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The determinants of childhood diarrhoea and acute respiratory infection: *Testing the importance of community-level determinants in Eswatini*

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DECLARATION

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DEDICATION

The success of this work is dedicated to God almighty, who persistently motivated and guided me to do my best at all times. To Him be the glory. Also to my parents, for their love and care for education.

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Firstly, I owe Dr Kerry Vermaak, my mentor and supervisor, my deepest thanks and appreciation for her persistent encouragement, supervision, constructive appraisal, mentorship, and the prompt response and urgency in reading and reviewing this work. She is so efficient and naturally supportive. May God continue to grow her mentorship spirit and bless her and her family. To her, I say thank you; without her contribution, this work would not have been a success.

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DEFINITION OF TERMS

Acute Respiratory Infections: These are infections that affect the part of the respiratory system between the paranasal sinuses and the pleural cavity and last for less than 30 days (Vardanyan, 2013). In the Eswatini Multiple Indicator Cluster, survey mothers were asked to report if at any time in the last two weeks before the survey their child had had an illness with a cough? If their child had had an illness with a cough, did he/she breathe faster than usual with short, rapid breaths or have difficulty breathing? (Eswatini Central Statistical Office and UNICEF, 2011; Gupta, Sarker, & Pal, 2014).

Cluster: A group of individuals or items that share common characteristics, such as those attending the same school or resident within an enumeration area defined for census taking (Eswatini Central Statistical Office & United Nations Population fund, 2007).

Compartments: Some categorisations of individuals who share similar characteristics (Chaturvedi, Masupe, and Masupe (2014); Johnson, 2006).

Community: A group of individuals that have similar characteristics such as race, age, area of residence, make collective decisions, and take collective action (Kidding, 2007).

Cross-sectional study: It is a research design that involves collecting information or data about a subject at one point in time (Kidding, 2007).

Dependent variable: A variable that is affected by another in the relationship between variables under study (Kidding, 2007).

Diarrhoea: In the Eswatini Multiple Indicator Cluster survey mothers reported if their child had had diarrhoea in the last two weeks before the survey was conducted (Eswatini Central Statistical Office and UNICEF, 2011).

Disease: It is a condition where a living organism causes the body to malfunction, exhibited through signs and symptoms (Last, 2001).

Epidemiology: The study of the determinants and occurrence, distribution, prevention and control of health problems (Bonita, Beaglehole, & Kjellstrom, 2006; Last (2001); You et al., 2015).

Gender: It is a socially constructed phenomenon that refers to roles, behaviours and responsibilities that are assigned by society (World Health Organisation, 2011).

Household: A group of individuals who share shelter, food and other living utensils and arrangements regardless, of kinship (Eswatini Central Statistical Office & United Nations Population fund, 2007; Eswatini Central Statistical Office and UNICEF, 2011).

Incidence: Refers to the number of new individuals who are infected by a disease in a specified period (Bonita et al., 2006).

Independent variable: A variable that is hypothesised to influence another variable (af Sillen, Nilsson, Mansson, & Nilsson) in the relationship between variables under study (Kidding, 2007).

Model: A tool used in epidemiology to depict the characteristics of an outbreak of a disease, and explicitly understand its transmission (Rothman, Greeland, & Lash, 2008).

Morbidity: Any state of departure from the physiological or psychological well-being (Bonita et al., 2006; Kidding (2007); Luby, Halder, Huda, & Johnston, 2011)

Mortality rate: The number of deaths in a population in a defined period, usually a year, and expressed per 1000, 10000 or 100000 (Kidding, 2007)**.**

Multilevel method: Statistical analysis utilised in cases where data is nested in more than one category and produces effects that change by categories or groupings (Gelman, 2006).

Prevalence: The number of individuals in a defined location with a disease or infection/number of individuals who are resident in a defined location, expressed as a proportion of the population (Bonita et al., 2006).

Reproductive number (R0): Describes the capacity of an infectious individual to infect the susceptible population (Rothman et al., 2008).

Secondary data: Data that was primarily collected to answer a particular research question but further used to answer other research questions that were initially not of primary interest (Hox & Boeije, 2005)**.**

Sex: It is the biological and physiological makeup of males and females (World Health Organisation, 2011).

Under-five: Children who are aged below five years.

ABBREVIATIONS

AOR	Adjusted odds ratio
ARI	Acute Respiratory Infection
CSO	Central Statistics Office
CI	Confidence interval
EAs	Enumeration Areas
GIS	Geographical information system
HIV	Human immunodeficiency virus
LBW	Low birth weight
MDGs	Millennium Development Goals
MICS	Multiple indicator cluster survey
OR	Odds ratio
QGIS	Quantum Geographical Information system
SDGs	Sustainable Development Goals
SIR	Susceptible infectious recovery
UNICEF	United Nations Children's Fund
URTI	Upper Respiratory Tract infection
WHO	World Health Organisation

ABSTRACT

Background: It has been noted that regardless of the observed decline in childhood mortality in developing countries, the mortality rate is still extremely high**.** Approximately 30 countries in Africa and Asia need to triple their current standard of reduction of childhood mortality to realise the sustainable development goal (SDG) number 3 of ensuring healthy lives and wellbeing for all age groups. The study investigated the following research questions: 1. what is the prevalence of childhood diarrhoea and ARIs? 2. What are the individual, household and community-level factors associated with childhood diarrhoea and ARIs? 3. To what extent do community-level factors explain variations in childhood diarrhoea and ARIs? 4. Which clusters or communities have a higher burden of childhood diarrhoea and ARIs?

Methodology: The study used a pooled secondary data analysis approach utilising data from the 2010 and 2014 Eswatini Multiple Indicator Cluster Surveys (MICS) that were cross-sectional. The study utilised 5340 children aged below five years as the unit of analysis. The outcome variables of the study were child diarrhoea and acute respiratory infection. The single-level multivariate logistic regression, multilevel multivariate logistic regression and Quantum GIS were used to answer the study questions. STATA 13 was used for the analyses.

Results: The study found that the magnitude of diarrhoea in Eswatini was 16.2% among under-five children. In the multilevel model, child age, current height for age, toilet facility region of residence overall community diarrhoea, were found to be important variables. For instance, children aged 6-11 months and 12-23 months were 434% and 290% respectively, more likely to have diarrhoea relative to those aged less than 6 months. Children with a normal and above normal current height for age had 91% and 93% respectively increased odds of having diarrhoea compared to those with a growth deficit. Children from households with no toilet facility were 283% more likely to have diarrhoea compared to those from households with a flush toilet. Residents in the Hohho region were 159% more likely to have diarrhoea compared to children who resided in the Lubombo region. Children from communities that had medium and high overall community diarrhoea were 26% and 877% more likely to have diarrhoea compared to children from communities with low overall community diarrhoea. The results showed a substantial variation of diarrhoea across communities. The individual-level factors explained

5.6% of diarrhoea across communities; household factors explained 65.3% of the variation while community-level factors explained 85% of the variation even though it was not significant.

The Mapping analysis revealed that the severity of diarrhoea was most pronounced in the Manzini region and the Shiselweni region when compared to the Hhohho region. A total of 31% of the constituencies had a high prevalence of diarrhoea between 18.4-28.1% in the Manzini region. A consideration of the Shiselweni region revealed that 50% of the communities had a high prevalence of diarrhoea of between 18.4-28.1%

The study found that the magnitude of ARI in Eswatini was 20.9% among under-five children.

In the multilevel model, maternal age, household wealth index, shared toilet with neighbours, and region of residence were important factors that explained the variation of ARI across communities. Individual factors explained about 76.05 % as shown by the PVC; household level factors explained about 94% of the variance, and community-level factors explained about 93.6% of the variation of child ARI across communities.

The study mapped the prevalence of ARI across communities (clusters) and found that the Hhohho region had four constituencies with a high prevalence of ARI, Motshane, Mbabane South, Mbabane East, Nkhaba and Tiphisini. In the Manzini region, five constituencies had a higher burden of ARI, namely Lamgabhi, Kwaluseni, Ntontozi, Mafutseni and Ludzeludze. In the Shiswelweni region, the burden of diarrhoea was higher among five constituencies, namely Zombodze, Mbangweni, Kubuta, Ngudzeni and Sigwe. In the Lubombo region, the burden of ARI was higher at Lubulini, Hlane, and Mhlume.

Conclusion: The study demonstrated that the prevalence of diarrhoea and ARI are still very high and a persistent public health problem in Eswatini. The causes of the high magnitude of diarrhoea and ARI vary by individual, household and community factors. Policies that aim to ensure reduction in child morbidity from diarrhoea and ARI in Eswatini include strategies and programmes that rectify characteristics of the community contexts which mainly in the socially and economically disadvantaged communities and regions of Eswatini.

Keywords: children under five, diarrhoea, Acute respiratory infection, community, Multilevel logistic regression, Eswatini

CHAPTER ONE
INTRODUCTION

1.1 Background and Problem Statement

From the 1990s, the global community has pushed the agenda of reducing the prevalence and incidence of child morbidity, to reduce child mortality. The mortality rate among children under five years in developing countries has decreased from approximately 12 million children in 1990 to 7 million in 2012 (World Health Organisation, 2016). However, it has been noted that regardless of the observed decline in childhood mortality in developing countries, the mortality rate is still extremely high (World Bank, 2016). The United Nations has argued that although the morbidity and mortality of children is declining, it is not doing so at the projected rate, with 1 in 12 children in Sub Saharan Africa still dying before their fifth birthday (UNICEF, 2016). Approximately 30 countries in Africa and Asia need to triple their current rate of reduction of childhood mortality to realise the sustainable development goal (SDG) number 3 of ensuring healthy lives and wellbeing for all age groups (UNICEF, World Health Organisation, World Bank Group, & United 2015).

Most of the cases of morbidity and mortality among children aged under five years are preventable. An estimated 15 percent of all deaths among children under five years globally are attributed to diarrhoea, 20 percent to acute respiratory infections (ARIs) such as pneumonia, 3% to HIV/AIDS and 2% to malaria (Walker, Rudan, Liu, et al., 2013; World Health Organisation, 2016).

Children are the most vulnerable sub population in most societies, and most deaths are due to diarrhoea and ARIs, especially among children less than two years of age (Donna & Chris, 2013; Walker, Rudan, Liu, Nair, Theodoratou, & Bhutta, 2013).

Even though immunisation services have intensified globally, the scourge of diarrhoea and ARIs are still threatening for children, with higher life loss seen in lower-income countries relative to middle-income countries (Walker, Rudan, Liu, Nair, Theodoratou, Bhutta, O'Brien, et al., 2013). In the Sub-Saharan region in 2011, a higher proportion of the mortality among children was due to diarrhoea (50%), while 43% was due to ARIs (Azage & Haile, 2015; Walker, Rudan, Liu, Nair, Theodoratou, & Bhutta, 2013).

Notably, geographical variation in morbidity and mortality rates has been repeatedly observed in developing countries (Houweling & Kunst, 2009; Kadala, Magadi, & Madise, 2006). A cross-sectional study conducted in Nigeria attributed this variation in child morbidity to the unequal distribution of socio-economic resources that in turn influence the behaviour and health care of the children (Oluwafunmilade, Adesanya, & Chiao, 2016). In Nigeria, children from wealthy households have a 52% reduced risk of developing an acute respiratory infection compared to those from poor households (Oluwafunmilade et al., 2016). In the field of public health, the social gradient concept stipulates that while morbidity and mortality affect children in both well off households and poor households, they are not equally affected (Houweling & Kunst, 2009). According to research, this is because children from well off households can afford better medical care, better diet and better living conditions, hence they are less prone to infectious diseases than those from economically disadvantaged households (Gupta, de Wit, & McKeown, 2007). The World Health Organisation (WHO) supports this finding, also reporting that children from poor households, particularly those in rural areas, have higher risks of morbidity and mortality (World Health Organisation, 2016). The difference in household size, socio-economic status, poor environmental sanitation and poor hygiene have also been cited as major factors influencing this disparity in the under-five morbidity rates (Fewtrell, Kaufmann, Kay, Haller, & Colford, 2005; Root, 2001). Kyu (2012) analysed Demographic and Health Survey (DHS) data from low and middle-income countries and found that children residing in poor communities are more prone to infections due to generally poor household living conditions, the unavailability of safe drinking water and poor environmental hygiene conditions, as well as few medical centres for timeous treatment. Yadav and Kesarwani (2015) attest that the households where children live are one of the most crucial factors in determining their survival. For example, factors such as poor air quality, poor building materials, poor sanitation, contaminated water and contaminated food are correlated with a higher risk of childhood morbidity and mortality (Yadav & Kesarwani, 2015).

The Eswatini Health strategic plan was put in place with technical support from the WHO, not only to reduce the morbidity and mortality of children due to diseases but also to do so for adults (WHO regional office, 2009). The key concern and motivator for the government of Eswatini was the sluggish decline seen in childhood morbidity and mortality since the 1990s, despite the global push to try and reduce these figures (WHO regional office, 2009). From 2007 to 2010 a promising downward trend was observed in the mortality of children below five years of age, from 120 deaths per 1000 live births down to 104 deaths per 1000 live births (Eswatini Government, 2012). The target for the government of Eswatini was to reduce this mortality rate down to 30 deaths per 1000 live births by 2015 (Eswatini Government, 2012). Regardless of the decrease in the overall childhood mortality rate over the years, it is still a major public health problem as the government is still very far from its designated target.

In 2008, approximately 112 out of 100 000 children died from diarrhoea in Eswatini, and in a single month in 2014, diarrhoea claimed the lives of 28 children (Dube, 2015). As a result, the government has intensified programmes for child vaccination and strengthening of the Eswatini Epidemiological Unit (EPU) to have an effective disease case notification system for diarrhoea outbreaks and other related childhood diseases (WHO regional office, 2009). The Ministry of Health, together with partners, has intensified paediatric surveillance systems to reduce morbidity and mortality. Reducing childhood diarrhoeal diseases and acute respiratory infections is one of the key deliverables of the Eswatini 2014-2019 Research Agenda (Eswatini Ministry of Health, 2014).

Even though several studies have been conducted elsewhere to understand the factors associated with childhood morbidity, in other developing countries their analyses were mainly focused on the demographic and socio-economic factors, without exploring household and community level factors and they also ignored the hierarchical nature of the national health surveys (Adenini, 2013; Osumanu, 2007; Yadav & Kesarwani, 2015). Indeed, Bellan, Pullian, Scott, Dushoff and MMED organising Committee (2012) advised that studying individual level data while excluding the population and the environmental factors is deceptive. There is a need for the application of eco-epidemiology, which integrates the individual, household and environmental factors when analysing disease dynamics (Bellan et al., 2012).

In Eswatini descriptive reports such as the Demographic and Health Survey (DHS) and Multiple Indicator Cluster Surveys (MICS) serve as the main sources of information on the prevalence or the magnitude of childhood diarrhoea and acute respiratory infections (Eswatini Central Statistics Office & Macro International Inc, 2008; Eswatini Central Statistical Office & UNICEF, 2011). These descriptive reports, however, fall short of a detailed analysis of the factors associated with the outcomes, hence presenting a gap/shortcoming in these reports. A cross-sectional study conducted in Eswatini in 2007 applied single-level logistic regression and found that socioeconomic and demographic factors were associated with neonatal mortality (Zwane & Masango, 2012). Added to this, there is a shortage of literature on the importance of household and community level factors in childhood diarrhoea and ARIs. Therefore, this study aims to provide information on the importance of community level factors, applying multilevel statistical methods in the context of Eswatini.

1.2 Location of the Study

The study is a secondary analysis of Eswatini's national Multiple Indicator Cluster Surveys in 2010 and 2014. It incorporates community-level analyses from both surveys using a pooled analysis of the MICS 2010 and 2014 data to understand the importance of community-level factors in childhood diarrhoea and ARIs. Eswatini is a developing country where the plight of morbidity and mortality among children aged less than five years is still unacceptably high. The child mortality rate in Eswatini was reported at 104 deaths per 1000 live births in 2010 (Eswatini Government, 2012). All four regions of Eswatini (Hhohho, Manzini, Shiselweni and Lubombo), including all 55 constituencies, are included in the analysis to assess the variability of diarrhoea and ARIs among children. Figure 1.1 below displays the geographical map of Eswatini, showing the four regions and 55 constituencies. The MICS surveys were conducted using a systematic probability approach, which permitted the generalisation of the results to the entire country.

Figure 1. 1: A map of Eswatini showing the four regions and 55 constituencies

Source: Plotted by the Author

1.3 Research Objectives

1.3.1 Main objective

The main objective of the study is to investigate the individual, household and community-level factors of childhood diarrhoea and ARIs using multilevel analysis.

1.3.2 Specific objectives:

1. To determine the prevalence of childhood diarrhoea and ARIs in Eswatini.
2. To investigate the individual, household and community-level factors associated with childhood diarrhoea and ARIs.
3. To determine the extent to which community-level factors account for variations in childhood diarrhoea and ARIs.
4. To do a mapping at the constituency level for childhood diarrhoea and ARIs.

1.4 Research Questions

1. What is the prevalence of childhood diarrhoea and ARIs?
2. What are the individual, household and community level factors associated with childhood diarrhoea and ARIs?
3. To what extent do community level factors explain variations in childhood diarrhoea and ARIs?
4. Which clusters or communities have a higher burden of childhood diarrhoea and ARIs?

1.5 Research Gaps and Justification of the Study

Eswatini was a member of the Millennium Development Goals initiative and has since renewed her commitment to the new agenda of Sustainable Development Goals (SDGs). One of the major

MGDs for Eswatini was to reduce by two thirds (60%) child mortality for the 15 years from 1990 to 2015 (Eswatini Government, 2012). To further intensify the commitment towards better health for all children aged under five years, Eswatini has adopted the United Nations sustainable development goals (SGDs) agenda for 2015 to 2030 (UNDP, 2015). To ensure that all countries work towards reducing child morbidity and mortality, a specific goal has been included in the SDG agenda; namely to ensure the health and well-being for all (goal number 3) (UNDP, 2015). In 2010 the magnitude of the occurrence of cases of diarrhoea and ARIs was reported to be 16% and 22% respectively in Eswatini (Eswatini Central Statistical Office & UNICEF, 2011). Childhood diarrhoea and ARIs thus remain a threat, hence the need for robust research to establish the factors related to the occurrence and outcomes of these diseases. In addition to this, addressing diarrhoea and ARIs is one of the priorities of the Eswatini National Health Research Agenda 2015-2019 (Eswatini Ministry of Health, 2014).

Eswatini also subscribes to the Human Rights Agenda, with emphasis placed on addressing the health and welfare of children aged below five years (World Health Organisation & United Nations Office of the Human Rights Commissioner, 2016). Key deliverables of the Human Rights Policy is for governments to provide remedies for the major causes of childhood morbidity and mortality, primarily in developing countries where the problem is manifested (World Health Organisation & United Nations Office of the Human Rights Commissioner, 2016). As explained, it remains critical for Eswatini to address the morbidity and case fatality rate due to diarrhoea and ARIs. Therefore, studies addressing the pertinent question of which of the individual, household and community-level factors are associated with childhood diarrhoea and ARIs in Eswatini remain pivotal.

The need to adopt multilevel methods of analysis to address childhood health problems cannot be overemphasised. Multilevel analysis can control for the variation or clustering of the outcome variables within communities, whereas a single level approach is not able to do so. Single level models are deficient as they cannot explain the complex relationship that the child has with the mother, the household, and the community where the child resides (Griffiths, Madise, Whitworth, & Matthews, 2004; Hox, 2002). Adenini (2013) agrees with the use of a multilevel analysis for this purpose, stating that the adoption of a multilevel analysis that incorporates the complex relationships and interactions that exist between children and their external environments has been found to yield reliable estimates.

Diarrhoea and ARI mapping are at the heart of this investigation to better understand where most of the cases are found. Therefore, this study aims to contribute to the understanding of the determinants including community-level factors, and the application of advanced statistical models that account for the variation or clustering of childhood diarrhoea and ARIs to better inform health policy for children aged less than five years.

1.6. Theoretical framework

The section describes the theoretical or conceptual framework that defines the individual, household, and community level factors that are associated with childhood morbidity. The objective of theories and conceptual frameworks is to uncover the attributive factors or the causality between factors associated with a phenomenon, in this case, diseases often associated with childhood morbidity and mortality (Nilsen, 2015; Pallon, 1987). A well-developed theory is expected to reveal how and why particular factors lead to the occurrence of a disease (Nilsen, 2015). Importantly, frameworks cannot be accepted or rejected based on whether or not they are aligned to evidence in the literature; instead, they assist with the formation of models that can validate or test tentative statements (hypotheses). Therefore, developing frameworks that can guide the thinking around the evidence produced by empirical studies is critical for the understanding of the environmental determinants of childhood morbidity and mortality (Nilsen, 2015; Pallon, 1987). The most crucial element of the health enquiry is able to adopt and apply the theoretical scholarship to statistical models that can explicitly explain the relationships that exist between factors (Masuy-Stroobant, 2001).

This study adopts the theory developed by Mosley and Chen (1984) to explain the pathways between the determinants of child diarrhoea and ARIs. Mosley and Chen developed their theory on child survival in the 1980s. The framework includes proximate and intermediate factors as the main risk factors that are associated with childhood morbidity and mortality. Distal factors, such as socioeconomic factors, operate through the proximate or intermediate factors to influence the survival of children (Macassa, Hallqvist, & Lynch, 2011; Pande, 2000).

In Macassa et al. (2011) viewpoint, the proximate factors are nested in the household level factors: environmental factors (polluted air, food, soil, insects); maternal factors (age, parity and birth interval); nutrient deficiency (vitamins and minerals); injury (accidental, intentional), and measures for controlling illness (personal preventive measures such as hand-washing and medical treatment). The Mosley and Chen's framework of proximate causes of child morbidity and mortality, which is linked to socio-economic factors at the individual, household and community levels, therefore, was adopted over other possible conceptual frameworks. Through the model developed by Mosley and Chen, the thesis aims to validate the application of the model and test hypotheses on the importance of community level factors on childhood diarrhoea and ARIs.

Both Diarrhoea and ARIs are major causes of child morbidity and mortality; in 2015 they accounted for about 8.9% and 15.5%, respectively of mortality among under five years children. Therefore, to achieve the SDG target which aim to reduce child morbidity and mortality of under-five to 25 per 1000 live births or below in 2030, both child diseases were considered in this study (Melese, Paulos, Astawesegn, & Gelgelu, 2019; Walker, Rudan, Liu, et al., 2013; You et al., 2015)

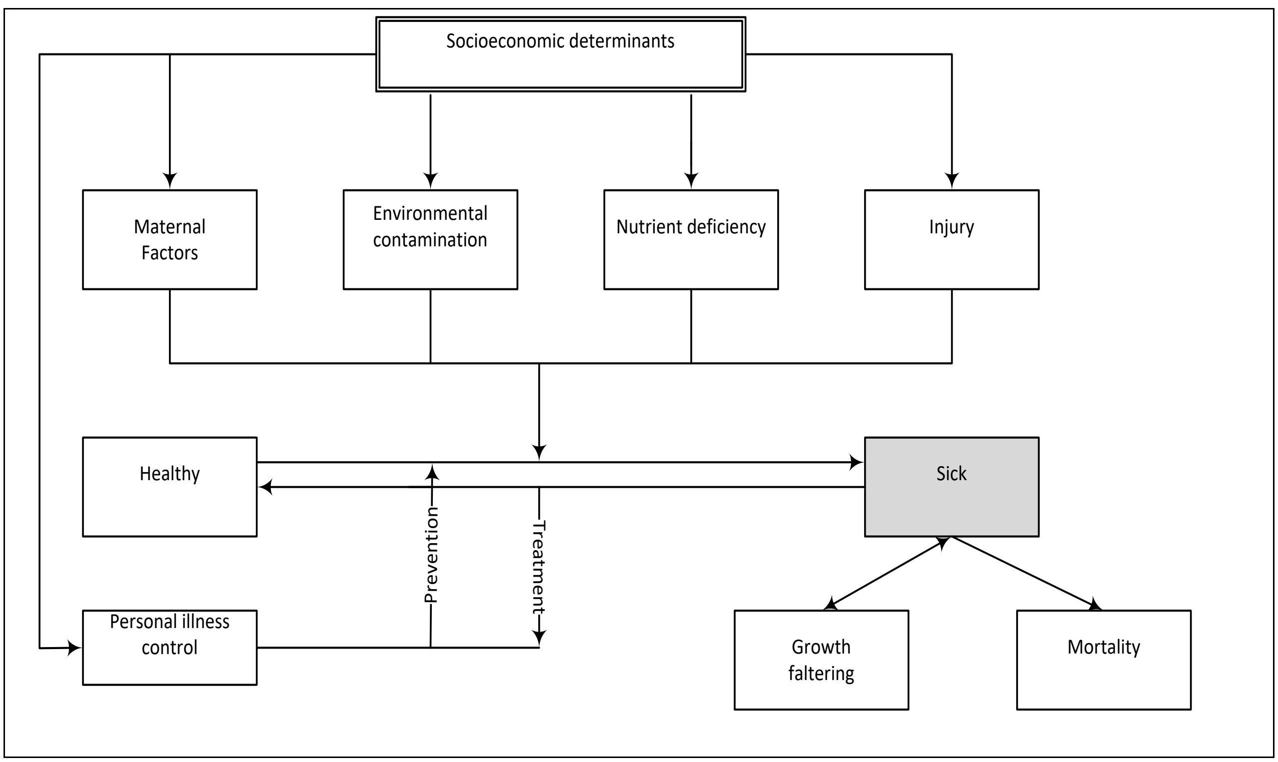


Figure 1.2: Mosley and Chen's conceptual framework

Source: Mosley and Chen (1984) pg. 142

The social and economic factors explained by the model include individual-level factors (fathers, mothers' productivity, norms, attitudes, and traditions), household level variables (income or wealth) and community-level factors. In the model, the community level factors were confined to the ecological setting, health system, political and economic variables). In this thesis, an expanded definition of community level factors was adopted to include aggregated household and community level factors. The individual factors and the household factors work through the proximate factors to influence the health status of children (morbidity and mortality) (You et al., 2015). In theory, the outcome variable (childhood morbidity and mortality) is measured as a single variable and child survival is often measured using the outcome variable morbidity (You et al., 2015). The study focuses on the outcome variable in the shaded box (Weber, Rutala, Fischer, Kanamori, & Sickbert-Bennett). This is because morbidity measures the condition or state of an individual being unhealthy, which can happen repeatedly, while mortality refers to a complete disappearance of life (death), which is a once-off event (You et al., 2015). However, there is a direct relationship between morbidity and mortality; a disease can become the absolute cause of mortality, or a child being sick (morbidity) may have compromised growth or vice versa.

The arrows in figure 1.2 show the relationship between a healthy child and a sick child. The pathways in figure 1.2 show that the maternal and environmental factors, nutrient deficiency and injury directly affect the state at which a child becomes healthy or sick. The distal factors (socio-economic factors) always operate through the proximate factors, as shown in figure 1.2. Worth noting is that a child can become sick (morbidity) through infections, lack of food with optimal nutrients and lack of personal illness control measures, particularly preventative care (Pande, 2000; You et al., 2015). The child being given treatment explains the pathway of a child going from being sick to being healthy again. The framework also explains that in cases where a child moves from a state of being healthy to being sick there is a probability of the child not regaining a completely healthy state and surviving below the optimal level of health (growth faltering), or of them simply dying. The relationship between the state of a child being sick and their growth faltering is causal. A child who experiences growth faltering is more likely to be sick and once sick, this child is more likely to die because of their illness.

1.7 Organization of the Thesis

The study is structured into ten clearly defined components**. Chapter one** provides the background information, including the problem statement as well as the rationale and justification of the thesis. The main and specific objectives were covered in this chapter. The conceptual framework that guides the study was comprehensively described in the chapter and the theoretical relationship posited between individual, household and community-level factors and childhood diarrhoea and ARIs was unpacked. **Chapter two** presents a review of the literature, clearly providing evidence emanating from the literature of what is known from previous studies investigating childhood diarrhoea and ARIs. It uncovers the gap that needs to be addressed to advance the body of knowledge on the subject. Furthermore, the chapter accumulates evidence from various studies to understand the association between the individual, household and community level covariates and childhood diarrhoea and ARIs. It adopts a funnel approach to literature synthesis that is systematically presented, starting from a broad view and moving on to a narrow focus on the evidence.

Chapter three explains the methodology, which includes the research design, study population, sample size analysis, inclusion and exclusion criteria, and the statistical analysis used to answer the research questions of the study. The statistical methods are explicitly explained since they are major contributors to the analysis of the data gathered for the study. **Chapter Four** provides the findings of the distribution of the sample and the interpretations that emanate from the study. **Chapter Five** provides information on the prevalence of diarrhoea in Eswatini and meets the objective of the study by providing a bivariate analysis (cross-tabulation) and presenting bivariate and multivariate logistic regression results. **Chapter Six** analyse the contextual determinants of childhood diarrhoea through a multilevel analysis of individual, household and community-level variables. **Chapter Seven** presents the prevalence of childhood acute respiratory infection and across-tabulation with childhood ARIs**.**

Furthermore, bivariate and multivariate results of the logistic regression of childhood ARIs are presented in the chapter**. Chapter eight** presents the contextual factors of childhood ARIs. Applying multilevel logistic regression, the chapter explains how much of the ARIs are explained by individual, household and community level factors. Additionally, the fixed effects of the models that explain the association of the individual, household and community level factors with ARI are explained. Finally, a summary is presented in the chapter. **Chapter nine** presents the mapping of childhood diarrhoea and ARIs using the Quantum Geographic Information system. **Chapter ten** provides a discussion of the study results and highlights their relevance and deviation from the existing evidence in the literature. Finally, conclusions drawn from the study and recommendations deduced from the study were presented in the chapter.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

The section provides a review and synthesis of the literature on the factors that affect childhood diarrhoea and ARIs at an individual, household and community level. The chapter is divided into two parts that review the literature related to childhood diarrhoea and mortality and the same for childhood ARIs. Most importantly, it endeavours to explore the theories that explain the transmission mechanisms of diarrhoea and ARIs.

The conceptual framework by Mosley and Chen (1984) provided the basis for the literature analysis of the factors that interact with diarrhoea and ARIs. Several search engines (Google Scholar, JSTOR, Books and PUBMED) were used to mine and build comprehensive literature for the study. To ensure that the literature was thoroughly examined for each of the variables, the search and presentation strategy began with a review of the factors associated with overall under-five mortality, mortality related specifically to diarrhoea or ARIs, and then the factors associated with morbidity related to diarrhoea and ARIs. Although this study does not focus on mortality, this strategy was adopted to ensure that a more extensive literature, particularly as it relates to community-level factors, was included in this review.

2.1.1 Overall child morbidity and mortality from communicable diseases

Knowledge on which communicable diseases are more likely to result in morbidity and mortality among children is very critical for policy and health programme formulation. According to Arifeen, Akhter, Chowdhury, Rahman, & Chowdhury, (2005) even though the death of a child is often a result of more than one cause, diarrhoea and ARIs have been cited as serious infections that contribute to high childhood mortality rates. According to UNICEF and WHO (2009), over 2.5 billion children die per annum of diarrhoea related diseases, and this has been consistent over the last two decades. Since the year 2000, diarrhoea incidence and prevalence has remained consistently high, primarily in developing countries (UNICEF & WHO, 2009). However, Rafael, Mohsen and Kyle (2012) noted a significant decrease in the overall mortality related to diarrhoea and ARIs globally from about 2.5 to 1.4 million and 3.4 to 2.8 million, respectively. Worth noting is that the (United Nations, 2012) argued that child morbidity and mortality due to communicable diseases varied according to the development level of the individual countries and the children's places of residence within their countries. These variations warranted closer study, specifically in the context of each country.

Research conducted by the United Nations showed that the difference in child mortality across the continent was due to differences in the development of the countries (UNICEF & WHO, 2009; United Nations Department of Economic and Social Affairs Population Division, 2011; United Nations, 2012). According to the United Nations, (2012), the Demographic Transition Model provides a basis to explain why developing countries still experience high childhood morbidity and mortality. The Demographic Transition Theory explains that countries are classified into four different stages (stages 1-4) based on their mortality rates and development patterns (Canning, 2011). In (Canning, 2011) argument, the mortality transition explained in the Demographic Transition Theory involves numerous factors which include the Epidemiological Transition Theory in which public health discourse should be a policy goal and suitable infrastructure aimed to deliver health services should be prioritised and made available in countries. The interaction between the Demographic and Epidemiological Theories is explained in figure 2.1 below.

Table 2. 1: Stages of the demographic and epidemiological transition theory

	Age of pestilence and famine	**Age of receding pandemics**	**Age of manmade and degenerative diseases**	**Age of delayed degenerative diseases**
Causes of death explained in the Epidemiological Theory	Predominance of communicable diseases	Decrease of communicable diseases	Predominance of non-communicable diseases	Predominance of non-communicable diseases
Mortality pattern explained in the Demographic Transition Theory	-High mortality among children and adults -Life expectancy at birth less than 40 years	-Mortality decreases among children -life expectancy at birth increases	-More people survive to elderly ages -life expectancy at birth above 70 years	-More people reach old age before dying -life expectancy at birth increases

Source: (United Nations, 2012)

The Demographic and Epidemiological Transition Theory is very critical in the analysis of health inequality since it provides a yardstick to measure the causes of morbidity and death and situates countries in the health development framework for comparative analysis. Research has found that most developing countries observe a slow decline in child morbidity and mortality (Caselli, Meslé, & Vallin, 2002). The slow decline was explained to be due to the lack of health care infrastructure and also to the re-emergence of infectious diseases such as diarrhoea, ARIs, HIV/AIDS, etc. (Caselli et al., 2002).

Even though the epidemiological transition theory was used to situate the study, it should be interpreted with caution, as it fails to control for the differentiated rate and extent of morbidity and mortality among countries (Caselli et al., 2002). The models of health transition provide fundamental bases for the understanding of why communicable diseases such as diarrhoea and ARIs are still a major threat in developing countries, but each country has a unique developmental model and health patterns, nested within different cultural and socio-economic contexts.

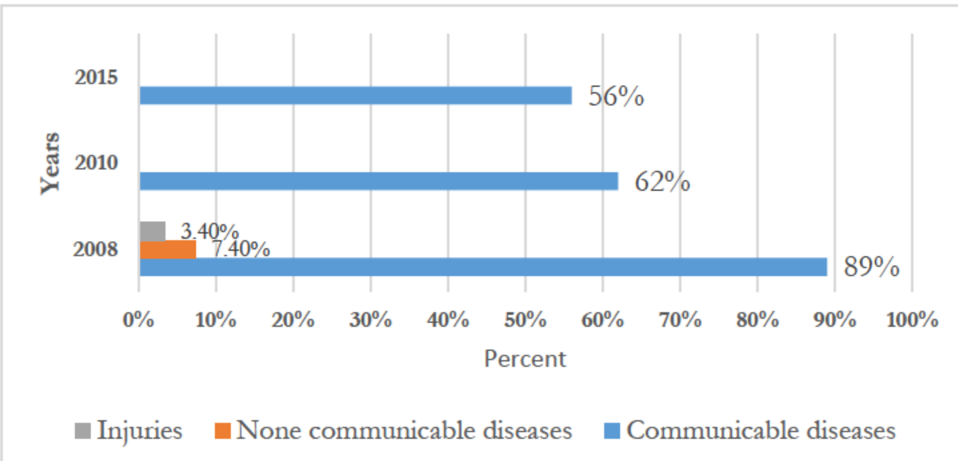


Figure 2.1 below shows the causes of death for children aged below five years at a global level.
Source: (United Nations, 2012)

Figure 2.1 above provides evidence that communicable diseases are still a major cause of mortality among children. Mortality due to communicable diseases among children aged below five years was 89% in 2008, decreasing to 62% (5.7 million) in 2010, with a further decrease to 56% (5.2 million) in 2015 (van Vuuren, 2017). Lower respiratory tract infection was ranked top with 1 million deaths, HIV/AIDS was responsible for760 000 deaths, diarrhoeal diseases caused 643000 deaths, tuberculosis caused 434000 deaths, and Malaria caused 403 deaths in 2015 (van Vuuren, 2017).

2.1.2 Definition and classification of diarrhoea

Diarrhoea is referred to as the irregular loose passing of stools, with increased frequency (Surawicz, Fac, & Ochoa, 2002 ; Viet Hung, 2006). Specifically, the stool should take the shape of a container, and diarrhoeal infection can either be acute or chronic (Surawicz et al., 2002). Diarrhoeal diseases that are persistent for less than two weeks are categorised as acute while those that are persistent for more than two weeks but less than four weeks are classified as chronic diarrhoea (Shashank & Angadi, 2016; Surawicz et al., 2002). Dysentery is a diarrhoeal disease that is characterised by bloody stools with mucus (Chaturvedi et al., 2014), but there is a range of diarrhoeal infections. The body of theory divides the range of chronic diarrhoeal infections into three broad classifications, namely inflammatory, watery and fatty diarrhoea (Juckett & Trivedi, 2011).

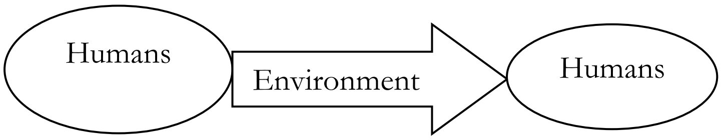
Acute diarrhoea is described as the increased frequency of loose stools that are normally without blood and which persist for less than two weeks (Surawicz et al., 2002 ; Viet Hung, 2006). The increase in the frequency of watery stools to more than three a day is one of the characteristics used to diagnose acute diarrhoea (Koletzko & Osterrieder, 2009). The main causal agents of acute diarrhoea are bacteria, viruses and parasites (Viet Hung, 2006). Studies conducted in developing and developed countries on the causes of acute diarrhoea revealed no variation in the causative agents; however, the proportion of the cases was higher in the developing countries compared to developed countries (Viet Hung, 2006). The frequency of the causative agents also varied between developed and developing countries (Cooke, 2010). Bacterial infection was responsible for two thirds (60%) of diarrhoea cases in developing countries (Cooke, 2010). However, in developed countries, viruses accounted for 40%, and protozoa accounted for 20% of diarrhoea cases. The variation in the burden of diarrhoea was not only observed between regions but also within individual countries and between seasons, with most cases occurring in winter (Cooke, 2010). Most of the diarrhoea cases in the underdeveloped countries were due to rotaviruses, *Vibrio cholera* and Shigella infections which were influenced by poor hygienic conditions (Koletzko & Osterrieder, 2009; Viet Hung, 2006).

2.1.3 Diarrhoeal infection and transmission mechanism

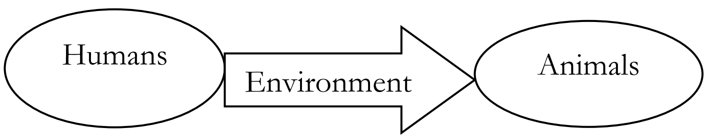
Diarrhoea is one of the dangerous diseases that can be transmitted from one person to the next through a vector (Chaturved, Masupe, & Masupe, 2014; Chaturvedi et al., 2014; Curtis, Cairncross, & Yonli, 2000). The bacteria, protozoa and viruses that cause diarrhoea are transmitted through a vector such as contaminated water and food (Chaturved et al., 2014). Their transmission can also be through person-to-person contact and contact with stools. However, water remains one of the instrumental transmission agents as it is a basic need, and diarrhoea may be contracted through drinking, bathing and other contacts with unclean water (Chaturvedi, Masupe, & Masupe, 2013; Chaturvedi et al., 2014). According to (Agarwal & Verma, 2012), diseases such as cholera, dysentery and diarrhoea are waterborne. At some point, everyone may have had diarrhoea; however, the intensity of the illness is what matters. The variation of the intensity of the diarrhoea is due to the immunity of the individual. Older people and children tend to have more intense/severe episodes of diarrhoea due to their weaker immune systems (Chaturvedi et al., 2014).

A detailed mechanism presented by (Curtis et al., 2000) demonstrates the cascade by which diarrhoea is transmitted from humans to the environment or vice versa. The cascade of transmission presented below provides an explicit picture of how one can be infected with diarrhoea.

1. Diarrhoea can be transmitted from human to human through the environment



2. Diarrhoea can be transmitted from humans to animals through the environment



3. Diarrhoea can be transmitted from animals to humans through the environment

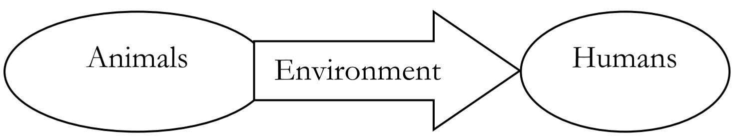
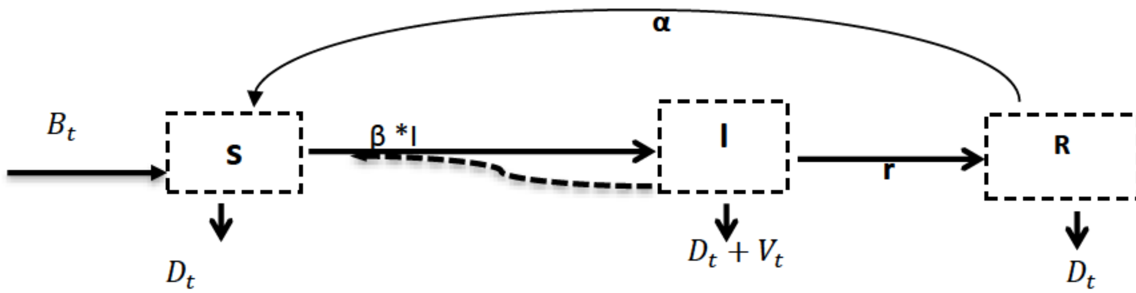


Figure 2.2: **Process of diarrhoea transmission**

Source: Curtis et al.(2000)

The transmission process of diarrhoea can further be presented in a model that clarifies the algorithm of transmission. The model of analysis below (Figure 2.3) shows the mechanism by which diarrhoea infection is transmitted across the child population.



Parameters
β → Transmission coefficient
r → Recovery rate
D_t → Natural death
$D_t + V_t$ → Death due to diarrhoea and natural death
α → Immunity loss

Figure 2.1: A diagram depicting the diarrhoea transmission using the Susceptible Recovery Model

Source: Chaturvedi et al. (2014)

The model above describes the compartments or classes of the susceptible infectious recovery (SIR) process that is widely used to explain the transmission of infectious diseases such as diarrhoea. To understand the factors that affect disease transmission, the biology, environmental factors, host population's behaviour and vector population's behaviour must be carefully studied (Bellan et al., 2012; Johnson, 2006). The SIR model consists of three compartments, which explain the cascade by which children are infected with diarrhoea from the time they are born. Children are born susceptible to diarrhoea infection (B_t). The susceptible (S) children are infected with diarrhoea at a rate of beta (β), which is the transmission coefficient. However, infected children influence the number of those susceptible by parameters (β*I). As the number of children who are infectious in the community increases, the risk of infection among the susceptible children increases as well.

According to Virginia Department of Health, (2011) the transmission of infectious diseases occurs through direct contact between infectious individuals (hosts) and susceptible individuals (hosts). Indirect transmission of infectious diseases occurs through intermediate mechanisms which could be the environment and other factors (Virginia Department of Health, 2011). However, as the number of infected children get vaccinated or treated against infections such as diarrhoea, they further lose immunity at a rate of (α) and move back to a state of being susceptible. The use of the SIR epidemiological model to explain the trajectory of infectious disease transmission and assumptions must be applied to the compartments of the model (Chaturvedi et al., 2013; Chaturvedi et al., 2014). To understand infectious diseases such as diarrhoea, improved approaches to studying the indirect and direct factors must be applied to the complex nature of the disease (Bellan et al., 2012).

2.1.4 Diarrhoea prevention

To prevent the infection and transmission of diarrhoea, its epidemiology must be clearly understood; however, there are also more factors involved in the prevention of diarrhoea. Nutrition is one of the critical factors for diarrhoea prevention, according to (Mathai, Raju, Bavdekar, & Pediatrics, 2011). Breastfeeding has been cited as one of the key factors in diarrhoea prevention among children (Mathai et al., 2011). The protective effect of breast milk and the role it plays in improving children’s immunity has been well documented in the literature (Divya et al., 2016). Therefore, appropriate weaning practices are also very essential to prevent diarrhoea infection among children (Divya et al., 2016; Kimani, 2013).

Factors such as improving hygiene and sanitation and access to clean and safe water supply have been found to lower the risk of diarrhoea among children (Divya et al., 2016). Developing countries have been found to have poor sanitation and hygiene, hence the observed increased risk of diarrhoea infection in such countries. According to (Shashank & Angadi, 2016), controlling for environmental contamination and improving hygiene is central to the prevention of diarrhoea. The children's mothers or primary caregivers have a central role to play in improving hygiene, sanitation and proper child feeding. A case-control study conducted in South Africa found that routine washing of hands provided a remedy as it reduced the transmission of diarrhoea (Burns, Maughan-Brown, & Mouzinho, 2017). In addition, the proper disposal of stools also provided a preventive measure for diarrhoea infection and transmission (Kimani, 2013).

2.1.5 Child level determinants and diarrhoea

Child level factors are categorised under the individual characteristics that function through proximate factors to impact the child's health status (Stallings & Rebecca, 2004). The age of the child, its gender, nutritional status, birth order, birth interval and breastfeeding status were found to be instrumental in the analysis of child health in numerous studies (Azage, Kumie, Worku, & Bagtzoglou, 2016; Stallings & Rebecca, 2004).

2.2. Age of the Child

2.2.1 Child age and overall mortality

Age has been widely used in the epidemiological analysis to study disease variation, dynamics and adjust for confounding factors (Reijneveld, 2003). It is one of the critical factors that is associated with childhood morbidity and mortality. Under-five mortality rates present a threat to the development of countries, especially in developing countries where the problem is more pronounced (World Health Organisation & UN Human Rights Council, 2013). In Bangladesh a cross-sectional study stratified the mortality of children aged under-five years into infant and child mortality; indicating estimates of 64% mortality in neonates, 58% in post-neonates and 61% among children in rural areas, whereas in urban areas the figures were 36% in neonates, 43% in post-neonates and 39% in children (Mondal, Hossain, & Korban Ali, 2009).

2.2.2 Child age and mortality from diarrhoea

A study conducted by Li Liu et al., (2016) in 192 countries found that globally, diarrhoea accounted for 9% of the mortality among children aged 1-59 months and these authors documented 0.3% deaths among neonates due to diarrhoea in the year 2015. The figures are not surprising as Sub Saharan Africa contributes to a high proportion of deaths due to diarrhoea, mainly among children aged 1-59 months (Li Liu et al., 2016). In Ethiopia (Mohammed & Tamiru, 2014) conducted a community-based cross-sectional study and reported that diarrhoea was the second greatest cause of death after pneumonia among children aged under five years.

2.2.3 Child age and diarrhoea morbidity

A cross-sectional study conducted in Ethiopia reported a reduced probability of contracting diarrhoea among children aged below 6 months relative to children aged 47 months and over (Azage et al., 2016). The justification could be that children below 6 months still shared antibodies from their mothers, provided through the breast milk that improved their immunity (Siziya, Muula, & Rudatsikira, 2013). Contrary, a cross-sectional study in Thailand showed that children aged 6 months and below were 1.5 times more likely to be infected with diarrhoea compared to children aged 45-49 months (Wilunda & Panza, 2009). In India, the probability of having diarrhoea decreased for children aged 24-35 months, relative to children aged below 6 months (Yadav & Kesarwani, 2015). The findings from Thailand contradicted the findings obtained in the African context where children below 6 months were less likely to be sick from diarrhoea compared to those 6 months and older (Azage et al., 2016; Siziya, Muula, & Rudatsikira, 2009; Yadav & Kesarwani, 2015). Similarly, a cross-sectional study conducted in Tanzania found that there was a negative relationship between child age and the prevalence of diarrhoea (Kawakatsu, Tanaka, Ogawa, Ogendo, & Honda, 2017).

A pooled cross-sectional analysis conducted in India found similar findings to those in Ethiopia; that children aged 6-11 and 12-23 months had higher odds of having diarrhoea OR 1.77 (95%, 1.63-1.93), OR 1.30 (95%,1.18-1.42) respectively compared to children aged less than 6 months (Yadav & Kesarwani, 2015). The WHO recommends that children under 6 months be exclusively breastfed hence reducing the risk of diseases such as diarrhoea.

In Sudan children who were aged 12-23 months and 24-35 months were more likely to have diarrhoea, OR 2.2 (95%, CI:2.02-2.44) and OR 1.8(95%, CI:1.71-1.18), compared to children 48-59 months of age (Siziya et al., 2009). A cross-sectional study conducted in Thailand found that children aged 6-47 months had higher odds of having diarrhoea compared to those aged 48-59 months (Wilunda & Panza, 2009). A similar direction of association where children aged 35 months and older were less likely to have diarrhoea compared to those aged 6 months and older was observed in African countries and Asia (Azage et al., 2016; Siziya et al., 2009; Yadav &

Kesarwani, 2015). A possible explanation for the reduced risk of diarrhoea among older children may be due to acquired natural immunity (Siziya et al., 2013).

2.3. Gender of the Child and Diarrhoea

2.3.1 Overall childhood mortality by gender

In the public health discourse, gender or sex has become one of the fundamental variables to explain disease transmission, patterns and disparities. According to the World Health Organisation (2011), it's a limitation to study differences in health status while overlooking sex and gender. In the study of public health, it is crucial to understand the health differences between males and females (World Health Organisation, 2011). In an analysis of the effect of sex on disease transmission, van Lunzen and Altfeld (2014) and World Health Organisation (2011), explain that:

- Male and female biological composition plays a critical role in explaining the differences in disease susceptibility;
- In terms of their immunity males and females differ depending on the type of the disease.
- Biological immunity changes over the course of people's lives, with males becoming less susceptible to communicable diseases with age than females.

The literature provides further evidence of the mortality disparity between male and female children. A cross-sectional study conducted in India using a life table approach showed that female children had a higher risk of mortality compared to males (Kuntla, Goli, & Jain, 2014). The increased risk of death among female children in India was attributed to societal norms which involved female children being less likely to be breastfed and being discriminated against by being denied proper medical care (Kuntla et al., 2014). A randomised controlled trial in Nepal stated that in developing countries, especially in Asia, female children had an overall increased risk of mortality (Rosenstock et al., 2013). According to Rosenstock et al. (2013), male children had a greater risk of early neonatal mortality (20%) while female children had a 43% increased risk of dying at the late neonatal stage. The increased late neonatal mortality rate among females was reportedly due to the environmental relationship with the sex of the child.

Conversely, the United Nations Department of Economic and Social Affairs Population Division (2011) found that generally male children had a higher probability of dying compared to their female counterparts, except in China and India where the risk was reversed. Similar findings were found in a cross-sectional study conducted in Vietnam, where male children's mortality exceeded that of female children (Le Pham, Kooreman, Koning, & Wiersma, 2011). Le Pham et al. (2011) pointed out that their findings were once again contrary to what had been reported in China and India, and attributed their findings to the Vietnamese lack of preference for male children seen in China and India.

2.3.2 Gender of the child and diarrhoea mortality

Gender has remained a factor that is instrumental in explaining disease dynamics and mortality. Findings of a cross-sectional study in Bangladesh found that after controlling for other factors, female children had higher odds of dying from diarrhoea compared to their male counterparts (Miltra, Rahman, & Fuchs, 2000).

2.3.3 Gender of the child and diarrhoea morbidity

The cross-sectional study conducted in Bangladesh discovered that there were more male children than females admitted with diarrhoea, but that more of the female children died from diarrhoea among those admitted (Mitra, Rahman, & Fuchs, 2000). This was because the female children were more likely to be taken to health care centres only when they were severely affected by the diarrhoea, relative to their male counterparts (Mitra et al., 2000). A desktop review of the literature in Nepal revealed a variation in the health-seeking behaviour among the parents of male and female children; male children were more likely to attend health facilities, and this was most likely due to gender preferences, where male children were favoured because of family lineage (Budhathoki, Bhattachan, Yadav, Pawan Upadhyaya, & Pokharel, 2016). The preference of sons over daughters when seeking health care was mainly observed among poor households, especially in India and China (Budhathoki, Bhattachan, Yadav, Pawan Upadhyaya, et al., 2016). In Asia, the discrimination against females when accessing care was thus prevalent and this translated into the morbidity and mortality differences that favoured the male children (Nuruddin, Hadden, Petersen, & Lim, 2009). A cross-sectional study conducted in Sudan found that males were 3% more likely to have diarrhoea compared to their female counterparts (Siziya et al., 2013). Similarly, a cross-sectional study conducted in Tanzania found that male children were 42% more likely to have diarrhoea compared to their female counterparts (Kawakatsu et al., 2017)

Conversely, in Burundi, a cross-sectional study found different results from those reported in Sudan and Tanzania. The study from Burundi reported no variation in the risk of having diarrhoea between male and female children (Diouf, Tabatabai, Rudolph, & Marx, 2014). This contradiction of findings between the developing countries on the effect of gender on child health requires further examination and carefully controlling for confounders.

2.4. Nutritional Status of the Child

2.4.1 Overall childhood mortality and nutrition status

Poor nutrition has remained high in most developing countries, especially in Sub Saharan Africa. Poor nutrition and malnourishment is a global public health problem with approximately 9 % and 12% of the world's malnourished children observed in the Sub Saharan region and South Asia respectively in 2006 (Collins et al., 2006). This public health problem has continued to be an important factor in the global SDG agenda for 2015 to 2030 (United Nations Department of Economic and Social Affairs Population Division, 2015). A report from the United Nations noted that childhood malnutrition increased the vulnerability of children to several infections (United Nations, 2013). According to Mason, Musgrove, and Habitcht (2003), a third of the global fatalities could be prevented if malnutrition could be addressed.

In the African region, the odds of children dying due to poor nutrition were four times higher than those in developed countries (World Health Organisation, 2016). A cross-sectional study conducted in Laos found that children from poor households and rural areas had a higher probability of being undernourished compared to those from rich households and urban areas (Kamiya, 2011). In Angola, a cross-sectional study also revealed that poor nutrition among children was more prevalent in rural areas compared to urban areas (Kennedy, Nantel, Brouwer, & Kok, 2005). According to (Strasser, 2003) rural areas are faced with poor nutrition and higher mortality, especially among children aged under five years. A cross-sectional study conducted in Ethiopia, meanwhile, showed that older children were more likely to die due to poor nutrition and malnourishment compared to younger children (Alemayehu, 2015).

2.4.2 Nutrition status and mortality from diarrhoea

The relationship between nutritional status and risk of infections is well documented in the literature, and nutritional interventions have been documented to reduce the incidence of mortality from diarrhoea (Rice, Sacco, Hyder, & Black, 2000). A systematic literature review from developing countries has found that children's nutritional status is positively associated with diarrhoea mortality (Rice et al., 2000). However, Salam, and Bhutta (2015) have noted that developing countries have paid very little attention to facilitating and establishing nutritional interventions, even though it has been irrefutably established that poor nutrition increased the risk of mortality from infectious diseases such as diarrhoea. Diarrhoea mortality accounted for an estimated 61% of the infectious disease-related deaths among children globally in the early 2000s, and this fatality rate was mainly increased by poor nutrition which compromised the children's immune systems (Caulfield, de Onis, Blössner, & Black, 2004; Sinharoy et al., 2016). Surprisingly, a cross-sectional study conducted in Rwanda did not significantly associate physical wasting with diarrhoea mortality, diverting from the norm that diarrhoea infection resulted in weight loss (Sinharoy et al., 2016). These contradictory results regarding wasting in the literature may be due to the lower sample size for the study, evident by the wider confidence intervals of the estimate (Sinharoy et al., 2016).

2.4.3 Nutrition status and child diarrhoea morbidity

The relationship between nutrition and childhood diarrhoea is bidirectional; diarrhoea causes malnutrition and malnutrition increase the risk of diarrhoea (Brown, 2003). An analysis in Vietnam revealed that children who were malnourished were predisposed to diarrhoea infection due to their compromised immune systems (Viet Hung, 2006). Malnutrition was associated with high morbidity and mortality in the poor regions of Sub Saharan Africa and Asia. According to

(Brown, 2003), the relationship between malnutrition and diarrhoea forms a trajectory that can be presented as follows:

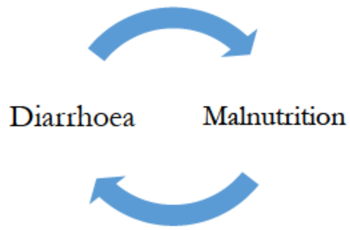


Figure 2.2: Relationship between malnutrition and diarrhoea

Source: Brown (2003)

Diarrhoea results in reduced dietary intake and mal-absorption of nutrients, catabolism and water in the intestines (Brown, 2003). Improper feeding of young children over a period of time results in malnutrition. This then results in a weakened immune system, raising susceptibility to infections such as diarrhoea, which in turn exacerbates the existing malnutrition (Brown, 2003).

A cross-sectional study conducted in Nigeria showed that more than 50% of childhood diseases were directly attributed to malnutrition (John, Yilgwan, Ige, Abok, & Okolo, 2013). Budhathoki,Bhattachan, Yadav, Pawan, Upadhyaya and Pokharel (2016) found that malnourished children were susceptible to morbidity, such as diarrhoea. (Pongou et al., 2006) added that children from poor households (primarily in developing countries) were most likely to be malnourished and thus vulnerable to developing childhood morbidity. Budhathoki, Bhattachan, Yadav, Upadhyaya, and Pokharel (2016) added that children who were malnourished had a higher probability of having persistent diarrhoea in Nepal. These findings were in agreement with the synergic relationship between diarrhoea and undernourishment explained in the literature.

2.5 Breastfeeding Status of the Child

2.5.1 Breastfeeding status and overall child mortality

According to the Canadian Paediatric Society (2006), apart from the improvement of the immune system, breastfeeding is very critical as it has psychological and developmental benefits as well as protecting against infections. Breastfeeding has been cited as the main recommended feeding strategy among children to curb morbidity and mortality (Victora et al., 2016). The literature underpins the benefits of exclusive breastfeeding for the first six months. The importance and benefits of exclusive breastfeeding have been documented, even for children with HIV positive mothers (Stein & Kuhn, 2009). The benefits of breast milk are not only realised during the first six months of a child's life, instead continued breastfeeding beyond six months up to two years, with carefully introduced complementary feeding, has been found to have a positive effect on the child's health (Stein & Kuhn, 2009).

A systematic literature review conducted in developing countries showed that exclusively breastfed children had a 12% reduced risk of mortality compared to non-breastfed children. A cross-sectional study conducted in 14 developing countries found that the probability of mortality among non-breastfed children by the age of 24 months was 7 times higher compared to breastfed children (Brahmbhatt & Gray, 2003). Notably, the findings of the study conducted in the 14 developing countries were in line with the literature confirming the benefits of breastfeeding among children in reducing mortality (Brahmbhatt & Gray, 2003). A cross-sectional study conducted in Pakistan also revealed that children who were breastfed had a reduced mortality risk compared to non-breastfed children (Ahmed, Kamal, & Kamal, 2016). Another cross-sectional study conducted by Oddy (2013) in 67 developing countries showed that countries with a low prevalence of breastfeeding were most likely to have high childhood mortality rates. In Nepal, a cross-sectional study by (Lamichhane, Zhao, Paudel, & Adewuyi, 2017) further confirmed the protective effects of breast milk on under-five mortality rates. (Lamichhane et al., 2017) also reported that Nepalese children who were not breastfed had 2.5 times higher odds of dying compared to breastfed children.

2.5.2 Breastfeeding status and mortality related to diarrhoea

The effect of breastfeeding on diarrhoea mortality has long been established in the body of the literature. A systematic literature review conducted by Lamberti, Walker, Niman, Victora and Black (2011) reported that predominately breastfed children were 2.28 times more likely to die from diarrhoea, partially breastfed children were 4.62 times more likely to die from diarrhoea and those not breastfed at all 10.52 times more likely to die from diarrhoea compared to exclusively breastfed children aged under five years. The protective effect conferred by exclusive breastfeeding is thus greatly pronounced when compared to the protection conferred to children predominately breastfed and those not breastfed at all (Lamberti et al., 2011).

In India conducted a cross-sectional study to investigate if breastfeeding had an effect on child mortality (Chandhiok, Singh, Singh, Sahu, & Pandey, 2015). According to their study, children who were breastfed had their mortality risk reduced by 97% compared to children not breastfed, after adjusting for other factors. The benefits of breast milk on reducing diarrhoea mortality were also documented by Ogbo, Agho, Ogeleka, Woolfenden, Page, Estwood and Global Child Health Research Interest Group (2017) in a cross-sectional study in Burkina Faso. The national findings from Burkina Faso revealed that children exposed to breast milk from birth and who had been breastfed exclusively had a 20% reduced risk of having diarrhoea compared to children who had not experienced the same. The effect of breast milk on improving the survival of children was evident not only in Africa but in Asia as well. The risk of mortality from diarrhoea among exclusively breastfed children was found to be reduced compared to those not exclusively breastfed in Bangladesh (Arifeen et al., 2001). Post-neonatal mortality was also found to be higher in children not exclusively breastfed compared to those exclusively breastfed in Bangladesh (Arifeen et al., 2001).

2.5.3 Breastfeeding status and morbidity from diarrhoea

The absence of exclusive breastfeeding among children aged below six months and the early weaning of those aged above six months increased the risk of these young children contracting diarrhoea in developing countries (Lamberti et al., 2011). A cross-sectional study conducted in Nepal showed that children breastfed for a period beyond six months had lower odds of having diarrhoea (Kalakheti, Panthee, & Jainc, 2016). These researchers observed new cases of diarrhoea among children who had not been exclusively breastfed for at least six months (Kalakheti et al., 2016). This was supported by findings obtained from a cross-sectional study in Brazil where exclusively breastfed children were also found to have a lower risk of having diarrhoea than children whose mothers had practised mixed feeding (Santos et al., 2016). Improper feeding and weaning practice and failure to breastfeed young children exclusively for the recommended six-month period following birth was a major risk factor for child morbidity and mortality (Mohammed & Tamiru, 2013). A cross-sectional study that sought to establish infant feeding practices and the risk of diarrhoea in Sub Saharan Africa showed that children that received breast milk in the first hour following birth had reduced odds of contracting diarrhoea compared to those that were breastfed after the first hour (Ogbo et al., 2017). Similarly, children that were exclusively breastfed were less likely to have diarrhoea (Ogbo et al., 2017).

2.6 Birth Order

2.6.1 Birth order and childhood mortality

The relationship between birth order and child mortality has long been established by several studies (Bjorkegren & Helena, 2017; Sinmegn Mihrete, Asres Alemie, & Shimeka Teferra, 2014). According to (Whitworth & Stephenson, 2012), the literature on demographic data has accumulated evidence showing that birth order is associated with child mortality. Adjusting for family size (Barclay & Kolk 2015) found that birth order was associated with the risk of death among children aged under five years. A study conducted in Sweden by (Lundberg & Svaleryd, 2016) revealed that firstborn children were more likely to have negative outcomes compared to subsequently born children. Evidence found in the study conducted by these researchers showed that the mortality curve was U-shaped for children aged under five years, with mortality higher for first born children and children born fifth and above in birth order (Lundberg & Svaleryd, 2016).

Similar findings to those found in Sweden were reported in a systematic review done in Ethiopia; where first born children had higher mortality compared to those children born second and third (Adinew, Feleke, Mengesha, & Workie, 2017). This study conducted in Ethiopia also found that first-born infants were two times more likely to survive in infancy compared to those born sixth in birth order.

2.6.2 Birth order and mortality from diarrhoea

Research from various studies noted that first born children had a higher risk of negative health outcomes (Lundberg & Svaleryd, 2016). According to Gyimah (2003) child birth order was associated with childhood diarrhoea. The cross-sectional study conducted in Ghana by Gyimah (2003) revealed that children with a high birth order were found to be more vulnerable to dying from diarrhoea. Gyimah (2003) also indicated that these findings could have been related to the fact that with more children, mothers had less time for each child, meaning that they could have received less quality care and attention and thus had an increased risk of exposure to pathogens. Similarly, (Brenoe & Molitor 2015) also reported that later-born children were more likely to have negative health outcomes due to the behaviour of their mothers.

2.6.3 Birth order and diarrhoea morbidity

A secondary analysis of the demographic and health survey data in Ethiopia found that as the birth order of the child increased, the risk of the child having diarrhoea increased (Sinmegn Mihrete et al., 2014). Children with birth orders higher than four were six times more likely to develop diarrhoea infection compared to children born first (Sinmegn Mihrete et al., 2014). It has been suggested that the overall number of children and birth order increased the risk of diarrhoea because the parents tended to compromise their attention and the quality of care provided (Mihrete, Alemie, & Teferra, 2014).

Not all authors found these results, however retrospective longitudinal study was conducted in Sweden using facility-based data, and the findings revealed that the policy effect of birth order was minimal, given that it could not be changed, and it only helped to broaden the understanding of its dynamics in relation to diseases (Bjorkegren & Helena, 2017). According to Bjorkegren, and Helena (2017)'s argument, the health status of children was not dependent on their differences in birth order; instead, it was the children who were born first who were reported to have bad health outcomes.

2.7. Low Birth Weight

2.7.1 Low birth weight and overall childhood mortality

The prematurity of infants is measured through an indicator referred to as low birth weight (Hughes, Black, & Katz, 2017). Several scholars, including the WHO have used the threshold of less than 2500g to define low birth weight (Hughes et al., 2017; WHO & UNICEF, 2004). Even though the 2500g threshold has been used, to allow for comparability between countries several studies have noted that this threshold may not be appropriate for all settings (Hughes et al., 2017; Sachdev, 2001). Low birth weight has remained an important factor because of its negative implication on childhood morbidity and mortality (Huong, 2014). A cohort study conducted in Brazil showed that children with low birth weights of less than 1500g were 6 times more likely to die and those with birth weights of 1500g-1999g were 86% more likely to die compared to children with weights of 2000-2499g.

2.7.2 Low birth weight and mortality and morbidity from diarrhoea

Low birth weight has been cited in the literature to be associated with a number of infections. Birth weight has not only negative effects during infancy but also has long-lasting effects beyond the childhood years. According to Huong (2014), children with low birth weights are most likely to die of diseases such as diarrhoea. According to Vaidya (2008) low birth weights remain a public health concern and should remain a priority to prevent child morbidity and mortality. Even though the WHO provides guidance on the preferred birth weights for children and the negative effects of low birth weights on childhood diarrhoea, there is also a dearth of literature on the subject.

2.8 Maternal Determinants and Childhood Diarrhoea

2.8.1 Mothers' age and overall child mortality

Child health has been explained in terms of the age of the mother. A cross-sectional study conducted in Nigeria pointed out that younger women were more likely to have healthy children and experience low child mortality compared to older women (Usman, Sheu Raheem, & Segun-Agboola, 2009). A cross-sectional study conducted in India found evidence that the children of educated women tended to survive better compared to children whose mothers were illiterate (Vikram, Desai, & Vanneman, 2010). Usman, Sheu Raheem, et al. (2009) justified these findings by stating that older women were more likely to be uneducated. A cross-sectional study conducted in 55 developing countries found that the child mortality rate was higher for mothers aged 12-17 years compared to that for children born to mothers aged 27-29 years (Finlay, O¨zaltin, & Canning, 2011). A retrospective cross-sectional study conducted in Londrina, Brazil also found that children born to mothers aged 12-19 years and 35 years and older had higher infant mortality compared to children whose mothers were aged 20-34 years (Ribeiro, Ferrari, Anna, Dalmas, & Girotto, 2014).

2.8. 2 Mothers' age and child mortality from diarrhoea

The effect of the mother's age on child mortality due to infectious diseases is documented in the literature. Developed countries which are in the last phase of the demographic transition experienced reduced mortality from diseases such as diarrhoea (Temin & Levine, 2009). The United Nations' global agenda of SDGs encourages all countries to improve education and employment for females so that they may acquire knowledge on disease prevention and also delay their first births until they are older (Finlay et al., 2011). A cross-sectional study of 188 demographic and health surveys conducted between 1990 and 2008, in 55 developing countries, revealed that mothers who had their first children while they were aged between 12 and 35 were more likely to have their children die of diseases such as diarrhoea and have other negative birth outcomes, compared to those who only gave birth for the first time when they were between the ages of 27 and 29 (Finlay et al., 2011). A secondary cross-sectional study conducted in Kenya revealed that younger mothers aged 15-19 years were more likely to have children with diarrhoea (Mbugua et al., 2014). The risk of childhood diarrhoea then decreased as the mothers got older (Mbugua et al., 2014). Luby et al., (2004) proposed that this phenomenon of the lower incidence of diarrhoea as the mothers got older occurred because as they got older women gained experience in nursing and caring for their children.

2.8.3 Mothers' age and child morbidity from diarrhoea

The literature reports that maternal age is associated with childhood diarrhoeal infections, and younger mothers have been identified to be a risk factor for child diarrhoea (Kembo & Van Ginneken, 2009). Most interventions aimed at the reduction of diarrhoea among children have focused on a medical approach to the problem yet, as evidenced, social factors such as maternal age are also very critical (Sikha et al., 2016). In a prospective study conducted in the Philippines, Brazil, Guatemala, India and South Africa children's infections such as diarrhoea and low birth weights were common among mothers aged 19 years and below and also among those aged 35 and above (Fall et al., 2015). It is worth noting that only a few studies have been done to investigate the relationship between maternal age and childhood diarrhoea in particular, but the evidence is consistent among those few conducted. Younger mothers lacked the experience and knowledge to prevent and treat diarrhoea infections, while older mothers most likely had not received adequate schooling and thus lacked basic knowledge of hygiene.

2.9 Mothers' Educational Status

2.9.1 Mothers' education status and overall child mortality

Maternal education levels have been found to be associated with child mortality. A cross-sectional study conducted in India showed that mothers with a better/higher level of education were empowered to space their children's births appropriately. This reduced the risk of child mortality compared to mothers with no or low levels of education (Whitworth & Stephenson, 2012). The mechanisms by which education improves children's survival is through the improvement of their social, cultural and economic environments (Vikram et al., 2010). A cross-sectional study conducted in Ghana by Buor (2003) confirmed that the relationship between child mortality and maternal education was based on sound theoretical knowledge.

The strong association between child health and maternal education is also well documented in Caldwell's (1979) typology of health. A cross-sectional study in Madagascar also reported on the importance of mothers' education for their children's survival as educated mothers were more likely to understand the severity of the disease and seek prompt medical care (Badji, 2016). However, the strong association presented in most studies between childhood mortality and maternal education levels does not automatically imply causality, since there may be other factors that may be cofounders for child mortality and maternal education. For example, even though maternal education levels had a strong association with child mortality in Madagascar, the wealth status of the household explained a third of the childhood mortality (Badji, 2016).

2.9.2. Mothers' education status and mortality related to diarrhoea

Several scholars have noted variations in the effects that maternal education has on child mortality from a communicable disease such as diarrhoea. These variations arise due to contextual factors (Dargent-molina, James, Strogatz', & Savitz', 1994; Mantwill, Monestel-Umaña, & Schulz, 2015). A cross-sectional study done in the Philippines in the 1990s reported that the protective effect of maternal education on mortality due to diarrhoea among children was effective only in communities that were economically and socially affluent. Little benefit was seen in economical and socially disadvantaged communities (Dargent-molina, James, et al., 1994). It is therefore based on this premise that the SDGs have emphasised the importance of reducing preventable diseases for all and ensuring healthy lives for everyone while improving the quality of education for all (UNDP, 2017). The importance of education emerged from the work of (Caldwell, 1979) in Nigeria, reported a strong association between maternal education and child mortality. Child mortality due to disease such as diarrhoea could be explained to vary because of the contextual factors that mediated the relationship in which children born to mothers with no education were almost 50% more likely to die compared to children born to mothers with an education (Adetoro & Amoo, 2014).

2.9.3 Mothers' education status and morbidity related to diarrhoea

The positive effect of mothers' education has long been recognised to reduce childhood diarrhoea, as several studies have explored the linkage between educated mothers and childhood diarrhoea (Inayat Shukr, Ali, Khanum, & Mehmood, 2009; Mohammed & Tamiru, 2013). The health of children below five years of age was analysed by (Chena & Hongbin Li, 2009) in China. According to these authors, the benefits of education were mainly evident by the improvements in the mothers' incomes, household sanitation and hygienic conditions. The findings of this cross-sectional study conducted in China found a reduced risk of exposure to diarrhoea as the postnatal nurturing of children was found to be optimal among children whose mothers were educated (Chena & Hongbin Li, 2009). The central question that remained unanswered by most studies was whether the relationship between mothers' education and their children's health was causal. According to Budhathoki, Bhattachan, Yadav, Upadhyaya, et al. (2016), mothers who were educated had more knowledge of their children's health status.

2.10 Hand Washing and Childhood Diarrhoea

2.10.1 Hand washing and overall child mortality

An experimental study conducted in a British museum reported that hand washing was very instrumental in the disruption of disease transmission (Burton, Cobb, Donachie, Judah, Schmidt , et al., 2011). There was a variation in the manner of hand washing and disease transmission, volunteers who washed their hands with water had approximately 23% contamination of their hands with bacteria while those who washed with water and soap only had an 8% bacteria contamination (Burton, Cobb, Donachie, Judah, Schmidt , et al., 2011). An observational study conducted in Southern Nepal showed that children who were delivered by mothers or birth attendants who washed their hands had a 75% reduced risk of dying compared to children delivered by mothers or birth attendants who did not wash hands (Rhee et al., 2008). A cross-sectional study conducted in Nepal investigated the effects of hand washing on child mortality (Rhee et al., 2008). The results reported in this cross-sectional study in Nepal showed that neonatal and infant mortality was reduced by 60% when mothers or birth attendants washed their hands with water and soap before handling the baby relative to infants whose mothers or birth attendants did not wash their hands at all (Rhee et al., 2008).

2.10.2 Hand washing and mortality related to diarrhoea

There is consensus in the literature that disease transmission and mortality from infections such as diarrhoea can be prevented by adequate hand washing. The hypothesis and theory established by the literature is that hands are covered in pathogens and if unwashed with clean water and soap these pathogens can increase the risk of mortality due to diarrhoea (Langford, 2009). However, not many studies have been conducted at a community level to measure the effects of hand washing on child mortality from diarrhoea. Hand washing is one of the important interventions that reduce disease infection and transmission Burton, Cobb, Donachie, Judah, Schmidt, Curtis, and Schmidt (2011) add that although hand washing is known to reduce diarrhoea related mortality among children, it is not yet clear what frequency of hand washing is required to break the chain of transmission of diarrhoea.

2.10.3 Hand washing and morbidity related to diarrhoea

Even though the health benefits of hand washing are significant in a number of studies, the continued paucity of hand washing remains a serious concern in both developed and developing countries (Budhathoki, Bhattachan, Yadav, Upadhyaya, et al., 2016; Burns et al., 2017; Watson et al., 2017). A systematic literature review found that hand washing among school-going children resulted in reduced odds of contracting diarrhoea (Mbakaya, Lee, & Lee, 2017). A randomised control study conducted in Pakistan found that children under five years of age who lived in households where hand washing with soap was practiced during cooking and when feeding children solid food had fewer risks of having diarrhoea compared to the control group

(Luby et al., 2004). Another investigation conducted in Pakistan demonstrated that the duration of diarrhoea infection was shorter in households that practiced hand washing (Pittet, 2005). This result (Pittet, 2005) led to the conclusion that hand washing as an intervention reduced the transmission and burden of diarrhoea in Pakistan.

Findings from an observational cross-sectional study in Bangladesh found that children who were from households where hand washing was done prior to cooking and preparing food had a reduced probability of having diarrhoea after controlling for parents' education, and ownership of a radio, television and mobile phone, among other factors, AOR 0.78 (CI:0.57–1.05). The same was not observed for children whose households did not wash their hands (Luby et al., 2011). The benefits of hand washing were significant even when they were washed with plain water (without soap) (Luby et al., 2011). These findings were in line with the epidemiological literature that hand washing removes bacteria. In Nepal, mothers who practiced hand washing with soap and water had their episodes of diarrhoea decreased by 30% per day (Budhathoki, Bhattachan, Yadav, Upadhyaya, et al., 2016). A randomised case-control study conducted in Pakistan found that infants who resided in households where hand washing was done using soap had an approximately 40% reduced risk of having diarrhoea compared to infants living in control neighbourhoods where hand washing was not done with soap (Luby et al., 2004). Cairncross, Hunt, Boisson, Bostoen, Curtis, Fung & Schmidt (2010) also point out that the effectiveness of hand washing with soap is consistently explained in the literature as instrumental in the prevention of diarrhoea.

2.11 Household Level Determinants and Childhood Diarrhoea

Household and environmental determinants play a crucial role in the transmission and prevention of diarrhoea. A detailed analysis of the household and environmental factors in Ethiopia that directly or indirectly affected the risk of a child having diarrhoea was undertaken by (Mohammed, 2014; Mohammed & Tamiru, 2013). In his analysis, Mohammed (2014) argued that socio-economic status, poor sources of drinking water, the lack of proper toilet facilities, improper washing of hands and improper disposal of children's stools were very instrumental in children's health.

2.11.1 Household wealth index and childhood mortality

Several studies have provided evidence that household socio-economic status is associated with child health (Rutstein & Johnson, 2004). The household wealth index has been widely used to categorise households into different classes of socio-economic status (Smits & Teendijk, 2013) and this index provides a fundamental measure to situate individuals and households into categories of development and wellbeing.

Even though the wealth index is a good index, it is not constructed using homogeneous variables; therefore, the meaning of wealth scores varies from country to country (Rutstein & Johnson, 2004; Smits & Teendijk, 2013). It is constructed using a combination of variables such as the availability of electricity, building materials, nutritional status, ownership of televisions, cars and phones, floor materials and cooking utensils, etc. (Smits & Teendijk, 2013).

2.11.2 Household wealth index and mortality from diarrhoea

The household wealth index has been reported to be associated with childhood diarrhoea. A cross-sectional study conducted in Ghana reported that children who resided in households with a better wealth status were more likely to survive compared to those with a poor household wealth status (Lartey, Khanam, & Takahashi, 2016). The results from this study showed that children from households with a higher wealth status had a 3.5% risk of dying compared to the 5.5% risk of dying among children from households with poor wealth statuses (Lartey et al., 2016). These results were in line with a study conducted in Sierra Leon, where poverty or material deprivation was associated with poor childhood survival rates (Marmot, 2005). In India, a cross-sectional study compared childhood mortality between households based on their building materials. Households constructed from poor building materials had higher child mortality rates compared to households constructed from better quality building materials (van der Klaauw & Wang, 2011). According to Marmot (2005) and van der Klaauw and Wang (2011) children who lived in households constructed from poor building materials were most likely to have no electricity, no proper toilets and not have a separate room for cooking. Unclean water, poor sanitation and hygiene, poor nutrition and a lack of medical care were also likely in these households.

2.11.3 Household wealth index and diarrhoea morbidity

Several studies have indicated that the household wealth index is associated with childhood diarrhoeal infection. For example, a cross-sectional study conducted in Indonesia showed that the household wealth index was significantly associated with childhood diarrhoea (Komarulzaman et al., 2014). Even after controlling for other confounders, increasing household wealth was found to significantly reduce childhood diarrhoea (Komarulzaman et al., 2014). According to Kyu (2012), the positive outcomes of a good household wealth index were improved conditions in the households where children resided and access to improved health care.

A cross-sectional study conducted in Nepal indicated that diarrhoea infections among children aged younger than five years differed in accordance with their socio-economic statuses. Children who lived in households categorised as rich were found to have better protection against diarrhoea infections (Budhathoki, Bhattachan, Yadav, Upadhyaya, et al., 2016). According to Budhathoki, Battachan, et al. (2016) the reduction in childhood diarrhoea occurrences in wealthy households was a result of improved health-seeking behaviours and improved hygiene and sanitation in these households. A cross-sectional study conducted in Nigeria supported these findings by confirming that children who resided in economically disadvantaged households experienced higher morbidity and mortality.

Boadi and Kuitumen (2005) and Rutstein, Staveteig, Winter, and Yourkavitch, (2016) also associated the socio-economic status of households with childhood diarrhoea. Evidence dating back to the 1990s, documented the unpalatable effects of poverty on the development of children (Brooks-Gunn & Duncan, 1997). Boadi and Kuitunen's (2005) cross-sectional study in Nigeria found that poor households had a higher prevalence of diarrhoea among children under five years of age. These authors also described the high diarrhoea infection rate in poor households as being due to unhygienic conditions, poor sanitation and poor nutrition in these households. Findings from a longitudinal study conducted in Kenya also showed that children who suffered from poor nutrition were found in poor households and their development was greatly comprised (Mutisya, Kandala, Ngware, & Kabiru, 2015).

Literature documented in Nigeria postulated that poor households had a poor household economy, poor sanitation and hygiene and poor community service provision that directly influenced childhood care (Usman, heu Raheem, & Segun-Agboola, 2009). (Kumar & Vollmer, 2013) a cross-sectional study conducted in India found big differences in the socio-economic statuses of households that practiced water treatment in comparison to those that did not. `

2.12 Water and Sanitation

2.12.1 Water and sanitation and overall child mortality

The public health benefits of an improved water supply and sanitation has motivated the global community and State leaders to sign the Millennium and Sustainable Goals Declaration to ensure healthier lives for all (Jeuland, Fuente, Ozdemir, Allaire, & Whittington, 2013; Prüss-Üstün, Bos, Gore, & Bartram, 2008). Poor sanitation and unclean water have been documented in the literature to be the main drivers of child mortality, especially in developing countries. According to (Overbey, 2008), water and sanitation remain critical agents for the transmission of diarrhoea, mainly through the faecal-oral route. Improving water quality and sanitation interrupts the incidence and prevalence of diarrhoea, hence reducing child mortality (Overbey, 2008). An analysis of DHS data from 70 countries revealed that children's odds of dying were reduced by 23% if their households had an improved water supply and sanitation (Fink, Gu¨nther, & Hill, 2011). In Nigeria, a cross-sectional analysis of the DHS indicated that children in the neonatal, post neonatal and young child age group had significantly reduced odds of dying (31%, 41% and

47% respectively) if they were resident in households with improved water and sanitation compared to those with unclean water and poor sanitation (Ezeh , Agho, Dibley, Hall, & N., 2014). These findings from the studies conducted in the developing countries provided compelling evidence that clean water supply and improved sanitation drastically reduced the risk of mortality among children (Ezeh et al., 2014; Fink et al., 2011).

2.12.2 Water and sanitation and mortality from diarrhoea

The effect of water and sanitation on childhood diarrhoea has long been discussed in the literature**.** Contaminated water remains a major problem for the causation of diarrhoea and mortality. A secondary analysis conducted in 70 developing countries found that after controlling for age and the gender of the children, and improved water supply and sanitation in their households was associated with an 8% reduced probability of dying due to diarrhoea compared to households with a poor water supply and sanitation (Fink et al., 2011). The importance of poor sanitation and a lack of clean water was also discussed by (Oloruntoba, Folarin, & Idowu Ayede, 2014), who reported that these were responsible for approximately 88% of the deaths caused by diarrhoea. Evidence documented by a study conducted in the Pacific reported that if no programmes and interventions were put in place to improve water quality and sanitation, approximately 135 million people could die (Gleick, 2002). The cross-sectional study conducted in India also found that the reduction of childhood diarrhoea was associated with improved sanitation (Kumar & Vollmer, 2013).

2.12.3 Water and sanitation and diarrhoea morbidity

Most cases of mortality result from diseases such as diarrhoea that are preventable and their transmission is increased by poor water supply and poor sanitation (Prüss-Üstün et al., 2008). A cross-sectional secondary analysis in Indonesia found that almost 86% percent of households in their sample were without piped water (Komarulzaman et al., 2014)**.** The adjusted findings of the Indonesian study revealed that households with piped water had a reduced number of children suffering from diarrhoea, OR 0.81 (CI: 0.71-0.93), compared to those without a piped water supply (Komarulzaman et al., 2014). (Komarulzaman et al. (2014) reported that for both water and sanitation to significantly affect the prevention of childhood diarrhoea, they needed to be improved concurrently. Finally, Oloruntoba et al. (2014)'s cross-sectional study also revealed that poor sanitation and unhygienic water supplies were risk factors for diarrhoeal infections.

2.13 Disposal of Child's Stools

2.13.1 Disposal of child's stools and mortality

Disposal of a child's stools is critical in the prevention of diseases and mortality. Evidence documented in the literature states that children's stools present the same risk for mortality and disease transmission as adults' stools (Rand, Loughnan, Maule, & Reese, 2015). According to Bawankule, Sigh, Kumar and Pedgaonkar (2017), improper disposal of stools was one of the main factors that predisposed children to faecal pathogens in India. In their study, the unsafe disposal of children's stools was observed to be more prevalent in rural areas than in urban areas. After controlling for demographic factors, it was found that this risk posed by the unsafe disposal of children's stools was mainly due to a lack of toilets facilities (Bawankule et al., 2017).

2.13.2 Disposal of child's stools and mortality from diarrhoea

There is a dearth of literature on the effects of child excreta on mortality due to diarrhoea. Unsafe disposal of stools has long been established in the literature to be one of the important risk factors for childhood mortality caused by diarrhoea. A cross-sectional study conducted in Indonesia showed that children from households that practiced unsafe disposal of the children's stools had higher odds of association (46%) with childhood diarrhoea (Cronin, Sebayang, Torlesse, & Nandy, 2016). A systematic review of the literature revealed evidence that safe disposal of children's stools reduced the risk of diarrhoea mortality by 32% (Fewtrell, Kaufmann, Kay, Enanoria, et al., 2005). However, Cairncross et al. (2010) observed that few clinical trials had been done to measure the effect of the disposal of children's stools on the mortality caused by diarrhoea. Some of the studies that had been used to inform policy on the subject had adopted an observational design which had limitations, mainly because the people who disposed of the children's stools inappropriately had similar characteristics (Cairncross et al., 2010).

2.13.3 Disposal of child's stools and diarrhoea morbidity

Unsafe disposal of stools has been found to influence the transmission of diarrhoea. A cross-sectional study done in India reported that approximately 80% of the children's stools were disposed of inappropriately (Cronin et al., 2016). This unsafe disposal of children's stools was thus found to be directly associated with diarrhoea in India. The odds of contracting diarrhoea were higher among children in households where their stools were not disposed of properly (AOR: 1.11; 95% CI: 1.01–1.21), compared to children whose stools were disposed of properly (Cronin et al., 2016). Another cross-sectional analysis conducted in Indonesia revealed that the improper disposal of children’s stools was prevalent among unhygienic households with a high number of diarrhoeal cases (Cronin et al., 2016). Households that practiced unsafe disposal of children’s stools in Indonesia thus had a higher probability of having diarrhoea compared to those that practiced safe disposal of the stools (Cronin et al., 2016).

2.14. Community Level Determinants and Childhood Diarrhoea

Research has shown that individual individual-level factors cannot adequately explain the health of an individual but that a new approach called eco-epidemiology should be applied to understand the community level causal pathways of disease (Bellan et al., 2012; Goldstick, Trostle, & Eisenberg, 2014; March & Susser, 2006). Few studies have been done to explain the contribution of community level factors in the understanding of childhood morbidity and mortality (Bellan et al., 2012). This gap identified by Bellan et al. (2012) and Yadav and Kesarwani (2015) on the shortage of studies that incorporate community-level factors were also noted by Yadav and Kesarwani (2015). To understand the dynamics of population health properly, there is a need to research why the health status of children varies by area of residence, neighbourhood conditions, the literacy rate in the community, and the prevalence of diarrhoea in the community. The limited number of studies in the literature that have looked at community level factors have focused on the effects of the community variables on child morbidity and this study seeks to add to the limited body of knowledge on child morbidity and mortality at a community level.

2.14.1 Area of residence and childhood diarrhoea

Research has shown that the health of children differs between rural and urban areas (Akoto & Tambashe, 2002). Evidence found in South Africa indicated that child morbidity and mortality in rural areas was 60% higher than in urban areas (Strasser, 2003). According to (Montgomery, 2009) the urban population has been improperly analysed, as the assumption was made that all individuals in urban areas had a better health status, yet the urban poor were unlikely to be significantly different from the rural poor. A cross-sectional study conducted in Kenya, after controlling for confounders, revealed that there was higher childhood morbidity and mortality in urban slums compared to rural areas (Rutstein et al., 2016). Another cross-sectional study, this time in Tanzania, also found that children that resided in rural areas had reduced odds (34%) of contracting diarrhoea than those that resided in urban areas (Kawakatsu et al., 2017).

2.15 Neighbourhood Conditions

Regardless of the proposed eco-epidemiological approach to the study of childhood morbidity and mortality, a gap remains in the understanding of individual household factors and community level factors. The dynamic approach in studying health pathways emphasises the study of multiple causal factors outside the biological and individual-level factors to allow for an informed understanding of the complex interactions of the factors (March & Susser, 2006). An integrative approach in the study of disease dynamics and health outcomes was also proposed by Singer and Ryff (2001) citing that multilevel analyses provided a better understanding of population health dynamics. However, some scholars identified a theoretical gap in studying risk factors at an individual level, as an individual's health was not defined only by their behaviour but also by the contextual environment where they resided, according to (Gabrysch, Edwards , & Judith, 2008). To fill this gap in the understanding of disease dynamics, numerous scholars recommended the analysis of health at a population or community level (Adedini, 2013; Gabrysch et al., 2008).

According to Meng (2010) socio-economic factors operate through space and place to influence health. In Ades (1989)'s view, analysing community level factors provides a localised understanding of the socio-economic environment. The environments where the children reside thus play a critical role in their survival (Akoto & Tambashe, 2002). Research has also shown that the health of children differs across neighbourhoods between rural and urban areas (Akoto & Tambashe, 2002).

2.15.1 Neighbourhood conditions and morbidity from diarrhoea

A literature synthesis by (Luby et al., 2011) revealed that the social and economic organisation of communities was very influential in understanding the health of children. The paradigm shift in the tradition of analysing disease dynamics from a micro level to a macro level was supported by numerous studies (Luby et al., 2011; National Research Council, 2001; Sampson, 2003). A cross-sectional study conducted in Malawi that aimed to understand the fixed effects and random effects of malaria and diarrhoea morbidity found that individuals aged from 6 to 40 years had a reduced risk of having malaria and diarrhoea relative to children aged under 5 years. A cross-sectional study conducted across African countries revealed that household and neighbourhood factors were very important factors that explained the prevalence and variation of diarrhoea (Bado, Susuman, & Nebie, 2016). A significant variation or clustering in malaria and diarrhoea cases was also observed at household factors and by Community diarrhoea endemicity, Community malaria endemicity) (Masangwi, Ferguson, Grimason, Morse, & Kazembe, 2015).

The literature posited that poor communities were more susceptible to childhood morbidity. According to Kyu (2012), this was because poor communities had an unmet need for medical care as medical facilities were often too far away to be accessed easily, a statement supported by (Sampson, 2003). The health of individuals varied between communities because of the different socio-economic statuses of these communities (Sampson, 2003). Research conducted by (National Research Council, 2001) in the Washington DC also revealed that children's health outcomes were associated with their communities' socio-economic environments; and communities that had a high degree of poverty tended to have higher childhood morbidity and mortality rates.

A study conducted by Macassa et al. (2011) in Sub Saharan Africa explained a conceptual framework that a community entails a system that encompassed the distribution and clustering of the exposures and risk factors interconnected between susceptible and infectious individuals. A cross-sectional Tanzanian study found that the place of residence the neighbourhood mattered in the study of infectious diseases such as diarrhoea (Masisha, Kapigab, Earlsc, & Subramanianc, 2008). A multilevel analysis of a cross-sectional study conducted in Indonesia revealed that at a community level both improved sanitation and clean water supply were important factors to reduce the risk of diarrhoea (Komarulzaman, Smits, & de Jong, 2017). Even if households, where children were resident, were better off in terms of water and sanitation, these children were still at risk of contracting diarrheal diseases if they lived and played in poor, polluted neighbourhoods (Komarulzaman et al., 2017). Similarly, another cross-sectional study conducted in Indonesia found that children from households with proper sanitation and amenities could still be at risk of diarrhoea if their communities as a whole had poor sanitation (Andres, Briceno, Chase, & Echenique, 2014; Komarulzaman et al., 2017).

Therefore, it was deemed important to understand the theoretical nuances of causal factors in a more comprehensive manner. Another factor to be taken into consideration was the application of single-level analyses when conducting community-level studies as these single-level analyses often limited the studies' findings, as they could not be generalised to the broader population at the community level.

2.16 Overall education attainment of the Community

2.16.1 Overall education attainment in the community and morbidity from diarrhoea

From a theoretical point of view, mothers' educational statuses played a critical role in improving the health statuses of their children. According to WHO and World Bank Group (2001), the higher the proportion of mothers with at least secondary education in the community the lower the risk of children getting sick and dying from preventable diseases such as diarrhoea. Mothers who resided in the rural areas tended to have poor educational levels compared to those in urban areas (WHO & World Bank Group, 2001). The typology of the factors influencing childhood health were documented by You et al. (2015), who revealed that the role of education was important for improving children's health through better health practices, sanitation and hygiene. Contrarily, however, a cross-sectional study in Sudan by Siziya, Muula and Rudatsikira (2009) found no association between maternal education and childhood diarrhoea.

2.17 Overall Prevalence of Diarrhoea in the community

2.17.1 Prevalence and morbidity from diarrhoea

The prevalence of diarrhoea was found to be instrumental in the transmission of diarrhoea (Choisy, Guégan, & Rohani, 2007). The higher the number of diarrhoea cases in the community, the more likely a significant number of children will be infected. According to Choisy et al. (2007), diarrhoea transmission depended on the faecal-oral route and contact between individuals infected and those not infected. The number of infectious individuals with diarrhoea in a community affected the number of susceptible individuals. The transmission mechanism of diarrhoea has been well explained through simple transmission models that explain the different compartments of the health of individuals in a community (Choisy et al., 2007). In a community where the prevalence of diarrhoea and faecal contamination was high, all children had the same risk of being infected regardless of their households' socio-economic status (Kyu, 2012). Even though the literature had it that the transmission dynamics were associated with the prevalence of a disease in a community, there was still a dearth of epidemiological studies that had investigated and incorporated the community-level factors. Mathematical models were used to determine the transmission rate during disease outbreaks to estimate the infection numbers as a parameter (R0) (Bellan et al., 2012; Johnson, 2006).

2.18 Acute Respiratory Infection

2.18.1 Definition and classification of acute respiratory infection

ARIs include all infections that affect the respiratory tract from the paranasal to the pleural cavity, which persist for less than 30 days (Vardanyan, 2013). They may be classified as upper or lower respiratory tract infections (Hart & Cuevas, 2007). The upper respiratory tract infections include several infections that affect the area of the nasal cavity and larynx while the lower tract infections affect the lungs and bronchi (Simoes, Cherian, & Chow, 2006; Vardanyan, 2013). Upper respiratory infections involve illnesses that include sinusitis, the common cold and middle ear infections (Matu, 2015). The symptoms of URIs include sore throat, fever, and runny nose and often take one to three days until the onset of the symptoms after being infected with the pathogens.

Viruses such as the adenovirus, respiratory syncytial virus, influenza etc. are the main etiological agents that lead to URTIs (Vardanyan, 2013). According to Vardanyan (2013), the symptoms of childhood URTIs include fever, cough, sore throat and a runny nose and may last for 14 days.

Lower respiratory tract infections have been cited to be the major cause of morbidity and death among children under five years of age (Vardanyan, 2013). Viruses and bacteria have been reported to be the most common etiological agents, including pathogens that cause pneumonia such as influenza, Streptococcus pneumonia and respiratory syncytial virus (van Jaarsveld et al., 2006). LRTIs manifest themselves through wheezing, difficulty in breathing, and cyanosis. Bronchitis and pneumonia are the most common infections (Vardanyan, 2013).

2.18.2 Transmission mechanism of acute respiratory infection

Communicable diseases occur when a suitable environment is present for susceptible hosts to interact with infectious agents. Viruses and bacteria can transmit acute respiratory infections through respiratory droplets and contaminated hands (Matu, 2015; World Health Organisation, 2008). According to Elsanita, Kurniadi, Wulandari and Setiawati (2015) ARIs are caused by microorganisms such as the coronavirus, rhinovirus, influenza virus, group A beta hemolytic streptococcus, and the para influenza virus. The symptoms of an ARI manifest themselves through coughing, fever, sneezing, nasal congestion, a runny nose, sore throat and heavy breathing (Elsanita et al., 2015).

2.18.3 Factors associated with acute respiratory infection

A conceptual framework by Mosley and Chen (1984) provides an analytical pathway of the possible determinants that influence child survival. The model demonstrates that individual level (child level, maternal factors); household level factors (indoor and outdoor air pollution, nutrition, etc.) and community-level factors predispose a child to morbidity and mortality. The synthesis of this section is based on the risk factors at individual, household and community level, and they are discussed in detail below.

2.19. Child Level Factors

2.19.1 Child age and childhood morbidity due to ARI

The literature reports that the incidence and prevalence of ARIs vary according to the child's age. A cross-sectional study conducted in Egypt found that children aged 6 to 23 months were more likely to have an ARI relative to children aged less than 6 months (Abdel Khalek & Abdel-Salam, 2016). However, in a study conducted in Bengal in India, a high prevalence of ARI was reported among children aged less than a year with a noted reduction of the infection rate among children over a year old (Gupta et al., 2014). According to Siya et al. (2009) in Iraq children aged 12-23 months and 24-35 months had higher odds of having an ARI compared to those aged 45-49 months, AOR 1.49 (95%CI: 1.26, 1.74) and AOR 1.32 (95%CI:1.16, 1.49) respectively. A cross-sectional study conducted in Rwanda found that children aged 24-59 months had lower odds (OR: 0.53, 95 % CI: 0.40-0.69) of having an ARI compared to those aged 0-11 months

(Harerimana, Nyirazinyoye, Thomson, & Ntaganira, 2016). Similarly, in Ghana, a cross-sectional study found that children aged 6-11, 12-23, and 24-59 months respectively, were 2.6 (95% CI: 1.76, 3.97), 2.6 (95% CI: 1.81, 3.83), and 1.8 (95% CI: 1.29, 2.59) times more likely to have a cough relative to children aged 0-5 months (Amugsi et al., 2015).

2.20. Child's Gender

2.20.1 Gender and mortality related to ARI

The evidence of the effect of gender on childhood mortality related ARIs is limited in the literature. However, the World Health Organisation documented that the susceptibility and immunity of individuals to communicable diseases such as ARIs could be explained by gender and sex (World Health Organisation, 2010). The concepts of gender and sex should be distinguished, as even though they are used interchangeably, they do not refer to one thing. Sex is the biological and physiological composition that enables differences between males and females, while gender is related to the societal constructions that are associated with the social roles of males and females (World Health Organisation, 2010). The importance and the need to bridge the gap between male and female children were established at the 1994 international conference on population and development (Programme of Action of the International Conference on Population and Development (ICPD, 2014)). Discrimination based on gender and increased girl child mortality from diseases such as ARIs was evident in India and China where an excess of mortality was observed among female children compared to males (UNICEF & The University of Edinburgh, 2015).

2.20.2 Gender and morbidity related to ARI

Sex is a major epidemiological factor that plays an important role in the study of health outcomes. ARI differs with the gender of the child. A cross-sectional study in Egypt revealed that male children were more likely to have an ARI compared to their female counterparts (Abdel Khalek & Abdel-Salam, 2016). Contrarily, a study conducted in India found that female children had a higher prevalence of ARIs, 45.8% relative to 43.4% for males (Gupta et al., 2014). A systematic review conducted of studies from developing countries found that generally, males tended to have a higher risk of developing ARIs relative to females (Matthew, Falagasa, Mourtzoukoua, & Vardakasa, 2007). According to Mathew et al. (2007) males were found to be more susceptible to infections by bacteria, fungi, viruses and parasites compared to females. The explanation for this was that male children had sex steroids that modified their immune system's genes, which then predisposed them to ARIs (Klein, 2000). Matthew et al. (2007) (Matthew et al., 2007) and Klein (2000) were thus of the same view regarding the higher rate of ARIs observed in male children being due to the composition of their immune systems being regulated by their sex hormones.

2.21 Malnutrition Associated with ARI

2.21.1 Malnutrition and childhood mortality due to ARI

Malnutrition not only increases the risk of death among children but also predisposes them to mortality from infectious diseases such as ARIs (Caulfield et al., 2004). Malnutrition is complex; defined in terms of weight for age or being underweight, height for age, stunting and wasting, and can be regarded as a risk factor for mortality from ARIs and also an outcome variable interacting with infectious diseases (Ezzati et al., 2002). The discourse of malnutrition interacting with several infectious diseases is explained to be a vicious cycle (Rodríguez , Cervantes, & Ortiz, 2011). Children who are infected by ARIs and other infections often become malnourished and malnourished children tend to die from diseases such as ARIs. Children who are malnourished have compromised immunity and hence are more likely to fall sick and die if not treated (Rodríguez et al., 2011). On the other hand, children who are sick have poor absorption of nutrients and hence a higher risk of becoming malnourished (Rodríguez et al., 2011).

2.21.2 Malnutrition and morbidity related to ARI

Undernourishment due to poor nutrition grossly affects the infection rate of diseases and continues to be a primary cause of childhood morbidity and mortality (Nandy, Irving, Gordon, Subramanianc, & Smith, 2005). The interaction between infections and poor nutrition is not linear. Poor nutrition predisposes children to infections and the literature reports that children who are infected with ARIs are more likely to be undernourished (Katona & Katona-Apte, 2008). The relationship between poor nutrition and infection presents a vicious cycle or a synergic relationship (Katona & Katona-Apte, 2008). Explaining the vicious cycle between poor nutrition and infections, Katona and Katona-Apte (2008) state that undernourished children don't frequently eat because of poor appetite, and thus they lose very important nutrients. They suffer from malabsorption, which interrupts the metabolism process, and hence they have poor immunity, lose weight, suffer mucosal damage and the severity and duration of their infections is increased. Approximately 50% of the global ALRI cases are attributed to malnutrition. In Tanzania, a prospective randomised double-blinded placebo study showed that underweight children had a 58% risk of having ARIs relative to children with a normal weight and wasting was associated with a 54% increased risk of having an ARI (Mwiru et al., 2013). A retrospective cohort study conducted in Indonesia found that children who were undernourished were more prone to have a high number of ARI episodes (more than seven), compared to children with a good nutritional status (Elsanita et al., 2015). Even though the findings of the study conducted in Indonesia showed a positive relationship between nutrition and ARIs it lacked plausibility because confounders such as demographic factors were not controlled.

2.22 Breastfeeding Status

2.22.1 Breastfeeding and child mortality related to ARI

Even though the protective effect of breast milk against diseases has been documented globally, there remains a high rate of poor child feeding practices shunning breast milk, especially in the developing world. Children who are breastfed receive antibodies from their mothers which are critical for strengthening their immune systems and reducing their susceptibility to diseases, eventually reducing the mortality rate from diseases such as ARIs (Al-Sharbatti & AlJumaa, 2012; Hajeebhoy, Nguyen, Mannava, Nguyen, & Tran Mai, 2014). Evidence from several researchers including the WHO has concluded that mortality from infectious diseases such as ARIs can be prevented by optimal breastfeeding (Al-Sharbatti & AlJumaa, 2012; Hill, Kirkwood, & Edmond, 2004). Furthermore, a systematic review done in developing countries reported that children inadequately breastfed had an 80% risk of dying from pneumonia relative to properly breastfed children (Sonego, Pellegrin, Becker, & Lazzerini, 2015).

2.22.2 Breastfeeding and child morbidity related ARI

Consistent evidence from the literature documents that breastfeeding improves the survival of children. A cross-sectional study conducted in India revealed that children who were not fed the first milk from their mothers (colostrum) had three times higher odds of getting sick and dying compared to those fed with colostrum (Jatrana, 2005). The findings from this Indian study were aligned to a secondary analysis of the 2003 multiple indicator cluster survey in Indonesia that determined that exclusively breastfed children were less likely to have ARIs, AOR 0.69 (95% CI: 0.54-0.88), compared to those who were not exclusively breastfed, even after controlling for other demographic factors (Mihrshahi et al., 2007). A cross-sectional study conducted in Bangladesh also revealed that children who were not exclusively breastfed or practiced mixed feeding had higher odds of dying due to ARIs compared to those who were exclusively breastfed (Arifeen et al., 2001). These results from the literature are not surprising since so much evidence has been accumulated in so many countries on the protective effects of breast milk.

2.23. Maternal Level Factors

2.23.1 Mother's education

2.23.1.1 Mother's education and child mortality due to ARI

The positive association between maternal education and child health has been documented and backed by theory (Badji, 2016; Caldwell, 1979). Sharing the same argument as Caldwell (1979) and Badji (2016) is Buor (2003) citing the theoretical basis of the significant association between maternal education and children's survival. Lack of education has promulgated stereotypes about health and decisions to seek medical care in developing countries (Buor, 2003). A cross-sectional study done in Bangladesh demonstrated that education had a positive effect on the risk reduction of mortality among children with ARIs (Azad & Rahman, 2009). Even though most of the studies reviewed were cross-sectional, they consistently revealed that maternal education was significantly associated with mortality from ARIs.

2.23.1.2 Mother's education and child morbidity due to ARI

Evidence from the literature has long established the relationship between maternal education and childhood survival (Azad & Rahman, 2009; You et al., 2015). Differences in mothers' years of schooling and severe acute respiratory infections in their children were tested among children aged 0-59 months in Bangladesh. The study found that children who were born to mothers with only a secondary education were 79% more likely to have severe ARIs compared to children born to mothers with secondary and higher levels of education (Azad & Rahman, 2009). A prospective study conducted in Turkey found that children born to mothers who had five years or less of schooling had a 35% risk of having ARIs compared to those with mothers who had more than five years of schooling (Etiler, Velipasaoglu, & Aktekin, 2002)

2.24 Household Level Factors

2.24.1 Household wealth

2.24.1.1 Household wealth index and child mortality from ARI

Household socio-economic factors have been cited as critical in explaining the variations in children's growth and development. The wealth index is an indicator that depicts position and class in society (Morris, Carletto, Hoddinott, & Christiaensen, 2000). However, the measurement of the household wealth index has been used in developing countries due to inadequate data on socio-economic position and class compared to developed countries (Morris et al., 2000). This does not mean that the household wealth index is not important for informing health status, but rather that its complexity must be considered when analysing it.

The health status of individuals, including children, can be explained by analysing the differentials associated with their socio-economic status (Vyas & Kumaranayake, 2006).

Economically disadvantaged households present a breeding environment for morbidity and mortality from communicable diseases such as ARIs (Bhujabal, 2015). A cross-sectional study conducted in Kenya showed that children from poor households were 82% more likely to experience mortality from ARIs compared to children from rich households (Kittur, 2014). This might be due to poor living conditions in their households that increased their risk of infections like ARIs because of poor health care.

2.24.1.2 Household wealth index and child morbidity from ARI

ARIs have been cited to be the leading causes of death in poor and economically disadvantaged communities. ARI is characterised as a disease of poverty since it is more prevalent in economically disadvantaged communities. In Brazil, it was noted that children residing in households with high socio-economic status were less likely to experience ARIs compared those residing in households with a poor socio-economic status (Thorn, Minamisava, Nouer, Ribeiro, & Andrade, 2011). In a multivariate analysis of secondary data in Rwanda, it was reported that children who resided in households with a poor socio-economic status were 27% more likely to have ARIs compared to households with a better socio-economic status (Harerimana et al., 2016). Such findings were in agreement with the existing literature because of poorer home environments predisposed children to illnesses. Poor economic conditions and environments thus presented hazards to health as the poor people residing in these conditions couldn’t afford proper health care and often presented with poor health (Ujunwa & Ezeonu, 2014).

2.25 Source of Cooking Fuel

2.25.1 Source of cooking fuel and child mortality from ARI

Energy is a key requirement for human survival and health, and the global agenda on SDGs also emphasised the importance of energy (UNDP, 2017). In Africa, most rural households use fire from solid biomass fuels, mainly wood, charcoal, dung and crop remains for cooking and heating (Bruce, Perez-Padilla, & Rachel Albalak, 2000; Taylor & Nakai 2012). In theory about the sources of cooking materials, households have been classified as using traditional and/or modern sources of cooking materials (Sepp, 2014). In developing countries, the cooking materials used are traditional and strongly associated with accessibility in the household, the community and affordability. Many households use fuels such as wood and cow dung because these are their main sources of energy and it is within their culture to use these even when they know the health implications associated with these types of fuels (Sepp, 2014; UNICEF, 2016; World Health Organisation, 2005).

In 2012, it was estimated that four million people died due to polluted air in their households (Balakrishnan et al., 2013; Bruce et al., 2015). Research has shown that the type of cooking material used is associated with childhood acute respiratory infection. A cross-sectional study conducted in Nigeria reported that 0.8%, 43% and 36% of neonatal, post neonatal and children's mortalities respectively were attributed to solid fuels (Ezeh, Agho, Dibley, Hall, & Page, 2014). The concern about indoor air pollution due to poor sources of cooking material was the fact that it directly resulted in ARIs (National Bureau of Statistics (NBS), 2011).

Under-five mortality from acute respiratory infections caused mainly by the burning of poor sources of cooking materials is aggravated by the fact that children are carried on their mothers' backs when they do household chores, especially in developing countries (Isara & Aigbokhaode, 2014). This is prevalent in Africa and children breathe gases and aerosols while their mothers are preparing food for their households (World Health Organisation, 2006). A cross-sectional study conducted in Bangladesh showed that households, where cooking was done inside the house, had a 25% higher risk of experiencing neonatal mortality, and an 18% higher risk for infant mortality due to ARIs (Khan, Nurs, Islam, Islam, & Rahman, 2017).

2.25.2 Source of cooking fuel and child morbidity from ARI

Developing countries have a high incidence and prevalence of ARIs due to the predominant use of biomass fuels such as wood, coal, cow dung and crop residuals (Schirnding et al., 2000). A cross-sectional study conducted in Ethiopia reported that children residing in households which used biomass fuels were two times more likely to have ARIs compared to those in households which used cleaner fuels (Sanbata, Asfaw, & Kumie, 2014). The risk of having ARIs among children from households which used biomass fuels was also reported to be two times higher relative to households which used a cleaner fuel in Nigeria by (Adesanya & Chiao, 2016).

2.26. Community Level Factors

Epidemiological studies have often focused on the individual and household level factors to explain disparities in health, often overlooking the importance of community or neighbourhood factors. Research should understand the reciprocal relationship between people and space and reject the incorrect practice of conceiving context and individuals as being independent

(Cummins, Curtis, Diez-Roux, & Sally Macintyred, 2007). Similarly, Adesanya and Chiao (2017) there is an association between the different levels of factors that influence the symptoms of ARIs at the individual, household, social, biological and environmental levels. Research highlights the challenge of differentiating the community effects and household resources on health; however, health and the place where people reside are significantly correlated. The importance of community-focused research should unravel and close the gap that exists in understanding the relationship between health and community level factors.

2.26.1 Area of Residence

2.26.1.1 Area of residence and child mortality from ARI

In the health discourse, evidence has been found in several studies that the area of residence is positively associated with health outcomes (Bernarda et al., 2007; Macintyre, Ellaway, & Cummins, 2002). The health status of children has remained poor due to a lack of optimal service provision in rural areas (Wuraola, 2016). In Nigeria, a cross-sectional study found that child mortality varied by ethnic groups, and children born to women in rural areas were more likely to die compared to those born in urban areas (Adedini, Odimegwu, Imasiku, & Ononokpono, 2015). The number of cases of children suffering from ARIs tended to increase in rural areas, which in turn translated to high mortality rates in rural areas compared to urban areas (Kimani-Murage et al., 2014). A cross-sectional study conducted in India found that the prevalence of ARIs was approximately 60% in rural areas while in urban areas; it was 64% (Kumar et al., 2015). Another study documented in Kenya detailed that children who resided in slums were found to have a higher mortality rate compared to children residing in non-slum areas (Montgomery, 2009).

2.26.1.2 Area of residence and child morbidity from ARI

Health outcomes vary according to the health status of the environment where people live (Bernarda et al., 2007). These authors assert that the differences in health status among people who reside in different areas should be explained from a compositional and contextual approach. People who share identical characteristics, such as education level and socio-economic status tend to reside in one geographical area, and this is observed in most communities (Bernarda et al., 2007). The pertinent question that remains to be answered is if the grouping of the individuals is haphazard or if it can be explained using theories. Besides group characteristics, other factors such as air quality in the environment also play a part in determining where people reside and impact on the community's health (Bernarda et al., 2007; Macintyre et al., 2002). (Macintyre et al., 2002) add that the community effects on health outcomes have not been adequately studied. A cross-sectional study conducted in Rwanda reported that after controlling for confounders such as demographic factors, children who stayed in urban areas were less likely to have ARIs, AOR 0.58 (95% CI: 0.38,0.88), compared to those staying in rural areas.

2.27 Immunisation

2.27.1 Immunisation and child mortality from ARI

Immunisation plays a critical role in preventing diseases and hence reduces the morbidity and mortality from preventable diseases such as ARIs. The transmission and severity of ARIs had consistently remained high due to a lack of vaccinations, limited laboratory diagnoses and ineffective drug use for controlling ARIs. A study conducted by (Madhi, Levine, Hajjeh, Mansoorc, & Cheriand, 2008) found that vaccines against ARIs have been found to reduce the risk of mortality. The effectiveness of vaccines such as Bacillle Calmetter Guerin (BCG) also been reported by (Cooper, Boyce, Wright, & Griffin, 2003) to prevent unnecessary mortality against diseases such as measles. However, the concern with studies analysing the effects of vaccines on reducing child mortality from diseases is the fact that their methodologies were not carefully analysed (Cooper et al., 2003).

Haemophilus Type B and pneumococcal conjugate vaccines (PCV) were reported to reduce the number of lives lost to pneumonia among under-fives (Gessner, Sutanto, & Linehan, 2005). However, it was noted that in several countries, the efficacy of PCV had not been validated. The WHO noted that the incidence and mortality of children due to ARIs, was high in Sub Saharan Africa and Asia, with approximately four million children dying each year (WHO, 2002). In a clinical trial conducted in Gambia, PCV conferred a 7% reduction in the episodes of pneumonia during the first week (Cutts et al., 2005). However, 100 children died a week after receiving the intervention from severe adverse events thus the children involved in the trial who received the PCV had an increased risk of mortality from ARIs compared to the children in the placebo group (Cutts et al., 2005).

2.27.2 Immunisation and child morbidity from ARI

According to (Matu, 2015), poor vaccination of children is associated with acute respiratory infections. A clinical trial conducted in India reported that children who received the pneumococcal conjugate vaccine had a 10% lower prevalence of ARIs approximately 27 months after their vaccination compared to children from the communities regarded as controls (Matu, 2015; Millar et al., 2006). The WHO has developed a global vaccine plan for 2012 to 2020 to help scale up immunisations and reduce child morbidity (World Health Organisation, 2014). Therefore, the global agenda has tried to increase the immunisation programmes, mainly in developing countries, as a means to reduce child morbidity (Brenzel, Wolfson, Fox-Rushby, Vaccine-preventable diseases. In: Jamison, & Brenan, 2006).

2.28 Conclusion

The chapter aimed to mine the evidence documented from several studies to understand what was already known about the risk factors and transmission dynamics of childhood diarrhoea and ARIs. The chapter revealed the gap in the literature in the understanding of the factors that influenced the health of children. Public health studies and interventions that focused only on individual risk factors were limited in their understanding of health, as individual factors alone could not adequately explain the variations that occurred in health dynamics (De Wet, 2013). The gap identified in the literature had to be addressed by incorporating community level factors to understand the dynamics of health at a macro level. For this reason, this study aimed to understand the effects of micro and macro-level factors on childhood diarrhoea holistically. Individual-level and household level factors had been associated with childhood diarrhoea; however, there was a limited understanding of the importance of community level factors in morbidity and mortality due to this condition.

The inclusion of a dynamic approach to studying health pathways, in which multiple causal factors outside the biological and individual-level factors were assessed, allowed for an informed understanding of the complex interactions of the factors. The application of multilevel modelling has been cited in the literature to be the most preferred method for studying hierarchical data. The section on diarrhoea, however, adopted a funnel approach to build the literature and better understand the subject even though some factors had limited information in the existing literature.

A funnel approach to the systematic analysis of the literature allowed for a better understanding of the studies previously conducted on the subjects of both diarrhoea and ARIs. The theoretical framework provided by You et al. (2015) guided what factors had to be investigated and researched in relation to childhood ARIs. Several studies have been conducted to document evidence of the risk factors for ARIs, such as child level, maternal level, household level and community-level factors (Ezeh et al., 2014; Thorn et al., 2011; Ujunwa & Ezeonu, 2014). It remained evident from the discussion of the literature that few studies had adopted a multilevel methodology for the analysis of acute respiratory infections. It is inappropriate to analyse hierarchical data using single-level methods, according to several scholars (Bellan et al., 2012; De Wet, 2013). Bellan et al. (2012) assert that studies that only study hierarchical data using individual-level factors are limited in their understanding of the dynamics and transmission of infections and lack any theoretical contribution concerning community-level factors in this regard.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter provides the details of the study design, sampling, study population, sample size calculation, methods of data collection, description of the outcome, explanatory variables, and an outline of the procedures used for data management and analysis.

3.2 Study Design and Sampling Procedures

The study used a secondary data analysis approach utilising data from the 2010 and 2014 Multiple Indicator Cluster Surveys (MICS) that were cross-sectional. Cross-sectional studies have typically been used to establish the prevalence, or level of a particular outcome or disease at one point in time (Levin, 2006). The MICS are nationally representative household surveys designed to provide estimates for a large number of indicators of the situation of children and women at national/area/sub-population level, in urban and rural areas, and all four regions in Eswatini. The four regions in Swaziland are Hhohho, Manzini, Shiselweni and Lubombo.

The Eswatini MICS applied a two-staged sampling methodology (Eswatini Central Statistical Office & UNICEF, 2011). The urban and rural areas within each region were identified as the main sampling strata, and the sample was selected in two stages. The first stage was the sampling of representative enumeration areas (EAs) by the Eswatini Central Statistics Office (CSO) (Eswatini Central Statistical Office and UNICEF, 2011). The Eswatini CSO demarcated each enumeration area in the 2007 national census (Eswatini Central Statistical Office and UNICEF, 2011). After a household listing was carried out within the selected EAs, a systematic sampling method was used at the second stage within each EA to select 15 households (Eswatini Central Statistical Office and UNICEF, 2011).

To solicit information on the children aged less than five years in each household, all women with children aged less than five years or caregivers who looked after children aged less than five years were interviewed. A 95.2% response rate was achieved in the 2014 survey, while a response rate of over 95% was achieved in the survey carried out in 2010 (Eswatini Central Statistical Office & UNICEF, 2011).

3.3 Study Population

The study utilised children aged below five years as the unit of analysis for both the pooled 2010 and 2014 surveys. The child questionnaire was administered to women/caregivers aged 15-49 years. The household module, women's module and children's module were merged from each of the surveys conducted in 2010 and 2014 to enable the analysis of the children's health at the household, maternal and child levels. The two surveys were further pooled together using the append command in STATA 13.

3.4 Sample Size

In the 2010 dataset, 5475 households were selected for the survey, but only 4834 completed the survey. A total of 4956 women aged between 15-49 years were eligible for the survey in 2010; 4688 completed the survey, and there was a total of 2647 children aged under five years.

In the 2014 survey, out of the 5214 households selected, only 4865 completed the survey. A total of 5001 women aged between 15-49 years were eligible for the survey in 2014, but only 4762 opted to complete the survey. The 2010 and 2014 MICS household, women and children's modules were first merged independently and then later pooled together. Data pooling is essentially important because a pooled analysis allows for the modelling of the exposure, confounding, and outcome variables, the choice of which variables to control for, and the type of analysis conducted can be standardised, thereby removing potential sources of heterogeneity across studies (Solomon & Abulie, 2018). Furthermore, data pooling provides larger sample sizes, hence providing the feasibility to examine uncommon exposures, rare diseases, and variation in associations among population subgroups with greater statistical power than is possible in individual studies (Solomon & Abulie, 2018). Several Epidemiological studies have implanted the approach of data pooling (Bosetti et al., 2001; Pereira et al., 2004). For the pooled 2010 and 2014 datasets, the women aged between 15-49 years had a total number of 5340 children under the age of five years. Therefore, the overall sample size for the study was 5340 children aged under five years. Several studies that used a secondary analysis to study the risk factors for diarrhoea or acute respiratory infections used the entire sample of children, similar to this study's approach (De Wet, 2013; Geberetsadik, Worku, & Berhane, 2015; Ogbo, Agho, Ogeleka, Woolfenden, Page, Eastwood, & Global Child Health Research Interest Group, 2017; Siziya et al., 2009).

3.4.1 Post hoc power analysis

In the research discourse, it has been widely established that numerous researchers, primarily in the health and social sciences discipline, conduct studies which do not have enough study power to establish an effect (Lenth, 2007). Study power refers to the probability that a significant association exists when it truly exists or the probability of failing to reject the null hypothesis when in fact the effect is not different from zero (Hedges & Rhoads, 2010). A post hoc power calculation is recognised in the literature as important as it allows a researcher to ascertain if their study can achieve 80% power at a 95% confidence interval, to detect a significant association between the explanatory variables and the outcome variables when it truly exists, basically avoiding a type 11 error (Park, 2004). (Lenth, 2007) explains that there is a great need for a researcher to conduct a retrospective power analysis (post hoc power analysis) so that they may explain the inference of their study with confidence. According to (Suresh & Chandrashekara, 2012) a post hoc power analysis is crucial to ensure that when there are results that are not statistically significant, it is because there is no relationship between the variables and not because of a lack of power by the study to detect the difference. A retrospective power analysis was, therefore conducted on this study using the epi info software.

Table 3. 1: Posthoc sample size calculation for diarrhoea and acute respiratory infection from the pooled 2010 and 2014 Multiple Indicator Cluster surveys

Assumptions: a) 95% confidence level, b) All children under five years selected in each household in the national survey from 362 enumeration areas. c) The total sample size for the pooled analyses when only one child selected per household = 5340 d) Desired precision +/- 0.05 (5%).

Pooled analysis for MICS 2010 and 2014					
95% Confidence limit of diarrhoea and acute respiratory prevalence estimates					
Diarrhoea prevalence rate (%)	Calculated minimum sample required	Cases of diarrhoea identified in the dataset	Acute respiratory infection prevalence (%)	Calculated minimum sample required	Cases of ARI identified in the dataset
16.18	362	864	20.92	724	1117

Source: Author’s calculation

Out of the total sample of 5340 children aged under five years from the pooled analysis, there were 864 (16.18%) reported to have suffered from diarrhoea in the last two weeks before the survey while 1117 (20.92%) were reported to have suffered from an ARI. The results above revealed that the study had enough power to detect a significant difference between the outcome (diarrhoea and ARIs) and the explanatory variables when it truly existed.

3.5 Data Collection

The datasets were requested from the MICS dataset website *http://mics.unicef.org/visitors/sign-in*. MICS consisted of four questionnaires used to collect the data: household questionnaires, questionnaires regarding the children under five years of age, and women's and men's questionnaires (Eswatini Central Statistical Office and UNICEF, 2011). The data for the children aged less than five years was obtained from their mothers or caregivers using the questionnaire regarding the children under five years. Therefore, the study utilised the data collected through the questionnaires for children aged under five as a unit of analysis.

3.6 Definition of the Study Variables

3.6.1 Outcome variables

The study used two outcome variables, diarrhoea and acute respiratory infections, to measure the morbidity among children aged less than five years. The two outcome variables were defined as binary or dichotomous and coded (1) if the child had had the illness and (0 if the child had not had the illness. The two childhood illnesses were investigated using the following questions:

Diarrhoea: In the last two weeks had (Benamer et al.) had diarrhoea?

Yes =1 No=0

Acute respiratory infection (ARI): At any time in the last two weeks, has (Benamer et al.) had an illness with a cough? When (Benamer et al.) had an illness with a cough, did he/she breathe faster than usual with short, rapid breaths or have difficulty breathing? Children who had had an illness with a cough and had breathing difficulties were coded as having an ARI (1) and those who had neither of the symptoms, or only one symptom were was coded as not having an ARI (0).

3.6.2 Explanatory variables

The study included:

- Individual-level variables of the children (age of the child, sex of the child, child birth size, breastfeeding status during the time of the survey, current weight for age of the child, given vitamin A), and maternal level variables (maternal age, maternal education, parity, marital status).
- Household-level variables (household wealth index, source of drinking water, location of drinking water, action taken to make drinking water safe, toilet facilities, shared toilet with neighbours, water available for hand washing, the availability of soap to wash hands in the household, household source of fuel for cooking, household floor material, household child stool disposal practices and the number of people sleeping together in a room.
- Community-level factors (area of residence, region of residence, community poverty, the proportion of women with at least a secondary education in the community, the proportion of households with access to piped water, the proportion of households with access to electricity, the overall community diarrhoea, the overall community ARIs, the

proportion of households with improved toilets in the community, and the proportion of households that practiced safe disposal of child stools).

The community level factors were aggregated from the individual, maternal, and household level variables. The aggregation of the individual-level variables was done by cluster to produce the community's level of interest; guided by the literature and categorised as Low (1), Medium (2), or High (3) (Adedini, Odimegwu, Imasiku, & Ononokpono, 2015; De Wet, 2013; O'Campo et al., 2015).

3.6.3 Diarrhoea individual-level factors

The table below presents the important variables that were informed by the literature and had a possible association with diarrhoea.

Age in months of the child was categorised as <6 months, 6-11 months, 12-23 months, 24-35 months, 36-47 months and >=48 months. (Adedini, 2013).

The birth size was based on the mother's assessment at birth and was calculated by following the literature and categorised as very small/small (1), average (2), and larger than average (3) (Adedini, 2013; Geberetsadik et al., 2015).

Height for age (stunted) was categorised as deficit (-2SD) (1), normal (-2SD to 2SD) (2), and above normal (>2SD) (3) (Adesanya, Darboe, Rojas, Abiodun, & Beogo, 2017; Temsutola & Varte, 2012).

Maternal education was categorised as none (0), primary (1), secondary (3), higher (4), and tertiary (Adedini, 2013; Mekonnen, Lerebo, Gebrehiwo, & Abadura, 2015).

The mothers' age was categorised as <25(1), 25-34 (2), and as 34 and above (3), (Adedokun, Adekanmbi, Uthman, & Lilford, 2017; Alam, Bhuia, Lovely, Hossain, & Das, 2013).

The variable parity was categorised as less than 3 (1), 3-4 children (2), and 5 and above (3) (Adedini, 2013).

Current breastfeeding status was categorised as currently breastfeeding (1), and not breastfeeding (2) (Vasconcelos, Rissin, Figueiroa, Lira, & Batista Filho, 2018). Table 3.2 table covers the definition and coding of the child and maternal level variables to be analysed in the study.

Table 3. 2: Definition and coding of the child and maternal level variables

Variables	**Definition**	**Coding**
Child age	Child's age in months	<6 months, 6-11 months, 12-23 months,24-35 months, 36-47 months and >=48 months
Child sex	Sex of the child	Male (1) female (2)
Child birth size	The size of the child at birth, as reported by the mother	Very small/smaller than average (1), average (2), very large /larger than average (3)
Child breastfeeding status	Current breastfeeding status of the child	Currently being breastfed (1), not breastfed (2)
Child height for age	The child's measured height for age at the time of the interview	Growth Deficit (-2SD) (1), normal (-2SD to 2SD) (2), above normal (>2SD) (3)
Maternal education	Level of education for the mother	None (0), primary (1), secondary (3), high school (4), tertiary (Docking et al.)
Maternal age	Age of the mother	Continuous variable 15-49 years
Parity	Children surviving per woman	Less than 3 (1), 3-4 children (2), 5 and above (3)
Marital status	Mothers' marital status	Married (1), formerly married (2), Never married (3)

3.6.4 Diarrhoea household-level factors

The household level variables that were documented and justified in the literature as being associated with childhood diarrhoea were also used in this study, and the definitions and coding of each of the variables are displayed below.

The household wealth index was categorised as poorest (1), poor (2), middle (3), richer (4), and richest (Docking et al.) (Eswatini Central Statistical Office and UNICEF, 2011; Kawakatsu et al., 2017).

The source of drinking water was categorised as piped (1), from a protected well (2), and an unprotected well/spring (3) (Siziya et al., 2009).

Action taken to make drinking water safe was categorised as yes (1), and no (2) (Oloruntomba, Folarin, & Ayede, 2014).

The toilet facilities were categorised as a flush toilet (1), pit latrine (2), and no facility, bush, or field (3) (Mbugua et al., 2014).

The question of whether or not the respondents shared a toilet with a neighbour was categorised as yes (1), no (2) (Alambo, 2015).

Water for hand washing was categorised as water available, with soap (1), and water not available (2) (Oloruntomba et al., 2014).

The disposal of children's stools was categorised as safe (1) and not safe (2) (Mihrete et al., 2014; Siziya et al., 2009).

The total number of children under five years of age were categorised as one (1), and two or more (2) (Alambo, 2015).

Table 3. 3: Definition and coding of the household level factors

Diarrhoea	**Definition**	**Coding**
Household wealth index	Household socio-economic status	Poorest (1), poor (2), middle (3), richer (4), richest (Docking et al.)
Source of drinking water	Main source of drinking water	Piped (1) Protected well (2) Unprotected well/spring (3)
Action taken to make drinking water safe	Treated water to make it safe for use	Yes (1), No (2)
Toilet facility	Type of toilet being used	Flush toilet (1) Pit latrine (2) No facility, bush, field(3)
Shared toilet with neighbours	Toilet facility shared with neighbours	Yes (1), No (2)
Water for hand washing	Water and soap available for hand washing in the household?	Water available with soap (1), water not available (2)
Disposal of children's stools	Disposal of children's stools	Safe (1), not safe(2)
Total number of children under 5 years of age	Number of children under 5 years of age in the household	0ne(1), 2 or more (2)

3.6.4.1 Construction of the household wealth index

A wealth index was created for this study even though one had already been constructed in the MICS datasets. The rationale for the construction of a new wealth index was to avoid multicollinearity between independently analysed variables such as household electricity and the type of floor materials used in the home, and the composite index; hence they were removed from the index.

A principal component analysis (PCA) method was used to construct the household wealth index. According to (Howe, Hargreaves, & Huttly, 2008), this method was widely used to assign the weight for each household score, and the scores were based on numerous variables that depicted the household's socio-economic position (Howe et al., 2008). In (Rutstein & Johnson, 2004) view, the algorithm used by the Demographic and Health index had to be used since it included a wider range of variables that defined the socio-economic status of the household. The PCA is a multivariate method that reduced the complexity of the data by stabling patterns and trends in the data, with no prior knowledge that acted as a reference if the data or the sample had some differences (Lever, Krzywinski, & Altman, 2017; Lolli & Girolamo, 2015).

The mathematical formula for the PCA was as follows:

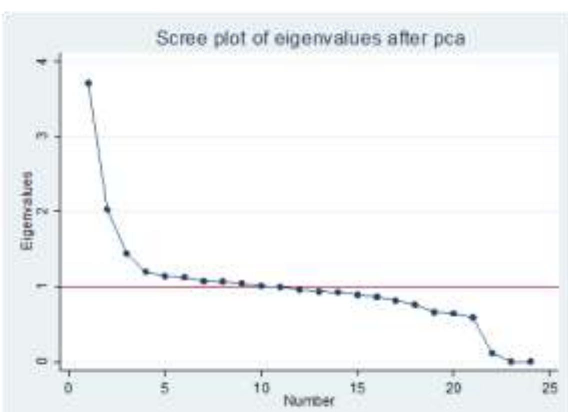
Principal component= $A * X$

The PCA represented the PC_i as a column vector that constituted the PC. The parameter A= $a_{i,j}$ represented a matrix for $a_{i,j}$ that showed the weights for the i^{th} component and j^{th} component. The parameter X= X_j showed the set of indicators.

3.6.4.2 Algorithm to create the wealth index

The following variables were used to create the wealth index: whether or not a household had a television (TV), a radio, a bicycle, a motorcycle or a scooter, a watch, an animal drawn cart, cattle, sheep, a bank account, and access to agricultural land. The study also assessed the main material used for the household's walls, floor and roof. These variables were recorded into binary variables (1=yes, 0=no). Some variables had multiple categories, for example, the type of roofing material had four categories, therefore for each category a binary variable was created such that there were four multiple binary variables for the roof material (Córdova, 2009). The PCA was run by including all the variables that determined the household's wealth. It is worth noting that that dataset was nationally representative; therefore, the household weight was included at the end of the command as [aweight=hhweight]. The product of the PCA was the eigenvalues with all the components and the proportions that were accounted for by each component in the model. About four of the variables for the MICS 2010 dataset (bank account, sheep, goats, asbestos/bamboo/mud wall) were dropped because they had zero variance. However, in the MICS 2014 data, the PCA model dropped three variables (walls built with mud, goats, sheep) since they had zero variance. Figure 3.1 and figure 3.2 show the eigenvalues for the MICS 2010 and 2014 wealth indexes, respectively. Figure 3.1 shows a total of 27 components. However, only 14 components had an eigenvalue above 1, which accounted for 62% of the variation of the components. The rest of the components have an eigenvalue below 1.

Figure 3. 1: Scree plot for the MICS 2010 eigenvalues of the wealth index



Source: Author's calculation

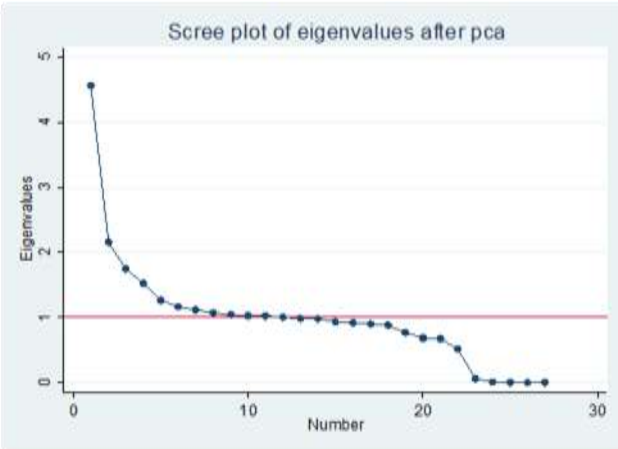


Figure 3.2: Scree plot for the MICS 2014 eigenvalues of the wealth index
Source: Author's calculation

Figure 3.2 shows the scree plot for the MICS 2014 eigenvalues. There were 25 components for the 2014 wealth index data. However, only 11 components have an eigenvalue above 1, and they cumulatively explain 69% of the variation. The distribution of the eigenvalues is very useful as the system uses these values to retain in the model if the value is greater than 1 (Rea & Rea, 2016). Eigenvalues measure the degree of variation of the data by providing a summary using ordination axes (Peres-Neto, Jackson, & Somers, 2003).

The second product of principal components was the eigenvectors. As seen in the figures below, 27 components were produced in the MICS 2010 analysis and 25 in MICS 2014 analysis. Among the loadings of the components, there were those with absolute eigenvalues of above and below 0.3; those below were omitted, and the model kept only those above 0.3.

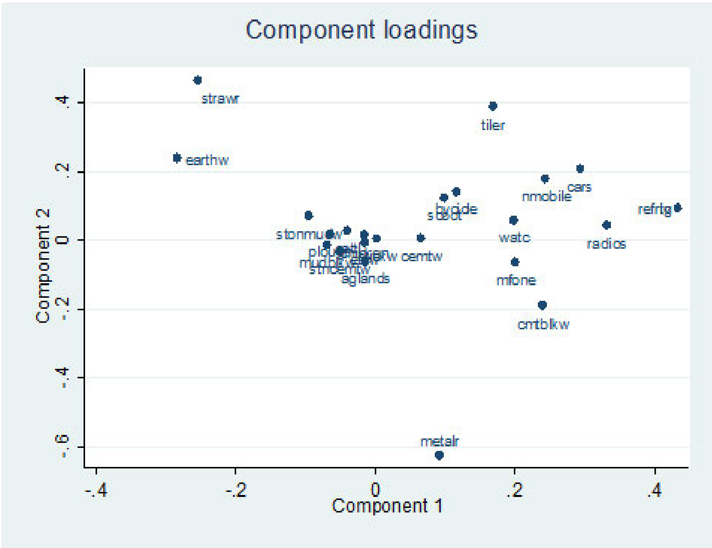


Figure 3.3: The MICS 2010 wealth index component

Source: Author's calculation

Figure 3.3 above shows the component loadings of the 27 components analysed in the MICS 2010 dataset for the wealth index. Most of the variables had high component loadings; examples of which were straw, dung floor, earth wall, tile floor and tile roof. However, several components had very low loadings of below 0, especially cement floor and metal roof with negative loadings below -4. In the 2014 MICS data loadings, a similar distribution of the loadings was observed with straw, dung floor, earth wall, and tile floor and tile roof. They once again had high component loadings.

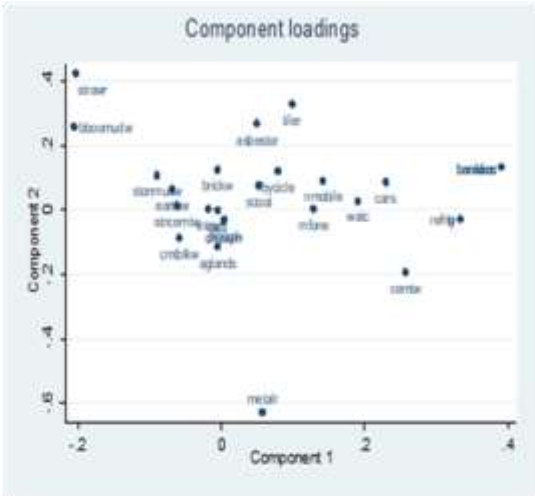


Figure 3.4: The MICS 2014 wealth index component loadings

Source: Author's calculation

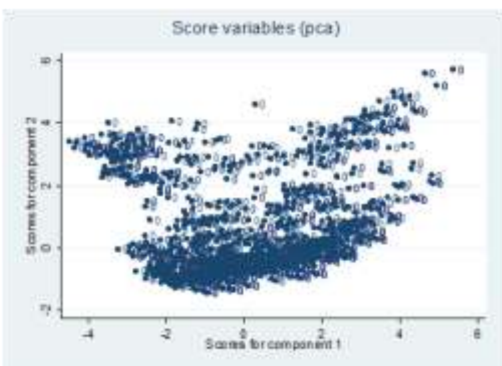


Figure 3.5: Score plots for the MICS 2010 analysis for the wealth index

Source: Author's calculation

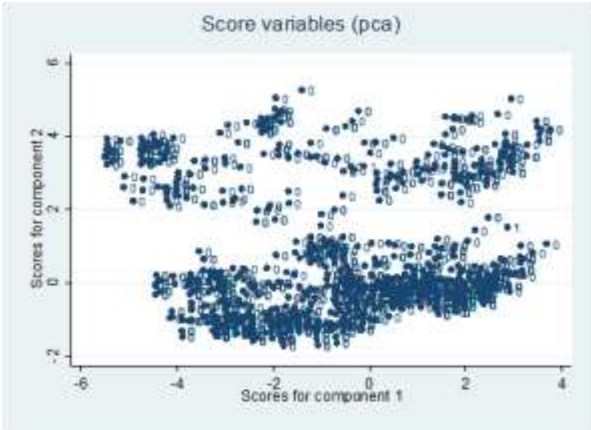


Figure 3.6: Score plots for the MICS 2014 analysis for the wealth index

Source: Author's calculation

Figures 3.5 and 3.6 above show the observations of the score plots for the component loadings on the two datasets. As shown in the figures, a significant number of the scores were between -4 and 2. However, some were outliers in both the 2010 and 2014 datasets with scores beyond 4.

The next step was to predict the wealth scores for all the components and create the five wealth quintiles from the programme. The wealth score quintiles were summed up for each of the five quintiles to determine the minimum and maximum values to be used as the cut-offs for creating the quintiles. However, before the quintile cut offs were done the variables used in the analysis were standardised by applying the mean and standard deviation from the survey for each variable, i.e. generated a new variable = (old variable–mean)/ standard deviation. The factor weights were then applied when calculating the wealth index scores to multiply the standardised variables by the factor weight. After the factor weights were assigned to each variable, a wealth score was assigned to each respondent in the household. This involved the scoring of the coefficients. The wealth quintiles were then developed to help create the cut-off point. Table 3.4 below shows the wealth index score ranges for both MICS 2010 and 2014.

Table 3. 4: MICS 2010 and 2014-wealth index cut-off range

MICS 2010 Wealth index range			MICS 2014 Wealth index range	
Quintile	WI score minimum	WI score maximum	WI score minimum	WI score maximum
Poorest	-6.723112	-1.527164	-5.513902	-2.418868
Poor	-1.514154	-.573018	-2.416896	-0.000207
Middle	-0.571214	0.6973317	0.0016206	1.414602
Rich	0.7035009	1.699867	1.417154	1.943405
Richest	1.700484	5.596185	1.952601	3.760742

Notes: WI=Wealth index

Source: Author's calculation

3.6.5 Diarrhoea Community-level factors

The literature was used to formulate and aggregate the community-level factors from the individual and household level factors, and Stata 13 was used to generate these variables. Several scholars stated that it was very critical to infer disease transmission to cover individual factors as well as those at the community level (Mekonnen et al., 2015). The study followed other studies to aggregate and categorise the variables. The community-level explanatory factors were aggregated from the individual and household level factors and categorised as Low, Medium, High based on the distribution of the proportion values calculated for each community cluster (Adedini, Odimegwu, Imasiku, & Ononokpono, 2015; De Wet, 2013; Ntenda & Chuang, 2018).

Table 3. 5: Definition and coding of the community level factors

Diarrhoea	Definition	Coding
Area of residence	Place of residence	Rural (1), Urban (2)
Region of residence	Administrative region	Hhohho (1), Manzini (2), Shiselweni (3), Lubombo (4)
Community poverty	Proportion of households in the poorest and poor quintiles	Low (1) Medium (2) High (3)
Maternal education level in the community	Proportion of women who had at least secondary level education in the community	Low (1) Medium (2) High (3)
Overall community diarrhoea	Proportion of diarrhoea reported in children under the age of five the community	Low (1) Medium (2) High (3)
Community safe drinking water	Proportion of households with piped water in the community	Low (1) Medium (2) High (3)
Community improved toilet facilities	Proportion of households with flush toilet facilities	Low (1) Medium (2) High (3)
Community safe disposal of children's stools	Proportion of households that practiced safe disposal of children's stools	Low (1) Medium (2) High (3)

36.5.1 Explanatory variables for acute respiratory infection

Literature reported that child, maternal, household and community level factors were very important in the explanation of the transmission dynamics of ARIs. The rationale for conducting studies, which incorporated community level inferences, was justified by Bellan et al. (2012).

3.6.5.2 ARI Individual-level factors

Table 3. 6: Definition and coding of ARI individual level factors

Variables	Definition	Coding
Child age	Child's age in months	0-11 months (1), 12-59 (2)
Child sex	Sex of the child	Male (1) female (2)
Child birth size	The size of the child at birth	Very small/smaller than average (1), Average (2), very large /larger than average (3)
Child breastfeeding status	Current breastfeeding status of the child	Currently being breastfed (1), Not breastfed (2)
Child height for age	The child's measured height for age at the time of the interview	Growth Deficit (1), normal (2), above normal (3)
Maternal education	Level of education for the mother	None (0), Primary (1), Secondary (3), High school (4), Tertiary (Docking et al.)
Maternal age	Age of the mother	Continuous variable 15-49 years
Parity	Children surviving per woman	Less than 3 (1), 3-4 children (2), 5 and above (3)
Marital status	Mothers' marital status	Married (1), formerly married (2), Never married (3)

3.6.5.3 ARI Household-level factors

At the household level, several selected factors were documented to be associated with ARIs (You et al., 2015). The factors included the household wealth index, the source of cooking material, the place where cooking was done, a place for hand washing, shared toilets with neighbours, floor materials, the number of children under five years of age in the household,

household electricity and the number of people sleeping in each room. The household factors are defined and coded in table 3.7 below.

Table 3. 7: Definition and coding of ARI household level factors

Variables	**Definition**	**Coding**
Household wealth index	Household socioeconomic status	Poorest (1), Poor (2), Middle (3), Richer (4), Richest (Docking et al.)
Source of cooking fuel	Source of cooking material used	Clean cooking fuel (1) Biomass cooking fuel (2)
Place where cooking was done	Location where cooking was done	In the living room house (1) Outside the living room (2)
Place for hand washing	Place of hand washing in the household	In the dwelling/yard/plot (1), Elsewhere (2),
Household electricity	Availability of electricity in the household	Yes (1), No(2)
Shared toilet with neighbours	Toilet shared with neighbours	Yes (1), No(2)
Number of people sleeping per room	Crowding index	One (1), two or more (2)
Number of children under 5 years	Children aged under 5 years in the household	One (1), two or more (2)

3.6.5.4 ARI Community-level factors

Several scholars stated that it was critical to infer disease transmission to cover the individual factors as well as the community level factors (Mekonnen et al., 2015). The study followed other studies to aggregate and categorised the variables (De Wet, 2013; Mekonnen et al., 2015). As suggested by the literature (Adedini, Odimegwu, Imasiku, & Ononokpono, 2015; De Wet, 2013;

Ntenda & Chuang, 2018), three quartiles (Low, Medium, High) were used to aggregate the variables from the individual and household variables into the community cluster.

Table 3. 8: Definition and coding of the ARI community level factors

Variables	Definition	Coding
Area of residence	Place of residence	Rural (1), Urban (2)
Region of residence	Administrative region	Hhohho (1), Manzini (2), Shiselweni (3), Lubombo (4)
Community poverty	Proportion of households in the poorest and poor quintiles	Low (1), Medium (2). High (3)
Maternal education level in the community	Proportion of women who had at least secondary level education in the community	Low (1), Medium (2), High (3)
Overall community ARIs	Reported ARI of children under five years	Low (1), Medium (2), High (3)
Community infrastructure-electricity	Percentage of households in the community who had access to electricity	Low (1), Medium (2), High (3)
Community fuel for cooking	Proportion of households in the community who used safe cooking fuel	Low (1), Medium (2), High (3)
Community location for cooking	Proportion of households in the community where cooking was done in a separate room or outside sleeping room	Low (1), Medium (2), High (3)
Community improved floor materials	Proportion of households with improved flooring in the community	Low (1), Medium (2), High (3)
Community number of people sleeping per room	Proportion of households in the community that had 2 or less people sleeping in the same room	Low (1), Medium (2), High (3)

3.7 Addressing the Study Research Question and Statistical Analysis

Data analysis was done using Stata 13 (Stata Corp, Texas). A standard bivariate and multivariate logistic regression model was used to understand the factors associated with diarrhoea and ARIs. A two-level, multilevel logistic regression was employed to measure the effect and extent of the variation of diarrhoea and ARI cases in the communities (Komarulzaman, Smits, & de Jong, 2014). The outcome variables (diarrhoea, ARIs) of the study were binary; hence multilevel logistic regression was the preferred model. Children under five years of age were influenced by maternal factors (level 2), connected to their households (level 3), and in turn, connected to their communities (level 4). Eventually, a final model (model 5) explained the individual, household and community level factors in one model (Komarulzaman et al., 2014).

3.8. Addressing Study Objectives

3.8.1 Objective one

What was the prevalence of childhood diarrhoea and ARIs? Descriptive statistics were generated to measure the prevalence or magnitude of diarrhoea and ARIs. The distribution of the variables was presented using frequencies and percentages.

3.8.2 Objective two

What were the individual, household and community level factors associated with childhood diarrhoea and ARIs? Bivariate statistics, which involved cross-tabulation between childhood diarrhoea and ARIs with some of the key individual, household and community-level factors was done using a chi-square test as appropriate to determine whether there was a 95% probability of a significant relationship.

The first stage was to fit a bivariate logistic model between each of the individual, household and community-level factors, then four models were fitted, which were the individual level, household level, and community-level factors, and a final model which was the combination of factors at the individual, household and community levels. Before the factors were entered into the multivariate models, a stepwise backward elimination regression was conducted and all the factors that had a $p < 0.20$ were included (Thompson, 1995). All statistics were interpreted at a 95% significance level.

Parameters for the multivariate logistic regression

The logistic regression model shares similar characteristics with the ordinary least squares regression model, except that it doesn't consider the assumptions of linearity, normality and heteroscedasticity of the covariates (Choi, 2013). The logistic regression function is presented by the notation $Z = \frac{1}{1+e^{-x}}$

The parameter z of the model stipulates that the range of z falls between zero (0) and one (1). The logistic regression model could be derived to represent a logistic function that presents the linear model developed from the logistic function by representing z as a linear square model, i.e. i represents parameters α and B_i as constants that are not known and an equation $z = \alpha + B_0 + B_1\ x_1, i + \ldots + B_{k-1}\, x_{k-1}, i.$

The two outcomes of the study (diarrhoea, ARIs) were binary coded as 1 or 0. The dichotomous variable was represented by parameter Y with a general logistic equation where

$\ln(P_i\ /1 - P_I) = \alpha + \beta_1 X_{1i} + B_2 X_{2i} + \ldots\ldots + \beta_k X_{Ki}$ $\ln(P_i\ /1 - P_I)$= represented the odds ratio

P_i =represented the probability of a child having diarrhoea or an ARI

X_{1i}, X_{2i}, X_{Ki} represented the study's explanatory variables

$\beta_k \ldots B_k$ = presented the gradient of the explanatory variables

3.8.3 Objective three

The third objective was to determine the extent to which community level factors explained regional variations in childhood diarrhoea and ARIs? For this level of analysis, a multilevel logistic regression was conducted that incorporated the random effects that measured variation and the fixed effects that measured the association between the factors.

3.8.4 Objective four

Which clusters or communities had a higher burden of childhood diarrhoea and ARIs? Spatial digital mapping of diarrhoea and acute respiratory infections was conducted. The analysis was made feasible because the MICS 2010 and 2014 sampling was based on the enumeration areas (clusters) and constituencies which allowed for the use of the sampling frame to relate the condition with the communities where they were rooted.

Model one: An empty model to produce the random variation of the intercept (random effects) and the intra class correlation coefficients.

Model two: The model included only individual level variables.

Model three: The model included household level factors.

Model four: The model consisted of community level factors.

Model five: The model consisted of individual, household and community-level variables in combination.

Model estimation parameters

The fixed effects were observed in the multilevel model and were essential for the estimation of the association between the diarrhoea and ARIs and the individual, household and community level factors. The statistics of the fixed effects model were expressed as Odds Ratios (OR) and 95% Confidence Intervals. The other measure referred to as the random effect, which measured the random variation of diarrhoea, and ARIs within communities was denoted as the intraclass correlation (Ostman-Smith et al.) and the proportion of change in the variance. The ICC was also the product of the model and was done to evaluate if the variation was within or across communities.

It remained critical to analyse the individual, household and community level variables using independent models to understand the level at which the factors were most likely to affect childhood diarrhoea and ARIs. The model proposed by You et al. (2015) provided an important basis for the analysis and approach of the methodology in which the factors were grouped into levels of proximate and intermediate factors. Adopting this approach in the analyses provided a rich and broad understanding of the extent to which individual, household and community-level factors were responsible for the occurrence of diarrhoea and ARIs while building a final model that could control for individual and household factors to test the relationship between community-level factors and the study outcomes.

Parameters of the multilevel logistic model

The Multiple Indicator Cluster surveys implemented a two-stage sampling procedure with several enumeration areas (EAs) chosen as clusters and were hence more appropriate to conduct multilevel models to account for clustering (Hox, 2002; Swaziland Central Statistical Office & UNICEF, 2011). The results of the model were presented in terms of Odds Ratios (OR) at a 95% Confidence Interval (95%CI). The parameters of the multilevel model were presented as follows:

$$ln\frac{P_{ijk}}{1-P_{ijk}}=\propto +x_{ijk}\beta + w_{ijk}\,\gamma + z_k n + u_{jk} + v_k$$

$ln\frac{P_{ijk}}{1-P_{ijk}}$ = was the logit in which p_{ijk} was the probability that the i^{th}child in the j^{th} family or household located in a $k^{th}the$ community had diarrhoea or acute respiratory infection. Parameters $x_{ijk}\beta,\ \ w_{ijk}$ and z_k were vectors of the individual (level 1), household/family (level 2) and community level factors or characteristics (level 3). The parameter $\propto$ was a constant while β, γ and n were vectors of estimated parameter coefficients; the household and family unexplained residual terms were represented by the parameters u_{jk} and v_k respectively.

3.9 Spatial Digital Mapping

A geographical information system was employed to present the spatial mapping of childhood morbidity due to diarrhoea and ARIs. The study combined the 2010 and 2014 MIC surveys. The surveys permitted the mapping analysis to understand the hotspots of child morbidity (Ettarh, 2011). The primary sampling units (PSU) were EAS, with 16 households systematically sampled under each EA with the name of the constituencies (Swaziland Central Statistical Office & UNICEF, 2011; Swaziland Central Statistics Office & Macro International Inc, 2008). The researcher merged the EA numbers and EA names to pool the data. A digital map can produce points, and polygons to produce a geographical mapping of the childhood diseases (Jensen, 1999), hence, ArcGIS was used to create a shape file for EAS and EAS names, to visualise the actual prevalence (hotspots) of child morbidity at the constituency and regional level (Fradelos et al., 2014).

3.10 Data Management

The data was requested from the MICS dataset website and was already removed of all information that could directly link it to the participants, such as names and contact details. The data was stored in a password-protected computer and encrypted. The EAS and patient datasets were stored separately from the rest of the dataset and only linked during the analysis. Only the study investigator and another authorised researcher, the project supervisor, had access to the dataset, and it was not used for any purpose except the purpose for which it was requested.

3.11 Ethical Considerations

All research studies dealing with human subjects must consider issues of Good Clinical Practice (GCP). GCP is defined as the international scientific set of standards that must be considered from the development of the protocol, research design, data collection and management, analysis and publication (World Health Organisation, 2005). The following was considered in this study:

3.11.1 Ethical issues

The study protocol was presented for technical review at a PhD workshop at the University of KwaZulu-Natal, organised by the School of Built Environment and Development Studies. The protocol was further submitted to the University of KwaZulu-Natal Higher Degrees Research

Review Board and the Eswatini National Health Research Review Board (NHRRB) for review of the science and ethical considerations and was approved by both ethics boards.

3.11.2 Informed consent

The study requested a waiver of the informed consent from the ethics committees since it was a secondary analysis. No consent was sought from participants since there was no direct contact with the participants. Instead, the study used data already collected from MICS 2010 and 2014 surveys. The study was thus classified to be of minimal risk and approved without the informed consent requirements.

3.11.3 Privacy and confidentiality

The lead investigators received training on procedures to protect participants' confidentiality and Good Clinical Practices (GCP). The datasets received were ready for use, with all patient protected health information (PHI) such as participants' identifiers, such as names or phone numbers, already removed. This information had been removed by the Eswatini Central Statistics Office and was stored separately from the entire dataset. The dataset was secured on a computer with password protection to prevent unnecessary interference. No identifiable participants' information will appear on any publication or reports.

3.11.4 Potential benefits and risks

The study was a secondary analysis; therefore, there were no direct benefits to the participants of the study. However, the results of the study will inform future planning and programming on childhood diarrhoea and ARIs. This study presented minimal risks because there was no direct contact with the participants.

3.12 Dissemination of Findings

Results from the study were disseminated to different stakeholders at the university, the health sector, including the Eswatini Ministry of Health and other partners, including the relevant technical working groups and at conferences. Furthermore, manuscripts were prepared and disseminated for publication in various journals.

3.13 Validity, Reliability and Rigour

The study adopted a positivist paradigm to investigate the factors associated with childhood morbidity and to generalise the results since it used a nationally representative survey (Swaziland Central Statistical Office & UNICEF, 2011). Reliability entails the ability of the study to be able to produce or show similar findings over time (replicability of the study at different time points) (Golafshani, 2003). The concept of validity refers to the ability of the study to measure what it was designed to measure and produce, accurate or meaningful results (Golafshani, 2003). The study conducted a post hoc power analysis to confirm if the sample size of children aged under five years was adequate to produce a significant difference when it truly existed (minimise type 11 error) (VanVoorhis & Morgan, 2007). The study sample size was deemed adequate for the analysis; 5340 children aged under five years were used for the pooled analysis and were hence more likely to represent the entire population of children from which the sample was drawn (VanVoorhis & Morgan, 2007). It applied advanced statistical methods and multilevel regression models which took into account the hierarchy or clustering of the national surveys (Khan & Shaw 2011; Sayed Saad, 2008).

3.14 Anticipated Problems/Limitations

The MICS were not conducted solely to collect data to answer the research questions of this study on child morbidity; therefore, some important variables, such as HIV testing were not captured. This study was conducted based on secondary analysis, which meant the researcher could only work with the variables that were included during the primary data collection (Boslaugh, 2007).

Although the sample size of children in this study was large (5340 for the pooled analysis), any missing data on key variables could potentially be a problem (Golafshani, 2003). Self-reporting could have biased the validity of the study, and studies have found that self-reporting accrued from the level of understanding of the questions (comprehension). Recall bias could also have arisen from participants' memory lapses and several cognitive factors (Brener, Billy, & Grady, 2003).

CHAPTER FOUR

CHARACTERISTICS OF THE STUDY SAMPLE

4.1 Introduction

The chapter presents the data analysis and interpretation of the findings. The variables were presented in a univariate analysis to understand their distribution. The findings of the univariate analysis were presented in three levels, the individual, and household and community level.

4.2 Individual-level variables

The individual level variables considered under the study include child and maternal variables. According to the framework developed by You et al., (2015) factors that influence child morbidity are at the individual, household and community level. Therefore, the section presents the sample distribution to understand the data.

The sample was relatively equally distributed across the age categories. When combining under 6 months and those 6-11 months, 20% of the children were under 1 year. There were an almost equal proportion of females and males in the sample (50.4% females' vs. 49.6% males). Based on the response from the mother or caregivers on child birth size, almost one third (31.4%) of the children were very large or larger than average, half of the children (50.1%) were rated average while almost one fifth (18.5%) were rated smaller than average or very small. Just over one quarter (26.3%) of the children was still being breastfed during the time of the survey.

Only a small proportion of the children had a growth deficit (1.2%), 86.5% were normal, and 12.3% were above normal at the time of the survey. About two thirds (62.8%) of the children were given vitamin A.

Almost two fifths (38.5%), of the children, were born to mothers aged 35 years and above and just more than one third (34.6%) were born to mothers aged 25-34 years while over one quarter (26.8%) of the mothers were aged less than 25 years. Only a small percentage (6.1%) of the children was born to mothers who had tertiary education. Almost a quarter (22.3%) of the children was born to mothers with no formal education. More than one third (36.4%) of the children were born to mothers who had five or more children ever born, and 38.9% were born to mothers who had less than two children ever born. Almost half (49.3%) of the children had mothers who were married, while a quarter (26.8%) had mothers who were not married and the remainder (7.1%) had mothers who were formerly married.

Table 4. 1: Distribution of the individual level variables

Child factors	**N=5340**	
Variable	**Frequency**	**Percent**
Age in months		
<6months	504	9.4
6-11 months	507	9.5
12-23 months	1055	19.8
24-35 months	1108	20.8
36-47 months	1096	20.5
48-59 months	1070	20.0
Sex		
Male	2649	49.6
Female	2691	50.4
Birth size at birth		
Very large /larger than average	771	31.4
Average	1229	50.1
Smaller than average /very small	454	18.5
Nutritional status		
Growth deficit	66	1.2
Normal	4619	86.5
Above normal	655	12.3
Child given vitamin A		
Yes	1605	62.8

Child factors	N=5340	
Variable	**Frequency**	**Percent**
No	949	37.2
Current breastfeeding status		
Breastfeeding	626	26.3
Not breastfeeding	1759	73.8
Maternal level factors		
Maternal age		
Less than 25	1433	26.8
25-34	1849	34.6
35 and above	2058	38.5
Maternal education		
None	1193	22.3
Primary	1318	24.6
Secondary	1487	27.9
High school	1018	19.1
Tertiary	324	6.1
Parity		
Less than 3	2078	38.9
3-4 children	1319	24.7
Marital status		
Married	2635	49.3
Formerly married	378	7.1
Never married	1433	26.8
Missing	894	16.7

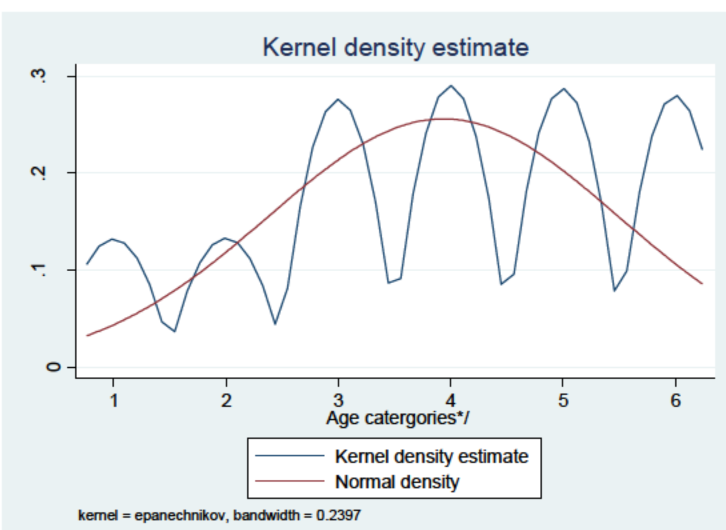


Figure 4. 1: A kernel density plot for the distribution of child age

Source: Plotted by the Author

Figure 4.1 above shows the univariate distribution of the child age. The figure shows that child age was normally distributed as most of the ages of the children were distributed around the mean as shown by the fluctuations around the normal curve.

4.3 Household-level factors

According to the literature, household-level variables are very important to explain the health dynamics of the population. The analyses of the household factors was guided by the conceptual framework (You et al., 2015).

Table 4.2 below present the distribution of the sample by the main variables at the household level. The results revealed that 20.0% of the children were from the poorest and poor households and a quarter (25.0%) from the richest households. Although 57.2% of the children were from households that had access to piped water, 7.0% were resident in households that obtained drinking water from a protected well, and more than one third (35.9%) of the children were resident in households obtaining drinking water from an unprotected well or river. The majority (90.0%) of the children were resident in households did not take any precautions to make water safe for drinking.

Concerning toilet facility, a significant number of the children, 70.8% were from households that used a pit latrine while 16.9% were resident in households with no toilet facility at all. Only a small proportion of the children were from households with flush toilets (12.3%). Over one third (34.3%) of the children were from households that shared their toilets with neighbours.

Similarly**,** 92.1% of the children were from households that had water for hand washing with soap.

Just over half (55.1%) of the children were resident in households that had no access to electricity, and 55.1% of the children lived in households that used electricity for cooking. However, more than two fifths (44.9%) of the children were resident in households that used biomass fuels for cooking. Most of the children (91.5%) were from households with improved floor material while a small proportion (8.5%) with the resident in households with a poor floor.

The findings also revealed that half (56.3%) of the children were from households that had less than three people that sleep per room, while 7.8% of the children were from households that had 5 and above people sleeping per room. With regard to child stool disposal, 81.4% of the children were from households that disposed of child stools safely. More than half (54.2%) of the children were from households where there were two or more children under five years.

Table 4. 2: **Distribution of the household level variables (n=5340)**

Variable	N	Percept
Household wealth index		
Poorest	1064	20.0
Second	1085	20.4
Middle	832	15.6
Fourth	1007	18.9
Richest	1330	25.0
Source of drinking water		
Piped	3053	57.2
Protected well	371	7.0
Unprotected well/River	1916	35.9
Actions to make drinking water safe		
Yes	533	10.0
No	4807	90.0
Toilet facility		

Variable	N	Percept
Flush toilet	658	12.3
Pit latrine	3779	70.8
No facility, Bush, Field	903	16.9
Shared toilet with neighbours		
Yes	1521	34.3
No	2920	65.8
Water for hand washing		
Available with soap	1741	92.1
Available with no soap	150	8.0
Household electricity		
Yes	2398	45
No	2942	55.1
Household fuel for cooking		
Electricity	2942	55.1
Biomass	2398	44.9
Household floor material		
Improved floor	4884	91.5
Poor floor	456	8.5
Number of people sleeping per room		
<3	3004	56.3
3-4	1921	36.0
>=5	415	7.8
Child stool disposal		
Safe	4346	81.4
Not safe	994	18.6
Number of under 5 children in the household		
One	2447	45.8
Two or more	2893	54.2

4.4 Community-level factors

Table 4.3 indicates the sample distribution by the community level factors. The analyses by area of residence showed that 79.4% of the children were from rural areas. Findings on the region of residence showed that the sample of children was equally distributed across the regions. For the Hhohho region, there were 22.9%, Lubombo, 23.2%. A majority of the children resided in the Shiselweni and Manzini regions, 28.3% and 25.5% respectively.

An examination of the community poverty revealed that there was no significant variation between the poverty level among the communities. More than one third (34.5%) of the children were from communities with a low proportion of mothers with at least secondary education, while 33.0% and 32.5% were from communities with a medium and high proportion mothers respectively with at least secondary education. The proportions of communities that have access to piped water were also analysed, as shown in table 4.3. It is worth to note that a majority 34.5% of the children were from communities with low access to piped water, while 33% were from communities with a high proportion with access to piped water.

Table 4.3 further showed the distribution of the study sample by proportion with access to electricity in the community. The results showed no variation in access to electricity at the community level. Considering the overall community diarrhoea, the findings revealed that a majority of the children, 33.3% were from communities where the overall community diarrhoea was high, and 34.2% were from communities where the overall community diarrhoea was low while 32.5% was from communities where the proportion of diarrhoea was medium. Worth to note was that a majority (56.4%) of the children were from communities with a low proportion of improved toilets while 10.4% were from communities where the proportion of improved toilets was low, and 33.2% were from communities where the proportion of improved toilets was high. There was an equal proportion, 33% of the children from communities that used improved fuel for cooking. Just below half,45.3% of the children were from communities with a low proportion of households with poor floor material whereas 22% were from communities with a medium proportion of households with poor floor material and a third (32.3) of the children were from communities with a high proportion of households with poor floor

Considering the overall community ARI, it was found that a majority of the children (34.9%) were from communities with a low overall community ARI, while 33.3% were from communities with a high overall community ARI. A third (34.3%) of the children were from communities with a low proportion of households that have 2 or less people sleeping per room**.** About 34.1% of the children were from communities where the practice of safe child disposal was low and 33.2% from communities where it was high.

Table 4. 3: **Distribution of the community level variables (n=5340)**

Variable	N	**Percent**
Area of residence		
Urban	1098	20.6
Rural	4242	79.4
Region of residence		
Hhohho	1222	22.9
Manzini	1364	25.5
Shiselweni	1523	28.3
Lubombo	1241	23.2
Community Poverty		
Low	1787	33.5
Meddle	1813	34.0
High	1740	32.6
Proportion of mothers with at least secondary level education in the community		
Low	1840	34.5
Medium	1764	33.0
High	1736	32.5
Proportion with access to piped water in the community		
Low	1842	34.5
Medium	1735	32.5
High	1763	33.0
Proportion of households with electricity in the community		
Low	1807	33.8
Medium	1771	33.2

Variable	N	Percent
High	1762	33.0
Proportion of diarrhoea in the community		
Low	1825	34.2
Medium	1736	32.5
High	1779	33.3
Proportion of households with Improved toilets in the Community		
Low	3014	56.4
Medium	554	10.4
High	1772	33.2
Proportion with improved fuel for cooking in the community		
Low	1805	33.8
Medium	1767	33.1
High	1768	33.1
Proportion of household with poor floor material in the community		
Low	2420	45.3
Medium	1172	22.0
High	1748	32.3
Overall community ARI		
Low	1863	34.9
Medium	1698	31.8
High	1779	33.3
Proportion of households that practised safe disposal of child stools in the community		
Low	1784	34.1
Medium	1778	33.0
High	1778	32.9
Proportion of households that have 2 or less people sleeping per room in the community		
Low	1833	34.3
Medium	1732	32.4
High	1775	33.2

4.5 Summary of the sample distribution

In summary, the findings revealed that the distribution of males and female children was almost equal in the sample. There was a large proportion of the children aged 24-35 months, 36-47 months and 48-59 months, 20.8%, 20.5%, and 20% respectively. The study revealed that a third of the children had a birth size larger than average. The relationship between child birth size and morbidity was long established in the literature (Hughes et al., 2017; Huong, 2014; West et al., 2018). Children of low birth size were most likely to be infected with diseases compared to those of average birth size (Hughes et al., 2017; West et al., 2018). The analyses of the sample by children currently being breastfed at the time of the survey revealed that generally slightly over a quarter of the children were being breastfed. The importance of breastfeeding cannot be overemphasised, as stated in the literature, that it strengthens the immune system and also protect children again infections (Victora et al., 2016).

With regard to maternal age, the study revealed that a majority of the children were born to mothers aged 35 years and above. A consideration of the children by their mother's education level revealed that almost a quarter of the children were born to mothers with at least a secondary education level. A majority of the children were born to women with less than 3 children.

The profile of the household wealth index revealed that the sample of the study had a similar distribution of the children between the poorest and poor households. More than half of the children were from households with access to piped water. About 10% of the children were from households where effort was made to make water safe for drinking.

It is worth to note that a majority of the children were from households that utilised pit latrines, with only 12.3% of households with flush toilets. Almost a third of the children were from households that shared toilets with neighbours. A majority of the children were from households that used biomass as a source of fuel for cooking.

With regard to community level factors, a majority of the children were from rural areas. The results are not surprising as more than 70% of the population in Eswatini reside in rural areas. Region of residence was also analysed and showed an almost equal distribution of the children across the four regions of Eswatini. However, the Shiselweni region had a slightly higher proportion of children followed by the Manzini region. A consideration of the community poverty revealed that there was an equal distribution of poverty across all the communities. When considering the level of maternal education in the community, it was found that a majority of the children were from communities where the proportion of mothers with at least secondary education was low. This is one of the key indicators that the country endeavours to improve as part of the SDGs (UNDP, 2017). When observing access to community electricity, it is evident from the results that the children were from communities that had an equal distribution of access to electricity.

It is worth to note that access to pipe water was found to be one of the key factors for child survival. The study found that a majority of the children were from communities where the proportion of access to piped water was low. Furthermore, the analysis also considered the proportion of diarrhoea at a community level. The findings revealed that most of the children were from communities with a low prevalence of diarrhoea. Similarly, for community ARI, more than half of the children were from communities with a low prevalence of ARI. There was an equal distribution (33%) of the children that resided in communities with a low, medium and high proportion of households that used improved fuel for cooking. The findings revealed that a majority (45.3%) of the children were from communities with a low proportion of households of poor floor material, while a third (32.3%) of the children were from communities with a high proportion of households with poor floor material.

CHAPTER FIVE

PREVALENCE OF DIARRHOEA, AND CROSS TABULATION OF CHILD DIARRHOEA

5.1 Introduction

The chapter presents the prevalence of diarrhoea in Eswatini. A graph with the estimates is presented in the chapter. The associations of the individual, household and community level factors on child diarrhoea were investigated.

5.2 Prevalence of childhood diarrhoea

The prevalence of reported childhood diarrhoea in the past two weeks before the survey was 16.2%, (95% CI: 15.2-17.2). Figure 5.1 below shows the graphical presentation of the prevalence of diarrhoea.

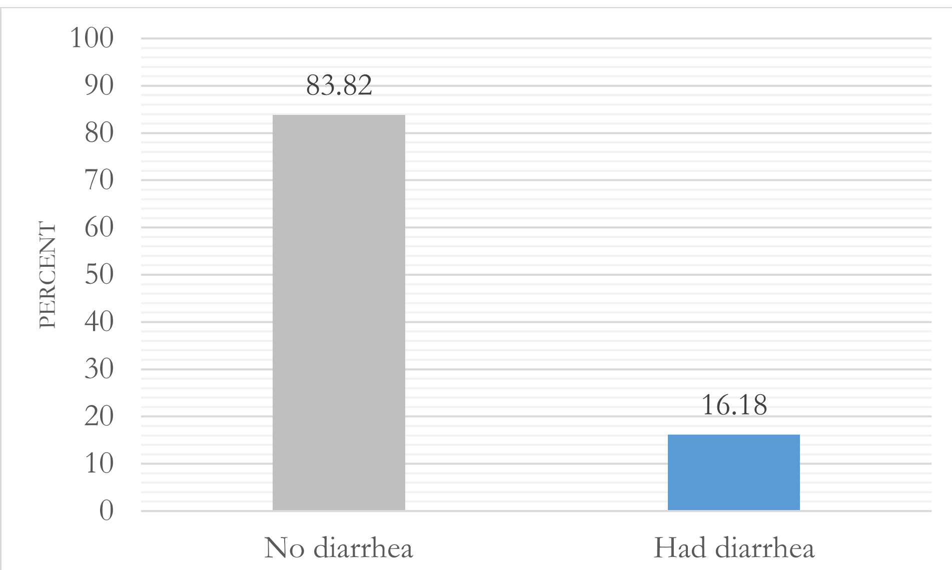


Figure 5.1: Child diarrhoea prevalence

Source: Plotted by Author

5.3 The bivariate analyses between individual level factors and childhood diarrhoea

The explanatory variables were analysed to ascertain their relationship to childhood diarrhoea. With regard to the child age, the analysis showed that diarrhoea was significantly associated with the age of the child ($p<0.001$). Three in ten (30.4%) of the children aged 6-11 months had diarrhoea, one quarter (25.3%) of those 12-23 months had diarrhoea, while those aged 36-47 months and 48-59 months had lower proportions of reported diarrhoea, 9.9% and 6.9% respectively.

An analysis of child current height for age showed a significant difference, ($p<0.001$). A higher proportion (27.9%) of children with a growth deficit had diarrhoea, while 16.2% and 14.3% of those who had a normal and above normal height for age respectively were reported to have had diarrhoea. The findings also showed a significant association between child diarrhoea and vitamin A ($p=0.002$). Almost one fifth (17.9%) of the children who were given vitamin A were also reported to have had diarrhoea while 13.4% of the children who had not received vitamin A were reported to have had diarrhoea.

Results from table 5.1 also revealed that reported diarrhoea among children was significantly different by current breastfeeding status ($p<0.001$). A quarter (25.0%) of the children who were reported not being breastfed during the time of the survey were reported to have had diarrhoea while 12.8% of the children who were being breastfed during the time of the survey were reported to have had diarrhoea.

A significant difference in the prevalence of diarrhoea was observed by maternal age (p<0.001). Children born to mothers aged less than 25 years had a higher proportion of diarrhoea (20.6%), while those born to mothers aged 20-34 years had 15.0% and 14.0% for those born to mothers aged 35 years and above.

An analysis of the bivariate relationship between child diarrhoea and maternal education showed that there was a significant relationship between child diarrhoea and maternal education (p=0.001). Children born to mothers with primary education had a significantly higher proportion of diarrhoea (18.1%). Surprisingly, children born to mothers with no education and tertiary education had an almost equivalent proportion of diarrhoea (13.6% and 12.0% respectively). The results may be due to the small sample size in the tertiary and no education categories, as observed through the 95% confidence intervals were wide.

Table 5. 1: Bivariate analysis between child diarrhoea and individual level variables

Variables	**Prevalence %**	**95% CI**	**P-value (X^2)**
Child Age			
<6months	16.6	12.3-22.2	<0.001 (240.05)
6-11 months	30.4	26.2-35.0	
12-23 months	25.3	22.6-28.2	
24-35 months	15.5	13.3-17.9	
36-47 months	9.9	8.0-12.0	
48-59 months	6.9	5.5-8.6	
Gender			0.917(0.01)
Male	16.8	15.2-18.6	
Female	15.5	14.1-17.0	
Birth size at birth			0.220 (1.51)
Very large /larger than average	22.3	18.5-26.7	
Average	21.3	18.6-24.1	
Smaller than average /very small	18.3	15.6-21.4	
Height for age (stunted)			<0.001(17.62)
Growth Deficit	27.9	18.2-40.2	
Normal	16.2	15.1-17.4	

Variables	Prevalence %	95% CI	P-value (X^2)
Above normal	14.3	10.7-18.7	
Given Vitamin A			0.002(9.33)
Yes	17.9	16.1-19.8	
No	13.4	11.3-15.6	
Current breastfeeding status			<0.001(52.42)
Breastfeeding	12.8	11.2-14.5	
Not breastfeeding	25.0	21.6-28.7	
Maternal level factors			
Maternal age			<0.001(28.07)
Less than 25 years	20.6	18.2-23.3	
25-34 years	15.0	13.3-16.8	
35 years and above	14.0	12.4-15.7	
Maternal education			0.001(18.89)
None	13.6	11.7-15.8	
Primary	18.1	16.0-20.4	
Secondary	17.4	15.2-20.0	
High school	15.8	13.5-18.4	
Tertiary	12.0	8.4-17.0	
Parity			0.077 (2.57)
Less than 3	17.6	15.7-19.7	
3-4 children	15.6	13.6-17.8	
5 and above	14.8	13.2-16.6	
Marital status			0.168(3.57)
Married	15.4	14.0-17.0	
Formerly married	20.1	14.6-27.1	
Never married	18.1	16.0-20.4	

5.4 Bivariate relationship between household level characteristics and child diarrhoea

The findings on the relationship between child diarrhoea and household characteristics were presented in table 5.2. The results showed that there was a significant relationship between diarrhoea and type of toilet facility in the household, (p<0.001). Children from households with no toilet or households that used a pit latrine had a higher proportion of children with diarrhoea, 18.6% and 16.5% respectively, while those from households with a flush toilet had a lower proportion of diarrhoea (11.2%).

There was a significant relationship between child diarrhoea and disposal of child stool, (p<0.001). About 23.2% of the children from households where child stools were not disposed safely had reported diarrhoea, while only 14.5% of children resident in households where child stools were disposed safely had reported diarrhoea.

Table 5. 2: Bivariate analyses between child diarrhoea and household level variables

Variables	**Prevalence**		**P-value**
	%	**95%CI**	**(X^2)**
Household wealth index			0.141 (6.90)
Poorest	17.1	14.9-19.6	
Second	14.8	12.7-17.2	
Middle	18.7	15.9-21.8	
fourth	16.0	13.3-19.2	
Richest	14.7	12.7-17.0	
Source of drinking water			0.162(3.64)
Piped	15.5	14.1-17.1	
Protected water	17.1	13.6-21.4	
Unprotected well/River	17	15.3-18.8	
Water for hand washing			0.999(0.00)
Available with soap	15.6	13.9-17.6	
Available with no soap	14.6	9.7-21.2	
Household electricity			0.062(3.49)
Yes	15.3	13.6-17.1	
No	16.8	15.5-18.3	
Actions to make drinking water safe			0.370(0.80)
Yes	15.3	12.3-18.9	
No	16.2	15.1-17.4	
Toilet facility			<0.001(15.88)
Flush toilet	11.2	8.6-14.3	
Pit latrine	16.5	15.2-17.9	
No facility, Bush, Field	18.6	16.0-21.5	
Shared toilet with neighbours			0.529(0.40)
Yes	15.9	13.7-18.3	
No	15.5	14.2-17.0	
Disposal of child stools			<0.001(34.11)
Safe	14.5	13.4-15.7	
Not safe	23.2	20.0-26.7	
Number of under 5 children in the household			0.995(0.00)
One	16.6	14.9-18.5	
Two or more	15.7	14.3-17.1	

5.5 The bivariate analyses between child diarrhoea and community level factors

Table 5.3 presents the result of the relationship between community level factors and child diarrhoea. There was a significant association between the overall community diarrhoea and child diarrhoea (p<0.001). Communities with a higher overall reported prevalence of diarrhoea in under-fives had a higher proportion of children with diarrhoea (27.9%) while those with medium and low overall community diarrhoea had 15.6% and 5.4% respectively.

Table 5. 3: **A bivariate analysis between child diarrhoea and community-level variables**

Variables	**Diarrhoea Prevalence**		**P-value**
	%	**95% CI**	(X^2)
Area of residence			0.126(2.34)
Rural	16.5	15.3-17.7	
Urban	14.8	12.1-18.0	
Region of residence			0.106(6.11)
Hhohho	14.6	12.6-16.9	
Manzini	16.1	14.0-18.6	
Shiselweni	17	15.2-19.1	
Lubombo	16.8	14.7-19.2	
Community Poverty			0.835(0.36)
Low	16.6	14.5-18.8	
Medium	16.6	14.9-18.5	
High	15.1	13.4-16.9	
Proportion of mothers with lower than secondary education level in the community			0.672(0.39)
Low	16.4	14.4-18.7	
Medium	15.4	13.7-17.3	
High	16.5	14.8-18.5	
Proportion of households with access to piped water in the community			0.213(3.10)
Low	17.1	15.4-19.0	
Medium	15.7	13.5-17.7	
High	15.5	13.5-17.7	
Overall community diarrhoea			<0.001(276.27)
Low	5.4	4.0-6.6	
Medium	15.6	13.7-17.5	
High	27.9	25.5-30.4	
Proportion of households that practised safe disposal of child stools in the community			0.794(0.46)
Low	16.4	14.3-18.6	
Medium	15.6	13.9-17.5	
High	16.4	14.7-18.3	

Variables	Diarrhoea Prevalence		P-value
	%	95% CI	(X^2)
Proportion of households with Improved toilets in the Community			0.174(3.50)
Low	16.7	15.4-18.2	
Medium	14.6	11.6-18.1	
High	15.7	13.7-18.0	

5.6 Summary of the bivariate analysis

The results showed that the prevalence of diarrhoea was generally higher for children aged 6-11 months. Current breastfeeding status was found to be associated with childhood diarrhoea. The maternal education level was also found to be an important variable for child diarrhoea. Maternal age was found to be associated with child diarrhoea. Children born to mothers aged 35 years and above had a lower proportion of diarrhoea.

Concerning household-level variables, type of toilet facility was found to be associated with diarrhoea. Children born to households with pit latrine and with no toilet facility had a significantly high proportion of diarrhoea relative to those with flush toilets. Child stool disposal was found to be associated with child diarrhoea. Children from households with safe child stool disposal had a lower proportion of diarrhoea compared to a child from households where child stool was not safely disposed of. At the community level, the overall community of diarrhoea played a critical role in explaining child diarrhoea.

5.7 Determinants of child diarrhoea in Eswatini: A single-level logistic regression

The section aimed to answer objective number 2 of the study: to investigate the individual, household and community level factors associated with childhood diarrhoea. To achieve the objective, a single level binary logistic regression was employed to determine the factors associated with childhood diarrhoea.

5.8 The bivariate and multivariate results of individual factors and childhood diarrhoea

The results of model 1 on the individual and maternal level variables were presented in table 5.4 below. The results of the bivariate analysis (unadjusted Odds ratio), which doesn't control for confounding variables revealed that the age of the child was associated with childhood diarrhoea.

Children aged 6-11 months were 119% more likely to have diarrhoea reported compared to children under 6 months. Similarly, children aged 12-23 months were 70% more likely to have had diarrhoea compared to children aged less than 6 months. Children aged 36-47 and above 48 months were 45% and 63% respectively less likely to have had diarrhoea compared to children aged less than 6 months.

Children born to mothers aged 25-34 years and 35 years and above were 32% and 37% less likely to have had diarrhoea compared to children aged less than 25 years. Children who were breastfeeding during the time of the survey were 128% more likely to have diarrhoea compared to those that were not breastfeeding at the time of the survey. As the children grow older, they develop immunity; hence breastfeeding status might be confounding with age of the child. Parity was also found to be a critical factor for child diarrhoea in Model I. Children born to women with a parity of five and above children were 19% less likely to have had diarrhoea compared to children born to mothers with parity of less than three children. Children born to mothers who were never married were 21% more likely to have had diarhoea, compared to children born to married women. Gender of the child and child birth size were not associated with diarrhoea in the crude model.

The result in table 5.4 further showed the results of an adjusted model. Child age was found to be statistically significant to child diarrhoea even after controlling for other individual level factors. Children aged 6-11 months were 207% more likely to have had diarrhoea compared to children aged less than 6 months. Similarly, children aged 12-23 months were 70% percent more likely to have diarrhoea relative to those aged less than 6 months. The results showed that children aged 48 months and above were 63% less likely to have had diarrhoea compared to those aged less than 6 months

Children birth size, height for age, given vitamin A; current breastfeeding status, maternal age, parity and marital status were not statistically significant in the individual multivariate model. The findings of the goodness of fit for the model showed statistically insignificant results p=0.628 at p<0.05, revealing that the model fitted the data well.

Table 5. 4: Bivariate and Multivariate for individual level variables and child diarrhoea

Variables	**Crude Odds ratio**		**Adjusted Odds ratio**	
	OR	**95% CI**	**AOR**	**95%CI**
Child Age (months)				
<6	1		1	
6-11	2.19	1.45-3.31*	3.07	1.84-5.11*
12-23	1.7	1.15-2.50*	3.02	1.76-5.18*
24-35	0.92	0.62-1.36	1.35	0.72-2.54
36-47	0.55	0.36-0.83*	0.77	0.39-1.56
>=48	0.37	0.24-0.57*	0.57	0.28-1.15
Sex				
Male	1		-	-
Female	0.91	0.77-1.07	-	-
Birth size at birth				

Variables	Crude Odds ratio		Adjusted Odds ratio	
	OR	**95% CI**	**AOR**	**95%CI**
Smaller than average /very small average	1.29	0.95-1.75	-	-
Average	1.21	0.94-1.57	-	-
Very large /larger than	1		-	-
Height for age (stunted)				
Deficit	0.39	0.23-0.65*	0.76	0.26-2.22
Normal	1		1	
Above normal	0.31	0.18-0.55*	0.72	0.23-2.18
Given Vitamin A				
Yes	1		1	
No	0.7	0.56-0.88*	0.72	0.24-2.18
Current breastfeeding status				
Breastfeeding	2.28	1.80-2.89*	1.36	0.94-1.98
Not breastfeeding	1		1	
Maternal age				
Less than 25	1		1	
25-34 years	0.68	0.55-0.83*	0.82	0.58-1.14
35 years and above	0.63	0.51-0.77*	0.7	0.43-1.13
Maternal education				
None	1		1	
Primary	1.4	1.11-1.76*	1.2	0.71-2.03
Secondary	1.34	1.05-1.71*	0.97	0.57-1.65
High school	1.19	0.93-1.54	1.04	0.59-1.82
Tertiary	0.87	0.56-1.34	0.83	0.37-1.84
Parity				
Less than 3	1		1	
3-4 children	0.86	0.70-1.07	1.24	0.88-1.74
5 and above	0.81	0.67-0.98*	1.47	0.95-2.28
Marital status				
Married	1		1	
Formerly married	1.39	0.93-2.07	0.86	0.52-1.43
Never married	1.21	1.01-1.46*	0.98	0.72-1.33

OR: Odds ratio**, AOR:** adjusted odds ratio, *significant at p<0.05

5.9 The bivariate and multivariate results of household-level variables and child diarrhoea

Table 5.5 displays the results of Model I (bivariate) and model II (multivariate model) on the household level variables. A consideration of the bivariate model showed that at the household level, type of toilet facility and child stool disposal in the household were the important factors that explain the risk of childhood diarrhoea. Children from households that had a pit latrine were 57% more likely to have diarrhoea compared to children from households that used a flush toilet.

In the same vein, children from households that had no toilet facility used the bush or field were 82% more likely to have diarrhoea, compared to children from households that used flush toilets.

With regard to child disposal of stools and the risk of diarrhoea in the bivariate model, children from households that did not dispose child stools in a safe manner were 77% more likely to have diarrhoea, relative to children from households that disposed child stools safely. The household wealth index, source of drinking water in the household, water available for hand washing, toilet shared with neighbours and household floor material were not associated with diarrhoea in the bivariate model.

The analysis of the association of household level variables and child diarrhoea was further conducted at the multivariate level (Model II). The findings showed that even after controlling for confounding factors, type of toilet facility in the household, and child stool disposal remained significantly associated with child diarrhoea. Children born to households with a pit latrine were 103% more likely to have diarrhoea, compared to children from households with a flush toilet. Similarly, children from households with no toilet facility or used a bush or field were 132% more likely to have diarrhoea, compared to children from households with a flush toilet. Children from households where child stools were not disposed safely were 92% more likely to have diarrhoea compared to children from households where child stools were disposed safely. Similar to model I, household wealth index, source of drinking water, and water for hand washing were not statistically significant to diarrhoea in the multivariate model (model II). Finally, the findings of the goodness of fit for the model showed statistically insignificant results $p=0.597$ at $p<0.05$, revealing that the model fitted the data well.

Table 5. 5: Bivariate and multivariate analysis for household level variables

Variables	Crude Odds ratio		Adjusted Odds ratio	
	OR	**95%CI**	**AOR**	**95%CI**
Household wealth index				
Poorest	1		1	
Poor	0.84	0.66-1.07	1.02	0.65-1.62
Middle	1.11	0.86-1.43	1.15	0.69-1.81
Rich	0.92	0.70-1.22	0.97	0.59-1.61
Richest	0.83	0.66-1.06	1	0.60-1.66
Source of drinking water				
Piped	1		1	
Protected water	1.21	0.92-1.58	1.14	0.66-1.97
Unprotected well/spring	1.09	0.84-1.40	0.83	0.59-1.16
Water for hand washing				
Available with soap	1.09	0.67-1.76	1.12	0.66-1.97
Available with no soap	1		1	
Water treated in the household				
Yes	1		1	
No	1.07	0.82-1.40	1.02	0.65-1.62
Household electricity				
Yes	1		1	
No	1.13	0.95-1.33	0.86	0.61-1.23
Toilet facility				
Flush toilet	1		1	
Pit latrine	1.57	1.16-2.12*	2.03	1.40-2.94*
No facility, Bush, Field	1.82	1.30-2.55*	2.32	1.33-4.07*
Household shared with neighbours				
Yes	1		-	
No	0.97	0.79-1.19	-	
Child stool disposal				
Safe	1		1	
Not Safe	1.77	1.44-2.18*	1.92	1.41-2.60*
Number of under 5 children in the household				
One	1.07	0.91-1.27	1	
Two or more	1		1.05	0.81-1.36

Notes: OR: Odds ratio, AOR: adjusted odds ratio, *significant at p<0.05

5.10 Relationship between community level variables and child diarrhoea

At the community level, only the overall community diarrhoea was found to be associated with the risk of diarrhoea. In the bivariate model, children from communities with medium overall community diarrhoea were 226% more likely to have had diarrhoea compared to those from communities with low overall community diarrhoea. Children resident in communities with high overall community diarrhoea were 583% more likely to have diarrhoea compared to those from communities with low overall community diarrhoea. Region of residence, community poverty, proportion of households with access to piped water in the community, proportion of mothers with at least secondary level education in the community, proportion of households that practiced safe disposal of child stools in the community, and proportion of households with improved toilets in the community were not significantly associated with child diarrhoea in the bivariate model.

In the multivariate model, the findings showed that only the overall community diarrhoea was associated with child diarrhoea. Children from communities with medium overall community diarrhoea were 234% more likely to have diarrhoea, compared to children from households with low overall community diarrhoea. Children from communities with high overall community diarrhoea were 600% more likely to have diarrhoea, compared to children from households with low overall community diarrhoea. The rest of the community factors were not significant in the multivariate l model. The model was further tested through Hosmer-Lemeshow goodness-of-fit to test if the model fits the data well and the results were insignificant p=0.992, revealing that the model fitted the data well.

Table 5. 6: **Bivariate and multivariate analysis for community level factors and child diarrhoea**

Variables	**Crude Model**		**Adjusted model**	
	OR	**95%CI**	**AOR**	**95%CI**
Area of residence				
Rural	1.13	0.88-1.45	1.05	0.79-1.38
Urban	1		1	
Region of residence				
Hhohho	0.85	0.67-1.07	0.96	0.74-1.24

Variables	Crude Model		Adjusted model	
	OR	95%CI	AOR	95%CI
Manzini	0.95	0.75-1.20	0.98	0.76-1.26
Shiselweni	1.02	0.82-1.25	0.86	0.68-1.08
Lubombo	1		1	
Community Poverty				
Low	1		1	
Medium	0.9	0.75-1.09	0.95	0.76-1.17
High	0.89	0.72-1.09	1.02	0.79-1.31
Proportion of mothers with less than secondary level education in the community				
Low	1		1	
Medium	0.94	0.78-1.13	1.05	0.86-1.30
High	0.97	0.79-1.20	1.14	0.89-1.46
Proportion with access to piped water in the community				
Low	1		1	
Medium	0.98	0.81-1.18	1.04	0.85-1.28
High	0.98	0.80-1.20	1.03	0.82-1.28
Proportion of households with Improved toilets in the Community				
Low	1		1	
Medium	0.85	0.64-1.12	0.92	0.68-1.25
High	0.93	0.77-1.12	0.9	0.70-1.15
Overall community diarrhoea				
Low	1		1	
Medium	3.26	2.50-4.26	3.34	2.80-4.62*
High	6.83	5.37-8.84	7	5.39-9.07*
Proportion of households that practiced safe disposal of child stools in the community				
Low	1		1	
Medium	0.95	0.77-1.17	0.97	0.77-1.20
High	1	0.82-1.23	0.95	0.76-1.18

Notes: OR: Odds ratio, AOR: adjusted odds ratio, *significant at $p<0.05$

5.11 Relationship between individual, household and community level variables and child diarrhoea

The final multivariate model was fitted to determine the individual, household and community level factors that are associated with childhood diarrhoea. The findings revealed that when individual, household and community-level variables were included in one model, child age, maternal education, type of toilet, child stool disposal, and proportion of diarrhoea in the community were significantly associated with child diarrhoea. Children aged 6-11 months were 162% more likely to have had diarrhoea, compared to children aged less than 6 months. Similarly, children aged 12-23 months were 105% more likely to have had diarrhoea compared to children aged under 6 months. Children from households with no toilet or used the bush were 118% more likely to have had diarrhoea compared to those from households with a flush toilet. Children from households where child stool disposal was not disposed safely were 40% more likely to have had diarrhoea compared to children from households where child stool was disposed safely.

A consideration of community-level variables showed that children from communities with medium and high overall community diarrhoea were 208% and 662% more likely to have had diarrhoea compared to those with low overall community diarrhoea. There was no statistical significance between the other community-level variables, as observed in table 5.7. The multivariate model was further tested using the Hosmer-Lemeshow goodness-of-fit test to ascertain if the model fits the data well. The result of the model showed that the model was not significant at p= 0.856, implying that it fits the data well.

Table 5. 7: Multivariate analysis for individual, household and community level factors

Variables	**Adjusted model**	
	AOR	**95%CI**
Child age		
<6months	1	
6-11 months	2.62	1.60-4.30*
12-23 months	2.05	1.29-3.26*
24-35 months	0.96	0.60-1.55
36-47 months	0.67	0.40-1.14
48-59 months	0.46	0.27-0.78*
Given Vitamin A		
Yes	1	
No	0.94	0.71-1.24
Maternal education		
None	1	
Primary	1.13	0.83-1.81
Secondary	1.08	0.72-1.61

Variables	Adjusted model	
	AOR	**95%CI**
High school	1.18	0.74-1.87
Tertiary	0.99	0.46-2.13
Parity		
Less than 3	1	
3-4 children	1.08	0.79-1.47
5 and above	1.04	0.75-1.45
Type of toilet facility		
Flush toilet	1	
Pit latrine	1.64	0.98-2.76
No facility, Bush, Field	2.18	1.19-4.01*
Child stool disposal		
Safe	1	
Not safe	1.4	1.01-3.92*
Place of residence		
Rural	0.98	0.67-1.38
Urban	1	
Region of residence		
Hhohho	1.16	0.80-1.70
Manzini	1.08	0.76-1.55
Shiselweni	0.71	0.51-0.99*
Lubombo		
Overall community diarrhoea		
Low	1	
Medium	3.08	2.10-4.53*
High	7.62	5.32-10.90*

Notes: AOR: adjusted odds ratio, *significant at $p<0.05$

5.12 Summary of the single-level logistic model

The section examined the determinants of child diarrhoea at the individual, household and community level using a single level logistic regression model. After controlling for confounding variables in the multivariate model, the findings showed that the risk of diarrhoea was high for children aged 6-11 months and 12-23 months. At the household level, the type of toilet was associated with diarrhoea. Children from households that had no toilet facility were 118% more likely have had diarrhoea. Higher odds of diarrhoea were observed among children from households where child stool was not disposed properly.

A consideration of the community-level factors showed that only the overall community diarrhoea was found to be an important covariate in the adjusted model. Higher odds of diarrhoea were observed among children from communities that had higher overall community diarrhoea when compared to children from communities with low overall community diarrhoea.

CHAPTER SIX

CONTEXTUAL DETERMINANTS OF CHILDHOOD DIARRHOEA: A MULTILEVEL ANALYSIS

6.1 Introduction

The chapter presents the analysis of the relative importance of community or contextual factors to child diarrhoea. To answer objective three of the study which is to determine the extent to which community level factors account for variation in childhood diarrhoea, multilevel logistic regression models were fitted to the data. Five models were used to produce the fixed and random effects from the multilevel models. The results were presented in levels which were in terms of the individual, household and community level.

6.2 Contextual factors associated with child diarrhoea

There were five models that were presented for the analysis. Model I: the empty model with only diarrhoea without covariates and the variance was apportioned to depict the hierarchical nature of the data**.** Model II included diarrhoea and the individual child and maternal level covariates, which are the age of the child, child birth size, and child current breastfeeding status, height for age, parity, child given vitamin A, maternal education, maternal age, and maternal marital status. Model III included diarrhoea and household level covariates: household-level wealth, source of drinking water, water available for hand washing, child stool disposal, type of toilet facility, toilet shared with neighbours, water treated in the household, and the number of children under five years in the household. Model IV included diarrhoea and the community level variables which are place of residence, region of residence, proportion of households in the community with improved toilet, proportion of households in the community with improved water source, proportion of households in the community that disposed child stool safe, proportion of women with at least secondary education in the community, overall community diarrhoea in the community. Finally, model V is the final model that included diarrhoea and combines all the individual, household and community level covariates. Table 6.1 below show the results of the multilevel logistic regression

Table 6. 1: The multilevel analysis between individual, household, community level and child diarrhoea

Variables Fixed effects	Model 1	Model 2 AOR(95%CI	Model 3 AOR(95%CI)	Model 4 AOR(95%CI)	Model V AOR (95%CI)
Child Age (months)					
<6		1			1
6-11		3.20(1.84-5.73)*			5.34(2.39-11.90)*
12-23		3.44(1.94-6.09)*			3.90(1.76-8.64)*
24-35		1.07(0.40-2.86)			1.51(0.38-5.98)
36-47		0.76(0.29-1.97)			1.12(0.24-5.33)
>=48		0.62(0.24-1.61)			1.15(0.31-4.34)
Sex					
Male		-			-
Female		-			-
Birth size at birth					
Smaller than average /very small		1			1
Average		1.04(0.71-1.58)			0.88(0.51-1.53)
Very large /larger than average		0.90(0.56-1.46)			0.49(0.23-1.04)
Current Height for age (stunted)					
Growth Deficit		1			1
Normal		0.58(0.14-2.33)			0.09(0.01-0.93)*
Above normal		0.55(0.13-2.35)			0.07(0.01-0.85)*
Given Vitamin A					
Yes		1			-
No		1.06(0.71-1.58)			-
Current breastfeeding status					
Breastfeeding		1			1
Not breastfeeding		0.70(0.46-1.05)			0.87(0.48-1.58)
Maternal level factors					
Maternal age					

Variables Fixed effects	Model 1	Model 2 AOR(95%CI	Model 3 AOR(95%CI)	Model 4 AOR(95%CI)	Model V AOR (95%CI)
<25		1			1
25-34		0.94(0.66-1.35)			0.89(0.49-1.60)
>34		0.61(0.36-1.03)			1.03(0.35-3.02)
Maternal education					
None		1			-
Primary		1.03(0.52-2.03)			-
Secondary		0.78(0.39-1.54)			-
High school		0.89(0.43-1.80)			-
Tertiary		0.32(0.12-0.90)*			-
Parity					
Less than 3		-			1
3-4		-			0.88(0.47-1.64)
5 and above		-			0.40(0.14-1.17)
Marital status					
Married		-			-
Formerly married		-			-
Never married		-			-
Household-level					
Household wealth index					
Poorest			1		1
Second			1.13(0.63-2.03)		0.91(0.41-2.01)
Middle			1.41(0.78-2.56)		1.10(0.45-2.67)
Fourth			1.19 (0.68-2.06)		1.14(0.49-2.67)
Richest			1.21(0.71-2.07)		0.65(0.29-1.49)
Source of drinking water					
Piped			1		1
Protected water			1.51(0.81-2.81)		0.94(0.31-2.83)
Unprotected well/spring			0.78(0.52-1.17)		0.65(0.35-1.25)
Water for hand washing					
Available with soap			1		1
Available with no soap			0.91(0.50-1.63)		0.78(0.28-2.19)
Water treated in the household					
Yes			1		-
No			0.97(0.58-1.61)		-
Toilet facility					
Flush toilet			1		1
Pit latrine			2.00(1.36-2.96)*		1.91(0.78-4.78)
No facility, Bush, Field			Omitted		3.83(1.14-12.88)*
Number of under 5 children in the household					
One			1		-
Two or more			1.05(0.78-1.39)		-
Disposal of child stools					

Variables Fixed effects	**Model 1**	**Model 2 AOR(95%CI**	**Model 3 AOR(95%CI)**	**Model 4 AOR(95%CI)**	**Model V AOR (95%CI)**
Safe			1		1
Not safe			2.13(1.50-3.02)*		1.77(0.94-3.33)
Community-level					
Area of residence					
Rural				1.12(0.88-1.44)	0.93(0.43-1.99)
Urban				1	1
Region of residence					
Hhohho				0.82(0.63-1.05)	2.59(1.08-2.65)*
Manzini				0.90(0.70-1,16)	1.38(0.59-3.26)
Shiselweni				1.02(0.81-1.29)	1.01(0.45-2.27)
Lubombo				1	1
Community Poverty					
Low				1	1
Medium				0.96(0.77-1.19)	1.22(0.60-1.52)
High				0.82(0.64-1.06)	1.09(0.48-2.44)
Community maternal level education					
Low				1	1
Medium				0.92(0.74-1.13)	1.31(0.66-2.61)
High				0.88(0.70-1.10)	1.20(0.55-2.59)
Community piped water in the community					
Low				1	1
Medium				0.92(0.74-1.13)	0.85(0.45-1.61)
High				0.88(0.70-1.10)	0.69(0.33-1.45)
Community improved toilet facility					
Low				1	1
Medium				0.81(0.60-1.10)	1.14(0.41-3.14)
High				1.00(0.78-1.28)	1.13(0.50-2.54)
Overall Community diarrhoea					
Low				-	1
Medium				-	3.60(2.26-6.20)*
High				-	9.77(4.59-20.80)*
Community safe disposal of child stools					
Low				1	1
Medium				0.97(0.79-1.20)	1.27(0.66-2.61)
High				1.001(0.81-1.25)	1.06(0.52-2.17)
Random effects	Empty	Individual	Household	Community	Final Model
Community variance (SE)	*0.669(0.177)	* 0.632(0.243)	*0.232(0.142)	0.102(0.4)	0.162(2.84)
VPC=ICC (%)	17.2	16.1	6.6	3.0	4.7
PCV (%)	Reference	5.6	65.3	85	75.8
Log likelihood	-2350.3252	-551.12547	-690.97028	-2353.338	-240.9493
Model-fit statistics					
AIC	4706.65	1140.251	1409.941	4738.676	565.8986
BIC	4726.399	1236.021	1486.02	4844.004	748.4153

Notes: SE refers to standard error. VPC refers to the variance partition coefficient, PCV refers to the Proportion Change in variance, AIC refers to Akaike information Criterion; BIC refers to the Bayesian information criterion. * Significant at P-value <0.05.

Table 6.1 above presents the results of the multilevel analysis. Model, I was fitted with the outcome variable only (diarrhoea) without any predictors. The model showed a statistically significant variation of the random effects in the risk of occurrence of diarrhoea between the communities (τ=0.669, $p<0.001$). The intraclass correlation (Ostman-Smith et al.) in the null model showed that 17.2% of the total variance in diarrhoea was attributed to the difference in the composition of communities.

In Model II, only the individual-level variables were included along with diarrhoea. The model produced fixed effects results, which is the measure of association. The result in table 6.1 above showed that the child age and maternal education were associated with child diarrhoea in the individual-level model. Children aged 6-11 and 12-23 months were 220% and 244% respectively, more likely to have had diarrhoea, respectively compared to children less than 6 months. Children born to women with tertiary education were 68% less likely to have had diarrhoea, compared to those with primary education level. Parity, child gender, maternal age, maternal marital status and childbirth size were not significantly associated with diarrhoea in the multivariate individual model. As shown in Table 6.1, relative to the model I, variation in diarrhoea between communities remained significant (τ= 0.632, p=0.001. The community level variance from the null model reduced from 0.669 to 0.632 after adding child level and maternal level factors. This implies that a significant fraction of the variance of diarrhoea across communities can be explained by child level and maternal (individual) level factors. The ICC in model II implied that 16.1% of the variance in diarrhoea was attributed to the difference in communities. The results of the child level and maternal level factors proportion change in variance (PCV) of the model showed that child and maternal level factors explained 5.6% of the variance of diarrhoea between communities.

Model III presents the effect of household-level variables along with diarrhoea. The results showed that the type of toilet facility and household disposal of child stools were statistically associated with child diarrhoea. Children born to households with a pit latrine were 100% more likely to have had diarrhoea, compared to children from households with a flush toilet. Children from households where child stools were not disposed safely were 113% more likely to have had diarrhoea, compared to children from households where child stools were disposed safely. The ICC of the model showed that 6.6% of the child diarrhoea was attributed to the difference between communities. The results of the PCV of the model showed that 65.3% of the variance of diarrhoea between communities was explained by household level factors.

In Model IV, only diarrhoea and community level predictors were included. The findings showed that there were no community-level variables that were associated with child diarrhoea. However, compared to model III, the results of model IV showed a drastic decrease in the variance of diarrhoea across communities ($\tau = 0.102$, $p<0.05$). The ICC of the model showed that 3% of the child diarrhoea was attributed to the difference between communities. The results of the PCV of the model showed that 85.0% of the variance of diarrhoea between communities was explained by community level factors.

The final model (model V) included the individual, household and community level variables. As the key independent variables of interest, all community level variables were retained in the model regardless of the results of the backward elimination model. It was found that the inclusion of the community level in the final model had independent effects on child diarrhoea, and moderated the association between households and child and maternal level variables. Some household-level variables such as household disposal of child stools were no longer significant in the final model.

The findings of the final model indicated that children aged 6-11 months were 434% less likely and those aged 12-23 months were 290% less likely to have had diarrhoea, compared to children aged below 6 months**.** Children that had the normal height for age were 91% less likely, and those with an above-average height for age were 93% less likely to have had diarrhoea compared to those that experience growth deficit

A consideration of the household factors showed that the type of toilet facility was associated with child diarrhoea. There was a significant difference between diarrhoea cases by type of toilet facility. As expected, children from households with no toilet facility or used a bush were 283% more likely to have had diarrhoea than those with a flush toilet.

Among the community-level factors, the region of residence, and the overall community diarrhoea were significantly associated with child diarrhoea in model V. Children who resided in the Hhohho region 159% more likely to have had diarrhoea relative to children from the Lubombo region. The findings also showed that children from communities with medium overall community diarrhoea were 260% more likely to have had diarrhoea compared to children from communities with low overall community diarrhoea. Children from communities with high overall diarrhoea were 877% more likely to have had diarrhoea, compared to children from communities with low overall community diarrhoea.

Relatively, the variance of diarrhoea at the community level in the final model was insignificant (τ= 0.162, $p>0.05$). The ICC decreased from 17.2% in the null model to 4.7% in model V showing that the inclusion of community level factors was important to explain the clustering of diarrhoea in the community. The final model indicates that the clustering of diarrhoea at the community level was a result of the composition of the communities by individual and household characteristics.

6.3 Summary of the multilevel findings on diarrhoea

The main aim of the section was to investigate the extent to which individual, household and community level factors account for variation in childhood diarrhoea. A multilevel logistic regression model was used to investigate the effect of the child level, household level and community level factors on the variation of childhood diarrhoea. The multilevel model applied the fixed effects to measure the association whilst the random effects measure the clustering and variation of diarrhoea

The adjusted model fixed effects results showed that at the individual level model (child level and maternal factors) child age and maternal education were associated with diarrhoea. At the household level type of the toilet facility and child stool disposal in the household were very instrumental in explaining the variation of child diarrhoea across communities. At the community level, the overall community diarrhoea was found to be associated with child diarrhoea.

Finally, the full model (model V) incorporated individual, household and community-level variables, established that at the individual level, child age, and height for age were important variables to explain the variation of diarrhoea across communities. Similarly, the final model showed that at the household level, type of toilet facility was associated with child diarrhoea. Additional, the final model established that among the community variables region of residence and the overall community diarrhoea were very important variables to explain the clustering of diarrhoea.

The findings showed that individual, household and community characteristics are important in explaining the risk of child diarrhoea. The null model showed a significant variation of diarrhoea across communities. Individual composition/ maternal composition, household and community characteristics are important predictors of child diarrhoea. However, none of the models explained the entire variance of diarrhoea in the community, implying that, there may be other factors not investigated in the study that affect the clustering of child diarrhoea.

CHAPTER SEVEN

PREVALENCE OF CHILD ACUTE RESPIRATORY INFECTION, AND CROSS TABULATION OF CHILD ARI

7.1 Introduction

A graph depicting the prevalence of ARI was first presented, and then the results of the bivariate analysis using the Chi-square test were also done. To further measure the relationship between individual, household and community level factors and ARI a bivariate and multivariate logistic regression was done.

7.2 Prevalence of acute respiratory infection

Figure 7.1 below shows the magnitude of acute respiratory infection. The findings found that the prevalence of childhood ARI was 20.9% (95%CI: 19.8%-22.0%).

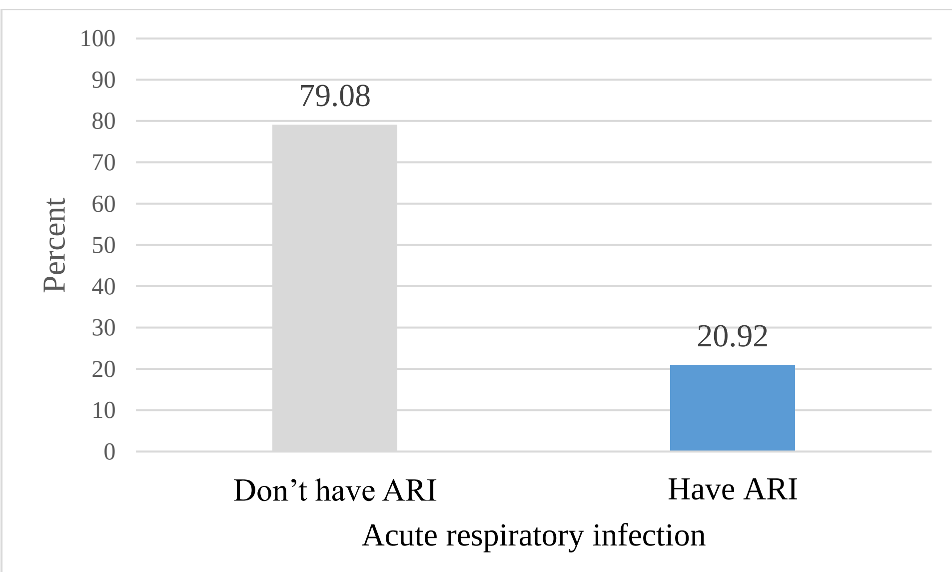


Figure 7.1: Prevalence of acute respiratory infection

Source: Plotted by the Author

7.3 The bivariate analyses between individual factors and childhood ARI

The individual explanatory variables were analysed to ascertain their relationship to childhood ARI. The individual child and maternal level factors included child age, child sex, child birth size, child current breastfeeding status, current height for age, child given vitamin A, maternal age, maternal education, parity, and maternal marital status. Among the individual-level variables, child age was found to be significantly associated with child diarrhoea (p=003). The proportion of ARI was higher among children aged 6-11 (24.9%), 12-23(22.3%), 24-35 (25.7%) and 36-47 months (21,6%) while for those aged less than 6 months and those aged 48-59 months had equally low ARI (18%). Children born to mothers without formal education and those with mothers with primary education had a higher proportion of ARI (24%). ARI was lower among children whose mothers had tertiary education (16.9%).

The bivariate results further revealed no significant relationship between child ARI and child sex (p=0.793), child birth size (p=0.404), child breastfeeding status (p=0.261), child given Vitamin A (P=0.076), Height for age (nutritional status) maternal age (p=0.071), parity (p=0.177), and maternal marital status (p=0.156).

Table 7. 1: **Bivariate analysis between ARI and child-level variables**

Variables	**% with reported ARI**	**95% CI**	**p-value (X^2)**
Child Age			0.003(17.70)
<6months	18	14.5-22.1	
6-11 months	24.9	20.9-29.3	
12-23 months	22.3	19.7-25.1	
24-35 months	25.7	22.7-29.0	
36-47 months	21.6	19.0-24.4	
48-59 months	18.0	15.7-20.6	
Sex			0.793(0.07)
Male	21.9	20.2-23.7	
Female	21.8	20.0-23.6	
Birth size			0.404(1.81)

Variables	% with reported ARI	95% CI	p-value (X^2)
Smaller than average /very small	20.9	18.0-24.1	
Average	21.2	18.8-23.9	
Very large /larger than average	17.5	14.1-21.5	
Height for age (stunted)			0.446(1.62)
Growth Deficit	22.2	20.8-23.6	
Normal	29.2	17.8-44.0	
Above normal	18.9	15.9-22.4	
Given Vitamin A			0.076(3.15)
Yes	25	22.9-27.3	
No	22	19.4-24.9	
Child breastfeeding status			0.261(1.26)
Breastfeeding	21.6	18.5-25.1	
Not breastfeeding	24.5	22.5-26.7	
Maternal level factors			
Maternal age			0.071(5.28)
<25	20.2	18.0-22.6	
25-34	21.6	19.4-23.9	
>34	23.3	21.4-25.3	
Maternal education			0.006(14.45)
None	23.6	21.2-25.2	
Primary	24.4	22.0-27.1	
Secondary	19.7	17.6-22.0	
High school	21.2	18.1-24.7	
Tertiary	16.9	12.8-21.9	
Parity			0.177(3.47)
Less than 3	21.5	19.5-23.8	
3-4 children	21.2	18.9-23.8	
5 and above	22.6	20.7-24.6	
Marital status			0.156(3.71)
Married	21.0	19.3-22.8	
Formerly married	24.7	20.1-29.9	
Never married	21.1	18.5-23.8	

7.4 Bivariate relationship between child ARI and household level factors

The significance of the association of household level variables and child ARI was tested through the Pearson Chi-square test. The results revealed that shared toilet with neighbours, the number of children less than 5 years in the household and household electricity were significantly associated with child ARI. Children who were from households that shared toilets with neighbours had a higher proportion of ARI (24.3%) compared to those that were from households that did not share a toilet with neighbours (20.5%). The reported ARI was observed to be higher among household without electricity (22.7%) when compared to those with electricity (20. 8%). The reported ARI was observed to be higher among households with only one child (23.8%) relative to those from households with two or more children (20.2%).

There was no significant relationship between household floor material, household wealth index, type of toilet used, source of cooking fuel, place of cooking, number of people sleeping per room in the household, and water for hand washing in the household. Table 7.2 below shows the relationship between household level variables and ARI

Table 7. 2: **Bivariate analysis for ARI and household level variables**

Variables	**% with reported ARI**	**95%CI**	**P-value (X^2)**
Household wealth index			0.247(5.42)
Poorest	23.5	20.9-26.3	
Second	22.0	19.5-24.7	
Middle	20.1	17.2-23.2	
fourth	21.7	19.0-24.7	
Richest	21.4	18.8-24.4	
Toilet facility			0.915 (0.178)
Flush toilet	23.2	19.0-27.9	
Pit latrine	21.6	20.2-23.1	
No facility, Bush, Field	21.7	19.0-24.7	
Shared toilet with neighbours			0.032(4.60)
Yes	24.3	21.8-27.1	
No	20.5	18.9-22.1	
Water for hand washing			0.382(0.76)
Available with soap	22.5	20.5-24.7	
Available with no soap	26.7	20.0-34.8	
Floor material			0.247(1.34)
Improved floor	21.7	20.4-23.0	
Poor floor	23.9	19.9-28.3	
Source of cooking fuel			0.382(0.76)
Electricity	22.0	18.6-25.8	
Biomass	22.8	20.5-23.1	
Place where cooking is done			0.500(0.45)
In the living room	22.0	18.6-25.8	

Variables	% with reported ARI	95%CI	P-value (X^2)
Outside the living room	22.1	20.5-23.1	
Number of person sleeping per room			0.052(5.90)
<3	21.8	20.1-23.6	
3-4	23.0	21.0-25.1	
5 and above	16.7	13.3-20.9	
Number of children under 5 years per households			0.021(5.32)
One	23.8	21.8-25.8	
Two or more	20.2	18.6-21.8	
Household electricity			0.023(5.17)
Yes	20.8	18.9-22.9	
No	22.7	21.1-24.4	

7.5 The bivariate analyses between community level factors and childhood ARI

Table 7.3 presents the results of the relationship between community level factors and ARI. The results depicted that the proportion of children with reported ARI was significantly higher in the Manzini region (25.6%), followed by Lubombo (22.0%), Shiselweni (21.2%) and Hhohho (17.1%), p<0.001). The results further showed that children from communities with a low proportion of mothers with at least secondary education had a higher proportion of ARI (23.2%). Community poverty was not significantly associated with child ARI, p=0.581. At the community level the bivariate results further showed that child ARI was not associated with the improved source of cooking material in the community, the proportion of households cooking outside the living room and proportion of households in the community with improved floor material, and area of residence

Table 7. 3: Bivariate analysis for ARI and community level variables

Variables	% with reported ARI	95%CI	95% P-value
Area of residence			0.063(3.45)
Rural	21.0	19.7-22.4	
Urban	24.9	21.7-28.5	
Region of residence			<0.001 (36.37)
Hhohho	17.1	14.8-19.6	

Variables	% with reported ARI	95%CI	95% P-value
Manzini	25.6	23.1-28.3	
Shiselweni	21.2	19.1-23.4	
Lubombo	22.0	19.6-24.7	
Community Poverty			0.581(1.08)
Low	22.7	20.4-25.2	
Medium	21.1	19.2-23.2	
High	21.6	19.7-23.8	
Proportion of mothers with at least secondary level education in the community			0.027(7.24)
Low	23.2	21.2-25.3	
Medium	22.2	20.2-24.4	
High	20.2	18.0-22.7	
Proportion of households with electricity in the community			0.550(1.20)
Low	22.1	20.1-24.2	
Medium	20.9	18.9-22.9	
High	22.6	20.2-25.1	
Proportion with improved fuel for cooking in the community			0.206 (3.16)
Low	22.4	20.4-24.5	
Medium	19.9	18.0-21.9	
High	23.2	20.8-25.7	
Location of cooking outside the room			0.759 (0.55)
Low	22.3	20.0-24.8	
Medium	22.1	20.1-24.1	
High	21.1	19.1-23.2	

7.6 Summary of the bivariate results for ARI

With regard to ARI, at the individual level, maternal education and child age were found to be associated with ARI. As expected, children born to women with no formal education had a higher proportion of ARI. Similarly, children aged 6-11 months had a higher proportion of ARI compared to children aged below 6 months.

At the household level, only households that shared their toilets with neighbours, the numbers of children under 5 years in the household and household electricity were associated with ARI. The findings showed that the more heterogeneous the region of residence, the more the variation of the prevalence of ARI. The proportion of women with at least secondary education in the community had an important effect on child ARI.

7.7 Determinants of child ARI in Eswatini: A single-level logistic regression

To achieve the objective, a single level binary logistic regression was employed to determine the factors associated with childhood ARI. The first stage was to fit a bivariate logistic model between each of the individual, household and community level factors.

7.8 The bivariate and multivariate results of individual factors and childhood ARI

Table 7.4 below contains the results of the bivariate analysis, which test whether each independent variable was significantly associated with ARI. Children aged 6-11 months were 51% more likely to have had ARI compared to children under 6 months. Similarly, children aged 24-35 months were 57% more likely to have had ARI compared to children aged less than 6 months. Child birth size was statistically associated with child ARI in the adjusted model of the individual factors. Children who were reported to be more than the average at birth were 70% more likely to have had a reported ARI compared to those who were smaller than average/very small.

In the bivariate model, maternal education was found to be significantly associated with child ARI. Children born to mothers with secondary education were 20% less likely to have had ARI compared to children born to mothers with no formal education. Similarly, children born to women with tertiary education were 34% less likely to have had ARI, compared to children born to women with no formal education. Child breastfeeding status, a child, given vitamin A, current height for age, and maternal age, parity and maternal marital status were not statistically associated with child ARI. The Hosmer-Lemeshow goodness-of-fit test was used to test how well the model fits the data. The findings showed that the model fit the data well, p= 0.045.

Table 7. 4. **Bivariate and multivariate analysis for individual level and ARI**

Variables			Adjusted	
	COR	95%CI	AOR	95%CI
Child Age (months)				
<6	1		1	
6-11	1.51	1.07-2.12*	1.28	0.76-2.14
12-23	1.31	0.97-1.76	0.96	0.56-1.65
24-35	1.57	1.16-2.14*	0.63	0.26-1.53
36-47	1.25	0.93-1.69	1.41	0.67-2.94
>=48	1	0.74-1.36	0.57	0.26-1.27
Sex				
Male	1		1	
Female	0.99	0.86-1.15	0.77	0.57-1.05
Birth size at birth				
Smaller than average /very small	1		1	
Average	1.27	0.94-1.71	1.41	0.92-2.16
Very large /larger than average	1.25	0.91-1.71	1.7	1.07-2.70*
Height for age				
growth Deficit	1		1	
Normal	0.69	0.36-1.32	1.25	0.31-5.03
Above normal	0.57	0.29-1.11	1.06	0.25-4.44
Given Vitamin A				
Yes	1			
No	0.73	0.50-1.06		
Current breastfeeding status				
Breastfeeding	1		1	
Not breastfeeding	1.18	0.94-1.45	0.96	0.63-1.47
Maternal level factors				
Maternal age				
<25	1		1	
25-34	1.08	0.89-1.32	1.05	0.72-1.55
>34	1.2	1.00-1.44	1.15	0.61-2.18
Maternal education				
None	1		1	
Primary	1.05	0.86-1.28	1.62	0.85-3.07
Secondary	0.8	0.65-0.97*	1.24	0.65-2.35
High school	0.87	0.68-1.11	1.15	0.58-2.28
Tertiary	0.66	0.46-0.94*	0.81	0.34-1.93
Parity				

Variables			Adjusted	
	COR	**95%CI**	**AOR**	**95%CI**
Less than 3	1		1	
3-4 children	0.98	0.81-1.19	1.05	0.70-1.57
5 and above	0.27	0.90-1.26	0.75	0.40-1.40
Marital status				
Married	1		1	
Formerly married	1.23	0.93-1.64	1.14	0.56-2.33
Never married	1	0.83-1.21	0.71	0.50-1.00

Notes: COR: Crude Odds ratio, AOR: adjusted odds ratio, *significant at p<0.05

7.9 The bivariate and multivariate results of household level variables and child ARI

Table 7.5 below show the results of unadjusted bivariate analysis and the adjusted multivariate logistic regression. In the bivariate model shared toilet with neighbours, the number of people sleeping per room and the number of children under five were significantly associated with child ARI at the household level. Children that were from households that did not share the toilet facility with neighbours were 20% less likely to have had reported ARI, compared to children from households that shared a toilet facility with other households. Children from a household where 5 and more people were sleeping per room were 28% less likely to have had ARI compared to children from households with less than three people sleeping per room. In the same vein children from households where there were 2 or more children under five years were 19% less likely to have had ARI than those where there was only one child resident.

A multivariate model that included ARI and only the household level covariates was conducted. The findings showed that even after controlling for other households' level confounding factors, children from the richest households were 11% less likely to have had ARI compared to children from the poorest households. Children that lived in households that did not share the toilet with neighbours were 25% less likely to have had reported ARI compared to children from households that shared toilets with neighbours. Children from households where the number of people sleeping per room were 3 to 4 were 26% more likely to have had ARI, relative to those from households with less than 3 people sleeping per room.

Table 7. 5: Relationship between household level `factors and ARI

Variable	**Bivariate Model**		**Adjusted model**	
	COR	**95%CI**	**AOR**	**95%CI**
Household wealth index				
Poorest	1		1	
Second	0.92	0.74-1.14	0.82	0.62-1.09
Middle	0.82	0.64-1.04	0.76	0.56-1.02
fourth	0.9	0.72-1.13	0.78	0.58-1.04
Richest	0.89	0.71-1.11	0.74	0.56-0.99*
Toilet facility				
Flush	1		1	
Pit latrine	0.92	0.70-1.19	0.79	0.59-1.06
No toilet	0.92	0.68-1.24	1	Empty
Shared toilet with neighbours				
Yes	1		1	
No	0.8	0.67-0.95*	0.75	0.62-0.90*
Floor material				
Improved floor	1		-	
Poor floor	1.13	0.89-1.45	-	
Source of cooking				
Electricity	1		1	
Biomass	0.99	0.79-1.24	1.1	0.86-1.41
Place where cooking is done				
In the living room	1		-	
Outside the living room	0.94	0,77-1.15	-	
Number of people sleeping per room				
Less than 3	1		1	
04-Mar	1.07	0.92-1.25	1.26	1.05-1.45*
5 and above	0.72	0.54-0.97*	0.85	0.60-1.19
Number of children under 5 years				
Less than 2	1		1	
2 or more	0.81	0.67-0.94*	0.85	0.73-1.00

Notes: COR: Crude Odds Ratio, AOR: Adjusted Odds Ratio, *significant at p<0.05

7.10 Relationship between community level variables and child ARI

With regard to community-level variables, place of residence, the region of residence, and the prevalence of ARI in the community were found to be associated with ARI in the bivariate model. Children from the rural areas were 20% less likely to have had a reported ARI Compared to children from urban areas. Regionally, children from the Hhohho region were 27% less likely to have had ARI, compared to children that resided in the Lubombo region. Community poverty, proportion of mothers with at least secondary level education in the community, proportion of households with improved toilets in the community, proportion of household with improved floor in the community, proportion of improved cooking material in the community and proportion of households with access to electricity in the community were not associated with ARI in the bivariate model.

Furthermore, a multivariate model was conducted. It could be seen in table 7.6 that the region of residence and proportion of mothers with at least secondary education in the community were associated with ARI in the adjusted model. Children from the Manzini region were 26% more likely to have had ARI, compared to children from the Lubombo region. It can be seen from the findings that children from communities with a higher proportion of mothers with at least secondary education were 28% less likely to have had reported ARI than those from communities with a low proportion of mothers with at least secondary education. The rest of the community level variables were not statistically associated with ARI. Table 7.6 below show the results of the household level analysis.

Table 7. 6: **Bivariate and multivariate analysis for community level variables and ARI**

Variables	Bivariate model		Adjusted model	
	COR	**95% CI**	**AOR**	**95%CI**
Area of residence				
Rural	0.8	0.66-0.98*	0.82	0.65-1.03
Urban	1		1	
Region of residence				
Hhohho	0.73	0.58-0.91*	0.79	0.62-1.00
Manzini	1.22	1.00-1.49	1.26	1.01-1.56*
Shiselweni	0.95	0.78-1.15	1.01	0.82-1.23
Lubombo	1		1	
Community Poverty				
Low	1		1	
Medium	0.91	0.76-1.09	0.98	0.80-1.20
High	0.94	0.78-1.13	0.94	0.74-1.19
Proportion of mothers with at least secondary level education in the community				
Low	1		1	
Medium	0.95	0.80-1.12	0.88	0.74-1.06
High	0.84	0.70-1.01	0.72	0.58-0.89*
Proportion of households with electricity in the community				
Low	1		1	
Medium	0.93	0.78-1.10	0.94	0.77-1.14
High	1.03	0.86-1.23	0.96	0.75-1.22
Proportion with improved fuel for cooking in the community				
Low	1		1	
Medium	0.86	0.73-1.02	0.88	0.74-1.06
High	1.05	0.87-1.25	1.03	0.80-1.31
Proportion of household with poor floor in the community				
Low	1		-	
Medium	0.88	0.73-1.06	-	
High	0.95	0.80-1.12	-	

Notes: COR: Crude Odds ratio, AOR: adjusted odds ratio, *significant at p<0.05

7.11 Relationship between individual, household and community level variables and child ARI

The final model was fitted to determine the individual, household and community level factors that are associated with childhood ARI. A back-wide elimination regression method was conducted to include important variables in the final model. Variables that had a $p < 0.20$ were kept in the final model.

The findings revealed that when all the individual, household and community-level variables were included in one model, child age, maternal age, shared toilet with neighbours, source of cooking material, household wealth index, and region of residence were significantly associated with child ARI. Children aged 6-11 months were 52% more likely to have had ARI compared to children aged less than 6 months. Children born to women aged 25-34 were 39% more likely to have had ARI compared to those born to women aged less than 25 years.

Children resident in households that did not share a toilet with neighbours were 28% less likely to have had reported ARI relative to those that shared toilet with neighbours. The household wealth index was also associated with ARI in the multivariate model. Children from the poor and middle households were 47% and 41%, less likely respectively to have had reported ARI compared to those from the poorest households.

With regard to community level factors in the final model, children from the Hhohho region were 37% less likely to have had reported ARI compared to children from the Lubombo region.

Table 7. 7: **Multivariate analysis for Individual, household and community level factors and ARI**

Variables	**Adjusted multivariate model**	
	AOR	**95%CI**
Child age		
<6months	1	
6-11 months	1.52	1.02-2.26*
12-23 months	1.23	0.86-1.77
24-35 months	1.44	0.85-2.42
36-47 months	1.34	0.80-2.23

Variables	Adjusted multivariate model	
	AOR	95%CI
48-59 months	0.67	0.38-1.78
Birth size at birth		
Smaller than average /very small	1	
Average	1.15	0.87-1.53
Very large /larger than average	0.88	0.61-1.27
Height for age		
growth Deficit	1	
Normal	0.58	0.26-1.30
Above normal	0.6	0.25-1.40
Maternal education		
None	1	
Primary	1.24	0.62-2.50
Secondary	0.87	0.43-1.74
High school	0.92	0.45-1.88
Tertiary	0.67	0.29-1.55
Maternal age		
<25	1	
25-34	1.39	1.06-1.83*
>34	1.24	0.84-1.83
Shared toilet		
Shared	1	
Not shared	0.72	0.54-0.95*
Source of cooking in the household		
Electricity	1	
Biomass	0.97	0.65-1.44
Household wealth index		
Poorest	1	
Poor	0.53	0.34-0.81*
Middle	0.59	0.36-0.96*
Rich	0.73	0.46-1.18
Richest	0.77	0.49-1.22
Number of people sleeping per room		
Less than 3	1	
03-Apr	1.24	0.93-1.64
5 and above	0.73	0.42-1.29
Area of residence		
Rural	0.94	0.67-1.31
Urban	1	
Region of residence		
Hhohho	0.63	0.42-0.96*
Manzini	1.04	0.71-1.52
Shiselweni	0.73	0.50-1.08
Lubombo	1	
Community Poverty		

Variables	Adjusted multivariate model	
	AOR	**95%CI**
Low	1	
Medium	0.91	0.65-1.27
High	0.75	0.49-1.15
Proportion of mothers with at least secondary level education in the community		
Low	1	
Medium	0.77	0.54-1.11
High		
Proportion with improved fuel for cooking in the community		
Low	1	
Medium	0.82	0.58-1.58
High	0.96	0.60-1.54
Proportion of households with electricity in the community		
Low	1	
Medium	1	0.71-1.41
High	0.88	0.58-1.34

Notes: COR: Crude Odds Ratio, AOR: Adjusted Odds Ratio, *significant at p<0.05

7.12 Summary of the multivariate logistics regression model an ARI

In the final multivariate model that included individual, household and community-level variables, child age and maternal age were found to be important covariates for ARI. The risk of ARI was high for children aged 6-11 months compared to those aged below 6 months. Increased odds of ARI were found among children born to women aged 25-34 years relative to those aged less than 25 years

In the final model, the results showed that the shared toilet with neighbours and household wealth index were found to be an important factor for child ARI. The odds of ARI were high among children from households that shared toilet with neighbours relative to those from households that did not share the toilets with neighbours. It was found that children from households that were poor and middle quartile of the wealth index were less likely to have ARI.

At the community level, children from the Hhohho region were found to have lower odds of ARI compared to those from the Lubombo region.

CHAPTER EIGHT

CONTEXTUAL DETERMINANTS OF CHILDHOOD ARI: A MULTILEVEL ANALYSIS

8.1 Introduction

The chapter investigates the Contextual determinants of childhood ARI. The chapter explains how much of the ARI is explained by individual, household and community level. Additionally, the fixed effects of the models that explained the association of the individual, household and community level factors with ARI. Finally, a summary was presented for the chapter.

8.2 Contextual determinants of childhood ARI through a multilevel analysis of individual, household and community level variables

To answer objective three (3) of the study which is to determine the extent to which community level factors account for variation in childhood ARI, a multilevel logistic regression was fitted. Five models were fitted to answer the objective: Model I: an empty model without covariates and the variance was portioned to depict the hierarchical nature of the data. Model II: include individual level variables. Model III: include household level variables. Model IV include community-level variables and finally, model V combines the individual, household and community-level variables. Table 8.1 below show the results of the multilevel logistic regression

Table 8. 1: The multilevel analysis for individual, household, community level and ARI

Variables	Model I	Model II AOR(95%CI	Model III AOR(95%CI)	Model IV AOR(95%CI)	Model V AOR (95%CI)
Child Age (months)					
<6		1			1
6-11		1.38(0.82-2.32)			1.41(0.97-2.06)
12-23		1.05(0.64-1.71)			1.26(0.89-1.78)
24-35		0.67(0.30-1.47)			1.31(0.69-2.17)
36-47		1.35(0.74-2.45)			1.13(0.69-1.83)
>48		0.60(0.31-1.16)			0.67(0.39-1.15)
Sex					
Male		1			-
Female		0.80(0.58-1.08)			-
Birth size					
Smaller than average /very small		1			1
Average		0.79(0.55-1.12)			1.03(0.78-1.36)
Very large /larger than average		0.57(0.36-0.91)*			0.90(0.62-1.29)
Height for age					
Growth deficit		1			1
Normal		1.02(0.25-2.09)			0.76(0.34-1.72)
Above normal		0.90(0.21-3.78)			0.74(0.31-1.76)
Given Vitamin A					
Yes		1			-
No		0.75(0.51-1.10)			-
Child breastfeeding status					
Breastfeeding		1			-
Not breastfeeding		0.94(0.62-1.42)			-
Maternal age					
Less than 25		1			1
25-34 years		1.00(0.66-1.50)			1.37(1.05-1.79)*
35 years and above		1.02(0.36-0.91)			1.09(0.75-1.59)
Maternal education level					
None		1			1
Primary		1.44(0.73-2.84)			1.03(0.52-2.02)
Secondary		1.11(0.56-2.22)			0.79(0.40-1.54)
High school		0.98(0.47-2.05)			0.75(0.38-1.50)
Tertiary		0.87(0.35-2.20)			0.69(0.31-1.56)
Household-level					
Household wealth index					
Poorest			1		1
Second			0.88(0.67-1.15)		0.57(0.37-0.87*)
Middle			0.73(0.55-0.98)*		0.59(0.37-0.93)*
fourth			0.82(0.62-1.08)		0.77(0.51-1.18)
Richest			0.79(0.60-1.03)		0.75(0.49-1.15)

Variables	Model I	Model II AOR(95%CI	Model III AOR(95%CI)	Model IV AOR(95%CI)	Model V AOR (95%CI)
Shared toilet					
Toilet shared			1		1
Not shared			0.82(0.70-0.97)		0.78(0.58-0.99)*
Floor material					
Improved			1		-
Not improved			0.77(0.52-1.13)		-
Number of people sleeping per room					
<3			1		1
3-4			1.19(1.01-1.41)*		1.22(0.93-1.61)
>4			0.80(0.58-1.10)		0.71(0.42-1.22)
Number of children under 5 years					
Less than 2			1		-
2 or more			0.88(0.76-1.03)		-
Cooking material					
Electricity					1
Biomass					0.98(0.68-1.43)
Source of cooking					
Electricity			1		-
Biomass			1.09(0.88-1.35)		-
Place where cooking is done					
In the living room					-
Outside the living room					-
Community-level					
Area of residence					
Rural				0.80(0.65-0.98)*	0.82(0.58-1.14)
Urban				1	1
Region of residence					
Hhohho				0.73(0.58-0.92)*	0.58(0.38-0.91)*
Manzini				1.32(1.06-1.64)*	1.19(0.80-1.79)
Shiselweni				1.02(0.83-1.26)	0.72(0.47-1.11)
Lubombo				1	1
Community Poverty					
Low				1	1
Medium				0.99(0.80-1.21	0.92(0.65-1.30)
High				0.99(0.78-1.27)	0.85(0.56-1.30)
Proportion of mothers with at least secondary level education in the community					
Low				1	1
Medium				0.90(0.74-1.09)	0.78(0.54-1.14)
High				0.73(0.59-0.91)*	0.77(0.51-1.17)
Proportion with improved fuel for cooking in the community					
Low				1	1
Medium				0.90(0.74-1.09)	0.85(0.59-1.23)
High				1.01(0.78-1.31)	0.88(0.57-1.35)
Proportion of households with electricity in the community					

Variables	Model I	Model II AOR(95%CI	Model III AOR(95%CI)	Model IV AOR(95%CI)	Model V AOR (95%CI)
Low				1	-
Medium				0.95(0.77-1.16)	-
High				0.94(0.73-1.21)	
Random effects	Model I	Model II	Model III	Model IV	Model V
Community variance (SE)	*1.094(0.213)	0.364(0.204)	*0.168(0.56)	*0.0.070(0.037)	0.287(0.127)
VPC=ICC (%)	24.9	10	4.9	2.1	8.03
PCV (%)	Reference	76.05	94	93.6	73.7
Log likelihood	-2711.2089	-578.03114	-2232.2847	-2709.4199	-942.85064
Model-fit statistics					
AIC	5428.418	1204.062	4488.569	5446.84	1955.701
BIC	5448.167	1325.035	4565.272	5539.002	2151.68

Notes: SE refers to standard error. VPC refers to the variance partition coefficient, PCV refers to the Proportion Change in variance, AIC refers to Akaike information Criterion; BIC refers to the Bayesian information criterion. * Significant at p <0.05.

Table 8.1 above presents the results of the multilevel analysis. The model I was fitted with ARI without any predictors. The model produced fixed effects results, which is the measure of association. The model showed a statistically significant variation of the random effects in the risk of occurrence of ARI between the communities (τ=1.094, p<0.05). The intraclass correlation (Ostman-Smith et al.) in the null model showed that 24.9% of the total variance in ARI was attributed to the difference in communities.

In Model II, only the individual level variables were included in the model. Only the variables that were found to be important in the backward elimination method were included, while others were retained as priori variables. It can be seen from the findings that only the child reported birth size was associated with child ARI in the individual level model. Children with a very large or larger than average birth size were 43% less likely to have had reported ARI compared those with a smaller than average/very small birth size. The community level variance from the null model decreased from 1.094 in the null model to 0.364 even though it was not significant, after adding individual level factors. This implies that the individual level factors can explain a significant fraction of the variance of ARI across communities. The ICC in model II was 10% showing that the clustering of ARI between communities was a result of the composition of communities by individual level factors.

At the household level, household wealth index was found to be associated with child ARI. Children from households with middle socio-economic status were 27% less likely to have had ARI compared to children from the poorest households to have had reported ARI. The results also showed that children from households with 3 to 4 people sleeping per room were 19% more likely have had ARI compared to those with less than 3 people sleeping in a room. Relative to model I, variation in ARI between communities remained significant (τ=0.168, $p<0.05$). The community level variance from the null model decreased from 1.094 to 0.168 after adding household level factors. This implies that the household level factors can explain a significant fraction of the variance of ARI across communities. The ICC in model III was 4.9% showing that the clustering of ARI between communities was a result of the composition of communities by household level factors.

In Model IV, only the community level variables were included. The findings showed that place of residence, the region of residence and proportion of mothers with at least secondary education in the community were significantly associated with ARI. Children who resided in rural areas were 20% less likely to have had reported ARI compared to children who resided in urban areas. Children from the Hhohho region were 27% less likely to have had reported ARI compared to those from the Lubombo region. However, children from the Manzini region were 32% more likely to have had reported ARI compared to those from the Lubombo region. It can be seen from the findings that children from communities with a high proportion of women with at least secondary education were 27% less likely to have had reported ARI compared to children from communities with a low proportion of mothers with at least secondary education in the community. Relative to model II, variation in ARI between communities remained significant ($\tau=0.070$, $p<0.05$). The community level variance from the null model decreased from 1.094 to 0.070 after adding community level factors. This implies that community level factors can explain a significant fraction of the variance of ARI across communitie. The ICC in model IV implied that 2.1 % of the variance of ARI was attributed to the composition of communities by community level characteristics.

The final model (model V) included the individual, household and community level variables. It was found that the inclusion of the community-level factors in the final model had independent effects on child ARI, and moderated the association between households and individual-level variables. Some individual and household level variables such as child age and shared toilet with neighbours were no longer significant in the final model. The results showed that children born to mothers aged 25-34 years were 37% more likely to have had reported ARI compared to those born to mothers under 25 years.

At the household level, household wealth index was found to be statistically associated with child ARI. Children from poor and middle socio-economic status were 43% and 41% less likely respectively to have had reported ARI, compared to children from the poorest households. It can be seen from the results that children from households that did not share a toilet with neighbours were 22% less likely to have had reported ARI compared to children from households that shared toilets with neighbours. Model V further showed the community level findings. The findings showed that children that resided in the Hhohho region were 42% less likely to have had reported ARI compared to children from the Lubombo region.

Relatively, the variance of ARI at the community level was insignificant ($\tau=0.287$, $p>0.05$). The community level variance from the null model decreased from 1.094 to 0.287 after adding the individual, household and community level factors. This implies that a significant fraction of the variance of ARI across communities can be explained by individual, household and community level factors. The ICC in model IV implied that 8% of the variance of ARI was attributed to the composition of communities by individual, household and community level characteristics.

8.3 Summary of the multilevel findings on ARI

The main aim of the section was to investigate the extent to which community level factors account for variation in childhood ARI. The findings showed the importance of individual-level, household and community level characteristics in explaining the risk of child ARI. The null model showed a significant variation of ARI across communities, and these results could be interpreted, taking into account the variation of ARI at the community level. Therefore, the environment where children are born and raised should be interpreted with consideration of the community setting to mitigate morbidity due to ARI in Eswatini.

Worth to note is that the intra correlation coefficient of the empty model was larger (24.9%) than the community level (2.1%). This suggests that community level characteristics can explain only a fraction of the variance of ARI at the community level.

The results further showed the results of the fixed effects for ARI. In the individual model, child birth size was associated with ARI. It was observed in the household level that shared toilet between neighbours, household wealth index and the numbers of people sleeping per room in the household were associated with reported child ARI. At the community level, the fixed effects result further showed that region and proportion of mothers with at least secondary education in the community were instrumental factors in explaining child ARI. Finally, the full model incorporated individual, household and community level variables and established that at the individual level, child age and maternal education were important variables to explain the variation of ARI across communities. Similarly, the final model showed that at the household level shared toilet and number of people sleeping per room in the household explained the variation of ARI.

Additionally, the final model established that the child age, maternal age, household wealth index, shared toilet with neighbours and region of residence explain the variation of child ARI across communities. Therefore, the variance of child ARI across communities can be explained by individual, household and community-level characteristics. However, none of the models explained the entire variance of ARI, implying that there may be unmeasured factors at the individual, household and community level that affect the clustering of child ARI.

CHAPTER NINE

Mapping of child diarrhoea and ARI: Application of Quantum Geographic Information Systems (QGIS)

9.1 Introduction

The section aimed to analyse and visualize the prevalence of diarrhoea and acute respiratory infection through geographic maps to answer objective number four of the thesis: Which communities (constituencies) have a higher burden of childhood diarrhoea and ARI? The cases of diarrhoea and ARI were mapped at the constituency level. There were 55 constituencies in Eswatini and four regions that were used for the mapping, namely Hhohho, Manzini, Shiselweni and Lubombo.

9.2 Mapping of the Prevalence of diarrhoea by constituencies at a national level

To visualize the prevalence of diarrhoea by constituencies, QGIS was used. The prevalence of diarrhoea was presented through four (4) quartiles expressed by the colour and prevalence range. The three colours that were used to depict the deference of diarrhoea in the constituencies were 1. **Red:** signified a high prevalence of diarrhoea between 18.4-28.1. 2. **Peach:** signified a medium prevalence of diarrhoea between 13.5-18.4. 3. **White**: signified a low prevalence of diarrhoea between 5.2-13.5. Figure 9.1 below display the prevalence of diarrhoea by constituencies. The findings showed that, out of the 55 constituencies, 18 (33%) had a high proportion of diarrhoea between 18.4-28.1 % (red colour).

A consideration of the proportion of diarrhoea by constituencies further showed that out of 55 constituencies 18 (33%) had a medium prevalence of diarrhoea between 13.5-18.4% (peach colour). Finally, it can be seen from figure 9.1 that of 55 constituencies 19(35%) had a low proportion of diarrhoea 5.2-13.5 %(white colour).

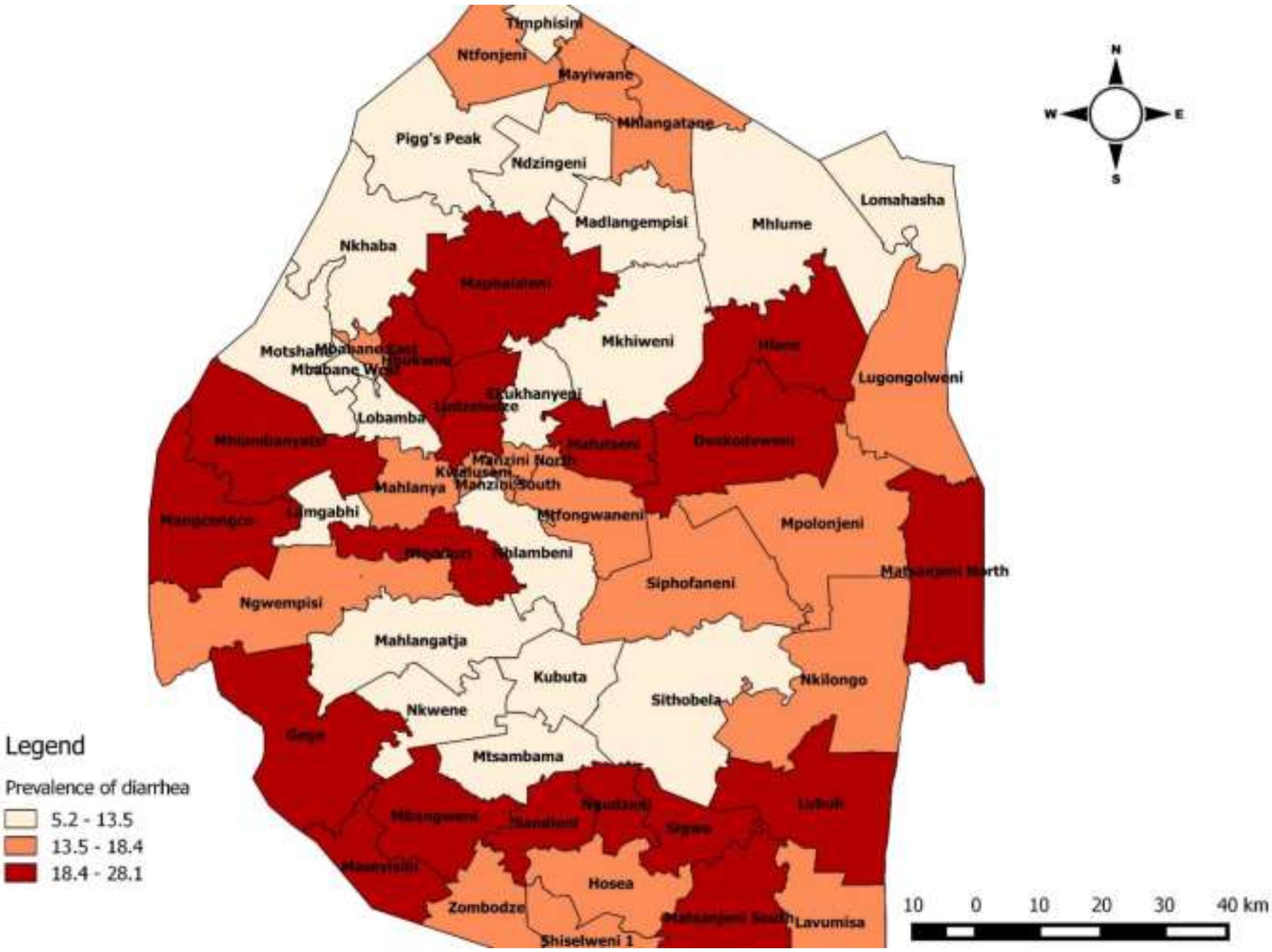


Figure 9. 1: the distribution of diarrhoea prevalence plotted by constituencies

Source: Plotted by the Author

9.3 Mapping of childhood diarrhoea by region of residence

Constituencies also did the mapping of diarrhoea under each administrative region. Figure 9.2 shows the prevalence of diarrhoea for the Hhohho region; figure 9.3 shows the mapping of diarrhoea for Manzini region and figure 9.4 show the prevalence of diarrhoea by the Lubombo region. It can be observed that out of 14 constituencies, there were only two (14%) (Maphalaleni and Hhukwini) that had a high prevalence of diarrhoea (red colour) of between 18.4-28.1. However, about 5 (50%)of the constituencies (Mbabane East, Madlangempisi, Mhlangatane, Mayiwane and ntfonjeni) had a medium prevalence of diarrhoea of about 13.5-18.4%. A majority 7 (50%) of the constituencies had a prevalence of diarrhoea of between 5.2-13.5%.

An analysis of the Manzini region showed that out of 16 constituencies, 5 (31%) of the constituencies had a high prevalence of diarrhoea of between 18.4-28.1%) while 6 (38%) had a medium prevalence of 13.5-18.4%. Only 4 (25%) of the constituencies had a low prevalence of diarrhoea between 5.2-13.5%.

A consideration of the Shiselweni region revealed that out of 14 constituencies, 7 (50%) (Matsanjeni South, Sigwe, Ngudzeni, Sandleni, Mbangweni, Maseyisini, and Gege) had a high prevalence of diarrhoeaof between 18.4-28.1%. However, only 4(29%) of the constituencies (Lavumisa, Shiselweni 1, Zombodze and Hosea) had a medium prevalence of diarrhoea between 13.5-18.4%). Within the Shiselweni region, 3 (21%) of the constituencies (Nkwene, Mtsambama and Kubuta) had a low proportion of diarrhoea of between 5.2-13.5%.

The Lubombo region mapping of diarrhoea was done by constituencies. As observed in figure 9.4, out of 11 constituencies, 4(36%) of the constituencies (Lubuli, Matsanjeni North, Dvokodweni, and Hlane) had a high prevalence of diarrhoeaof between 20.5-28.1%. It was also observed that 5 (45%) of the constituencies (Siphofaneni, Mpolonjeni, Mhlume Lugongolweni and Nkilongo) had a medium proportion of diarrhoeaof between 12.8-20.5%. The region observed only 2(18%) of the constituencies (Lomahasha and Sithobela) had a lower prevalence of diarrhoea between 5.2-12.8%.

Comparatively, it can be observed that the Manzini, Shiselweni and Lubombo regions had a high prevalence of diarrhoea when compared to the Hhohho region where there are only two constituencies with a high prevalence of diarrhoea.

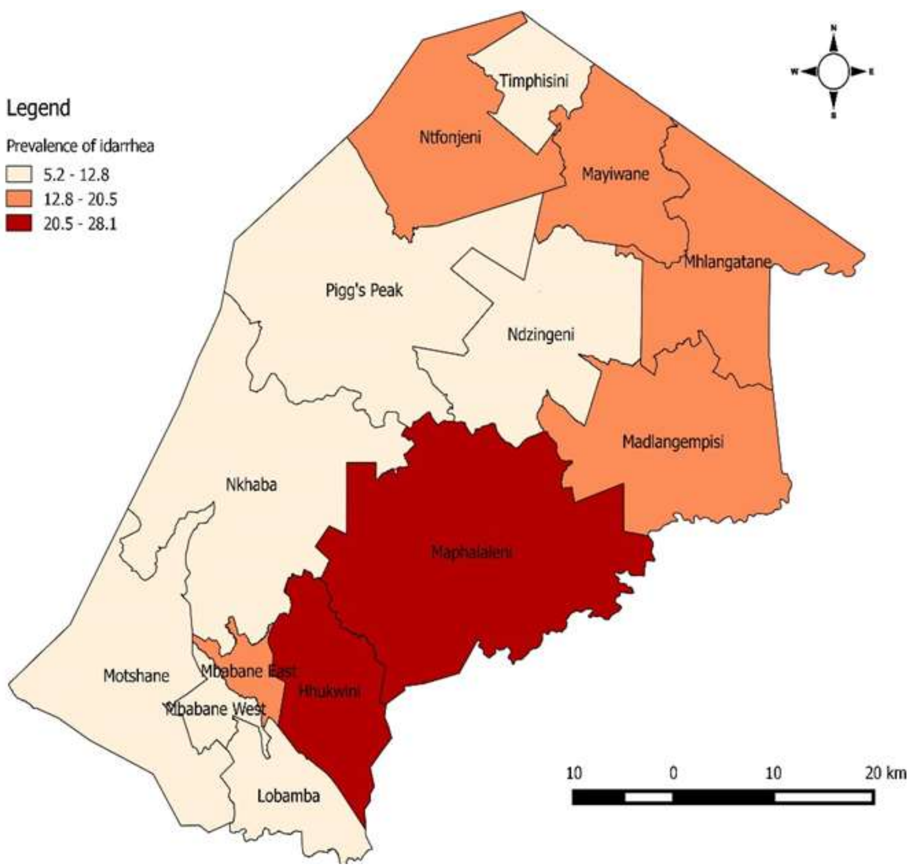


Figure 9. 2: Prevalence of diarrhoea by constituencies in the Hhohho region

Source: Plotted by Author

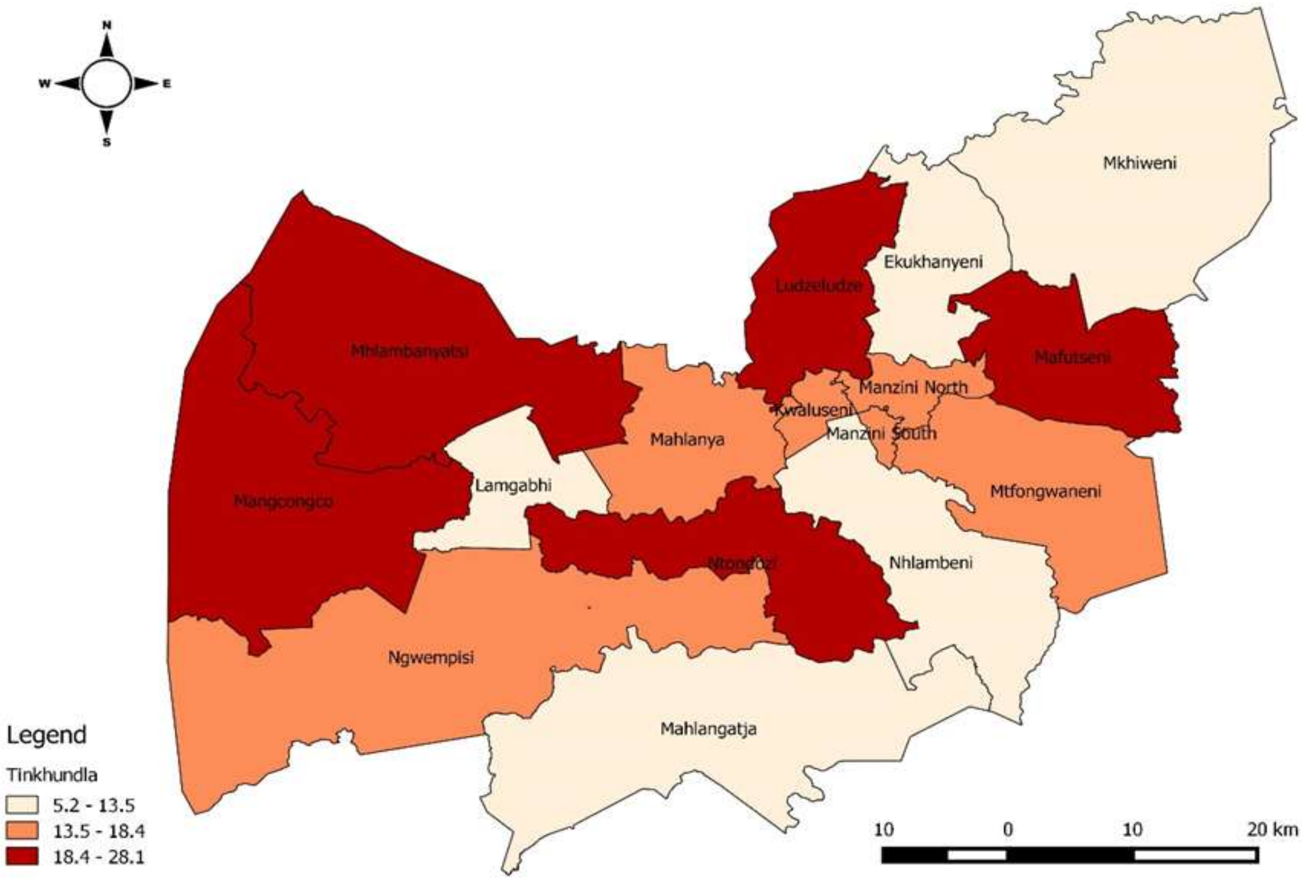


Figure 9. 3: Prevalence of diarrhoea by constituencies in the Manzini region

Source: Plotted by Author

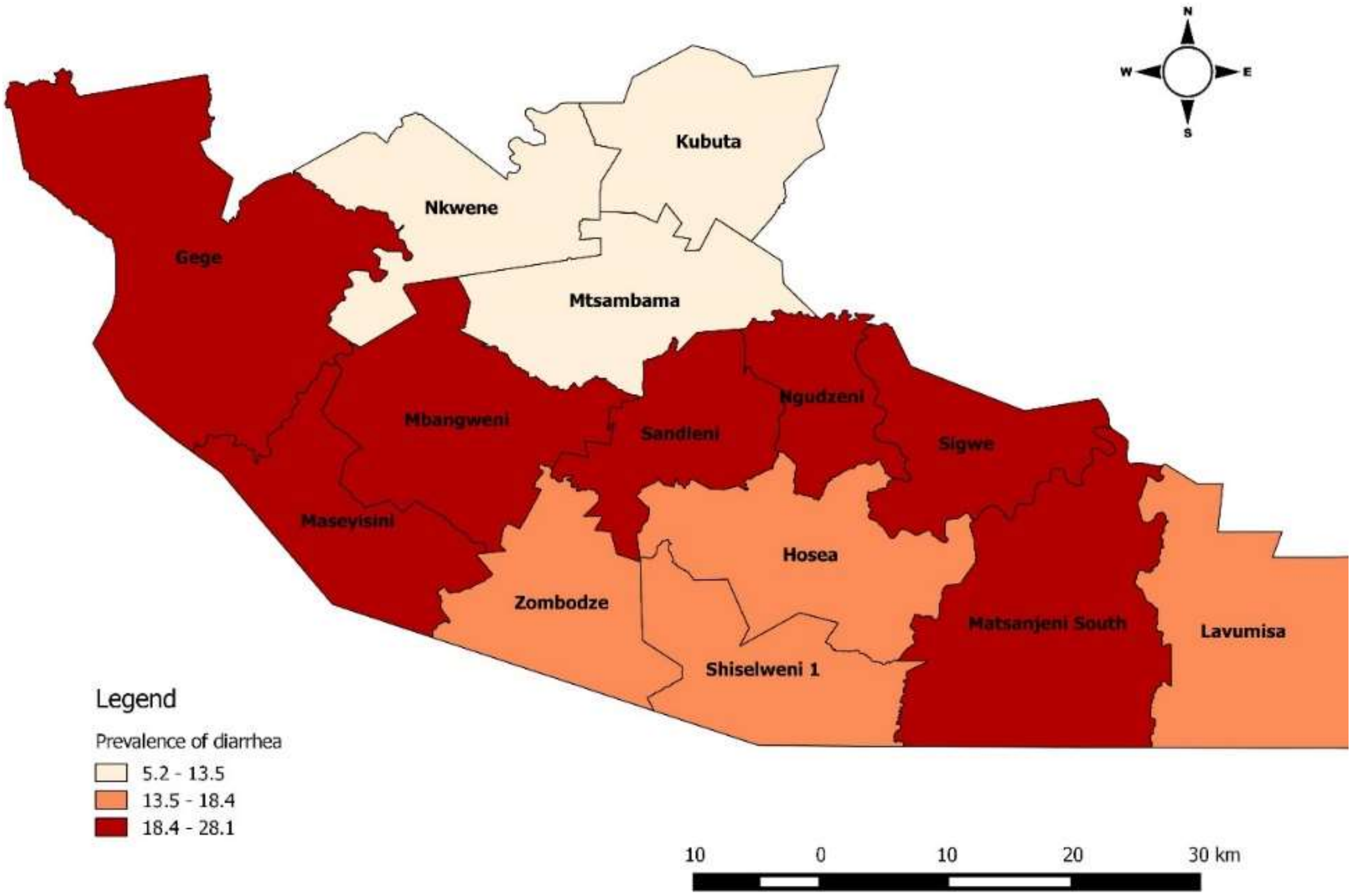


Figure 9. 4:Prevalence of diarrhoea by constituencies in the Shiselweni region

Source: Plotted by the Author

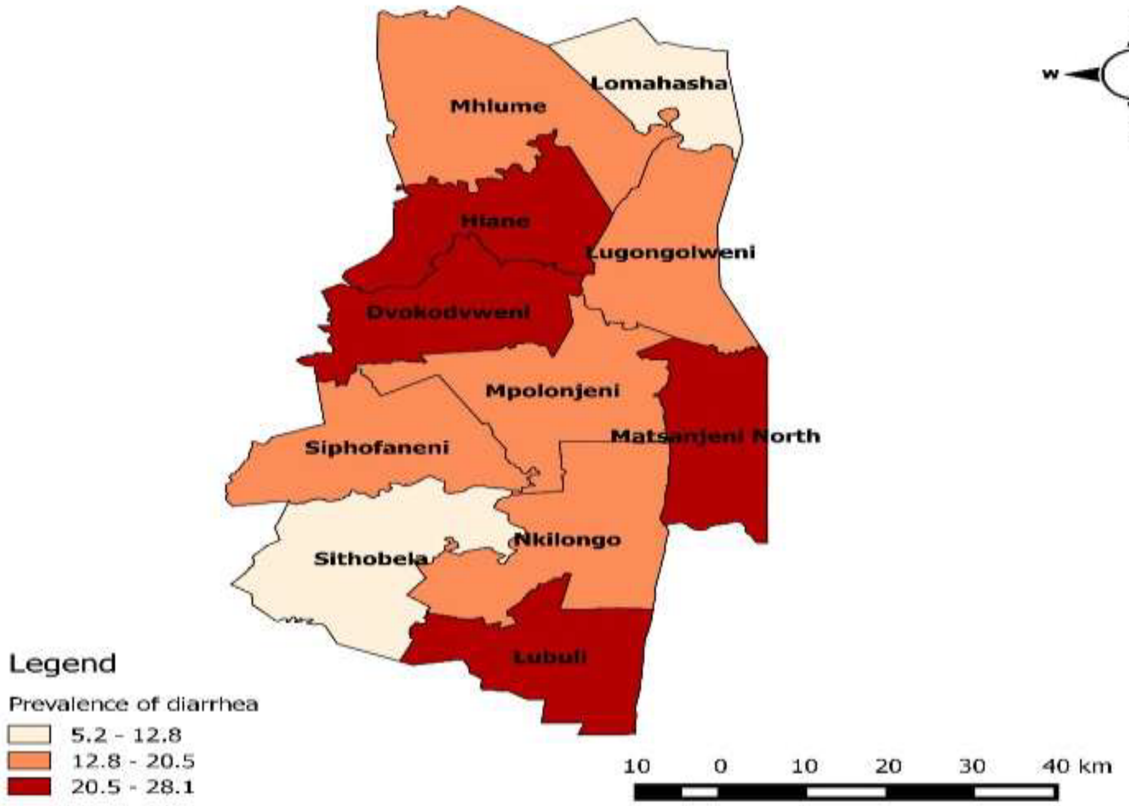


Figure 9. 5:Prevalence of diarrhoea by constituencies in the Lubombo region

Source: Plotted by Author

9.4 Mapping of the Prevalence of Acute respiratory infection by constituencies at a national level

To visualize the prevalence of ARI by constituencies, QGIS was used. The prevalence of ARI was presented through four (4) quartiles expressed by the colour and prevalence range. The three colours that were used to depict the deference of ARI in the constituencies were 1. **Red:** signified a prevalence of 31-46%, 2. **Peach:** present a medium prevalence of 15-21%. 3. **White**:

colour depicts the low prevalence of ARI of between 0.0-15%. Figure 9.5 below shows the prevalence of ARI by constituencies. The findings showed out of the 55 constituencies, 8 (15%) had a proportion of ARI between 31-46% (red colour).

A consideration of the proportion of ARI by constituencies further showed that of 55 constituencies 38 (69%) had a medium prevalence of ARI of between 15-31% (peach colour). Finally, it can be seen from figure 9.6 that of 55 constituencies 9(16%) had a low proportion of ARI of between 0-15% (white colour).

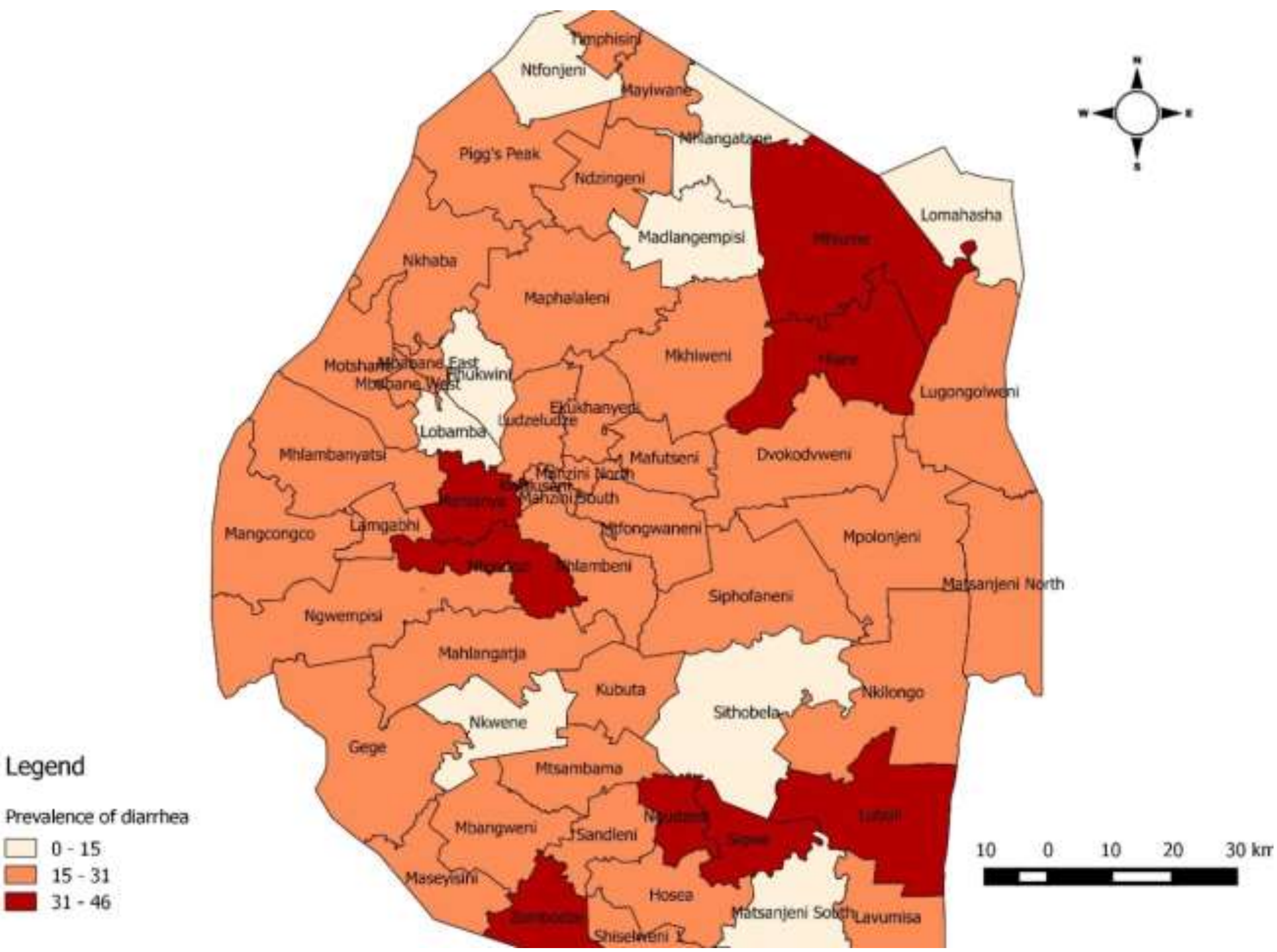


Figure 9. 6: The distribution of acute respiratory prevalence by constituencies

Source: Plotted by Author

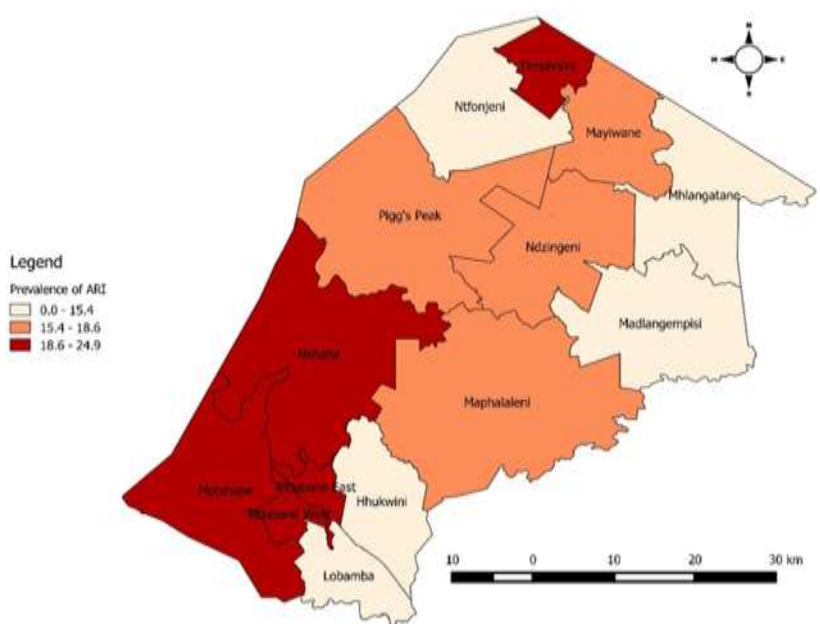
9.5 Mapping for childhood ARI by administrative region

The mapping of diarrhoea prevalence was also done by administrative regions. A prevalence of ARI from Figure 9.7 shows the prevalence of ARI for the Hhohho region. It can be seen in figure 9.7 that in the Hhohho region, out of 14 constituencies, 5(36%) of the constituencies (Motsane, Mbabane East, Mbabane West, Nkhaba and Timpisini) had a high prevalence of ARI between 18.6-24.9% (Red colour). Figure 9.7 further showed that 4 (29%) of the constituencies (Maphalaleni, Ndzingebni, Piggs Peak, and Mayiwane) in the Hhohho region had a medium prevalence of ARI of between 15-31% (peach colour). The results also showed that there were 5 (36%) of the constituencies (Lobamaba, Hhukwini, Madlangempisi, Mhlanagatane, and Ntfonjeni) in the Hhohho region had a low prevalence of ARI between 0.0-15.4%) (white colour).

An analysis of the Manzini region showed that out of 16 constituencies, 5 (31%) of the constituencies (Lamgabhi, Ntontozi, Mahlanya, Kwaluseni, and Mafutseni) had a high prevalence of ARI of between 25.2-33.3%) (red colour). It can be seen in figure 9.8 that there were 5(31%) of the constituencies (Nhlambeni, Manzini North, Ludzeludze, Ekukhanyeni, and Emkhiweni). There were 6(38%) of the constituencies in the Manzini region with a medium prevalence of ARI of between 19.8-25.2%) (peach colour). It can be observed in figure 9.8 that 6(38%) of the constituencies (Mahlangatja, Ngwempisi, Mangcongco, Mhlambanyatsi, Mtfongwaneni, and Manzini South had a lower prevalence of ARI between 0.0-19.8%) (White colour).

A consideration of the Shiselweni region revealed that out of 14 constituencies, 5 (36%) (Zombodze, Mbangweni, Ngudzeni, Sigwe and Kubuta) had a high prevalence of ARI of between23.6-46.2%. Only 3(21%). Only 3(21%) of the constituencies (Mtsambama, Shiselweni, and Hosea) had a medium prevalence of ARI of between 18.4-23.6%) (peach colour). A majority, 7(50%) of the constituencies (Lavumisa, Matsanjeni South, Sandleni, Maseyisini, Nkwene and Gege), had a low prevalence of ARI of between 0.0-18.4%(white colour).

The Lubombo region mapping of ARI showed that of 11 constituencies, 3(27%) (Lubuli, Hlane, and Mhlume) had a high prevalence of ARI between 31-46% (Red colour). A majority of the constituencies, 7(64%) had a medium prevalence of ARI between 15-31 %(Peach colour). Very few constituencies, 2(11%) in the Lubombo region had a low prevalence of ARI between 0-15% (White colour).



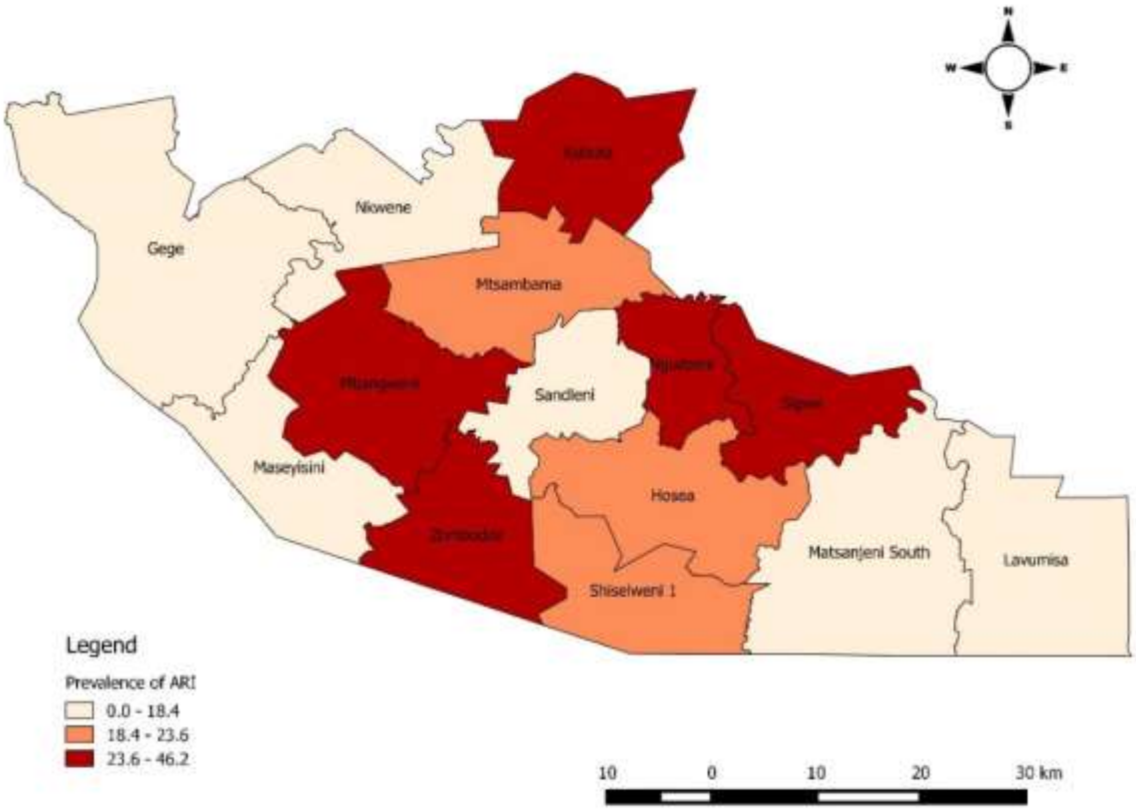


Figure 9. 7: Mapping of child ARI in the Hhohho region

Source: Plotted by Author

Figure 9. 8 Mapping of child ARI in Shiselweni

Source: Plotted by Author

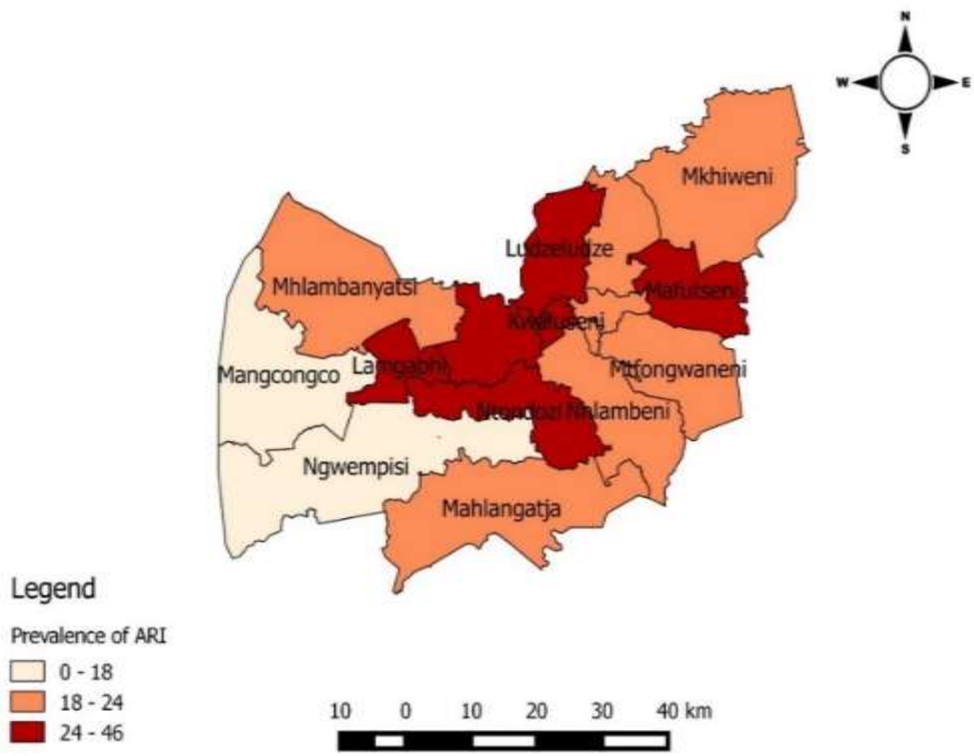


Figure 9. 9: Mapping of child ARI in the Manzini region

Source: Plotted by Author

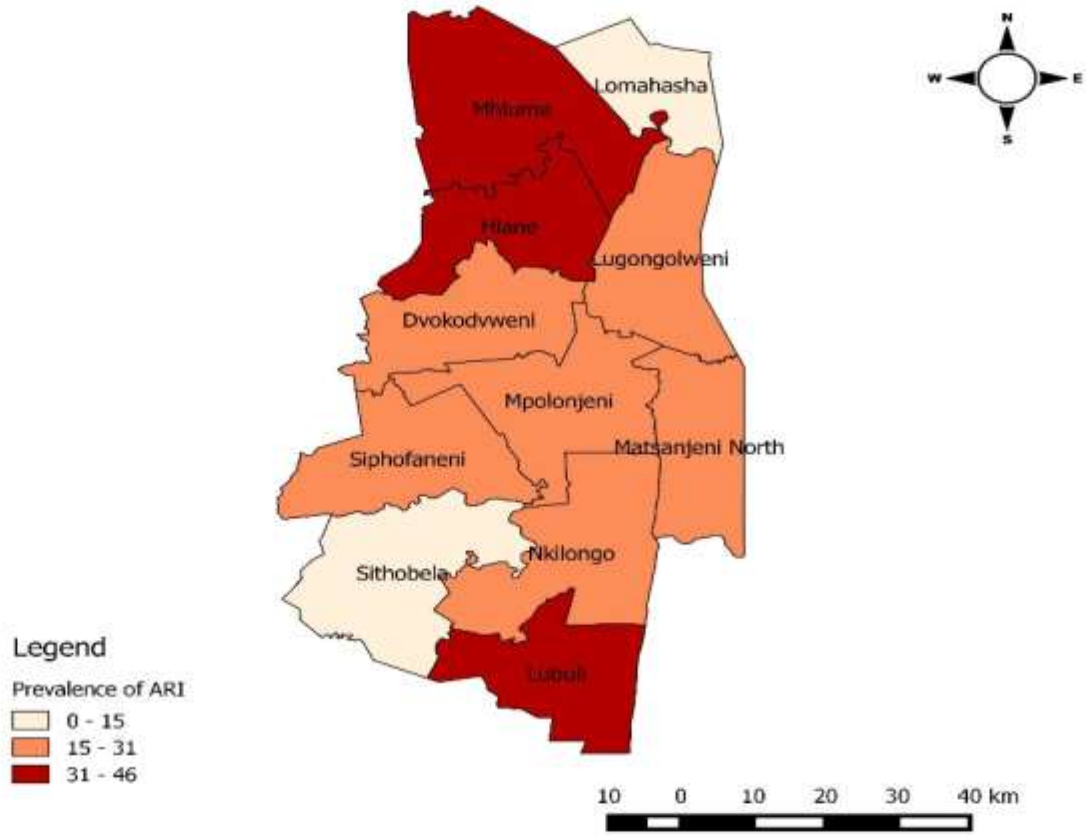


Figure 9. 10: Mapping of child ARI in Lubombo

Source: Plotted by Author

CHAPTER TEN

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

10.1 Introduction

The first objective was to determine the prevalence of childhood diarrhoea and ARI in Eswatini. The second objective investigated the individual, household and community level factors associated with childhood diarrhoea and ARI. Thirdly, the study aimed to determine the extent to which community-level factors account for variation in childhood diarrhoea and ARI and finally did a mapping at the constituency level for childhood diarrhoea and ARI.

This discussion chapter follows the sequence on the presentation of the findings from chapter four to nine. The first section discusses the prevalence of diarrhoea. The second section covers the individual, household and community level factors associated with childhood diarrhoea. The third section discusses the extent to which community level factors account for variation in childhood diarrhoea. The fourth section discussed the prevalence of ARI. The fifth section discusses the individual, household and community level factors associated with childhood ARI. The sixth section discusses the extent to which community level factors account for variation in childhood ARI. Section seven discusses the mapping of child diarrhoea and ARI. Section eight discusses the mapping of child ARI. Section nine discusses the study's contribution to the body of theory. Section ten discusses the strength and weaknesses of the study. Finally, section eleven presents the conclusions and recommendations of the study.

10.2 Discussion on the prevalence and levels of child diarrhoea in Eswatini

The study found that the magnitude of diarrhoea in Eswatini was 16.2% among under-five children. The magnitude of diarrhoea has increased from 13% in 2007 to 16.2% in 2014, revealing that diarrhoea remains a persistent problem in Eswatini (Eswatini Central Statistical Office, 2008). The scourge of diarrhoea has persistently affected several countries, especially sub-Saharan countries and South Asia (Walker, Rudan, Liu, Nair, Theodoratou, & Bhutta, 2013). A report on the progress of the country towards reducing child mortality due to diseases such as diarrhoea showed no remarkable reduction (Eswatini Governamnet, 2010). The problem of the poor progress towards the reduction of child mortality is not unique in Eswatini, a cross-sectional study done in 46 African countries revealed that the efforts and strategies aimed at reducing child morbidity and mortality from preventable diseases such as diarrhoea are not enough (Kipp et al., 2016). The results suggest that much need be done in the Kingdom of Eswatini to reduce the prevalence of diarrhoea to achieve SDG 3, to ensure healthy lives and wellbeing for all (UNDP, 2017).

The results revealed that diarrhoea prevalence was higher among children aged 6-11 months and 12-23 months, with growth deficit, given vitamin A, and were not breastfeeding during the survey, born to mothers aged less than 25 years and with primary level education, children living in a household with no toilet facility and practiced unsafe child stools disposal, and from communities with a high prevalence of diarrhoea.

10.3 Discussion among individual, household, and community level factors associated with child diarrhoea

In the single multivariate logistic regression, the study found that at the individual level, only child age was associated with child diarrhoea. The findings revealed that children aged 6-11 months and 12-23 months had higher odds of reported diarrhoea. Previous research supports the study findings that children aged 6-23 months generally have higher odds of diarrhoea compared to children under 6 months` (Melese et al., 2019; Yadav & Kesarwani, 2015). The results contradicts a study done in Thailand where children younger than 6 months were more likely to be infected with diarrhoea (Wilunder and Panza,2009). Similarly a study conducted in Tanzania found a negative relationship between child child diarrhoea and child age (Kawakatsu et al.2017).

The study found that children born to households with a pit latrine and no toilet facility had higher odds of diarrhoea compared to those from households with a flush toilet. The influence of toilet facility on child diarrhoea has been documented in the literature (Bizuneh, Getnet, Meressa, Tegene, & Worku, 2017; Gunsa, Rodamo, & Dangiso). A study done in Ethiopia found that children from households without a latrine toilet had reduced odds of diarrhoea compared to those with a latrine toilet (Gedamu, Kumie, & Haftu, 2017). Poor sanitation has been documented in the literature to be among the drivers of child morbidity and mortality especially in developing countries (Overbey, 2008).

The study found that children from households where child stools were not disposed safely were 92% more likely to have diarrhoea compared to children from households where child stools were disposed safely. Several authors have researched the importance of disposal of child stools in explaining the occurrence of child diarrhoea (Bawankule et al., 2017; Zedie & Kassa, 2018). In India, the risk of diarrhoea was higher among children whose stools were disposed unsafely (Bawankule et al., 2017). Similar results were found in Bangladesh, where the odds of diarrhoea were higher among children that disposed child stools, unsafe relative, to those whose stools were disposed safely (Islam et al., 2018).

10.4 Discussion of the effect of contextual determinants on variation in child diarrhoea

The third objective of the study was to determine the extent to which community level factors account for variation in child diarrhoea. The multilevel modelling approach was applied to identify the determinants of child diarrhoea. The multilevel logistic regression was used to test how much of the child diarrhoea is explained by individual, household and community level factors. The study findings showed that the variation of child diarrhoea could be explained jointly by individual household and community level factors.

The findings produced both association (fixed effects) and variance (random effects) of child diarrhoea in the multilevel model. With regard to the contribution of individual-level factors, the study findings showed that there was a significant variation of diarrhoea across communities that can be explained by child-level factors. Even after adding the household and community level factors, the study found that child age and maternal education explained the variation of diarrhoea.

Children age 6-11 months and 12-23 months had a higher risk of reported diarrhoea compared to children aged less than 6 months. Previous studies done elsewhere found that children aged above 6-23 months had a higher risk of diarrhoea (Vasconcelos et al., 2018; Yadav & Kesarwani, 2015). This might be due to the loss of immunity of the children due to decreased antibodies conferred from the mother and the introduction of foods that may be contaminated with bacteria and contact with human or animal excreta. After 6 months most children are introduced to complementary feeding which may be prepared under unhygienic conditions that predispose children to diarrhoea. The decrease in the risk of diarrhoea after 23 months could be due to that the children develop immunity after repeated infections to diarrhoea (Azange et al. 2016). Contrary, a study done in Ethiopia found that children less than 6 months were more at risk if child diarrhoea (Alemayehu, Ayele, Kloos and Ambelu, 2020). One possible explanation could be that children under 6 months could be initiated on complementary feeding under unhygienic conditions.

Children born to women with tertiary education were found to have lower odds of reported diarrhoea. The positive effect of mothers' education has long been recognised to reduce childhood diarrhoea, as several studies have explored the linkage between educated mothers and childhood diarrhoea (Inayat Shukr et al., 2009; Mohammed & Tamiru, 2013). However, after adding household and community level factors in the multilevel model maternal education was no longer significant. A similar relationship between maternal education and child diarrhoea was observed in Kenya (Kawakatsu et al., 2017). However, the study findings showed that a significant association between maternal education and child diarrhoea reduced to non-significance in the final model. The positive effects of maternal education in reducing the odds of child diarrhoea turn to be realized in economically affluent communities but has less effect in poor communities (Dargent-molina, Shermana, Strogatz', & Savitz', 1994). The lack of association of between maternal education level and child diarrhoea in the final multilevel model has been found in a study done in Ethiopia (Alemayehu, Ayele, Kloos and Ambelu, 2020).

The current height for age (stunted) became significant when the household and community level factors were added. Findings from Brazil showed that children with a low height for age and those with above normal height for age were less likely to have diarrhoea (Vasconcelos, Rissin, Figueiroa, Lira, & Batista Filho, 2018).

Considering the contribution of household level factors in explaining the variation of child diarrhoea, the study showed that the intra community variance was significant to explain child diarrhoea across communities. The results suggest that at the household level, type of toilet facility and disposal of child stools were important in explaining the variation of child diarrhoea. Even after including individual and community level factors, children from households with no toilet facility were more at risk of having reported child diarrhoea. Prior studies documented the importance of the type of toilet facility in explaining child diarrhoea (Azage et al., 2016; Komarulzaman et al., 2014). In Ethiopia, children that were from households that didn't have a toilet facility were 143% more at risk of having reported diarrhoea (Azage et al., 2016). Contrary, a study conducted in Ethiopia found reduced likelihood of having diarrhoea among children from households with unimproved latrine facilities (Alemayehu, Ayele, Kloos and Ambelu, 2020).

At the household level, the disposal of child stools was found to be an important variable to explain the variation of child diarrhoea. Children from households that practiced unsafe disposal of child stools were 113% more likely to have reported diarrhoea. The importance of the disposal of child stools has long been documented in the literature. Unsafe disposal of child stools was found to be associated with diarrhoea in India (Bawankule et al., 2017). The odds of contracting diarrhoea were higher among children where stools were not disposed properly compared to children whose stools were disposed properly (Bawankule et al., 2017). However, when the individual and community level factors were added in the model, the risk of having diarrhoea was reduced to non-significance, implying that, some of the individual and community level factors were correlated with child diarrhoea and any other variable in the individual and community level (Akinyemi & Morakinyo, 2018). Hence, the results don't mean that the practices of disposal of child stools is not important in explaining the occurrence of child diarrhoea, but the adjusted model presented a different pathway of interaction in the adjusted model. Improper disposal of child faeces contaminate the environment; hence a child crawling and playing nearby could be predisposed to diarrhoea. However, there was no significant association between child stool disposal and diarrhoea in a cross sectional study in Ethopia (Solomon & Abulie, 2018)

Considering the contribution of community-level factors in explaining the variation of child diarrhoea, the study showed that the intra community variance was insignificant and small to have a significant effect to explain child diarrhoea in communities. The results of the study are inconsistent with prior studies (Messelu & Trueha, 2016; Zicof, Sri Rahardjo, & Murti, 2018). The results suggest that as much as clustering of diarrhoea was observed across communities, but community level factors cannot explain a significant fraction of the variation of diarrhoea**.** This can be partly explained that there is homogeneity in the exposure to diarrhoea across the communities**.** Therefore, individual and household factors are important in explaining the variation of reported diarrhoea in the community in Eswatini.

10.5 Discussion on the mapping of the prevalence of diarrhoea by constituencies

The objective of the study was also to identify the clusters or communities that have a higher burden of childhood diarrhoea. The prevalence of diarrhoea was mapped at a constituency level to help understand the magnitude of diarrhoea using colours and proportions. The study revealed an unequal severity of diarrhoea prevalence across the constituencies. The severity of diarrhoea was most pronounced in the Manzini region and the Shiselweni region when compared to the Hhohho region. A total of 31% of the constituencies had a high prevalence of diarrhoea of between 18.4-28.1% in the Manzini region. A consideration of the Shiselweni region revealed that 50% of the communities had a high prevalence of diarrhoea between 18.4-28.1%. The variation of the prevalence of diarrhoea across the regions may be due to the difference in the socio-economic development of the regions, mainly the Hhohho region with low child poverty (Imai, 2009). The variation of child diarrhoea was also observed in regions of low socioeconomic status (Bosetti et al., 2001; Solomon & Abulie, 2018). A study conducted in Ghana found that the variation of the severity of diarrhoea across the communities and regions was due to the clustering of the environmental and sociodemographic factors across the disadvantaged areas (Bosetti et al., 2001). For instance, in the Shiselweni region, high diarrhoea severity was observed among rural communities.

The results have an epidemiological implication suggesting that the transmission of diarrhoea across the constituencies is largely influenced by the varying nature of the risk factors of diarrhoea (Bosetti et al., 2001). Rural areas turn to have the poor with low education level and poor access to medical care being clustered in rural areas (Pereira et al., 2004). The environments where the children reside play a critical role in child survival (Akoto & Tambashe, 2002).

10.6 Discussion on the prevalence of child ARI in Eswatini

ARI has long been documented to be a major cause of child morbidity and death, especially in developing countries (Kipp et al., 2016). The study found that the magnitude of ARI in Eswatini was 20.9% among under-five children. The results suggest that Eswatini still have a high proportion of ARI**.** Similar results were reported in Malawi, where the prevalence among under 5 children was 32% (Cox et al., 2017)**.**

The prevalence of ARI was found to vary by several factors. The study reported that the prevalence of ARI was high among children aged 6-11 months, and 24-35 months, born to women with no education level or had primary education level, from households with a shared toilet facility, from households with no electricity, resided in urban areas, from the Manzini region and communities with low proportion of women with at least secondary education.

10.7 Discussion of individual, household, and community level factors associated with child ARI.

In the single level multivariate logistic regression, the study found that at the individual level child age and maternal age were associated with child ARI**.** The findings revealed that children aged 6-11 months had 52% increased odds of reported ARI compared to those aged under 6 months. The results of the study are in line with results from Iraq, where children aged 6-11 months were 49% more likely to have reported ARI compared to those aged under 6 months (Siziya et al., 2009). Similarly, in Ghana, a cross-sectional study found that children aged 6-11, 12-23, and 24-59 months had a higher risk of ARI, relative to children aged 0-5 months (Amugsi et al., 2015).In Egypt a cross sectional study found that children aged 6-23 months had a higher risk of ARI compared to those less than 6 months (Abdel-Kahalek and Abdel-Salam, 2016).

Similar to studies conducted elsewhere, maternal age was found to be significantly associated with child ARI. Mothers aged 25-34 years had a significantly higher odds of children with ARI relative to those aged less than 25 years. The results are in line with the findings found in Colombia, suggesting that the odds of ARI were higher among children born to women aged 20 years and above (Cárdenas-Cárdenas, Castañeda-Orjuela, Chaparro-Narváez, & Hoz-Restrepo, 2017). There was no significant association in a study done in Kenya between child ARI and maternal age (Muthoni and Ngesa, 2017).

The adjusted model further showed that at the household level, shared toilet with neighbours, and household wealth index were important factors that explained child ARI. Children from the poor households were more likely to have ARI. Children from households categorised under the middle wealth index had lower odds of having ARI when compared to those from the poorest households. Similar findings were found elsewhere (Akinyemi & Morakinyo, 2018; Azad, 2008). In a study done in Nigeria, the risk of ARI was high among children from the poorest and poor households when compared to the richest households (Akinyemi & Morakinyo, 2018;

Azad, 2008). In Bangladesh, children from disadvantaged households had 29% increased odds compared to children from well off households (Azad, 2008).

The study also found a shared toilet with neighbours to be an important factor influencing child ARI. However, few studies or none that were found in the literature investigating the relationship between shared toilet with neighbours and child ARI. Never the less children from households with a shared toilet with neighbours were found to have higher odds of ARI relative to those who did not.

The findings of the study showed that children who resided in the Hhohho region were less likely to have ARI compared to children in the Lubombo region. The Lubombo region has been cited as the most underdeveloped region and with the worst estimate of child poverty (Imai, 2009). Even though the Manzini region was not significant in the adjusted model, children who resided in the Manzini region were 4% more likely to have ARI compared to children from the Lubombo region. Region of residence has been found in several studies to be very important determinants of child ARI (Adesanya et al., 2017). In Nigeria child, ARI was significantly different by region of residence. Children from the north east and south of Nigeria had greater odds of ARI relative to children from the South west region (Adesanya et al., 2017). Region or place of residence is important since diseases turn to follow the socioeconomic gradient, where poor regions turn to observe higher risk of diseases relative to well off regions (Wuraola, 2016). Individuals who share similar socioeconomic class and status turn to reside in one location (Bernarda et al., 2007).

10.8 Discussion on the effect of contextual determinants on variation in child ARI

To understand the interplay and variation of child ARI, multilevel modelling was used. The third objective of the study was to determine the extent to which community level factors account for variation in child ARI. The multilevel logistic regression was used to test how much of the child ARI was explained by individual, household and community level factors. The study findings showed that the variation of child ARI is explained jointly by individual, household and community level factors.

The findings produced both fixed effects and random effects of child ARI in the multilevel model. With regard to the contribution of individual level factors, there was a significant and large amount of the variation of ARI across communities that can be explained by child-level factors. At the individual level, only the reported child birth size was found to be associated with child ARI. Low birth weight remains a public health concern and should remain a priority to prevent child morbidity and mortality (Vaidya, 2008). The study found that children who were very large or larger than average had 43% increased odds of having reported ARI compared to those that were smaller than average /very small. However, after including household and community level factors, the relationship between childbirth size and ARI was reduced to be insignificant. Similarly, a study done in Cameroon found no significant relationship between child birth weight and reported ARI (Tazinya et al., 2018).

Considering the contribution of household level factors in explaining the variation of child ARI, the study showed that the intra community variance was significant and large to have a significant effect in explaining child ARI across communities. The results showed that children who resided in households that were in the middle socioeconomic status and had less than three children sleeping per room had a lower risk of having reported ARI. Even after the inclusion of individual and community level factors children who resided in households with middle wealth index had 41% reduced odds of having ARI when compared to children from the poorest households. Prior studies had documented that the household wealth index is instrumental in explaining child ARI (Azad, 2008; Thorn et al., 2011). ARI is characterized as a disease of poverty since it is more prevalent in economically disadvantaged communities (Thorn et al., 2011). In Brazil, it was noted that children residing in households of high socioeconomic status were less likely to experience ARI compared to those residing in households of poor socio-economic status (Thorn et al., 2011). In a multivariate analysis of a secondary data in Rwanda, it was reported that children who resided in households with poor socioeconomic status were 27% more likely to have ARI compared to a household with high socio-economic status (Harerimana et al., 2016). The findings are in agreement with the literature; poor home environments predispose children to illnesses. Poor economic conditions and environment strongly present a hazard for health and often present with poor health care (Ujunwa & Ezeonu, 2014).In Nigeria there was no significant association between child ARI and community wealth index(Adesanya and Chio,2016).

The variation of child ARI across communities was also found to be explained by the number of children sleeping per room. The results showed that the odds of having ARI were higher for children where children sleeping per room were 3 to 4 relative to those less than three. However, after adding the individual and community level factors the significance of the number of children sleeping per room reduced to non-significance, implying some of the individual and community level factors were confounders (Akinyemi & Morakinyo, 2018). Hence, the results do not imply that the number of children sleeping room is not instrumental in explaining the occurrence of child ARI, but the controlled model presented a different pathway of interaction between the number of children sleeping per room and child ARI.

Considering the contribution of community-level factors in explaining the variation of child ARI the study showed that the intra community variance was significant and large, suggesting the importance of place of residence, region of residence, proportion of mothers with at least secondary education in the community were very important in explaining the variation of child ARI across the communities.

A consideration of the place of residence, the results found that children who resided in rural areas had 20% reduced odds of ARI compared to those who resided in urban areas. This may be due to the fact that health outcomes vary according to how well is the environment where people live (Bernarda et al., 2007). A cross-sectional study conducted in India found that the prevalence of ARI was approximately 60% in rural areas while in urban areas was 64% (Kumar et al., 2015). Evidence documented in Kenya detailed that children who resided in slums were found to have a higher mortality rate compared to children in non-slums (Montgomery, 2009). However, after adjusting for individual and household level factors place residence was non-significant. This implies that it might have been confounded by the individual and household factors that changed the pathways of the relationship between place of residence and ARI (Akinyemi & Morakinyo, 2018). Therefore, the results don't suggest that the place of residence is not important in understanding the risk of ARI.

A consideration of the region of residence in influencing the variation of child ARI, the study found that even after adding individual and household level factors in the model, children who resided in the Hhohho region had 42% reduced odds of ARI compared to those in the Lubombo region. Prior studies had documented the importance of the region of residence in explaining the variation of child ARI (Adedini, Odimegwu, Imasiku, Ononokpono, & Ibisomi, 2015; Oluwafunmilade et al., 2016). The Hhohho region is developed compared to the Lubombo region (Imai, 2009).

Furthermore, the results found that the variation of child ARI can be explained by the proportion of maternal education in the community. The findings showed that children from communities with a high proportion of mothers with at least secondary education had 27% reduced odds of having reported ARI relative to children from communities with a low proportion of women with at least secondary education. However, after adjusting for individual and household level factors, place of residence was not significant. This implies that it might have been confounded by the individual and household factors that changed the pathways of the relationship between the proportion of mothers with at least secondary education in the community and ARI. Evidence from the literature has long established the relationship between maternal education and child survival (Azad & Rahman, 2009). The importance of maternal education and severe acute respiratory infection was tested among children aged 0-59 months in Bangladesh (Azad, 2008; You et al., 2015). The study found that children who were born to mothers with less than secondary education level were 79% more likely to have severe ARI compared to children born to mothers with a secondary and higher level of education (Azad & Rahman, 2009).

The study also observed that the variation of child ARI was not entirely explained by the individual, household and community level factors. It can be learnt from the study that there may be some factors that explain the variation of child ARI across communities that were not measured in the study, suggesting that the variation of child ARI is not only a result of the individual, household and community-level factors measured in the study but some variables not measured may be important to explain child ARI. Previous studies that applied the multilevel approach to measure child ARI deduced similar findings (Cárdenas-Cárdenas et al., 2017; Harerimana et al., 2016). The unmeasured factors, which might have an effect on child ARI, may include climate, lifestyle factors, Physiological factors, HIV status.

10.9 Discussion on the mapping of the prevalence of ARI by constituencies at a national level

The objective of the study was also to identify the clusters or communities that had a higher burden of childhood ARI. The prevalence of ARI was mapped at a constituency level to help understand the magnitude of ARI using colours and proportions. The study revealed an unequal severity of ARI prevalence across the constituencies. The severity of ARI was equally distributed across three regions. In the Hhohho region, about 36% of the constituencies had a high prevalence of ARI between 18.6%-24.9%, Manzini region about 31% of the constituencies had a high prevalence of ARI between 25.2% to 33.3%, Shiselweni region had about 36% of the constituencies with a high prevalence of ARI of between 23.6-46.2%, while the Lubombo region had 27% of the constituencies with a high prevalence of ARI of between 15%-31%. The difference in the prevalence of ARI across the regions in the communities may be due to the variability in socioeconomic status as well as the climatic characteristics of the regions and communities (Ann Muthoni, 2017). It was observed that the prevalence of ARI in the study was

20.9%; however, three of the regions Manzini, Shiselweni, and Lubombo region were above the prevalence. The government need to prioritize these regions, specifically the communities in these regions and reduce the risk of ARI. The variation of the prevalence of ARI is not unique in Eswatini, in Kenya; approximately 18 provinces had prevalence above the national level (Ann Muthoni, 2017)

10.10 Contribution of the study to the understanding of child diarrhoea and ARI

The theoretical framework developed by Mosley and Chen guided the study. A well-developed theory is expected to reveal how and why particular factors lead to the occurrence of a disease. Through the model developed by Mosley and Chen, the thesis aimed to validate the application of the single and multilevel models and test hypotheses on the importance of community-level factors in explaining childhood diarrhoea and ARI.

The study has contributed to knowledge in several ways. The investigation of child diarrhoea and ARI has been under-researched in Eswatini. To the knowledge of the researcher; this is the first study to investigate the factors associated with child diarrhoea and ARI let alone to test the importance of the community level factors. Child health is important in Eswatini since the country is part of the global agenda on sustainable goals. Therefore, to understand the magnitude and the determinants of child diarrhoea and ARI is of utmost importance if the country has to meet the 2030 agenda on SDGs. Applying the single-level logistic regression, the study contributed to the understanding of the determinants of diarrhoea and ARI in Eswatini. At the individual level, the findings showed that child age, child height for age, a child is given vitamin

A; current breastfeeding status, maternal age, and maternal education were significantly associated with child diarrhoea.

At the household level, the study found that the type of toilet facility and child disposal practices were very critical to explain the occurrence of diarrhoea in Eswatini. At the community level, the study contributed that the prevalence of diarrhoea at the community is very important to explain the risk of occurrence of diarrhoea among children.

The study followed the Mosley and Chen's framework to understand the effect of contextual determinants on the variation in child diarrhoea. The study results seem to agree with the conceptual framework proposed by Mosley and Chen that individual level, household and community level characteristics are important to explain the variation of child diarrhoea at the community. Therefore, the study makes contributions that at the individual level child age, maternal education and child height for age explain the variation of child diarrhoea. At the household level, the variation of child diarrhoea was explained by the type of toilet facility and disposal of child stools. The study has contributed that the risk of diarrhoea was high for children without a toilet facility and practiced unsafe disposal of child stools disposal, implying the need for the country to ensure that programs aimed at ensuring all households own a standard toilet facility and dispose child stools properly are put in place.

Essentially, the study aimed to demonstrate the importance of community level factors. The study contributed that the overall community diarrhoea and region of residence were very important to explain the variation of diarrhoea across the community.

The study also contributed to the understanding of factors that are important in explaining the risk of reported acute respiratory infection in Eswatini. To the knowledge of the researcher, it is the first study in Eswatini to have measured the importance of community level factors. Guided by the conceptual framework developed by Mosley and Chen, the study made some theoretical contribution that the individual, household and community-level factors are all important in explaining the variation of child ARI in the community. The result in chapter 7 and 8, showed that children with small birth size and born to mothers aged 25-34 had higher odds of having ARI. It was found in the study that children that resided in the poorest households had higher odds of having ARI.

The focus of the study was to investigate the importance of community level variables in explaining the variation in child ARI. The study found that the area of residence, the region of residence and the proportion of women with at least secondary education were important factors to explain the risk of reported ARI as suggested by the conceptual framework.

The study contributed to knowledge through the use of neighbourhood factors to understand their importance explaining the risk of diarrhoea and ARI and the use of multilevel logistic regression. The application of a multilevel analysis incorporates the complex relationship and interaction that exist between the child and their neighbourhood (Adenini, 2013). The study contributes to evidence in Eswatini by investing the factors associated with ARI beyond the individual and household level factors by incorporating the neighbourhood characteristics (Adenini, 2013; Osumanu, 2007; Yadav & Kesarwani, 2015). Few studies or none in Eswatini has investigated the importance of the neighbourhood characteristics on the occurrence of child diarrhoea and ARI.

10.11 Strength and limitations of the study

The study used a nationally representative survey. The MICS is representative of the entire population hence make it possible to generalize the study results to the entire population. The study pooled two surveys to enhance the sample size. An adequate sample size ensures that the study has the power to determine the significant difference when it truly exists and avoid type II error and increase the accuracy and precision of the study estimates (Lewis & Mason, 2017). The two-pooled surveys were from the MICS 2010 and 2014 and had similar sampling methodology.

The study employed two analysis methods to understand the determinants of diarrhoea and ARI. The single-level and multilevel logistic regression were used to answer the research questions of the study. The two methods triangulate each other. The application of the multilevel logistic regression approach may be regarded as strength for the study. Multilevel analysis control for the variation or clustering of the outcome variables within communities compared to the single-level approach. Single level models are found wanting to explain the complex relationship that the child has with the mother, the household, and the community where the child resides (Griffiths et al., 2004; Hox, 2002). Most studies done elsewhere applied the single level analysis that ignores the hierarchical nature of the national health surveys (Adenini, 2013; Osumanu, 2007; Yadav & Kesarwani, 2015). Therefore, the application of multilevel logistic regression in the study provides a better understanding of the variability of diarrhoea and ARI across the community, household and individual factors.

The use of geographical maps to show the distribution of diarrhoea and ARI across communities could also be regarded as strength for the study. The mapping of child diarrhoea and ARI provided a better understanding as to where most of the cases were found.

Regardless of the strength of the study, the results need to be interpreted within the context of several limitations. The mothers or caregivers who reported on the child diarrhoea and ARI could have suffered from recall bias, which leads to misclassification error (Althubaiti, 2016). Diarrhoea. The study is cross-sectional, which presents major limitations of establishing causation between the predictors and diarrhoea or ARI.

The mothers/caregivers used their perception to report on the size of the baby at birth. This could present an error, as it is challenging to validate the perception of the mother on the childbirth size if indeed was correct. However, this could not have a major limitation since this variable has been used even in other studies of this nature (Adedini, 2013; Huong, 2014).

To generate the community level variables, the enumeration area (EA) referred at the Primary sampling unit (PSU) was used to aggregate the individual and household level variables. The process of aggregation into the various PSUs may have resulted in misclassification. Nonetheless, a test for multicollinearity and back wide selection regression procedure was applied before the models were fitted.

The study also presents limitations in terms of the individual, household and community characteristics not explaining entirely the variation of child diarrhoea and ARI, meaning there may be important factors that were not included in the model. The factors not included may be sociocultural factors, genetic factors and HIV status that were not in the MICS dataset. Nonetheless, these shortcomings could not have great shortcoming on the accuracy and precision of the study estimates.

10.12 Conclusions, recommendation and policy implications

10.12.1 Conclusions on child diarrhoea

The study aimed to answer four research questions: 1. what is the prevalence of childhood diarrhoea? 2. What are the individual, household and community level factors associated with childhood diarrhoea? 3. To what extent do community level factors explain variations in childhood diarrhoea? 4. Which clusters or communities have a higher burden of childhood diarrhoea?

The study demonstrated that the prevalence of diarrhoea and ARI are still very high and a persistent public health problem in Eswatini. The causes of the high magnitude of diarrhoea and ARI vary by individual, household and community factors. For example, a quarter of the children aged 12-23 months had diarrhoea while three in ten children among those 6-11 months had diarrhoea.

The second objective sought to determine the individual, household and community level factors associated with childhood diarrhoea? The study concluded that at the individual level, only child age was associated with child diarrhoea. Children aged 6-11 months and 12-23 months had higher odds of diarrhoea when compared to those aged less than 6 Months. At the household level, the results concluded that the risk of diarrhoea was high among children from a household without a toilet facility and didn't dispose child stools safely.

For community level factors, the region of residence and overall community diarrhoea were significantly associated with diarrhoea. The study found reduced odds of diarrhoea among children that resided in the Shiselweni region relative to the Lubombo region. However, children who resided in communities with a medium and high overall community had increased odds of diarrhoea when compared to children from communities with low overall community diarrhoea

The thesis also aimed to address the objective, to what extent do community level factors explain variations in childhood diarrhoea? To address the research, question the study aggregated the individual and household level factors by primary sampling unit to create the community level characteristics. Children who resided in the Hhohho region had a higher risk of diarrhoea relative to the Lubombo region. The risk of diarrhoea was higher among children communities with the high and medium prevalence of diarrhoea. Therefore, the study managed to prove that the region of residence and overall community diarrhoea were associated with an increased likelihood of diarrhoea among the children.

The final objective was to map the clusters that had a higher prevalence of diarrhoea. The study provided evidence that the Hhohho region had two constituencies, namely Maphalaleni and Hhukwini, had a higher burden (colour red) of diarrhoea. In the Manzini region, 5 constituencies had a higher burden of diarrhoea, (painted red) namely Mangcongco, Mhlambanyatsi, Ludzeludze, Ntontozi and Mafutseni. In the Shiswelweni region, the burden of diarrhoea was higher among sevenconstituencies, namely Gege, Mbangweni, Maseyisini, Sandleni, Ngudzeni Sigwe, and Matsanjeni south. In Lubombo region, the burden of diarrhoea was higher at Lubulini, Matsanjeni South, Dvokodvweni, and Hlane. The results give evidence and important information on the more problematic constituencies that should be targeted to mitigate the problem of diarrhoea

10.12.2 Conclusions on child ARI

The study aimed to answer four research questions on child ARI: 1. what is the prevalence of childhood ARI? 2. What are the individual, household and community level factors associated with childhood ARI? 3. To what extent do community level factors explain variations in childhood ARI? 4. Which clusters or communities have a higher burden of childhood ARI?

With regard to acute respiratory infection, the study concluded that the prevalence of ARI was high. The problem of ARI among under-fives has generally been documented in developing countries (Kipp et al., 2016). The prevalence of ARI was higher among children aged 6-11 and 23-35 months. The study concluded that the prevalence of ARI reduced with the maternal education level. The prevalence of ARI was higher among children that resided in urban areas. The prevalence of ARI was higher in the Manzini region than in the Lubombo region.

In an attempt to answer research question number two, which is to determine the individual, household and community-level factors associated with child ARI, the conclusion drawn from the study was that children aged 6-11 months and born to mothers aged 25-34 months had increased odds of ARI. At the household level, children who resided in the Hhohho region and shared toilet with neighbours had reduced odds of ARI.

Objective four of the study was to determine the individual, household and community factors that are important in explaining the variation of ARI. It can be concluded from the study that jointly individual, household and community level factors are important to account for the variation in child ARI. The study managed to establish that childbirth size, household socioeconomic status, number of children sleeping per room were important to explain the variation of ARI. It was deduced from the study findings that place of residence, the region of residence and the proportion of mothers were important neighbourhood factors to explain the variation of ARI.

The final objective was to map the clusters that had a higher prevalence of ARI. The study produced evidence that the Hhohho region had four constituencies painted red on the map, namely Motshane, Mbabane South, Mbabane East, Nkhaba and Tiphisini had a higher burden of ARI. In the Manzini region, five constituencies had a higher burden of ARI, (painted red), namely Lamgabhi, Kwaluseni, Ntontozi, Mafutseni and Ludzeludze. In the Shiswelweni region, the burden of diarrhoea was higher among five constituencies, namely Zombodze, Mbangweni, Kubuta, Ngudzeni and Sigwe. In the Lubombo region, theburden of ARI was higher at Lubulini, Hlane, and Mhlume. The results give evidence and important information on the more problematic constituencies that should be targeted to mitigate the problem of ARI.

10.12.3 Recommendations and policy implications

The study has several policy implications.

First, there is need for the governments of Eswatini to scale up strategies to fast track socio-economic development in the socially and economic deprived communities and regions, otherwise child diarrhoea and ARIs will continue to increase in some regions in Eswatini.

Second, to reduce the magnitude of diarrhoea and ARI, the government must spearhead programs that aim to advance the sanitation, education level among mothers in the communities, including the availability of proper or improved toilet facilities in the households.

Thirdly, the understanding of the community characteristics is necessary for a reasonable reduction in child diarrhoea and ARIs to be achieved. Factors that were found to be significant to both diarrhoea and ARI should be used to inform programming on the most important factors that are associated with the diarrhoea and ARI.

The risk of diarrhoea and ARI was found to be lower among children aged less than 6 months. This could be the effects of breastfeeding; hence programs aiming to promote breastfeeding among under-fives must be continued.

The study contributes to the risk factors that need to be targeted to reduce the magnitude of diarrhoea and ARI. Therefore, the collaboration between government and partners should be strengthened to mitigate the exposure factors to diarrhoea and ARI. Mapping of the problematic constituencies was conducted for both diarrhoea and ARI. This should assist the government in targeting the hotspot areas for both diarrhoea and ARI and addressing the problems in those constituencies.

10.12.4 Scope for further research

The study adopted a multilevel approach to disentangle the importance of the individual, household and community-level factors. However, further research is required to comprehensively understand why child diarrhoea and ARIs continues to be a major public health problem in Eswatini. Therefore, the study suggests the following areas for further research:

1. Qualitative studies should be conducted to triangulate the quantitative approach, to further inform programming and policies on why child diarrhoea and ARIs continue to be a public health problem in Eswatini.
2. Further studies on community variables that permit the individual and household variables to be aggregated at the constituency level to improve the power of the test and further strengthen the confidence of the results.
3. Further research is needed on other unobserved individuals, household and community variables influencing child morbidity. For example, Maternal and child HIV status is an essential factor that greatly compromises the health of children but was not available for the secondary analysis

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