases searched included CINAHL, Medline, EBSCOhost, and PubMed. Additional databases included ProQuest, which I used to search published dissertations related to my topic. The key search terms for the literature search included *diarrhea in children* or *child* or *under-five*, *exclusive breastfeeding*, *breastfeeding*, *length of breastfeeding*, *acute respiratory infection*, *pneumonia*, *vaccination* or *immunization*, *Uganda*, and *socio-ecological model*.

Theoretical Foundation

The theoretical framework for this study was drawn from the socioecological model (SEM). The theory was first developed by Bronfenbrenner (1979) to explain the influence of the surrounding environment on an individual's development. He extended this theory to account for the complexity of human development within nested systems. Bronfenbrenner portrayed the environment as made of different levels (Figure 1)—intrapersonal, community, organizational, and international—illustrated as concentric circles, with each of these representing the levels of the social world that influence a person's behavior or development.

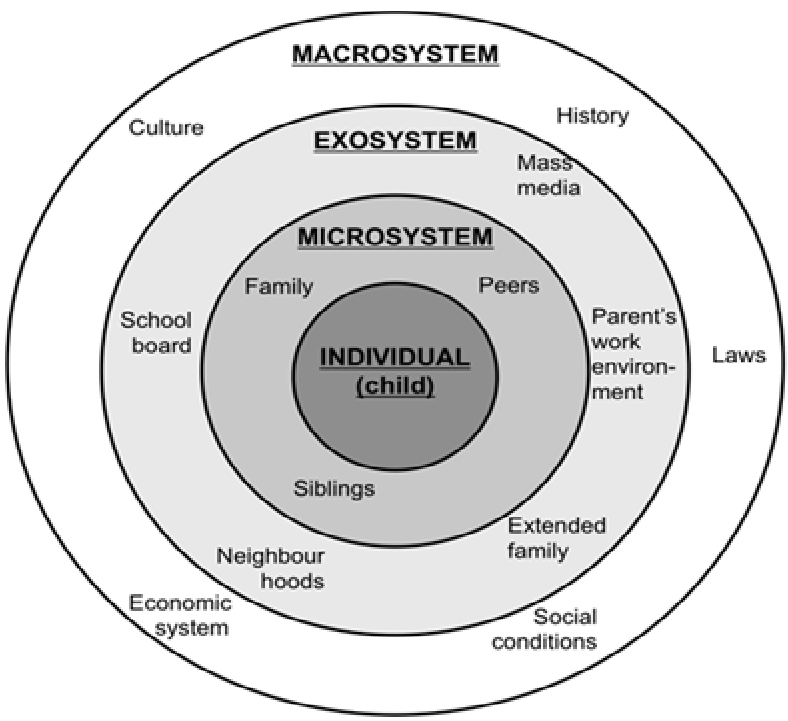

Figure 1. Bronfenbrenner's socioecological model. Reprinted from *Influence of a lifestyle intervention in preschool children on physiological and psychological parameters (Ballbeina)*: *Study design of a cluster randomized controlled trial*, by Niederer, I., Kriemler, S., Zahner, L., Bürgi, F., Ebenegger, V., Hartmann, T., ... Puder, J. J, 2009, *BMC Public Health*, *9*(1), 94. Copyright 2009 by licensee BioMed Central Ltd. Reprinted with permission.

According to the theory, the ecological system is made up of socially organized levels that influence human growth and development. These include the individual or *microsystem* level, which refers to the immediate environment that impacts the developing child's health and includes elements such as school, caregivers, and biological and personal history factors. The outer system levels (*exosystem* and *macrosystem*) symbolize more distal environmental and societal factors, such as culture, social norms, economy, and national and international bodies (Bronfenbrenner, 1994). The theory is based on the notion that human behavior functions within these spheres of social influence.

This depiction by the SEM provides a useful framework for understanding the effects of multifaceted levels of influence such as individual, family, social system, and public policy on behavioral and health outcomes (Bronfenbrenner, 1979). Researchers have used SEM to understand health behaviors and the factors that influence them. Pinzón-Rondón, Zárate-Ardila, Hoyos-Martínez, Ruiz-Sternberg, and Vélez-van-Meerbeke (2015), in a multilevel study, used Bronfenbrenner's SEM to describe factors that are associated with diarrhea in children by individual characteristics and environmental systems. Individual factors included young age of the child and short-term breastfeeding. Household factors included low maternal education, employment, and lack of sanitation.

A study by Lee and Stewart (2013) additionally demonstrated the application of the SEM in research. In this study, the SEM lens was used to reveal that environment and society factors shape students' resilience through the involvement of students, staff, and community in a comprehensive manner to build resilience in students. In another study, Schneiderman, Kools, Negriff, Smith, and Trickett, (2015) used the SEM to describe how a combination of environment and structural factors determines the mental health of maltreated youth.

In public health promotions, SEM has been used to describe the complex interaction between people and their environment in regard to disease prevention (Hirsch, Lin, & Otten, 2016; Simon et al., 2014). Hirsch et al. (2016) developed an SEM of food practices that described the influence of the individual, interpersonal, institutional, community, and societal factors and how these factors interplay to influence the choice of food for children by caregivers. This model was applied in a study by Van Acker et al. (2012) on an afterschool physical activity program. From this study, it was identified that the success of an afterschool physical activity program was dependent on both personal and environmental factors and a socioecological framework was needed to understand which interventions were likely to increase afterschool activity programs. Similarly, in another study, Scribner, Theall, Simonsen, and Robinson (2010) presented an ecological framework for HIV risk and the alcohol environment, which consisted of individual alcohol consumption behavior, microsystem-level elements such as social and sexual networks, and exosystem- and macrosystem-level elements such as the neighborhood alcohol environment and formal and informal policies. These levels were perceived to act together to impact HIV risk.

The risk factors for childhood diarrhea are multiple and vary depending on the setting (Furmaga-Jabłońska, Ułamek-Kozioł, Tarkowska, Brzozowska, & Pluta, 2014);

thus, grounding this study in the socioecological framework provides an opportunity to illustrate how selected risk factors function in the different spheres of environmental and societal factors to impact the occurrence of diarrhea in children. Key assumptions about this model are that the interaction between the individual and the environment is mutual and the multiple levels of the environment are overlapping rather than hierarchical, with both direct and indirect factors influencing health behavior (Hirsch et al., 2016). This is relevant in this study, as the risk factors for diarrhea in children are numerous and may be interrelated. Furthermore, in a later article, Bronfenbrenner (1994) stated that though there are different structures in the environment that influence behavior, these structures are embedded in each other, with each system playing a significant role in influencing how the other structures operate.

Diarrhea in Children

Diarrhea is defined by the WHO as the passage of loose stools three or more times a day or more frequently than normal (WHO, 2016a). In children, it is the second largest cause of mortality in developing countries. Though there has been a substantial reduction in the number of deaths due to diarrhea in the last 10 years (Chopra et al., 2013), morbidity and mortality due to diarrheal disease in children are unacceptably high. This is especially true for areas such as Uganda, which has a high burden of the disease. Globally, diarrhea contributes close to a million deaths in children annually (Liu et al., 2015), with an estimate of 2.9 episodes/child year (Walker, Perin, Aryee, Boschi-Pinto, & Black, 2012), and there are about 1.731 billion episodes of diarrhea per year in children under 5 years of age (Walker et al., 2013b). The highest incidence and deaths due to diarrhea are in children less than 2 years of age (Mohammed & Tamiru, 2014; Strand et al., 2012; Walker et al., 2012; Walker et al., 2013b).

Uganda is among the countries with the highest burden of childhood diarrhea (UNICEF, 2009). The prevalence of childhood diarrhea in Uganda in 2011 was reported to be 23% (UDHS, 2011). Similar results have been seen in community cross-sectional surveys carried out in neighboring countries. Cameroon reported a prevalence of 23.8% (Tambe, Nzefa, & Nicoline, 2015) in 2012 for children under 5 years, while in Western Ethiopia, a higher prevalence of 33.5% was reported in 2010 in the same age group (Merga & Alemayehu, 2015). Uganda is a developing country with limited resources, and it was ranked low on the Human Development Index at 163/188 in 2015. The estimated life expectancy at birth in Uganda is 58.5 years (United Nations Development Program [UNDP], 2015) and the under-5 mortality rate is high at 85/100,000 live births (You, Hug, Ejdemyr, & Beise, 2015). In 2008, it was estimated that 16% of all under-5 deaths (n = 189,990) in the country were due to diarrhea (Walker et al., 2013b). The high burden of diarrhea in Uganda's children represents a significant burden not only on Uganda's health system, but also on the households that must take care of sick children, as well as on the growth, development, and survival of children.

A child with diarrhea can experience short-term effects such as dehydration and electrolyte disturbance. Single, sporadic episodes of diarrhea in healthy children are typically self-limiting, with no long-term consequences. However, several episodes per year in a child can result in nutritional deficits and long-term consequences such as growth faltering, impaired cognitive development, and poor school performance

(Alkizim, Matheka & Muriithi, 2011; Walker et al., 2013b). Without effective intervention, diarrhea in children can result in rapid depletion of water and sodium regardless of the causative pathogenic agent, potentially resulting to death due to extreme dehydration (Farthing et al., 2013).

Children with diarrhea are at a higher risk of life-threatening dehydration than adults when they get diarrhea because water makes up a higher proportion of children's bodyweight and children have a higher metabolic rate, so they use more water in a day than older children and adults do (Alkizim et al., 2011). Therefore, younger children are at a higher risk of dehydration than older children. A child with diarrhea can lose body fluids as much as 3 times the circulating blood volume (Alkizim et al., 2011). Diarrhea in children can manifest as acute watery diarrhea, which is the most common type of diarrhea (Verma, Rajput, & Singh, 2016) and lasts less than 7 days. This type of diarrhea was under consideration in this study. Less common types of diarrhea are bloody diarrhea, referred to as *dysentery*, and *persistent diarrhea*, or diarrhea that lasts at least 14 days (Moore et al., 2010; Walker et al., 2013a). However, an acute episode can progress to persistent diarrhea (Moore et al., 2010).

Deaths from diarrhea occur mainly as a result of dehydration (Farthing et al., 2013), and this outcome can be prevented by administration of oral rehydration salts (ORS), which is a simple, effective, and inexpensive treatment (Santosham et al., 2010). Since the 1970s, WHO has recommended use of oral rehydration therapy to combat dehydration (UNICEF, 2009), and this intervention is regarded as one of the most important child health interventions due to its ability to save the lives of children

(UNICEF, 2012). Case studies done in the 1980s in Brazil, Egypt, Mexico, and the Philippines reported a marked reduction in childhood mortality that could be attributed to the introduction and use of oral rehydration therapy (Victora, Bryce, Fontaine, & Monasch, 2000). However, its use today is not ubiquitous in areas where the disease is prevalent (Blum, Oria, Olson, Breiman, & Ram, 2011; Gao, Yan, Wang, & Dang, 2013), and UNICEF (2012) estimated that only a third of childhood diarrheal episodes in sub-Saharan Africa receive the recommended ORS treatment.

Factors that contribute to the underuse of ORS include insufficient knowledge of ORS and its use (Essomba, Koum, Adiogo, Ngwe, & Coppieters, 2015; Thammanna, Sandeep, & Sridhar, 2015), perceptions such as other drugs being considered more effective in stopping diarrhea than ORS (Blum et al., 2011), and stock outs of ORS in health facilities (Bagonza, Rutebemberwa, Eckmanns, & Ekirapa-Kiracho, 2015; Charyeva et al., 2015). Gao et al. (2013) investigated 14,112 households in Western China on the use of ORS and found that the utilization rate was 34% among children less than 36 months of age. ORS use was more likely in households in villages that had ORS available in village clinics. Sillah, Ho, and Chao (2013), in a similar analysis in Gambia, recruited 400 mothers with children under 5 years of age who had diarrhea. The rate of ORS use in this population was 4%, and higher practice of ORS was positively correlated with higher education level of mothers, higher maternal age, and higher socioeconomic status. In Uganda, the UDHS 2011 reported that 44% of children suffering from diarrhea in the 2 weeks preceding the survey were given ORS.

In addition to preventing deaths due to childhood diarrhea by administration of ORS, addressing the risk factors for childhood diarrhea is underscored as one of the greatest opportunity in public health today (Rudan et al., 2013) to reduce child mortality. The International community tried to address this through the Millennium Development Goals (MDGs) which were established after the United Nations Millennium Summit in 2000 (United Nations, 2015). The fourth goal sought to decrease child mortality by two-thirds by the year 2015. One of the recognized key steps to achieving this was to reduce the incidence of childhood diarrhea, one of the two diseases that contribute massively to childhood mortality in children under-five years of age. Majority of the countries with a high burden of deaths due to childhood diarrhea were not able to achieve the goal with only about a third of the countries reducing their under-five mortality by two thirds or more (You et al., 2015). Uganda was among the countries that did not achieve this goal (United Nations Development Program [UNDP], 2013).

As the end of the Millennium Development Goals came to a close in 2015, Sustainable Development Goals (SDG) were developed and one of the objectives is to achieve an under-5 mortality rate of 25 or fewer deaths per 1,000 live births by the year 2030 in all countries (UNDP, 2016). Acceleration in reduction of childhood deaths is required to achieve this objective, and a factor that can contribute to this is substantial decreases in mortality from childhood diarrhea, and other common childhood illnesses. By studying risk factors for childhood diarrhea that have not been thoroughly researched in Uganda, this study aims to provide an improved understanding of how the risk factors of length of breastfeeding, comorbidity with acute respiratory infection and vaccination status of the child impact on the incidence of childhood diarrhea thus providing the health community with an opportunity to further reduce the incidences of childhood diarrhea in the future.

Risk Factors for Childhood Diarrhea

Some studies have identified risk factors for childhood diarrhea that include early weaning, lack of awareness of good personal, and food hygiene practices (George et al., 2014), low maternal education (Mbugua et al., 2014; Mohammed, & Tamiru, 2014), poor sanitation practices and lack of adequate safe water (Ferdous et al., 2014; Mihrete et al., 2014; Mohammed & Tamiru 2014; Yilgwan & Okolo, 2012). These unsanitary environments give the diarrhea causing organisms an opportunity to spread easily.

Other scholars have assessed risk factors for diarrhea by enteric pathogens. A multisite study by Kotloff et al. (2013) assessed the etiological agents of childhood diarrhea in multiple sites - four in Africa and three in Asia. It was found that the most common causes of diarrhea in children were rotavirus, *Cryptosporidium*, enterotoxigenic *Escherichia coli*, and *Shigella*. Bonkoungou et al. (2013) in a case-control study in Burkina Faso, analyzed stool specimens of children under 5 years of age suffering from diarrhea and reported rotavirus (30%) and diarrhea *E. coli* (24%) as the most predominant pathogens for acute diarrhea. Other less reported agents were *Salmonella* (9%), *Shigella* (6%), adenovirus (5%) and *Campylobacter* (2%).

A multi-site cohort study that involved intense diarrhea surveillance of children from birth to two years, found norovirus, rotavirus, *Campylobacter*, astrovirus and, *Cryptosporidium* as the leading causes of diarrhea. *Shigella spp* was detected in children above 2 years (Platts-Mills et al., 2015). Five pathogens were found to be significantly associated with diarrhea in children in a study done in Central Africa Republic by Breurec et al. (2016). These were rotavirus, norovirus, astro-virus, *Shigella/EIEC* and, *Cryptosporidium hominis/parvum*. The leading cause of diarrhea in this study was rotavirus. Similarly, in the study by Kotloff et al. (2013), most episodes of diarrhea were attributed to rotavirus. These findings are replicated in the study by Sire et al. (2013), done in Senegal whereby the authors identified rotavirus as the most common enteric pathogen for infectious diarrhea in children under-five (27%) followed by *Shigella* (12%), *Escherichia coli* (8%) infection, adenovirus (8%), *Salmonella* infection (4%) and, lastly *Campylobacter jejuni* (3%). However O'Reilly et al., (2012) in their study found that it was *Salmonella* and *Shigella* infections that were significant as cause of death from diarrhea but it should be noted that this study only examined children who were hospitalized. These studies demonstrate that bacterial, viral, and protozoa cases all play a role in diarrhea in children (Leung, Chisti & Pavia, 2016).

Breastfeeding

Exclusive breastfeeding of babies is described by WHO (2017c) as feeding a baby on breast milk only without giving any other liquids or solids including water, with the exception of oral rehydration solution or drops of medicine from birth up to six months of age. Studies have shown that it reduces the risk of childhood illnesses such as respiratory and gastrointestinal infections (Duijts, Jaddoe, Hofman & Moll, 2010; Haile & Biadgilign, 2015). UNICEF (2015) recommends that children should be exclusively breastfed from birth until six months of age and complementary foods introduced from six months with continued breastfeeding up to at least two years as this not only protects children against disease but helps children to survive.

The protective effect of exclusive breastfeeding is thought to be through a reduced chance of microbial exposure that could be present in contaminated food or water and also through immunological mechanism and other bioactive substances that provide non-specific immunity and essential nutrients in the breast milk (Strand et al., 2012). Other foods / milk given to a baby lead to a reduction in the growth of beneficial bacteria such as Lactobacillus that lead to a higher pH in the intestine and increase the growth of pathogenic bacteria making the intestinal environment of the child more susceptible to infection (Gribble, 2011). Additionally, in low income settings, early weaning in infants is discouraged as other foods could be nutritionally inferior (UDHS, 2011).

Studies have shown a correlation between reduced morbidity and the practice of exclusive breast feeding. Hanieh et al. (2015) found that among a prospective cohort consisting of 1,049 infants from India, exclusive breastfeeding in early infancy significantly reduced the risk of severe illness from diarrhea [*OR* =0.39, 95% *CI* (0.2, 0.7)] and suspected pneumonia. Similarly, Lamberti et al. (2011) found that not breastfeeding greatly increased the risk of both diarrhea incidence and mortality particularly at younger ages. The researchers estimated that not breastfeeding was associated with a 165% increase in diarrhea incidence in children 0–5 month old.

Despite evidence that supports the positive and cost-effective health impacts of exclusive breastfeeding on child survival, breastfeeding practices are not optimal in most developing countries (Black et al., 2013; Lamberti et al., 2011). The practice of exclusive breastfeeding varies with different communities. In Central African Republic, the rate of exclusive breastfeeding among infants under 6 months of age was found to be 16% from a case-control study (Breurec et al., 2016). In Uganda, exclusive breastfeeding of infants until 6 months of age is 63% (UDHS, 2011) but when considered among sub-groups, 82% of infants 0 to 1 month are exclusively breastfed and this figure goes down to 69% among infants aged 2-3 months and 41% in infants 4-5 month old. These statistics indicate that the prevalence of breastfeeding in Uganda reduces as the child grows up. There is need to explore if mothers continued with the breastfeeding practice, if this would offer protection against diarrhea morbidity as this would be a cost effective manner of reducing the health burden of diarrhea morbidity in the country.

Length of Breastfeeding

As noted from the studies mentioned, the health effects of exclusive breastfeeding of infants under 6 months have been well established particularly the effect on reduction of morbidity and mortality due to infectious diseases. From the time Newsholm's findings in 1906 (Morabia, Rubenstein & Victora, 2013) demonstrated the protective effect of exclusive breastfeeding against diarrhea, exclusive breastfeeding has been acknowledged as an effective tool against diarrhea morbidity and mortality. Of recent, Black et al. (2013), estimates that 800,000 childhood deaths would be avoided every year if every child was exclusively breastfed for the first six months of their lives. However it is not clear from literature the effect breastfeeding beyond the exclusive period and into the weaning period has on diarrhea incidence and mortality.

Building upon this evidence on the effects of exclusive breastfeeding in the first 6 months of life, the present literature review addresses the effect longer breastfeeding periods beyond the 6 months has on incidences of morbidity including diarrhea in children. Strand et al. (2012) in their study that followed up infants from Nepal aged 6 to 35 months, found that the children who were not breastfed had a higher risk of having a prolonged diarrheal episode as compared to those that were breastfed. This finding led the researchers to recommend that in low resource settings, breastfeeding may be the most important modifiable risk factor for childhood diarrhea and that extended duration of breastfeeding should be continued beyond infancy in populations where diarrhea is common. Understandably, this study aims to establish if extended breastfeeding periods would have an impact on incidence of diarrhea among children in Uganda, which has been described as a high burden country for childhood diarrhea (UNICEF, 2009).

Some studies done in other countries have drawn a positive association between continued breastfeeding and reduced morbidity and mortality in children. In Ethiopia, Girma and Berhane (2011) in a case control study consisting of 74 cases and 222 controls deduced that children under five years of age who had never been breastfed in their lifetime had a higher risk of dying than those who were breastfed [*OR* = 13.74, 95% *CI* (3.34, 56.42)] and 23% of deaths in the study area were due to diarrhea. Similar finding have been noted by other researchers. Lamberti et al. (2011) analyzed the effect of exclusive breastfeeding in the exclusive breastfeeding window and beyond, in a meta-analysis study. The researchers found that not breastfeeding greatly increased the risk of both diarrhea incidence and mortality particularly at younger ages. They estimated that not breastfeeding was associated with a 165% increase in diarrhea incidence in 0–5-month-olds [*RR*=1.32, 95% *CI* (1.06, 1.63)], a higher risk of hospitalization for diarrhea, [*RR*=6.05, 95% *CI* (2.44, 14.97)], and an excess risk of diarrhea mortality [*RR*=1.47, 95% *CI* (0.67, 3.25)] in the same age group. There was a 32% increase in diarrhea incidence in the children 6–11-month-olds. Not breastfeeding was also associated with a 47% increase in diarrhea-related mortality in 6–11-month-olds [*RR*=5.66, *CI* (1.86, 17.20)] and a 157% increase in children 12–23-months old.

Furthermore, the impact of breastfeeding on morbidity was demonstrated by Dey et al. (2013). In this descriptive study carried out in a Bangladesh hospital (n=2,869), lesser proportions of hospital visits were noted by breastfed infants 0-11 months infected with different enteric pathogen than in non-breastfed infants. Similarly, Haile, and Biadgilign (2015) found that optimal breastfeeding practices among infants were associated with lower risks of illness including diarrhea. In India, Chandhiok, Singh, Singh, Sahu, and Pandey (2015), examined infant mortality against a set of variables with breastfeeding as a time dependent covariate. The hazard of infant death was 97% less amongst children that were breastfed as compared to those not breastfed [*HR*=0.03; 95% *CI* (0.029, 0.033)], which adds weight to the importance of continued breastfeeding among children on reducing childhood morbidity and mortality. However a study that aims to assess specifically the benefit of continued breastfeeding on incidence of diarrhea among children in Uganda has not been done.

Patel et al. (2015) conducted a cross-sectional survey on children in India and reported that not providing exclusive breastfeeding for 6 months increased the rate of hospitalization in the children while breastfeeding for less than 2 years was associated with increased rates of diarrhea in the children. In the study by Leung et al. (2015) the presence of both diarrhea and pneumonia in children under 5 years of age presenting to a diarrheal hospital in Bangladesh was associated with lack of breastfeeding.

Fisk et al. (2011) study that used data from the Southampton Women's Survey, compared effect of breast feeding on childhood infections and gastrointestinal morbidity, and found significant protective effect of breastfeeding against respiratory and gastrointestinal infections in infants from birth to 6 months. However the duration of breastfeeding in the second half of infancy was less strongly related to diagnosed respiratory tract infections and gastrointestinal morbidity as compared to breastfeeding in the first half of infancy.

Given that childhood diarrhea accounts for close to a million deaths among children under-5 (Liu et al., 2015) and continues to act as the second leading cause of death among children (Walker et al., 2012), it is important to establish if continued breastfeeding has an impact on the incidence of diarrhea then promotion of breastfeeding may be a cost effective intervention.

Acute Respiratory Infections

Acute respiratory infections (ARIs) are the most common illnesses in children under 5 years of age (Boloursaz et al., 2013) and the leading cause of death among children in the same age group in developing countries (Walker et al., 2013b). Pneumonia is a common and severe respiratory tract infection (Roomaney et al., 2016). Researchers often use the terms ARI, ALRI (acute lower respiratory infection) and pneumonia interchangeably and the distinction is not clear (Roomaney et al., 2016). In the 2011 Uganda Demographic and Health Survey (UDHS), the term ARI was used as a proxy measure for pneumonia (UDHS, 2011).

Cough and fast and / or difficult breathing (tachypnea and / or dyspnea) are clinically recognized as signs of childhood pneumonia (Mosites et al., 2014; Noordam, Carvajal-Velek, Sharkey, Young, & Cals, 2015). Pneumonia can be caused by viruses, bacteria or fungi (Challa, Gangam, & Amirapu, 2017). Viruses are the more common etiologic agents of ARI in children though bacterial pathogens are associated with higher risk of morbidity and mortality (Mosites et al., 2014). Two of the most common bacterial agents of pneumonia are *Haemophilus influenzae* type b (Hib) and *Streptococcus pneumonia* (Mosites et al., 2014; Roomaney et al., 2016). There are few studies that have investigated the etiology of pneumonia in sub-Saharan Africa (Benet et al., 2015). Rudan et al. (2013) assert that though pneumonia in children can be caused by numerous pathogens, it is difficult to identify the exact causal pathogen especially in children from low resource settings. Furthermore, identification of the pathogen does not necessarily identify causality and most infections are of mixed etiology. The researchers' further reported that most of the deaths due to pneumonia were attributed to the two main bacterial agents - *Haemophilus influenzae* type b (Hib) and *Streptococcus pneumonia.* Similarly in a case-control study in Mali, Benet et al. (2015) found that among children with Pneumonia, the cases were due to these two agents together with human metapneumovirus and respiratory syncytial virus. Risk factors mentioned for pneumonia in children included malnutrition, low birth weight, non-exclusive breastfeeding, air pollution, indoor crowding, lack of measles vaccination in children under one year, parental smoking, zinc deficiency, mother's experience as a caregiver, and concomitant diseases (Boloursaz et al., 2013).

There has been a worldwide reduction in mortality from childhood pneumonia (Walker et al., 2013b) but it remains as the disease contributing the largest to childhood mortality worldwide (Chopra et al. 2013; Gill et al. 2013; Rudan et al., 2013) and it is the most common reason for hospital admission in children in low and middle income countries (Bhutta et al., 2013; Walker et al., 2013b). Majority of the deaths (81%) from pneumonia occur in the first 2 years of life (Walker et al., 2013b).

Although pneumonia can affect people of all ages, children under 5 years of age are at most risk and the majority of pneumonia mortality occurs within the first 2 years of life (Walker et al., 2013b). It is estimated that 156 million childhood clinical pneumonia cases occur annually resulting in approximately 2 million deaths in children during the first 5 years of life (Bhutta et al., 2013) and the burden of pneumonia is highest in South-East Asia and Africa, with the highest incidence seen in poor and marginalized groups (Liu et al., 2012; Walker et al., 2013b). Pneumonia can be prevented through immunization, adequate nutrition, and provision of healthy environmental conditions (Leung, Chisti, & Pavia, 2016). Additionally, it can be treated with low cost antibiotics (Gill et al., 2013). Despite this, pneumonia accounts for 15% of all deaths of children under 5 years of age (Walker et al., 2013b). Routine data from health management information systems including data on the etiology and epidemiology of pneumonia in children in developing countries are often insufficient and most data reported rely on global household survey programs such as the Demographic Health Surveys (Hancioglu, & Arnold, 2013; Nankabirwa, Tumwine, Mugaba, Tylleskär, & Sommerfelt, 2015). In Uganda, 28% (UDHS, 2011) of children were reported to have pneumonia.

Diarrhea and Acute Respiratory Infections

ARI and diarrhea are the top killers of children worldwide (Walker et al., 2013b) and they have been reported to occur together though this co-occurrence is not well understood (Chisti et al., 2011; Leung et al., 2015). IVAC (2014), states that in every 20 seconds, a young child under the age of 5 years succumbs to either of these two major but preventable diseases. There is a gap in literature that looks at how ARI and diarrhea in children are related (Leung et al., 2015). Walker et al. (2013a) assessed this relationship by carrying out a study on two cohorts of children who were under 3 years of age in South India and Nepal to determine if infection with ARI or diarrhea increases the risk of infection with the other disease in the same time period. It was found that ARI and diarrhea present as simultaneous comorbidities more than would be expected by chance alone and in both countries, children who experienced more days of diarrhea had increased risk for subsequent ARI episodes. In their analysis the risk of ARI contingent upon prevalence of diarrhea was not as strong as diarrhea being a risk factor for ARI. ARI was a significant risk factor for occurrence of diarrhea only among the South Indian infants.

Other studies have investigated diarrhea as an independent risk factor for increasing the risk of sequential infection with ARI. Ashraf et al. (2013) investigated the association between the length of a diarrheal incidence and risk of an incidence of pneumonia among children less than 5 years of age in Pakistan and found that a recent diarrheal illness was associated with an increased risk of subsequent pneumonia. For every additional day that a child had diarrhea in the 2 weeks before the onset of pneumonia, there was a slight increase in the risk of pneumonia [*OR*=1.06, 95% *CI* (1.03, 1.09)] and the attributable risk of pneumonia cases due to a recent exposure to diarrhea was 6.1%. Similar findings are seen in the study by Schmidt, Cairncross, Barreto, Clasen, & Genser (2009) who assessed the effect of diarrhea on subsequent respiratory infections in cohorts of children from Ghana and Brazil. The risk of a subsequent acute lower respiratory tract infection increased by 1.08 (95% *CI* 1.0-1.15) as the daily prevalence of diarrhea increased though this was only observed in the cohort from Brazil. The reverse relation of pneumonia as a risk for diarrhea was not noted in either country. The potential severe consequence of pneumonia and diarrhea coinfection is demonstrated by the study by Leung et al (2015). In this study both diseases were investigated in children to determine the risk factors for concurrent presentation on diarrhea and pneumonia in a resource limited setting in Bangladesh. It was clear that children presenting with diarrhea and pneumonia had an over 80 times higher risk of death and a three times longer length of stay in hospital compared with those who had diarrhea only.

There is need to understand the influence of ARI on development of diarrhea considering the high burden of ARI in low resource settings as earlier noted. Additionally, many of these children do not get treatment for ARI and this could predispose them to other infections such as diarrhea. Mosites et al. (2014), asserted that globally, 50% of children who have pneumonia do not receive the necessary treatment.

In Ethiopia, Astale, and Chenault (2015), estimated that a third of all children with pneumonia did not receive treatment. In Uganda, similarly a large percentage of children who had pneumonia did not receive the necessary treatment as observed in the study by Kibuule, Kagoya and Godman (2016). In this study, the authors were investigating the use of antibiotics among children under 5 years who had ARI and found that treatment of ARI in children under-5 was suboptimal. In the 200 households they were investigating that had a child with ARI, 53.5% (p=0.322) of these were treated poorly. Similarly, in a study done on six countries in sub-Saharan Africa to identify health care seeking behavior for children suspected to have pneumonia, Noordam et al. (2015) in a multi-country study found that in Uganda children who had pneumonia, hospital care was sought for only 60% of the children whereas in Tanzania it was 85% of children suspected to have pneumonia that were taken to a hospital and in Ethiopia, only 30% of children were taken to a health facility.

Vaccination

Childhood vaccinations are known to have immense health and economic benefits (Bustreo, Okwo-Bele, & Kamara, 2015; Stack et al., 2011; Ozawa et al., 2011) with the potential to significantly impact childhood morbidity and mortality. The Expanded Program on Immunization (EPI) was established by the World Health Organization in 1974 (Tao, Petzold, & Forsberg, 2013) targeting vaccine preventable childhood diseases and has since been adopted by national immunization programs across the world. In Uganda, the Uganda National Expanded Program on Immunization (UNEPI) is the body charged with management and administration of immunization services in Uganda.

According to UNEPI, a child is considered to be fully immunized if they have received all doses for each of the four vaccines: polio (4 doses administered at birth or at first contact with a health provider - 6, 10 and 14 weeks); measles (administered at 9 months); Bacillus Calmette-Guerin (BCG) against tuberculosis (administered at Birth); and Diptheria-Pertussis-Tetanus-Hepatitis B-Haemophilus *Influenzae* b (DPT-HepB-Hib) given to prevent diphtheria, pertussis, tetanus, influenza, and hepatitis B respectively. DPT-HepB-Hib is given in three doses administered at 6, 10, and 14 weeks by the age of 12 months (Uganda Ministry of Health [MOH], n.d.). Some vaccines are in the national schedule but not yet fully available such as the rotavirus (Uganda MOH, n.d). By the end of 2015, the global coverage of immunization against rotavirus was 23% and it had been introduced in 84 countries of the world (WHO, 2017d).

Globally, less than half of children receive complete vaccination coverage (Tao et al., 2013). In India, Shrivastwa et al. (2015) study revealed that India's immunization coverage as low. Only 57% children were fully vaccinated among children aged 12-36 months. The situation is almost similar in Uganda where only 52% of children were fully immunized (UDHS, 2011). This is in comparison to results from a community-based prospective cohort study by Nankabirwa, Tylleskär, Tumwine, and Sommerfelt (2010). In this study, 51% of all infants below 6 months in Uganda had been fully vaccinated. This indicates that immunization coverage in Uganda falls way below the target set by WHO to achieve at least 90% vaccination coverage nationally in all countries and 80% coverage in every district by the year 2020 (WHO, 2017d).

Canavan, Sipsma, Kassie & Bradley (2014) compared immunization rates among six countries from Africa (Burundi, Ethiopia, Kenya, Rwanda, Tanzania and Uganda). Rwanda had the highest proportion of children (66.2%) who had received the four vaccines. Ethiopia had the lowest proportion at 13.3% while Uganda and Tanzania had less than 50% coverage. However, a higher vaccination coverage was reported by Babirye et al. (2012) from a cross-sectional study in Uganda, whereby 77.2% of the 821 children in the study were fully vaccinated which could be explained by the fact the study was carried out in a purely urban area whereas some studies have indicated that vaccination coverage is higher in urban than in rural areas (Singh, 2013; Restrepo-Méndez et al., 2016). Surprisingly the study by Shrivastwa et al. (2015), done on a large nationally representative sample in India showed that children from rural areas reported better vaccination coverage for some vaccines compared to children in the urban areas. However the authors attributed this observation to the presence of large slum areas in urban areas in India which are characterized by high concentrations of poor and uneducated families that have poor access to health care facilities.

Some of the reasons mentioned that influence demand for childhood immunizations in Uganda include mother's understanding of the importance of the vaccinations, fear of side effects and disinterest or ignorance (Vonasek et al., 2016). In these mentioned studies, the highest coverage was with BCG, the first vaccination and vaccination coverage declined steadily with subsequent vaccinations. These routine immunizations are provided for free by the Ugandan Ministry of Health (Uganda MOH, n.d.).

Vaccination and Disease Prevention

Epidemiological evidence from some studies show that vaccines confer non-specific benefits to children by changing morbidity and mortality of infections unrelated to the infection targeted by the vaccine (Biering-Sørensen et al., 2012; Sankoh et al., 2014; Shann, 2011). There is, however, a gap in knowledge on the contribution of these non-specific effects to reducing morbidity and mortality due to diarrhea in children. In the randomized control trial by Aaby et al. (2010) in Guinea-Bissau to test the non-specific effects of measles vaccine at 4.5 and nine months on childhood mortality, the vaccine contributed to a 22% reduction in all-cause mortality yet prevention of measles related deaths contributed to only a small part (4%) of this all-cause mortality. This effect is also seen in the community case-control study by Girma & Berhane (2011). Cases consisted of children under-five who had died in the preceding year while controls were the surviving children from the same community and in the same community. An excess in mortality (six times higher) was observed among children who had not received any vaccination leading to the authors concluding that children who had received routine immunizations had a lower chance of dying than those who had not received any immunization. This reduced mortality was not due to a specific condition but captured mortality from all causes.

In Uganda, children receive the BCG vaccine at birth or at the first contact with the health service primarily to protect them against severe forms of tuberculosis. The non-specific effect of BCG vaccines is elaborated in some analyses. These studies have indicated that this vaccine may have non-specific effects on childhood morbidity and mortality that cannot be fully explained by its protective effect against tuberculosis. For instance De Castro, Pardo-Seco and Martinón-Torres (2015) studied 464,611 hospitalizations of children that spanned over 15 years and were able to demonstrate that BCG vaccination at birth significantly reduced hospitalization due to prevention of respiratory infections and sepsis, not related to tuberculosis with a preventive fraction of 41.4% and 52.8% respectively but no significant effect on child mortality. Aaby et al. (2011) study also demonstrated that early BCG administration had beneficial effect beyond prevention of tuberculosis infection in the neonatal period.

In Uganda these findings are replicated in the observational study done by Nankabirwa et al. (2015). From this study it was observed that child mortality was substantially lower among children who had received BCG vaccination than those who had not received the vaccination. This non-specific effect of vaccines is also demonstrated by polio vaccine in the study done by Lund et al. (2015) in Guinea-Bissau. In this randomized trial, newborns were randomized to either receive oral polio vaccine at birth with BCG or to receive BCG alone and thereafter oral polio vaccine at 6 weeks (controls). Oral polio vaccine was seen to provide non-specific protection on overall survival of infants especially when given early after birth.

Findings from these studies suggest that vaccines are associated with reduced morbidity and mortality, more than is expected from their pathogen-specific intended purpose however much remains to be learned regarding the mechanism by which certain vaccines could potentially reduce all-cause mortality (Saadatian-Elahi et al., 2016). Additionally, the exact protection against high burden diseases, specifically childhood diarrhea, is not clear. This study intends to identify if there is an association between vaccinations and morbidity due to childhood diarrhea.

A child who has been taken for immunizations has a higher chance of also receiving vaccines against diarrhea for instance the rotavirus and pneumococcal vaccine, where they are available. Rotavirus has been seen in several studies to be the most common cause of childhood diarrhea (Breurec et al., 2016) and children who are vaccinated with the rotavirus vaccine have reduced illness and deaths (Breurec et al., 2016). Until effective vaccines against all causes of diarrhea are fully available and vaccination coverage is high, prevention remains the key for preventing childhood diarrhea and this study aims to add knowledge to this area by exploring risk factors that once understood, can be applied in reducing instances of childhood diarrhea.

It is worthy to note that Walker et al. (2013b) stated that though childhood diarrheal deaths had reduced from the year 2000 to 2011 in the areas most affected by the disease, there had not been an improvement in treatment practices within that duration and the authors speculated that the reduction could have been due to improvement in nutrition, general environmental and socio economic development that could have led to this, therefore giving justification on further identification of risk factors that can be employed in prevention. The authors further stated that this reduction in mortality due to diarrhea in children had not occurred in all low and middle income countries and these discrepancies could be attributed to differences in immunization rates and breastfeeding practices that were within the countries in these regions, factors which this study intends to identify if they are associated with occurrence of diarrhea in children.

Summary and Conclusion

This literature review chapter has served to explain how this study fits within the current body of literature. The review began with an overview of diarrhea in children, with a focus on the situation in sub-Saharan Africa and Uganda. The literature review went further to discuss relevant literature for this study relating to breastfeeding in children, acute respiratory infections and vaccinations of children. The literature review related to each of the research questions, has also been discussed by reviewing the association between incidences of diarrheal disease with the length of breast feeding, presence of acute respiratory infection and immunization status of children. Most of the reviewed literature available is observational rather than experimental. This is understandable as it would be considered unethical to perform randomized control trial on interventions that are already recommended by the World Health Organization; interventions such as breastfeeding and vaccination of children. The reviewed literature is mostly from cross-sectional, cohort, case-control studies, meta-analysis and a few randomized control trials. The manner through which the research questions will be tested will be provided in the next chapter of methods.

Chapter 3: Research Method

Introduction

The main purpose of this study was to examine the association between the incidence of diarrhea in children and the length of breastfeeding, the presence of acute respiratory infection (ARI), and the vaccination status of the child among children in Uganda. This was achieved through a secondary analysis of a data set derived from the 2011 UDHS. The results of this study, obtained through quantitative methods, are expected to aid in the fight against childhood diarrhea in Uganda. In this chapter, a detailed description of the research methodology that was used to test the research questions for this study is provided. Descriptions of the UDHS 2011 dataset, the research design, the rationale for the design, threats to validity of the study, and ethical considerations are also presented.

Research Design and Rationale

This study used a quantitative cross-sectional research design to answer the research questions and test the associated hypotheses. The following were the research questions:

1. Is there an association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the length of breastfeeding of the child (as determined by the number of months a child has been breastfed)?
2. Is there an association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the presence of acute

respiratory infection (as determined by the presence of cough accompanied by short, rapid breathing within the past 2 weeks)?

3. Is there an association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the vaccination status of the child (as determined from the vaccination card and/or mother's verbal report)?

The dependent variable was incidence of diarrhea, and the independent variables were length of breastfeeding, presence of ARI, and vaccination status of the child. A quantitative research approach was chosen for this study because it was the most appropriate choice for the study variables and to answer the research questions. Additionally, a quantitative methodology would allow for objectivity of findings. A quantitative predictive analysis was incorporated in the research design to allow for the identification of potential associations between variables by using statistical methods to analyze current facts to predict future events such as disease occurrence.

Methodology

Data Source

The data for this study were derived from the UDHS, which is part of the DHS Program. Demographic health surveys are nationally representative population-based surveys that collect a wealth of information in the areas of population, health, and nutrition by incorporating large sample sizes ranging from 5,000 to 30,000 households (DHS Program, n.d.). These surveys are largely supported by the U.S. Agency for International Development (USAID). Demographic health surveys are conducted every 5 years and have been conducted in developing countries since 1984. Between 1984 and 2011, 250 nationally representative surveys in 90 countries were conducted (ICF International, 2012). Data from the DHS Program are considered accurate, reliable, and nationally representative (DHS Program, n.d.), and these data are particularly valuable to researchers in developing countries where there is an absence of reliable population-based morbidity and mortality data and much of the available data are not nationally representative (Walker, 2013b). DHS data sets are available to researchers for free; however, permission should first be acquired from the DHS Program. For this study, I used data only from the 2011 UDHS, which was the fifth and most recent DHS carried out in Uganda at the time of this study. The UDHS 2011 collected data through three sets of questionnaires: household, women's, and men's questionnaires.

Population

The target population for my study was children in Uganda from birth to 5 years of age. Data for this age group were obtained from data from the women's questionnaire. The population of women was aged 15-49 years, and the data were captured by asking these women for information about their children who were born in the 5 years prior to the survey. Interviews in the 2011 UDHS were carried out successfully on 8,076 women, and data were captured on 7,535 children. For this study, my inclusion criteria were children under 5 years of age who were alive and had data on recent diarrheal illness. I then investigated the relationship between this outcome and the independent variables through statistical analysis.

Sampling and Sampling Procedure

The 2011 UDHS was designed to be representative at the national level by using a national population census as the sampling frame. It was also representative at the regional level through selection of clusters from both urban and rural areas (UDHS, 2011). From these clusters, households to be included in the 2011 UDHS and the men and women in these households were selected to form the sample. For the UDHS 2011 sample, 10,086 households, 9,247 women, and 2,573 men were identified. I used a subset of this sample by considering only the information on children provided by women in the sample.

In order to calculate the minimal sample size that was needed for my study, the statistical power, the effect size, and the alpha level desired were considered. The statistical power level of the test was set at 80%, and it measured the probability of rejecting the null hypothesis. The effect size was set at a medium size of .15 for a multivariable regression analysis, and the alpha level was set at .05. G*Power version 3.1 was used to determine the minimum sample size required, and this gave a minimum sample size of 134 to test the association between the dependent variable and independent variables. However, the sample size used was larger, as the available data set of children meeting the inclusion criteria was considered in the analysis.

Procedures for Recruitment, Participation, and Data Collection

In order to be granted permission to access the DHS data set, I had to first register with the DHS program website, create a research project request that contained the project title and the purpose of the study, and then select a region of interest and a country. A notification that permission was granted was then sent. The requested data can only be used for the current study; if any other study is to be done using the data, a new request should be submitted. The data were thereafter downloaded after IRB approval. The permission letter is located in Appendix A.

Pretesting of DHS Questionnaires

Pretesting of the survey instrument, the UDHS, was conducted in areas not selected for the main survey to prevent influencing the survey results and was conducted in the same manner that was to be followed in the main field work. Pretesting was done 2 to 3 months prior to the main survey by trained field staff. Pretesting included both rural and urban regions and was conducted in the seven main local languages in Uganda (UDHS, 2011). This was done to check for translation errors and skip patterns in the questions and survey procedure (ICF International, 2012). Another pretest of the questionnaire was done to determine the effectiveness of the computer-assisted field data editing program and to guide development of the data editing guidelines for the 2011 UDHS.

Data Collection

Data collection for UDHS 2011 was done from June to December 2011. There were 10,086 households that were selected for the sample, and of these, 9,480 were occupied during the data collection period. The household response rate was 95%, as 9,033 households were interviewed. The response rate for women was 94%, as 8,674 out of 9,247 eligible women identified were interviewed. Those who had incomplete information were eliminated, leaving a sample of 8,076 women. Sample weights were applied in order to compensate for the unequal probability of selection between the strata that had been geographically defined, as well as for nonresponse. Information about the data collection process for DHS is available on the DHS website (DHS Program, n.d).

Instrumentation and Operationalization of Constructs

The women's questionnaire used in the UDHS 2011 was sufficient to answer the research questions. The DHS questionnaires are standardized and are revised and reviewed throughout the phases of the DHS program. To determine the incidence of diarrhea in a child, respondents were asked if the child had three or more loose, watery stools at any time in the 2 weeks preceding the survey. To determine the length of breastfeeding of the child, a question asked if the last-born child was being breastfed at the time of the survey. This variable, together with the age of the child, was used to identify how long a child had breastfed in months. To determine the presence of ARI, the respondent was asked if the child had been ill with cough accompanied by short, rapid breathing at any time during the 2 weeks preceding the interview. To determine the vaccination status of the child, respondents were first asked if they had a health card, which usually has the dates and types of vaccines administered for each child. If the vaccination card was missing or the information was incomplete, the interviewer asked the respondent whether the child had received each vaccine and how many times the child had received each vaccine.

Operationalization of Variables

Demographic variables. These variables included the age and sex of the child; the age, education level, and religion of the mother; the number of children in the family;

and residence in an urban or rural area. The variables were selected for inclusion as potential covariates as they might affect the relationship between the independent variables and the outcome variable.

Dependent variable. The outcome/criterion variable was incidence of diarrhea.

Independent variables. The predictor/explanatory variables were length of breastfeeding, presence of acute respiratory infection, and vaccination status of the child.

Table 2

List of Variables

Variable	Measurement	Variable type
Demographic variables		
Age of the child	Age of the child in months	Continuous
Sex of the child	Female/male	Dichotomous—female/male
Age of the mother	Age in years	Continuous
Education level of the mother	No education Primary level Secondary level Higher education	Categorical
Religion of the mother	Catholic Protestant Muslim Pentecostal SDA Other	Categorical
Number of children in the family	Children under 5 years of age in the household	Discrete
Residence	Urban/rural	Dichotomous—urban/rural
Dependent variable		
Incidence of diarrhea	A child ill with diarrhea at any time during the 2 weeks preceding the interview	Dichotomous—yes/no

(table continues)

Variable	Measurement	Variable type
Independent variables		
Length of breastfeeding	Children who were still breastfeeding from 6 months of age	Continuous
Vaccination status	A child from 12 months of age who had completed the immunization schedule by receiving the following vaccines: 4 doses of polio, measles, Bacillus Calmette-Guerin (BCG), and Diptheria-Pertussis-Tetanus-Hepatitis B-*Haemophilus influenzae* b (DPT-HepB-Hib)	Categorical— Yes Partially No

Data Analysis Plan

Data analysis was conducted using SPSS version 23.0 provided by Walden University, and multivariable regression analysis was done to establish the differences in the odds of experiencing the outcome of interest between various subgroups when the important factors were controlled for. The sequential steps for building the model in this study included the following:

1. Descriptive analysis was used to generate frequencies on all variables.
2. Preliminary analysis was conducted prior to running analysis, to test for the assumptions of the statistical tests.

3. Bivariate analysis. Binary logistic regression was conducted to assess for unadjusted associations between the incidence of diarrhea and the independent variables. It was only the predictor variables that were found to be statistically significantly associated with the outcome variables that were included in the final model.
4. Testing of collinearity was done to test associations/correlations between explanatory variables (breastfeeding x ARI, breastfeeding x vaccination status, and ARI x vaccination status). Multivariable logistic regression analysis was conducted for each research question to test the association of a predictor variable with the outcome variable after adjusting for other variables.

Odds ratio (*OR*), 95% confidence interval (*CI*), and *p* value were used to determine which independent variables were likely to increase or decrease the odds of an incidence of diarrhea. A *p*-value of less than 0.05 was considered to reflect statistical significance. Specific research questions and hypotheses are described below, together with the analysis conducted.

Research Question 1

Is there an association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the length of breastfeeding of the child (as (determined by the number of months a child has been breastfed)?

Null Hypothesis 1 (*Ho*1): There is no association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the length of breast feeding of the child (as (determined by the number of months a child has been breastfed).

Alternative Hypothesis 1 (*Ha*1): There is an association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the length of breastfeeding of the child (as (determined by the number of months a child has been breastfed).

Planned analysis: Multivariable logistic regression

Outcome variable: Incidence of diarrhea (diarrheal episode within the past 2 weeks, yes/no)

Independent variable: Length of breastfeeding.

In this analysis, children less than 6 months of age who were in the exclusive breastfeeding bracket were not considered for this research question. Length of breastfeeding was derived by identifying the children who were breastfeeding at the time and their age in months. Therefore the sample for this research question comprised of children aged 6 months and above who had a valid response on the dependent and independent variable. The final model was constructed by including the independent variable and variables that were significant at the bivariate level.

Research Question 2

Is there an association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the presence of acute respiratory infection (as determined by the presence of cough accompanied by short, rapid breathing within the past 2 weeks)?

Null Hypothesis 2 (*Ho*2): There is no association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the presence of acute respiratory infection (as determined by presence of cough accompanied by short, rapid breathing within the past 2 weeks).

Alternative Hypothesis 1 (*Ha*2): There is an association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the presence of acute respiratory infection (as determined by the presence of cough accompanied by short, rapid breathing within the past 2 weeks).

Planned analysis: Multivariable logistic regression.

Outcome variable: Incidence of diarrhea.

Independent variable: Presence of ARI.

For this analysis, I obtained the sample of children aged 0 to 5 years who had a valid response on the outcome measure and independent variable. The final model was constructed by including the independent variable and variables that were significant at the bivariate level.

Research Question 3

Is there an association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the vaccination status of the child (as determined from the vaccination card and/or mother's verbal report)?

Null Hypothesis 3 (*Ho*3): There is no association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the vaccination status of the child (as determined from the vaccination card and/or mother's verbal report).

Alternative Hypothesis 3 (*Ha*3): There is an association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the vaccination status of the child (as determined from the vaccination card and/or mother's verbal report).

Planned analysis: Multivariable logistic regression.

Outcome variable: Incidence of diarrhea.

Independent variable: Vaccination status.

To test the association between the incidence of diarrhea in children with the vaccination status of the child, the sample comprised of children from the age of 12 months to 5 years that had a valid response on the dependent and independent variable. The independent variable was classified into three categories. Children who had received all of the recommended EPI immunizations were categorized as fully immunized, those who had received at least one or more but not all immunizations were categorized as partially immunized and those who had not received any immunization were categorized as not immunized. The final models were constructed by including the independent variables and variables that were significant at the bivariate level.

Threats to Validity

External validity regards to the generalization of the study findings to the general population. The manner in which the UDHS 2011 sample was obtained provided external validity to the study as the data were collected to be representative of the target population at the national and regional levels. The potential threats to internal validity were the self-report nature of the disease conditions by respondent's care giver without confirmation from a health care provider, and recall bias. There were no threats to internal validity of the study such as testing reactivity or reactive effects of experimental arrangements as the study was purely observational. Other threats to validity such as history or maturation effects were not applicable due to the nature of the data collection. The data were collected in a manner that minimized bias such as using previously translated questionnaires in situations where use of English was a barrier in communication, ensuring privacy at the time of the interview, assurance of confidentiality of results to the participants, and obtaining informed consent (ICF International, 2012). However the data for this study was collected in a cross-sectional manner therefore causality cannot be established.

Ethical Procedure

Permission to carry out this study was sought from the Walden Institutional Research Board (IRB) and the IRB number approval number is 03-20-17-0476919 (Appendix B). DHS surveys are administered to individuals after an informed consent is obtained. They are anonymous surveys that do not allow any potential identification of any household or individual in the data file. The dataset were accessed after the IRB approval and will be used for this study only and will not be passed to any other researcher without permission from the DHS program. If I require the data for any future study, additional permission will be sought from the DHS program. I will retain the DHS data in a password protected computer hard drive where it cannot be accessed by unauthorized persons and at the completion of the dissertation process, the data set will be transferred to a password protected compact disc where it will be archived and destroyed after 5 years.

Summary and Transition

This chapter has covered a description of the methodology of the study. This has included the research design and rational, description of sampling procedure and procedure of collecting DHS data which is my source of secondary data. The sample for this study has been described as well as the study variables, statistical tests, threats to validity and ethical considerations. In Chapter 4, the results of the statistical analysis are presented, followed by a discussion of the results in Chapter 5.

Chapter 4: Results

Introduction

The purpose of this study was to assess the association between the incidence of diarrhea in children under 5 years of age and length of breastfeeding, presence of ARI, and vaccination status of the child by analyzing secondary data, the UDHS 2011 dataset developed by the DHS (n.d.) in Uganda. The UDHS 2011 is a nationally representative population-based survey that collected information in Uganda in the areas of population, health, and nutrition.

In this chapter, the data collection process and the results of the study are reported. Descriptive statistics on the dependent variable, the main independent variables, and other covariates are reported, and these are presented as mean and standard deviations for continuous variables and frequencies and percentages for categorical variables, as summarized in tables and figures. Bivariate analysis between the dependent variable and each of the independent variables was conducted, and their chi-square, crude odds ratio (*COR*), *p*-value, and *CI* results are reported. Finally, multivariable logistic regression models were conducted for each research question, and these results are reported and summarized in tables. The statistical findings are organized by the research questions and hypotheses. This study included three research questions, which are presented below with the corresponding hypotheses.

Research Question 1

Is there an association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the length of breastfeeding of the child (as determined by the number of months a child has been breastfed)?

H_0: There is no association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the length of breastfeeding of the child (as determined by the number of months a child has been breastfed).

H_A: There is an association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the length of breastfeeding of the child (as determined by the number of months a child has been breastfed).

Research Question 2

Is there an association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the presence of acute respiratory infection (as determined by the presence of cough accompanied by short, rapid breathing within the past 2 weeks)?

H_0: There is no association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the presence of acute respiratory infection (as determined by presence of cough accompanied by short, rapid breathing within the past 2 weeks).

H_A: There is an association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the presence of acute respiratory infection (as determined by presence of cough accompanied by short, rapid breathing within the past 2 weeks).

Research Question 3

Is there an association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the vaccination status of the child (as determined from the vaccination card and/or mother's verbal report)?

H_0: There is no association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the vaccination status of the child (as determined from the vaccination card and/or mother's verbal report).

H_A: There is an association between incidence of diarrhea in children (as determined by an episode within the past 2 weeks) and the vaccination status of the child (as determined from the vaccination card and/or mother's verbal report).

Data Collection

The study used a secondary data set, the UDHS 2011, which was developed by the DHS program, which recruited the participants and collected the data. I requested use of the data and thereafter received written permission from the data host to access, download, and use the data for this study. This archival data were collected in Uganda from June to December 2011 through the administration of three questionnaires (household, men's, and women's) on a sample that was representative both nationally and regionally. Data on children were provided by women through the women's questionnaire. From the women's dataset, I was able to extract data regarding the dependent variable, independent variables, and other important variables included in the study, such as the age and sex of the child; the age, religion, and education level of the mother; the residing place, whether urban or rural; and the number of children in the family. More details on the method of data collection and sampling procedure carried out by the DHS team are presented in Chapter 3 of this study.

Results

Descriptive Characteristics of Children

The calculated minimum sample size required for testing the association between the dependent variable (diarrhea outcome) and independent variables (length of breastfeeding, ARI, and vaccination status) was 134, as discussed in Chapter 3 of this study; however, a sample of 7,323 children was used for this study. The UDHS 2011 dataset had a population of 8,076 children, and from this population, I filtered only the children who were alive and those who had a response on the outcome variable. Thus, a sample of 7,323 children remained.

Apart from the mentioned dependent and independent variables, other variables included in this study were the age of the children, number of children per household, and gender of the child. Among the children, 3,668 (50.1%) were female and 3,655 (49.9%) were male. Age of the children ranged from 0 to 59 months. The mean age was 28.8 months, with a standard deviation of 17.3 months. The mean ages for males and females were similar (28.7 for males with standard deviation of 17.4 and 28.9 for females with standard deviation of 17.2). The descriptive statistics are summarized in Table 3. Age was further categorized into age groups of 0-11 months, 12-23 months, 24-35 months, 36-47 months, and 48-59 months to allow comparisons between the different age groups, as illustrated in Figure 2. Proportionate age distribution by gender to compare the female and male children's age distribution within the age groups indicated that the highest percentage of female children was in the age group of 12-23 months (21.2%), while the highest percentage of male children was in the age group 0-11 months (22.8%).

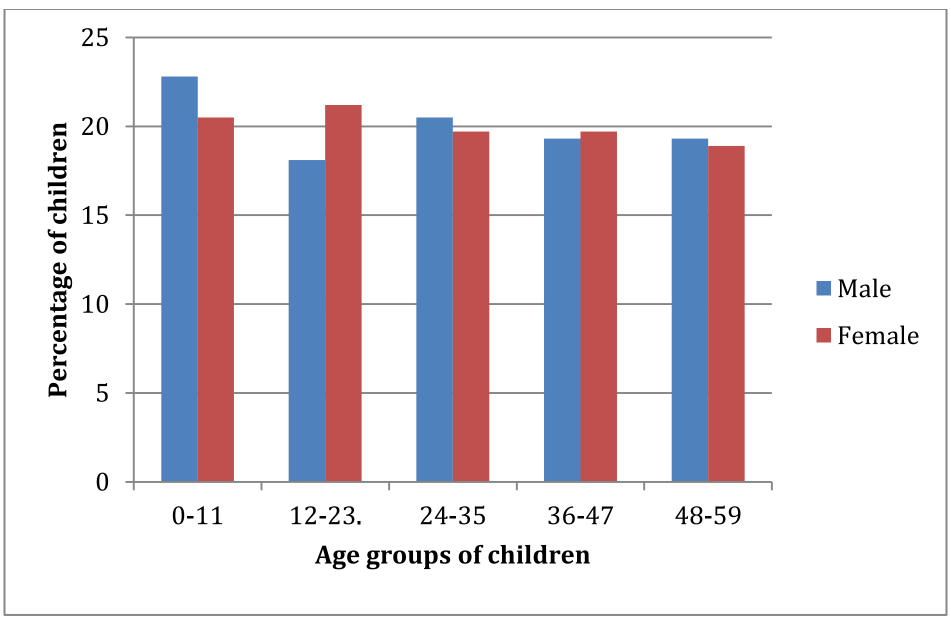

Figure 2. Proportionate distribution by age and gender of the study sample.

The children's data were collected on the last-born child in each participating household. Data for the number of children per household were as follows: 45.9% of households had two children under 5 years of age, 24% had one child under 5 years of age, 23.9% had three children under 5 years of age, 4.9% had four children under 5 years of age, and households with five or six children made up 2% of the sample. This was further recoded into two distinct categories to allow comparisons between the households with few children and those with a high number of children. Households with two or fewer children constituted 70.3% of the sample, while those with three to six children constituted 29.7%

Descriptive Characteristics of the Women

The sample of women who provided information on the children is described as consisting of women who were the primary caregivers of the children. Variables of the women that were considered were age, education level, religion, and residing area (urban or rural). The number of women was equal to the number of children because each woman provided information on only the last-born child. Among the women, 14.5% had received no education, 63.4% had a primary-level education, 18.5% had a secondary-level education, and 3.6% had a higher level education, which could be tertiary or university level. The majority of the sample was from rural households (85.9%), as compared to those from urban areas (14.1%). A higher proportion of the mothers belonged to the Catholic religion (41.3%), followed by Protestants (29.6%). These descriptive statistics are summarized in Table 3.

Table 3

Descriptive Characteristics of the Study Sample

	Variable		Study sample (*N* = 7,323)	
			n	%
Child	Age in months	0 -11	1,627	22.2
		12-23	1,464	20.0
		24-35	1,476	20.2
		36-47	1,407	19.2
		48-59	1,349	18.4
	Sex	Females	3,668	50.1
		Males	3,655	49.9
	Number of children in household[a]	1	1,715	24.0
		2	3,289	45.9
		3	1,711	23.9
		4	353	4.9
		5	56	0.8
		6	34	0.5
Mother	Age in years	15-19	413	5.6
		20-24	1,809	24.7
		25-29	2,177	29.7
		30-34	1,348	18.4
		35-39	1,001	13.7
		40-44	448	6.2
		45-49	127	1.7
	Education level	No education	1,059	14.5
		Primary	4,642	63.4
		Secondary	1,355	18.5
		Higher	267	3.6
	Residence	Urban	1,036	14.1
		Rural	6,287	85.9
	Religion	Catholic	3,027	41.3
		Protestant	2,165	29.6
		Muslim	954	13.0
		Pentecostal	924	12.6
		SDA	139	1.9
		Other	114	1.6

[a]Children who were not permanent residents of the household were omitted.

Descriptive Statistics of the Dependent and Main Independent Variables

Diarrhea. The number of children in the study who had a diarrhea episode in the 2 weeks preceding the survey was 1,766 (24.1%), with the highest proportion in the age group 12-23 months (31.5%). Occurrence of diarrhea decreased with increasing age, as illustrated in Table 4.

Table 4

Descriptive Statistics of Children With Diarrhea by Age Group

	Diarrhea (*N* = 7,323)				
Age group in months	No		Yes		Total
	n	(%)	*n*	(%)	*N*
0-11	1,117	20.1	510	28.9	1,627
12-23	908	16.3	556	31.5	1,464
24-35	1,139	20.5	337	19.1	1,476
36-47	1,192	21.5	215	12.2	1,407
48-59	1,201	21.6	148	8.4	1,349
Total	5,557	100.0	1,766	100.0	7,323

Length of breastfeeding. The mean length of breastfeeding among the children was 24 months, *SD* = 17.7 months. The mean length of breastfeeding was significantly lower in the children with diarrhea than the children without diarrhea (18 months, *SD* = 13.57 vs. 25 months, *SD* = 18.38, respectively; $p < 0.001$), indicating that children who had diarrhea had breastfed for a statistically significantly shorter duration than the children without diarrhea.

ARI. Among the children, 15.2 % (1,113) had ARI in the 2 weeks preceding the survey. The highest occurrence of ARI was in the youngest age group (0-11 months), as indicated in Table 5.

Table 5

Descriptive Statistics of Children With ARI by Age Group

Age group in months	ARI (*N* = 7,317[a])				
	No		Yes		Total
	n	%	*n*	%	*N*
0-11	1,343	21.6	283	25.4	1,626
12-23	1,194	19.2	267	24.0	1,461
24-35	1,263	20.4	213	19.1	1,476
36-47	1,223	19.7	183	16.4	1,406
48-59	1,181	19.0	167	15.0	1,348
Total	6,204	100.0	1,113	100.0	7,317

[a]Six missing variables.

Vaccination. Vaccination status is presented by age groups (Table 6) from 12-59 months. In the age group 12-23 months, 51.7% of the children were fully vaccinated, 44.5% were partially vaccinated, and 3.8% were not vaccinated. Partially vaccinated children were those who had received at least one but not all of the required vaccinations. Vaccination status for the subsequent age groups did not differ much from this age group.

Table 6

Percentage of Children Who Had Received Vaccinations

Age in months	BCG	DPT-HepB-Hib1	DPT-HepB-Hib2	DPT-HepB-Hib3	P0lio 0	Polio 1	Polio 2	Polio 3	Measles	Fully vaccinated	Partially vaccinated	No vaccination	[a]Total number of children
12-23	93.7	92.3	85.5	72.3	67.1	92.2	83.5	64.0	75.7	51.7	44.5	3.8	1,464
24-35	94.3	91.7	85.8	72.8	67.5	92.8	84.9	61.6	82.1	50.7	45.2	4.0	1,476
36-47	93.8	94.2	86.5	73.1	65.3	93.3	84.4	60.6	83.8	51.3	45.0	3.7	1,407
48-59	96.0	94.5	87.5	73.7	65.0	94.4	88.2	62.5	86.5	52.5	44.7	2.8	1,349

[a]Total number of children is less than 7,323 because those in age group < 12 months are excluded.

Bivariate Analysis

Bivariate analysis was conducted for each of the selected covariates on the dependent variable to identify the association of each predictor variable with diarrhea. These results are summarized in Table 7. When compared to children of those women who were youngest (15-19 years), children of the women who were older were less likely to have diarrhea. The *COR* values for 20-24 years, 25-29 years, 30-34 years, 35-39 years, 40-44 years, and 45-49 years were 0.76, 0.52, 0.46, 0.51, 0.43, and 0.53 respectively. The COR was significant ($p < 0.05$) for all age groups, indicating that protection from diarrhea was significantly associated with the age of the mother. Urban or rural residence was not found to be significantly associated with occurrence of diarrhea (p=0.33).

Regarding the education level of the women, the children of mothers who were most educated were less likely to have diarrhea as compared to those with no education. Those of mothers who had primary-level education were 1.25 times more likely to have had an episode of diarrhea compared to those with no education (*COR* = 1.25; *CI* = 1.07, 1.47; p=0.005). There were no significant differences in the reported incidence of diarrhea for the children of mothers who had secondary education and children of mothers with no education (*COR* = 0.98; *CI* = 0.80, 1.19; p=0.83). The children of those mothers who had a higher education, were least likely to have had diarrhea compared to those who had no education (*COR* = 0.52; *CI* = 0.35, 0.76; $p < 0.001$). Each category of education level represented the highest level the woman had attained and not necessarily completion of that education level.

There were mixed findings for religion of the mother. When compared to Catholics, whose religion was dominant in the data, being Protestant was not associated with diarrhea in children (COR = 1.1; *CI* = 0.97, 1.25; p= 0.13), while the odds of diarrhea among Muslim children were 1.31 times greater than the odds of diarrhea among children of Catholic women (COR = 1.31; *CI* = 1.10, 1.54; p=0.001). Children of Pentecostal women were 1.22 times more likely to have diarrhea than children of Catholic women (COR = 1.22; *CI* = 1.03, 1.44; p=0.021). The children of those who were Seventh Day Adventist (SDA) were 40% less likely to have an occurrence of diarrhea than children of Catholic women, and this difference was statistically significant (*COR* = 0.60; *CI* = 0.37, 0.97; p=0.038), while being in other religions had no significant association with occurrence of diarrhea (*COR* = 0.98, *CI* = 0.63, 1.54; *p*=0.958 respectively).

Age of the child was significantly associated with the incidence of diarrhea. Comparisons were carried out with the age group 6-11 months as the reference category as children less than 6 months were omitted from the analysis as this was the age group least likely to be exposed to agents that cause diarrhea as explained in the literature review section. As the age of the child increased, the likelihood of having diarrhea reduced significantly. Among the children aged 12-23 months, the *COR* was 0.81 (*CI* = 0.63, 0.96; *p*=0.019). *COR* for children aged 24-35 months was 0.39 (*CI* = 0.32, 0.47; p<0.001). *COR* for children aged 36-47 months was 0.24 (*CI* = 0.19, 0.29; *p*<0.001) and the *COR* for children aged 48-59 months was 0.16 (*CI* = 0.13, 0.20; *p*<0.001).

The number of children in the household and a child's gender had no significant association with diarrhea (*p*=0.904 and *p*=0.213 respectively).

Bivariate analysis was also conducted for the main independent variables on the dependent variables and the results are summarized in Table 8. Length of breastfeeding was a continuous variable and the results for the association between the length of breastfeeding and diarrhea was a negative relationship with statistically significant findings. For every additional month of breastfeeding from 6 to 36 months, the odds of having diarrhea decreased by 5% (*COR* = 0.95; *CI* = 0.94, 0.95; *p*<0.001). Length of breastfeeding was further categorized and the same trend was observed with less likelihood of diarrhea as the duration of breastfeeding increased. Compared to children breastfed less than 12 months, children breastfed for 12 months and above were less likely to develop diarrhea. Most importantly children breastfed for 24 months and above were 64% less likely to have diarrhea than children breastfed for 6-11 months (*COR* = 0.36; *CI* = 0.28-0.46; p<0.001).

Bivariate analysis for ARI and diarrhea resulted in significant results as shown in Table 8. Children who had ARI were twice as likely to have diarrhea as compared to children who did not have ARI (*COR* = 2.18; *CI* = 1.91, 2.50; p<0.001). The association between the vaccination status of children and diarrhea was tested for children aged above 12 months as children below this age may have not completed the immunization schedule, for instance the measles vaccine is given at 9 months of age. In this group, there was no statistically significant evidence of protection against diarrhea afforded by full vaccination (*COR* = 1.10; *CI* = 0.76, 1.59; p=0.619). This was not the case for those who were partially vaccinated as the statistical evidence revealed such children to have higher odds of an episode of diarrhea (*COR* = 1.52; *CI* =1.04 – 2.20; p=0.02) than those not vaccinated, indicating that partial vaccination offered no protection to the outcome of diarrhea.

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Table 7

Bivariate Analysis of Predictor Variables and Diarrhea Among Children

Variable	Diarrhea (*N* = 7,323)		COR[a]	*p*-value	95% CI	Chi-square
	No (*N* = 5,557) *n* (%)	Yes (*N* = 1,766) *n* (%)				
Maternal age in years						
15-19 (reference)	267 (64.6)	146 (35.4)	1.00	-		
20-24	1,276 (70.5)	533 (29.5)	0.76	0.018	0.60-0.95	30.93
25-29	1,697 (78.0)	478 (22.0)	0.51	<0.001	0.41-0.64	1,093.49
30-34	1,075 (79.7)	273 (20.3)	0.46	<0.001	0.36-0.59	1,508.39
35-39	782 (78.0)	220 (22.0)	0.51	<0.001	0.39-0.66	735.76
40-44	362 (80.6)	87 (19.4)	0.43	<0.001	0.32-0.59	757.29
45-49	98 (77.2)	29 (22.8)	0.53	0.008	0.33-0.84	50.06
Residence[b]						
Urban (reference)	798 (77.10)	237 (22.9)	1.00	-		
Rural	4,759 (75.7)	1,528(24.3)	1.08	0.330	0.92-1.26	0.90
Education						
None (reference)	827 (78.1)	232 (21.9)	1.00	-		
Primary	3,434 (74.0)	1,208(26.0)	1.25	0.005	1.07-1.47	60.51
Secondary	1,063 (78.5)	292 (21.5)	0.98	0.831	0.80-1.19	0.02
Higher	233 (87.3)	34 (12.7)	0.52	0.001	0.35-0.76	0.03
Religion[b]						
Catholic (reference)	2,342 (77.4)	684 (22.6)	1.00	-		
Protestant	1,637 (75.6)	528 (24.4)	1.10	0.132	0.97-1.25	5.13
Muslim	690 (72.3)	264 (27.7)	1.31	0.001	1.10-1.54	102.15
Pentecostal	681 (73.7)	243 (26.3)	1.22	0.021	1.03-1.44	28.59
SDA	118 (84.9)	21 (15.1)	0.60	0.038	0.37-0.97	18.65
Other	88 (77.2)	26 (22.8)	0.98	0.958	0.63-1.54	0.00
Age of child (months)[c]						
6-11 (reference)	472 (57.0)	359 (43.0)	1.00	-		
12-23	908 (62.0)	556 (38.0)	0.81	0.019	0.63-0.96	30.41
24-35	1,139 (77.2)	337 (22.8)	0.39	<0.001	0.32-0.47	9,952.45
36-47	1,192 (84.7)	215 (15.3)	0.24	<0.001	0.19-0.29	38,355.65
48-59	1,201 (89.0)	148 (11.1)	0.16	<0.001	0.13-0.20	68,785.55

(*table continues*)

Variable	Diarrhea (*N* = 7,323)		COR[a]	*p*-value	95% CI	Chi-square
No. of children[d]						
≥ 3 (reference)	1,635(75.9)	519 (24.1)	1.00	-		
≤ 2	3,791 (75.8)	1,247(24.2)	1.01	0.904	0.89-1.13	0
Sex of child[b]						
Male (reference)	2,751 (75.3)	904 (24.7)	1.00	-		
Females	2,806 (76.5)	862 (23.5)	0.93	0.213	0.83-1.04	2.40

[a]COR was obtained by running dependent variable with independent variable at a time using unadjusted binary logistic regression. [b]1 missing. [c]Variables do not add up to 7,323 because the age group < 6 months is excluded. [d]Variables do not add up to 7,323 because children who were not permanent members of the household were excluded.

Table 8

Bivariate Analysis of Main Independent Variables and Diarrhea Among Children

Variable	Diarrhea (*N* = 7,323)		COR[a]	*p*-value	95% CI	Chi-square
	No *n* = 5,557 *n* (%)	Yes *n* = 1,766 *n* (%)				
Length of breastfeeding[b]						
Continuous			0.95	< 0.001	0.94-0.95	97,425
Categorical						
6-11 months (ref)	437 (56.1)	342 (43.9)	1.00	-		
12-23 months	612 (80.1)	407 (39.9)	0.85	0.092	0.07-1.02	8.08
24-35 months	480 (77.9)	136 (22.1)	0.36	<0.001	0.28-0.46	4,935.624
36-47 months	630 (86.2)	101 (13.8)	0.20	<0.001	0.15-0.26	22,744.56
48-59 months	539 (89.1)	66 (10.9)	0.15	<0.001	0.11-0.21	23,945.08
ARI[c]						
No (ref)	4,861 (78.3)	1,344(21.7)	1.00	-		
Yes	695 (62.3)	420 (37.7)	2.18	<0.001	1.91-2.50	16,508.13
Vaccination status[d]						
No vaccination (ref)	161(81.7)	36 (18.3)	1.00	-		
Partial vaccination	1,882 (74.7)	636 (25.3)	1.52	0.028	1.04-2.20	23.21
Full vaccination	2,387 (80.3)	584 (19.7)	1.10	0.619	0.76-1.59	0.062

[a]COR was obtained by running dependent variable with independent variable at a time using unadjusted binary logistic regression. [b]*n* = 3,750 because the age group < 6 months is excluded. [c]3 missing variables. [d]*n* = 5,686 because the age group < 12 months is excluded.

Multivariable Analysis

Multivariable analysis was conducted to assess significant factors influencing the outcome of diarrhea with the main independent variables when other factors were controlled. Multivariable logistic regression was carried out by fixing each main predictor variable at a time (i.e. length of breastfeeding, ARI, and vaccination). The main assumptions for using a binary logistic regression model are that the dependent variable is binary, the model is fitted correctly by including variables that are meaningful, the observations should be independent, there should be at least 10 observations per independent variable in the model, and the variables should not be too highly correlated with each other, greater than the absolute value of .8. These assumptions were met prior to running the binary logistic models.

The covariates that were statistically significant at bivariate analysis level and those that possessed a *p*-value of ≤ 0.2 (maternal age, maternal education level and religion) were included in the multivariable analysis models. Number of children in the family, the sex of the child and residence variables did not meet this criterion and were left out of the multivariable models. A multivariable regression model was constructed for each research question. In each model, a backward Wald regression was performed and the variables that did not significantly predict diarrhea were removed from the model. Interaction of significant factors with main variable was also assessed and thereafter confounding effects ($\frac{cOR-aOR}{cOR}x100\%$) were assessed at 10% cut off. Variables that resulted in a 10% change or more in the *AOR* as compared to the *COR* were left in the model. After assessing for confounding and interaction, the full model including all the relevant variables was constructed for each research question.

Research Question 1. Is there an association between incidence of diarrhea in children (as determined by an episode within past two weeks) and the length of breast feeding of the child (as determined by the number of months a child has been breastfed)? To answer this research question, multivariable regression analysis to determine the association of length of breastfeeding and diarrhea was performed using multivariable logistic regression. Length of breastfeeding, as the main predictor variable was categorized as children who were breastfeeding within the 6-11, 12-23 and 24-35 months age group. Children who were breastfeeding below 6 months of age were left out as the study's main interest was the length of breastfeeding beyond the exclusive breastfeeding period which is up to 6 months of age. The final model was obtained as shown in Table 9.

When other variables were controlled for, the association between the length of breastfeeding and diarrhea remained negative but the association weakened. The model explained 16.6% of the variation in occurrence of diarrhea (Nagelkerke R square = 16.6). The Hosmer and Lemeshow test was not significant (p=0.279) indicating that the model fits the data. The *AOR* for breastfeeding in the age group 12-23 months increased to 0.98 (*CI* =0.80, 1.20) from the *COR* of 0.85 (*CI* = 0.07, 1.02) when the analysis was adjusted for age and education level of the mother, though this association remained non-significant (p=0.817). The *AOR* at 24- 35 months was significant and it adjusted from 0.36 (*CI* = 0.28, 0.46; p<0.001) to 0.42 (*CI* = 0.33, 0.54; p<0.001). This meant that children who were breastfeeding beyond 23 months to 35 (3 years) were 58% times less likely to have an incidence of diarrhea compared to those who breastfed until 11 months. The results indicate that when the mothers continued with breastfeeding beyond 24 months until at least 3 years, these children had some protection from diarrhea that was not seen in the children of whom breastfeeding after 11 months was not observed.

Maternal age and education level of the mother, contributed significantly to this model (p=0.025 and p<0.001 respectively) while religion was left out as a non-significant variable (p=0.54).The null hypothesis states that there is no association between the incidence of diarrhea and the length of breastfeeding. These significant results at 24-36 months of breastfeeding while other variables are controlled for lead to rejection of the null hypothesis. The role of maternal age and education play relative to protecting children from diarrhea is further supported from this analysis as the *AOR* increased as compared to the unadjusted *COR*.

Table 9

Logistic Regression Results for Length of Breastfeeding and Incidence of Diarrhea

	AOR	*p*-value	CI
Length of breastfeeding in months			
6-11 months (reference)	1.00		
12-23	0.98	0.817	0.80-1.20
24-35	0.42	<0.001	0.33-0.54
36-47	0.24	<0.001	0.18-0.31
48-59	0.19	<0.001	0.14-0.26

Note. Variables adjusted in the model are maternal age and education level of the mother.

Research Question 2. Is there an association between the incidence of diarrhea in children (as determined by an episode within past two weeks) and the presence of ARI (as determined by the presence of cough accompanied by short rapid breathing respectively within past two weeks)? A multivariable logistic regression was conducted to answer this research question with the main predictor variable as ARI. The variables that were controlled for were child's age, maternal age, maternal education level and religion of the mother. In the final multivariable model, adjustment of other variables slightly weakened the association between ARI and diarrhea but the association remained significant (*AOR* = 2.013; *CI* =1.74, 2.32; p<0.001 vs. *COR* = 2.188; *CI* = 1.91, 2.50; p<0.001). The final model was obtained as shown in Table 10. This final model explained 14.2% of the variation in occurrence of diarrhea (Nagelkerke R square = 14.2) and the model was a good fit (Hosmer and Lemeshow test: p=0.579).

Results from the logistic regression model indicate that children who had ARI were twice as likely to have diarrhea as children who did not have ARI. The control variables of age of the mother, education level, religion contributed significantly to this model (p<0.001 for all variables). The statistically significant results of the association between diarrhea and ARI while controlling for other variables indicate that there is sufficient evidence to reject the null hypothesis that states that there is no significant association between the incidence of diarrhea and the occurrence of ARI.

Table 10

Logistic Regression Results for ARI and Incidence of Diarrhea

	AOR	*p*-value	CI
ARI	2.01	<0.001	1.74 -2.32

Note. Variables adjusted in the model are age of the child and age, education level, and religion of the mother.

Research Question 3. Is there an association between incidence of diarrhea in children and the vaccination status of the child (as determined from the vaccination card and / or mother's verbal report)? A multivariable regression analysis was conducted to assess the association between vaccination status and the incidence of diarrhea. The main predictor variable was the vaccination status and children above 12 months of age were considered. Maternal age, maternal education level and religion, variables were controlled for in this analysis. Similarly like in the previous models, the number of children in the family, sex of the child and residence variables was left out due to non-significant results. The final model was obtained as shown in Table 11.

In the final model there was minimal change in the *AOR*. Full vaccination of children did not offer protection to diarrhea (*p*=0.607) as was seen in the bivariate analysis. At bivariate analysis, *COR*=1.10; *CI* = 0.76, 1.59; *p*=0.619 while at multivariable analysis, *AOR* =1.104; *CI* = 0.756, 1.613; *p*=0.607. Children who were partially vaccinated had higher odds of having an incidence of diarrhea and this had statistically significant findings (AOR = 1.491; *CI* =1.021 – 2.177; p = 0.039). This means that vaccinating children fully was not associated with occurrence of diarrhea and partial vaccination was not of any added benefit protection to diarrhea. This model explained 7.5% of the variation in occurrence of diarrhea (Nagelkerke R square = 0.075) and the Hosmer and Lemeshow test was not significant. The hypothesis for this research question states that there is no association between the incidence of diarrhea and vaccination status of the child. Due to the non-significant findings based on full vaccination, there is no sufficient evidence from this study to reject the null hypothesis.

Table 11

Logistic Regression Results for Vaccination Status in Children Aged Above 12 Months and Incidence of Diarrhea

	AOR	*p*-value	CI
Vaccination status		0.035	
No vaccination (reference)	1.00		
Partial vaccination	1.49	0.039	1.021–2.177
Full vaccination	1.10	0.607	0.756–1.613

Note. Variables adjusted in the model are age, education level, and religion of the mother.

Summary

There were three research questions, each with its hypothesis that the study results sought to answer. In this chapter the descriptive statistics, results from the bivariate analysis and multivariable logistic regression models have been presented. The bivariate analysis for the covariates indicated significant findings for age of the child, age of the primary care giver who was the mother, the mother's education level and religion when their association with the incidence of diarrhea was tested. There were no significant findings for the tested relationship of the number of children in the household, sex of the child and residence with the incidence of diarrhea. The variables with significant findings were included in the multivariable logistic regression models with the main predictor variables. The first research question sought to identify the association between the incidence of diarrhea in children and the length of breastfeeding. In the multivariable regression model while controlling for other variables, the results indicate a longer breastfeeding period from beyond 24 months was statistically significantly associated with a lower occurrence of diarrhea. The null hypothesis for this research question indicating that there is no association between the incidence of diarrhea and the length of breastfeeding was thus rejected. The second research question sought to test the association between the incidence of diarrhea and co-occurrence with ARI. The multivariable regression results while controlling for other variables indicate that occurrence of diarrhea is statistically significantly associated with the co-occurrence with ARI. Children who had ARI were twice as likely to have an incidence of diarrhea as children who did not have ARI. The null hypothesis for this research question stating that there is no association between the incidence of diarrhea and the occurrence of ARI was also rejected.

The third research question sought to test the association between the incidence of diarrhea in children and the vaccination status of the child among the children above 12 months of age. Full immunization of children was not significantly associated with the occurrence of diarrhea. Partial immunization of children had significant findings whereby there was a higher likelihood of having an incidence of diarrhea with partial immunization. However, since full immunization rather than partial immunization is the recommended practice, the null hypothesis for this research question was not rejected.

In Chapter 5, the results from this study are discussed in greater detail together with the interpretation of the findings. Recommendations arising from this study, the social change implications and the conclusion of the study are discussed as well.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

This study contains an examination of the association between the outcome of diarrhea in children and the length of breastfeeding of the child, co-occurrence with ARI, and the vaccination status of the child based on data from the UDHS 2011. Data extracted from this data set represented children below 5 years of age in Uganda. Childhood diarrhea is a disease of high burden in Uganda, and these results are of significance, with potential health, social, and economic impact for the country. There is a lack of existing research on how the length of breastfeeding, coinfection with ARI, and vaccination status of the child impact on the incidence of diarrhea among children in Uganda, and this study fills that gap. The results provide information that can be used together with other known interventions to help reduce the incidence of diarrhea among children in Uganda. In this chapter, I summarize and provide an interpretation of the results gathered from this study and report the findings by the research questions. The study's limitations, recommendations and implications are also discussed.

Interpretation of the Findings

In this study, the outcome variable was diarrheal disease. Diarrhea in children is defined as the passage of loose, watery stools more than three times in 24 hours. The data analyzed were obtained from women who were asked if their children had an episode of diarrhea in the previous 2 weeks. It was found that 24% of the children had an incidence of diarrhea. Age of the child was significantly associated with diarrhea, whereby occurrence of diarrhea decreased with increasing age of the child. This occurrence was highest in the age group 12-23 months. Other studies have shown that the highest incidence and deaths due to diarrhea occur in children less than 2 years of age (Mohammed & Tamiru, 2014; Strand et al., 2012). In the second half of an infant's life, though the child's immunological capability increases with age, the child is transitioned from exclusive breastfeeding to solid foods, which may lead to exposure to contaminated weaning foods leading to diarrhea.

Other demographic variables seen to have an association with diarrhea included maternal education level and maternal age. Children of the women who had achieved the highest education level had the most protection from diarrhea when compared to children of women with no education. This finding was similarly seen in studies by Mbugua et al. (2014); Mihrete et al. (2014); and Islam, Hossain, Khan, and Ali (2015). Low education level of the mother or caregiver was cited in these studies as a risk factor for childhood diarrhea. Higher education level of the mother could act as protective against diarrhea, in that higher material education may increase the likelihood of better health outcomes through increased knowledge of disease prevention and better usage of health care services. In this study sample, the education level of women was quite low, whereby the majority of the mothers had attained only primary-level education (63.4%). Most of the women were in the age group 20-29 years, an age when they should have completed secondary education.

Maternal age was found to play a significant role in the occurrence of diarrhea in children. Children of older women were less likely to have diarrhea as compared to children of younger women. This finding is similar to findings by Pinzón-Rondón et al.

(2015), whereby younger mothers reported diarrhea more frequently in their children than older women did. The residence of the child had no association with the occurrence of diarrhea in this study. Children from rural areas did not show a significant association with diarrhea when compared to children from urban areas. However, given that the majority of the children were from rural areas, with only 15% being from urban areas, the data on residence area did not provide a good comparison. Studies that have shown an association of childhood diarrhea and residence include a study by Anteneh, Andargie, and Tarekegn (2017) that demonstrated that children from rural areas were 11 times more likely to report occurrence of diarrhea as compared to children from urban areas. Mengistie, Berhane and Worku (2013) conducted a study in Ethiopia that also showed a higher occurrence of diarrhea in children from rural areas as compared to urban areas. This association was not observed in this study.

The number of children within the households in this study ranged from one to six, and the highest percentage of respondents reported two children in the household (45.9%). Households that had few children (two or fewer children) did not show a significant difference in occurrence of diarrhea when compared to households that had three or more children. This is in contrast with the findings of Mihrete et al. (2014), which showed that in households with two or fewer children, the risk of diarrhea decreased significantly compared to households with more than three children. Similarly, in a study by Tambe, Nzefa, and Nicoline (2015), there was a higher occurrence of diarrhea in children who were from households that had more than two siblings.

Research Question 1

This research question aimed to test the association between the incidence of diarrhea and the length of breastfeeding. The average length of breastfeeding was 24 months, which is commendable, in that UNICEF (2015) recommends exclusive breastfeeding within the first 6 months of life with continued breastfeeding to at least 2 years of age. At 6 months of age, breastmilk alone is no longer sufficient to meet the nutritional needs of the infant, and the child is introduced gradually to other foods and liquids along with breastmilk, in a process referred to as *weaning* or *complementary feeding*. The length of breastfeeding differed among children with diarrhea and those without diarrhea. The children who had diarrhea had breastfed for an average of 18 months, whereas those without diarrhea had breastfed for a longer period, with an average of 25 months, and this difference was statistically significant (p<0.001). Literature has indicated that when children are exclusively breastfed within the first 6 months of life, they are protected from childhood illnesses that include diarrhea. WHO (2017b) and UNICEF (2015) recommend that children be exclusively breastfed within the first 6 months of life so as to achieve this benefit. Further, they recommend that as complementary foods are introduced, breastfeeding should continue to at least the age of 2 years. The first research question was intended to test whether continued breastfeeding beyond the first 6 months of life would still protect children from diarrhea. Consequently, the analysis excluded children who were less than 6 months of age.

The results indicate that as the length of breastfeeding increased, the children had some protection from diarrhea. These findings align with those of other studies such as

Leung et al. (2015), which showed that breastfeeding was protective against diarrhea in children less than 60 months of age. Lamberti et al. (2011) demonstrated that infants and young children aged 6-23 months who were not breastfeeding had a higher risk of death from diarrhea as compared to children who were breastfeeding. For the age group 24-35 months in this study, children breastfeeding were 58% less likely to have an incidence of diarrhea as compared to those not breastfeeding at all. It has been documented that exclusive breastfeeding plays an important role in the survival of children. This study adds evidence that breastfeeding continued beyond this period contributes to the survival of children through its protective role relative to the incidence of diarrhea.

In the multivariable logistic regression model, when maternal age and education were controlled for, the strength of the association weakened as compared to the bivariate analysis results, giving further evidence that higher age and higher education level in the mother play a role in protecting a child from diarrheal disease. It is necessary to note that though the mothers provided information on their children's breastfeeding status, the children were receiving complementary feeding, and the frequency or amount of breastfeeding, which might have had an influence on the findings, could not be determined from this study.

Research Question 2

With the second research question, I sought to test the association between the incidence of diarrhea and the presence of ARI in children. The occurrence of these two diseases progressively declined up to the age of 5 years, and this reduction could be thought of as a result of being able to fight infections better due to immunity getting stronger as the child gets older. Overall findings revealed that 15% of the children had ARI in the 2 weeks before the survey. ARI is the leading cause of death among children under 5 years of age among countries in sub-Saharan Africa, followed by diarrhea, as was elaborated in Chapter 2 of this study.

Children who had ARI had a higher likelihood of having diarrhea as well, and even with control of other variables that may influence the occurrence of diarrhea, it was seen that the likelihood of having diarrhea increased when a child already had ARI. The significant findings of the association between ARI and diarrhea have important implications. Children who have ARI are likely to have diarrhea, and this finding calls for extra vigilance for these children so that they are closely monitored to avoid these children subsequently having diarrhea. This could have great repercussions for the child because comorbidity of the two diseases in the child is likely to result in more dire consequences (Leung et al., 2015). These findings also suggest that an integrated approach to the prevention and management of the two diseases would be beneficial. This is further supported by a study by Walker et al. (2013a) indicating that there could be shared risk factors for the two diseases. Walker et al. discovered that presentation of ARI and diarrhea simultaneously was more prevalent than what would be expected if the occurrence was by chance alone.

This finding builds on evidence provided by Leung et al. (2015), who investigated risk factors for concurrent presentation of these diseases in resource-constrained communities. It was clear that children presenting with diarrhea and pneumonia had an over 80 times higher risk of death and a three times longer length of stay in hospital compared with those who had diarrhea only. Additionally, Ashraf et al. (2013) demonstrated this association; however, theirs was a reverse association, whereby a recent diarrheal incidence increased the risk of pneumonia. Irrespective of which disease preceded the other, control of one infection is likely to reduce the occurrence of the other disease, and thus a coordinated solution to both diseases should be considered. In interpreting these results, it is noted that variables other than age of the child and age, religion, and education level of the mother may confound or mediate this association but were not available in the data set. Data on these variables might permit a more nuanced understanding of this association. Nevertheless, the results demonstrate findings indicating potentially important practical applications. A child appearing at the health system with ARI is an opportunity to prevent a future case of diarrhea.

Research Question 3

With the third research question, I sought to test the association between the incidence of diarrhea and the vaccination status of the child. This was tested in children above 12 months of age, in that it is expected that by this age, the child has completed the immunization schedule, and therefore children above 12 months of age were the research question's main interest. Among the children aged 12 to 23 months, 51.7% were fully vaccinated, 3.8% had received no vaccinations and 44.5% were partially vaccinated. Findings from the bivariate and logistic regression results while controlling for other variables did not indicate a significant association between complete immunization status and occurrence of diarrhea. Previous studies (Girma & Berhane, 2011; Saadatian-Elahi et al., 2016;) have elucidated that childhood vaccines confer nonspecific benefits that contribute to reduction in all-cause morbidity and mortality in children. This study was not able to demonstrate that this non-specific benefit applies to reduction in occurrence of diarrhea.

Partially vaccinating children did not protect them from diarrhea. Children who were partially vaccinated could have received minimal vaccines, as they had received at least one vaccination but not completed all of the recommended EPI vaccinations. The proportion of children receiving the immunizations reduced with each subsequent vaccination, and as such, many of the partially immunized children could have received the initial vaccines and faltered on most of the subsequent vaccines, thus failing to support a protective effect for diarrhea in this group.

There could be other reasons for the nonsignificant results for full vaccination. Vaccine potency is preserved by maintaining it at a specific range of low temperature during storage and transportation, which is referred to as cold chain. Vaccines failing due to noncompliance to the cold chain, especially in rural areas, where there may be challenges in electricity supply is a possibility (Ateudjieuet al., 2013; Yakum et al., 2015). However, this study was not able to assess the viability of the vaccines administered. Additionally, though the DHS data collection process was designed to ensure valid data collection on vaccination by corroborating the mother’s report with the information on the vaccination card, in cases where the vaccination card was not available, the interviewer relied on the mother’s recollection, and there was the possibility of the mother not reporting accurate information, which could have influenced these findings.

The study revealed other important findings. The proportion of children who had been partially vaccinated was quite high (44.5%). This implies that as vaccines were received at health care facilities, caregivers were at some point exposed to the health system, but for various reasons, the children were not taken to the health facility to complete the immunization schedule. Additionally, the coverage for BCG vaccine, which is the first vaccine administered at birth or at first contact with a health care provider, was very high (93.7%), indicating a high level of healthcare services access followed by a gradual decline in vaccination coverage, such that only 75.7% received the measles vaccination given at 9 months. The reasons for immunization dropout could be explored further to help improve the immunization completion rate.

Application of the Socioecological Model

Findings from this study reconfirm the significance of the SEM in explaining how socioeconomic and environmental factors influence the occurrence of disease. The socioecological perspective has helped in developing the understanding that there are various risk factors involved in the occurrence of diarrhea. This study has identified the risk factors as length of breastfeeding and comorbidity with ARI. Other factors identified in this study include the age and the education level of the mother. These factors function together to influence the outcome of diarrhea, thus supporting the application of the SEM in explaining the multifactorial dimension of childhood diarrhea.

Additionally, the socioecological perspective has shown that these factors operate at different levels of the socially organized environment. They operate from the individual level in factors such as the child's age, caretaker's age, and caretaker's education level, to the family and community environment that would support and promote breastfeeding. The influence of the higher systems is seen, such as the macrosystems level, which involves the health care system that is involved in prevention and control of other diseases such as ARI, as well as public policy systems that discourage early childbearing and support higher educational attainment for women. Grounding this study in the socioecological framework has provided an opportunity to illustrate how selected risk factors function in the different spheres of environmental and societal factors to impact the occurrence of diarrhea in children.

Limitations of the Study

This study has produced findings that are relevant to the public health community, especially in populations that are struggling with high morbidity and mortality from diarrheal disease in children. In discussing the findings, it is important to note that all analyses were limited to the variables and data captured by the UDHS, as the data were secondary data; therefore, other factors that may have influence on the occurrence of diarrhea were not captured in this analysis. The confounding variables included in the models may not have constituted an exhaustive list of possible influences, in that only those that were readily available in the UDHS 2011 were tested. As also noted by Furmaga-Jabłońska et al. (2014), the risk factors for childhood diarrhea are multiple and vary depending with the setting. Another limitation was that the information provided by the mothers on diarrhea and ARI required recall of past events accounts which were not validated by medical personnel or health records. There is the possibility of information on the diseases not being completely accurate. Likewise, mothers who did not have vaccination cards for their children could have provided inaccurate information on their children’s vaccinations. Further, beyond 6 months of age, these children were receiving complementary feeding, and the intensity and frequency of breastfeeding may have varied from one child to another. Such variability could have influenced the findings, especially for the first research question, which addressed the association between diarrhea and length of breastfeeding. Another limitation of this study was that the data used were collected in a cross-sectional manner, and causality cannot be determined from this study.

Recommendations

The findings from this study are representative for Uganda due to use of a large scale nationally representative dataset. The recommendations from this study are based on the findings from the study, strengths of the study, the limitations as well as the reviewed literature. Further studies which capture data on the frequency of breastfeeding and information on when breastfeeding exactly ceased is recommended. Additionally an objective measure of assessing the outcome of diarrhea and ARI would add validity to the findings. Nevertheless from these findings I would recommend that mothers of children from areas with high burden of diarrhea to continue breastfeeding the children beyond the exclusive breastfeeding period up to at least 3 years of age as this could help reduce the occurrence of diarrhea. Also, for a child who presents with ARI or diarrhea, there should be awareness of the potential of coinfection with the other disease thus more vigilance by the child’s care giver and the health system could be done to prevent this. These diseases could also be approached from an integrated programmatic approach on their prevention and management especially in high burden areas.

Almost half of the children were partially immunized. Partially immunized children are not only at risk for vaccine-preventable morbidity and mortality but as seen from this study, they have higher likelihood of having diarrhea as compared to fully immunized children. Strategies that investigate the key challenges related to understanding the barriers to full immunization among children in Uganda and also identifying if the reasons for non-vaccination are different from those of partial vaccination would help identify these mitigating circumstances thus help improve immunization coverage. There is also need to identify reasons for the decline in vaccination coverage from birth as the child grows older.

Though education level of the mother was not one of the main study's variables, this study has shown that a higher education level is associated with lesser incidence of diarrhea thus efforts put to promote women's education attainment in Uganda should be emphasized. Additionally, other factors that may influence the occurrence, prevention and management of diarrhea such as the use of ORS were not investigated but should be considered for a complete understanding of a conceptual model that can be applied in prevention and treatment of childhood diarrhea.

Implications

Diarrhea in children is a significant public health problem in Uganda and other countries in the region. Findings from this study have the potential to have an impact on reducing the burden of this disease. Moreover this does not require designing new interventions rather than putting emphasis on interventions already in place such as continued breastfeeding and control of infections. These are interventions that are low cost and thus applicable in health systems that are resource restrained. Further to that, there are policy implications. Women in this society could be supported to avoid early marriages that would lead to them having children at a very early age and policies that promote women to attain higher education should be emphasized. This information is of importance to the immediate caretakers of the children, the health community and the governments as knowledge of the impact of the length of breastfeeding, prevention and control of ARI, improving the education level of women and discouraging early marriages together with other proven interventions could help reduce the incidence of diarrhea among children in Uganda.

Conclusion

This study has revealed the importance of continued breastfeeding of children as this has not only numerous health benefits but could also confer some protection against diarrhea which remains a major health concern among children in Uganda. Additionally ARI is seen to commonly occur together with ARI thus the awareness of possibility of co-occurrence of both ARI and diarrhea should lead to greater emphasis of prevention and early treatment of either disease. The length of breastfeeding which is determined by the mother and the mother’s environment, co-occurrence with ARI and education level of the mothers are all modifiable risk factors that have an impact on diarrhea in children and should be considered in prevention programs targeting diarrhea in children.

This study has contributed to the larger body of literature by filling a gap regarding variables that have an impact on the incidence of diarrhea and these findings can be generalized to the country level since the data used was from a nationally representative household survey.

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Appendix A: Authorization to Use Data Set

DHS Download Account Application
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You have been authorized to download data from the Demographic and Health Surveys (DHS) Program. This authorization is for unrestricted countries requested on your application, and the data should only be used for the registered research or study.

All DHS data should be treated as confidential, and no effort should be made to identify any household or individual respondent interviewed in the survey. The data sets must not be passed on to other researchers without the written consent of DHS. Users are required to submit a copy of any reports/publications resulting from using the DHS data files. These reports should be sent to: archive@dhsprogram.com.

To begin downloading datasets, please login at: http://www.dhsprogram.com/data/dataset_admin/login_main.cfm
Additional resources to help you analyze DHS data efficiently include: http://dhsprogram.com/data/Using-Datasets-for-Analysis.cfm, a video on Introduction to DHS Sampling Procedures - found at:http://youtu.be/DD5npelwh80 and a video on Introduction to Principles of DHS Sampling Weights - found at: http://youtu.be/SJRVxvdIc8s

The files you will download are in zipped format and must be unzipped before analysis. After unzipping, print the file with the .DOC extension (found in the Individual/Male Recode Zips). This file contains useful information on country specific variables and differences in the Standard Recode definition.

Please download the DHS Recode Manual: http://dhsprogram.com/publications/publication-dhsg4-dhs-questionnaires-and-manuals.cfm

The DHS Recode Manual contains the documentation and map for use with the data. The Documentation file contains a general description of the recode file, including the rationale for recoding; coding standards; description of variables etc. The Map file contains a listing of the standard dictionary with basic information relating to each variable.

The Demographic and Health Surveys (DHS) Program
ICF INTERNATIONAL
530 Gaither Road
Suite 500
Rockville, MD 20850, USA

Appendix B: Walden IRB Approval

IRB Materials Approved
IRB <irb@mail.waldenu.edu>

Anne Muli <anne.muli@waldenu.edu>;

This email is to notify you that the Institutional Review Board (IRB) confirms that your doctoral capstone entitled, "Variables that impact incidence of diarrhea amongst under-five in Uganda " meets Walden University's ethical standards. Since this project will serve as a Walden doctoral capstone, the Walden IRB will oversee your capstone data analysis and results reporting. Your IRB approval number is 03-20-17-0476919.

This confirmation is contingent upon your adherence to the exact procedures described in the final version of the documents that have been submitted to IRB@waldenu.edu as of this date.

If you need to make any changes to the project staff or procedures, you must obtain IRB approval by submitting the IRB Request for Change in Procedures Form. Please note that Walden University does not accept responsibility or liability for research activities conducted without the IRB's approval, and the University will not accept or grant credit for student work that fails to comply with the policies and procedures related to ethical standards in research.

You are expected to keep detailed records of your capstone activities for the same period of time you retain the original data. If, in the future, you require copies of the originally submitted IRB materials, you may request them from Institutional Review Board.

Congratulations!
Research Ethics Support Specialist
Office of Research Ethics and Compliance
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