UNIVERSITY OF THE WESTERN CAPE

Faculty of Community and Health Sciences

Evaluation of the effect of poor water, sanitation and hygiene practices on growth and the incidence of infectious diseases in infants and young children aged 6-23 months in a selected rural district, Zambia

Raider Habulembe (3115970)

A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Public Health Nutrition, School of Public Health, University of the Western Cape (South Africa).

Supervisor: Prof. Nelia Steyn
RD (SA), MPH, PhD

Co-Supervisors: Prof. Thandi Puoane
B (Cur), MPH, Dr PH

Prof. Charles Michelo
BSc, MBChB; MPH, MBA, PhD

Date:

Key words:

Water, sanitation, and hygiene practices

Diseases

Infant and child feeding and care

Infant and child growth

Malnutrition

Nutritional status

Monze

Zambia

Declaration of originality

I declare that the *Evaluation of the effect of poor water, sanitation and hygiene practices on growth and infectious disease incidence in infants and young children aged 6-23 months in a selected rural district, Zambia* is my own work, that it has not been submitted for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged by complete references.

Full name: …….….Raider Habulembe Mugode............... **Date**...14th August 2018.................

Signed..

Abstract

Background: Poor water, sanitation and hygiene (WASH) services and practices in communities are known to be responsible for most of the infections occurring among infants and young children in developing countries. A combined effect of disease, poor diet, care practices and other factors among infants/children are known to lead to undernutrition reported in most developing countries. Apart from the reduced growth and productivity potential that malnutrition exhibits on the affected population, it is also an underlying cause to 50% of child mortality in poor communities. In light of this, the primary objective of the study was to evaluate the effect of poor WASH practices on growth and infectious disease incidence in infants and young children aged 6-23 months in the rural district of Monze in Zambia.

Methods: The study used a quasi-experimental design following up a cohort of infants and children aged 6-23 months in Monze, Zambia. The comparison was the fact that the experimental area (Njolamwanza) had been receiving WASH services for some period before the survey through the District Medical Officer compared to the control area (Hamangaba) which not yet received any. Both areas were measured at baseline and a year later. Nothing was added to the experimental area. The sampling and calculations of the sample size were performed based on the prevalence of malnutrition and infectious diseases occurring in the area and the size of the population. A questionnaire and observation checklist were used to collect household data on social demographic factors, WASH practices, incidence of infectious diseases, parasite infestations, health care seeking behaviour, food security and feeding practices. Weight, height, and mid-upper-arm circumference measurements were taken of all infants. Weight-for-age (WAZ), weight-for-height (WFH) and height-for-age (HAZ) z scores were calculated in order to determine underweight, wasting and stunting, respectively. A recording sheet was used to record disease data from child health facility records. At the end of each interview, the trained interviewer asked for permission to observe several places. The areas of observation included the household's toilet structure and use, food and utensil storage areas, infant/child play areas, hand washing place, waste disposal places, and presence of faeces in the yard, as well as the cleanliness of the mother and infant/child.

Data analyses: The outcome variables (HAZ and WAZ) were first tested for normality using the Shapiro-Wilks test. Descriptive analysis was done by means of frequency distributions for

social, economic and demographic variables; water, sanitation and hygiene; infant/child illness; nutrition status; and other key variables. Significance testing was done using the chi-square value of the crosstabulation. Cross-tabulations were performed on predictor variables with the outcome variables to find those with statistical significance. Significant variables, and other variables which were not significant but important to the study, were put in the logistic regression model to find associations between predictors and outcome variables. Some variables such as infant/child and mother's hygiene practices were reduced to composites to make it easier to use them when determining personal hygiene levels. Most of the continuous variables were also categorised to interpret the data meaningfully. To address the main theme of the research, namely whether the community with WASH services had better nutritional status than the one with none, the ANCOVA test was used.

Findings: The findings showed a high prevalence of unsafe WASH services and practices, and diseases in both areas although they were higher among the control group which did not have the WASH interventions. At baseline 45.4% (19.5% control vs 74.1% experimental, p<0.01) had toilet facilities at their homes compared to 69.2% (46% control vs 95% experimental, p<0.01) at follow-up. Sanitary disposal of infant/child faeces was practised by 41.8% (19.1% control vs 66.4% experimental group, p<0.01) at baseline and 78.2% (70.3% vs 87%, p<0.01). The population accessing a safely managed source of drinking was 70.7% (56.1% control group and 87.1% intervention, p<0.01) and 77.5% (66.9% control and 88.2% experimental, p<0.01). Good hygiene practices were common among 71.3% (72.3% control vs 70.1% experimental, p=0.71) households at baseline and 85.7% (80% control vs 91.8% experimental group, p=0.016) at follow-up. The most common diseases of the infants/children were coughing 69.2% (77.5% control vs 60.4% experimental p<0.01), fever 51.9% (58.3% control vs 45.1% experimental, p=0.24), diarrhoea 40.7% (43.0% control vs 38.2% experimental p=0.40) and eye infection 36.9% (59.6% control vs 13.2 experimental, p<0.01) at baseline and coughing 49% (50.5% control vs 47.3% experimental, p=0.66), fever 38.3% (35.9% control vs 40.9% experimental p=0.48), diarrhoea 26% (43.0% control vs 38.2% experimental p=0.42) and eye infection 36.9% (43.7% control vs 6.5% experimental, p<01). The poor WASH factors that were considered to be high included non-availability of a toilet, unsafe disposal of infant/child faeces, lack of a hand washing place, unsafe water sources and poor hygiene practices (follow-up only). Such factors affect the infant/child's nutritional status and development, mostly through mediating factors such as disease. Six diseases were common

among infants/children and statistical models were built using the four most prevalent, namely coughing, fever (a proxy for malaria), diarrhoea and sore eyes. Several WASH factors such as availability of toilet, the frequency of toilet cleaning, mother's hygiene and deworming were associated with various diseases. Undernutrition was similarly high in both areas and deteriorated further during the study period. Stunting was higher in the experimental group while wasting was more prevalent in the control group but with no significant difference between the groups. However, the increase in stunting was higher in the experimental group. The ANCOVA suggest that the growth of infants/children was not likely to be influenced by having received the WASH services or not. However, the findings may be due to the fact that WASH factors have several pathways through which it causes undernutrition and the sample may not have been adequate to capture such distal associations. The study did not include the key health condition-environmental enteropathy.

Conclusions: Although WASH factors did not show an association with stunting, its effect on growth was observed through the association of some diseases with WASH factors such as mother's hygiene, and household size (overcrowding) with diarrhoea; mother's hygiene, distance to the toilet and household size (overcrowding) with coughing; and toilet availability with sore eyes. Worm infestations, represented by the factor deworming, was associated with stunting. The influence of height for age z scores at baseline on height for age z scores at follow up in the ANCOVA analysis is also to an extent an impact of disease and poor diet as reported in other studies.

Date: 14th August, 2018

Table of contents

Table of Figures

List of Tables

Dedication

I dedicate my thesis to my daughters – Mwitwa, Chinyama and Ninziye and to my son Muyanjilwa. Special thanks to my husband, Luke for encouraging and walking with me in the process of writing.

Acknowledgements

We acknowledge the support provided by the Research Support Centre at the University of Zambia, School of Medicine (UNZA-SoM) through the Southern African Consortium for Research Excellence (SACORE), which is part of the African Institutions Initiative Grant of the Wellcome Trust (company no. 2711000), a charity (no. 210183) registered in England; The National Institutes of Health (NIH) through the Medical Education Partnership Initiative (MEPI) programmatic award No. 1R24TW008873 entitled "Expanding Innovative Multidisciplinary Medical Education in Zambia" at UNZA-SoM; We also acknowledge the various contributions made by the following people for this work: The members of the UNZA-SoM SACORE Steering Committee (Margret Maimbolwa, Paul Kelly, Hellen Ayles, & Charles Michelo) as well as Mr Maxward Katubulushi, Ms Choolwe Nkwemu Jacobs, Ms Mutanti Simonda and Ms Mulemwa Mwangala.

Special gratitude to my supervisors, Prof. Nelia Steyn, Prof. Thandi Puoane and Prof. Charles Michelo for guidance, support and suggestions throughout my writing process and the unmeasurable knowledge and skills imparted to me; more especially for believing in me. Because of you, I submitted this thesis. I would also like to thank Dr Musonda for analytical guidance.

I also acknowledge the Monze DHMT for allowing me to conduct the study and their support rendered during the study. I also thank the staff at Hamangaba and Njolamwanza Health Facilities for their support and patience during the data collection process. I also acknowledge the data collectors who were committed and willing to work in hard conditions and to dedicate their time away from home to collect data.

The SACORE Journal club members, we had a good time together in the process of writing and supporting one another.

List of publications

Raider H. Mugode, Thandi Puoane, Charles Michelo, and Nelia P. Steyn "Feeding a child slowly"; a responsive feeding behaviour component found to reduce the likelihood of stunting: population based observations from rural Zambia. (Accepted for publication with *Journal of Hunger and Environmental Nutrition, December 2017*)

P. Funduluka, S. Bosomprah, R. Chilengi, **R.H. Mugode**, P.A. Bwembya, B. Mudenda (2017) Marketing of breast-milk substitutes in Zambia: evaluation of compliance to the international regulatory code. *Journal of Public Health | pp. 1–7*

R. H. Mugode and C Michelo, (2013) Staff competencies at Health Facilities Implementing an outpatient therapeutic Programme for Severely Acute Malnourished Children. *Medical Journal of Zambia vol. 40, No.3*

Charles Michelo**, Raider Habulembe Mugode** (2012) Set criteria in management of severely Malnourished Children in Zambia: Evidence from the Evaluation of an Óutpatient Therapeutic Care Programme (OTP). *Medical Journal of Zambia vol. 39, No.3*

Workshops and Conferences attended

Regional Nutrition and HIV Workshop Report, Johannesburg, South Africa 14-16th June, 2016

Regional Nutrition in Emergency Training, organized by the UNICEF East and Southern Africa (ESA) Regional Office, Johannesburg, South Africa, 28th to 31st March 2017

Nutrition in emergency training workshop, Chibombo, Zambia, 31st October to 4th November 2016

Abbreviations

ADB	-	African Development Bank
AIDS	-	Acquired Immune Deficiency Syndrome
BMI	-	Body Mass Index
CI	-	Confidence Intervals
CSO	-	Central Statistical Office
EE	-	Environmental Enteropathy
ENA	-	Emergency Nutrition Assessment
FAO	-	Food and Agriculture Organisation
FCS	-	Food Consumption Score
GRZ	-	Government of the Republic of Zambia
GMP	-	Growth Monitoring and Promotion
HAZ	-	Height-for-Age z-score
IBM-WASH	-	Integrated Behavioural Model for Water, Sanitation, and Hygiene
LSHTM	-	London School of Hygiene and Tropical Medicine
MACEPA	-	Malaria Control and Evaluation Partnership in Africa
MDGs	-	Millennium Development Goals
MOH	-	Ministry of Health
MUAC	-	Mid Upper Arm Circumference
NCI	-	National Cancer Institute
NFNC	-	National Food and Nutrition Commission
NRWSSP	-	National Rural Water Supply and Sanitation Programme
OR	-	Odds ratio
P	-	P value
SACORE	-	Southern Africa Consortium for Research Excellence
SD	-	Standard Deviation
SDGs	-	Sustainable Development Goals
SMART	-	Standardized Monitoring and Assessment of Relief and Transitions
STHI(s)	-	Soil-transmitted helminths
SUN	-	Scaling Up Nutrition
TDRC	-	Tropical Disease Research Centre

UN	-	United Nations
UNDP	-	United Nations Development Programme
UNICEF	-	United Nations International Children Emergency Fund
UNZA	-	University of Zambia
WASH	-	Water Sanitation and Hygiene
WAZ	-	Weight-for-age z-score
WFP	-	World Food Programme
WHA	-	World Health Assembly
WHO	-	World Health Organisation
WHZ	-	Weight-for-Height z-score
ZDHS	-	Zambia Demographic and Health Survey

Glossary

1000 days – is the period between a woman's pregnancy and her child's second birthday.

Basic hygiene facilities: a handwashing facility with soap and water available on premises

Catch-up growth: Catch-up growth is characterized by height velocity above the limits of normal for age for at least 1 year after a transient period of growth inhibition; it can be complete or incomplete. Although catch-up growth can be expressed in terms of height velocity, the change in height standard deviation score is more appropriate (Wit & Boersma, 2002).

Control group: it refers to the study population from the study area that did not receive WASH interventions as provided by the District Medical Office in Monze

Diarrhoea was defined as ≥3 liquid stools in the preceding 24-hour period. An episode of diarrhoea was defined as diarrhoea lasting >1 day and separated from another episode by >48 h without diarrhoea (Checkley et al., 2008).

Disease burden: Disease burden is the impact of a health problem on a given area, and can be measured using a variety of indicators such as mortality, morbidity or financial cost. This allows the burden of disease to be compared between different areas for example regions, towns or electoral wards (see small area analysis section). It also makes it possible to predict future health care needs.

Environmental enteropathy (EE) is a chronic disease of the small intestine characterized by gut inflammation and barrier disruption, malabsorption and systemic inflammation in the absence of diarrhoea and is caused by repeated faecal contamination (Watanabe & Petri, 2016). It is also known as environmental enteric dysfunction (EED).

Growth deficit: Child growth that is not occurring according to the expected WHO growth reference standards.

Growth faltering: also called "failure to thrive", can occur during childhood. It is defined as a growth rate below that appropriate for a child's age and sex. It can affect height, weight and head circumference with values being lower than expected (Nutricia, n.d.).

Infants: Children less than and equal to 12 months of age.

Experimental group: it entails the study population that was from the study area that had received WASH interventions as provided by the District Medical Office by the time of commencement of the study.

Limited hygiene facilities: facilities Households that have a handwashing facility but lack water and/or soap are classified as having.

Open defecation: refers to the practice whereby people go out in fields, bushes, forests, open bodies of water, or other open spaces rather than using the toilet to defecate (UNICEF, n.d.)(GRZ, 2016).

Overweight: Excess weight relative to height; commonly measured by BMI among adults. The international reference is as follows: i) 25 –29.99 kg/m^2 for grade I (overweight) ii) 30 –39.99 kg/m^2 for grade II (obese) iii) > 40 kg/m^2 for grade III. For children, overweight is measured as weight-for-height z-scores of more than two standard deviations above the international reference.

Pathogens—disease-causing agents.

Persistent diarrhoea: lasts 14 days or longer (WHO, 2017).

Phase 1: is the baseline of the study when children between 6-23 months of age were enrolled in the study and the first data collection was conducted.

Phase 2: is the follow-up of the study when the second set of data was collected from the same children enrolled at baseline.

Soil-transmitted helminths (STH): are intestinal worms transmitted through faecal-oral contamination or through the skin. They include hookworm (*Ancylostoma duodenale* and *Necator americanus*), roundworm (*Ascaris lumbricoides*) and whipworm (*Trichuris trichiura*) (Uniting to Combat National Tropical Diseases Coalition, 2017).

Stunting: Failure to reach linear growth potential because of inadequate nutrition or poor health. Measured as height-for-age z-scores that are more than two standard deviations below the median value of the reference group. Usually a good indicator of long-term undernutrition among young children (Mahmud & Mbuya, 2016).

Underweight: Weight-for-age reflects body mass relative to chronological age. It is influenced by both the height of the child (height-for-age) and his or her weight (weight-for-height). It is defined as the percentage of children aged 0–59 months, whose weights are less than two standard deviations below the median weight for age groups of the WHO Child Growth Standards median (de Onis and Blössner, 1997; WHO, 2010).

Wasting: Weight divided by height that is two standard deviations below the median value of the international reference. It describes a recent or current severe process leading to significant weight loss, usually a consequence of acute starvation or severe disease. Commonly used as an indicator of undernutrition among children, and especially useful in emergency situations such as famine (Mahmud & Mbuya, 2016).

Young children: Children who are older than 12 months but less than five years of age.

z-score: The deviation of an individual's value from the median value of a reference population, divided by the standard deviation of the reference population (Mahmud & Mbuya, 2016)

CHAPTER 1 : INTRODUCTION

Chapter 1 is introductory to the thesis. It provides an overview of four main aspects: the burden of diseases related to water, sanitation and hygiene (WASH); the accessibility of WASH facilities in Zambia; the nutrition practices of mothers, adolescents, infants and young children; and the interventions that Zambia has been implementing in an effort to improve WASH facilities / practices and nutritional status, especially of infants and children. It moves on to highlight the gaps that lead to the development of this study, and the contribution of the findings to existing literature. The chapter highlights the rationale and significance of the research, and concludes with an overview of the thesis.

1.1 Disease Burden and Access to Water, Sanitation and Hygiene (WASH)

1.1.1 Burden of diseases related to WASH factors

Poor WASH services and practices is the leading cause of conditions such as diarrhoea, intestinal worm infestations, cholera, trachoma, and schistosomiasis, and these are particularly detrimental to the survival and development of infants and children (Jaarsveld et al., 2005; Harhay, Horton & Ollliaro, 2010). Prüss et al., (2002) estimates that poor WASH factors accounts for approximately 4% of all deaths globally and 5.7% of the total disease burden, due to diarrhoea and other directly related diseases. **Diarrhoea** due to poor WASH facilities / practices was regarded as the second highest burden of disease on a global scale (WHO, 2017a). Diarrhoea among infants/children in developing countries occurs on average three times per year, with each of the episodes likely to be life-threatening and depriving infants/children of necessary nutrients (WHO, 2017a). In Zambia, about 16% of children under five years suffer from diarrhoea episodes, with the incidence being higher among infants and children 6-23 months old (27.8% for infants 6-11 months and 27.6% for children 12-23 months)(CSO et al., 2014).

Other diseases such as ascariasis, trichuriasis and hookworm, often referred to as **soil-transmitted helminths** (STH), are the most prevalent parasites found in the human gastrointestinal tract, infecting an estimated 1.5 billion people worldwide, 24% of the global population (WHO, 2017b). In sub-Saharan Africa, about 89.9 million school-age children are infected with one or more STH species ("*Ascaris lumbricoides* - roundworm, *Trichuris trichiura*

-whipworm*, Ancylostoma duodenale* and *Necator americanus* - hookworms") (Brooker et al., 2006). In Zambia, no recent studies are available on worm infestations. However, in 1998 about 24% of children under five had worms, mostly Ascaris and hookworm (Luo et al., 1998). The data was not disaggregated according to age categories.

In addition to STH, **malaria** continues to thrive in poor sanitary conditions. Each year, there are 300 million to 500 million cases of malaria throughout the world, and about 1 million infant/child deaths (UNICEF, 2005). Globally, malaria cases have been reducing from about 262 million in 2000 to 214 million in 2015 declining by 18%, with 88% of cases occurring in the African Region (WHO, 2017c). In Zambia, the incidence of malaria appeared to be fluctuating over the years (Figure 1-1). The highest peak was in 2012, at 15.9% for infants less than 12 months of age and 24.4% for children above 12 months (Ministry of Health, 2012, 2016).

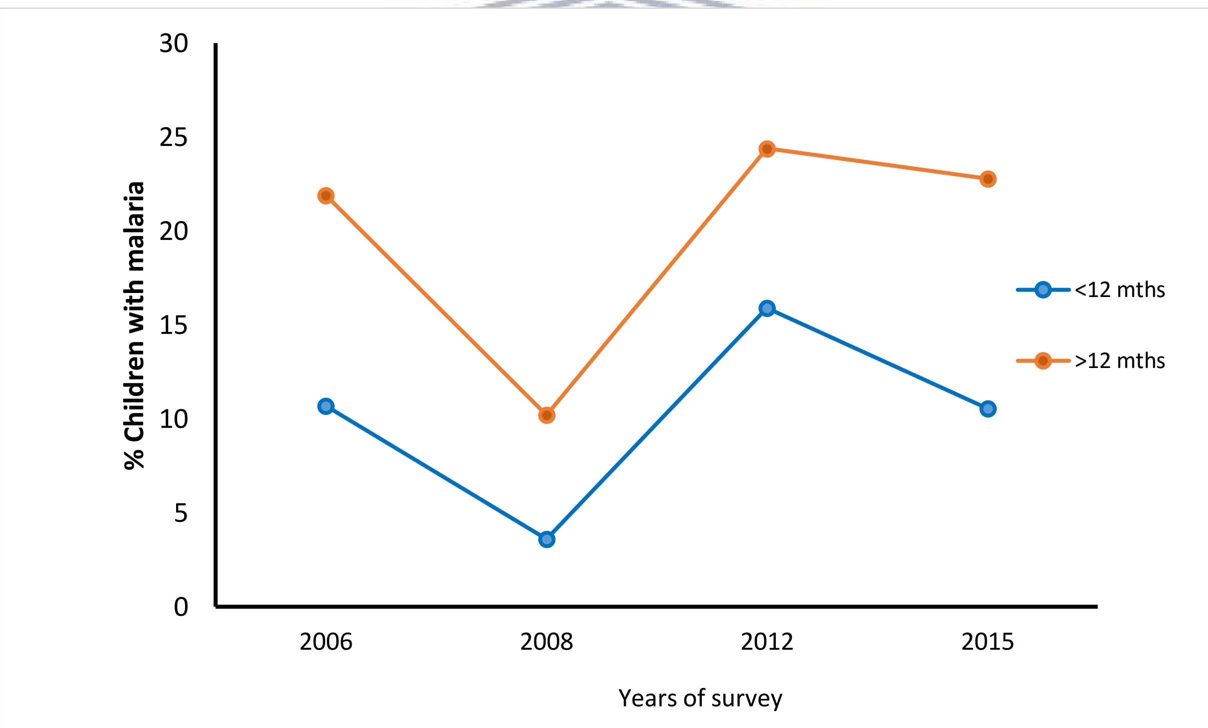


Figure 1-1: Malaria trends from 2006 to 2015 for infants and children under five years old by microscopy or RDT positivity (Ministry of Health, 2012, 2016)

About 230 million people globally are infected with ***schistosomiasis*** (Colley et al., 2014), and 218 million people required preventive treatment in 2015, with 90% of those from the African continent (WHO, 2017d). Data on schistosomiasis prevalence rates for infants and children 6-24 months in Zambia are not available. However, in 2012 about 22.1% of the population had schistosomiasis with little change from 1986 (26.5%), and 32.7% of the population required preventative treatment (Sokolow & Chloe, 2016).

Eye infections are number six of the top ten major illnesses among children under five years, after malaria, respiratory infections and diarrhoea (Ministry of Health, 2014). The number of children under five years visiting the health facilities for eye infection treatment decreased from 137 per 1000 population in 2006 to 68 per 1000 population in 2012 (Ministry of Health, 2009; Ministry of Health, 2014).

However, ***malnutrition*** has remained high for almost three decades (Table 1-1), with stunting remaining consistently above 40% (CSO et al., 2003; CSO et al., 2014).

Table 1-1: Nutritional status of infants and children aged 0-59 months from the Demographic and Health Surveys in Zambia

Overall	**1992 ZDHS**	**1996 ZDHS**	**2003 ZDHS**	**2009 ZDHS**	**2014 ZDHS**
Underweight (weight-for-age) % < -2SD	25	24	28	15	14.8
Stunting (height-for-age) % < -2SD	40	42.0	47	45	40.1
Wasting (weight-for-height) % < -2SD	5	4	5	5	6.0
Stunting by age (% < -2SD)					
< 6 Months				18.0	13.6
6-8 Months				26.0	25.1
9-11 Months				32.6	38.5
12-17 Months				42.8	43.1
18-23 Months				58.9	54.0
24-35 Months				53.2	51.0
36-47 Months				50.9	41.6
48-59 Months				46.5	34.6

Sources: (CSO, UNZA, 1993; CSO, MOH, 1996; CSO et al,. 2003; MOH et al., 2009; CSO et al., 2014)

1.1.2 Accessibility to safe water, sanitation and hygiene facilities/practices in Zambia

A supply of safe drinking water ensures a lower risk of acquiring infections such as gastrointestinal diseases. According to WHO & UNICEF (2015, 2017), 89% of the population worldwide have access to a safe source of drinking water, while 58% have access to safe water sources in sub-Saharan Africa (WHO & UNICEF, 2017). There is a difference in access to safe water between rural (84%) and urban areas (96%) (UNICEF & WHO, 2015).

In Zambia, the population having access to a safe source of drinking water increased from 49% in 1990 to 65% in 2015, and a substantial increase was recorded in rural areas from 24% in 1990 to 51% in 2015. A slight reduction of 2% was observed in urban areas (from 88%

in 1990 to 86% in 2015). The use of safe and surface water (water on the surface of the land such as from dams, rivers, lake, wetland or streams) is currently 23% and 12% respectively (UNICEF & WHO, 2015).

Approximately 68% of the global population use a safe sanitation facility, with a disparity between the urban (82%) and rural (51%) population (Aboud & Akhter, 2011; WHO & UNICEF, 2015). In sub-Saharan Africa, less than 20% of the population have access to safely managed sanitation, and open defecation is practiced by 23% of the population. In Zambia, use of safely managed sanitation facilities narrowly increased from 41% in 1990 to 44% in 2015. In urban areas, the use of safely managed sanitation facilities decreased from 59% in 1990 to 56% in 2015, while in rural areas it increased from 29% to 36% in 1990 and 2015 respectively. Open defecation is practised by 14% of the population in Zambia, with a notable difference between the urban (1%) and rural (22%) areas (WHO & UNICEF, 2015).

Hygiene behaviours or practices cover a wide range of areas including Personal hygiene (including handwashing), menstrual hygiene, food hygiene and general hygiene (surface cleaning, laundry etc). All the facets of hygiene involve things we do to break the chain of infection in the home (Bloomfield and Nath, 2006). However, one of the easier method to measure hygiene currently is use of hand washing technics (WHO & UNICEF, 2017). In 2015, less than 50% of the population used basic handwashing facilities in African countries where data was available (WHO & UNICEF, 2017). In sub Saharan Affrica, the population with basic hygiene services were 15%, limited services (without water or soap) was 22% and those with no hand washing facilities were 63%. Zammbia had 14% with basic services, 28% with limited services and 59% had no handwashing facility (WHO & UNICEF, 2017).

1.1.3 Nutrition practices of mothers, adolescents, infants and children

It is estimated that in developing countries 37% of infants less than six months old are exclusively breastfed (Victora et al., 2016). In Zambia, it is estimated that 65.8% of postpartum mothers can breastfeed within one hour after birth (CSO et al., 2014) and 73% exclusively breastfeed their babies. The bottle-feeding rate is about five percent (5% for infants and children 0-23 months). Studies show that complementary foods are introduced too early in life for 17% of infants below six months, while 83% of infants 6-9 months received complementary foods (CSO et al., 2014). Poor feeding practices may cause malnutrition (Madise & Mpoma, 1997; WHO, 2017e).

According to Black et al., (2008), malnutrition is the underlying cause of 30% of childhood deaths. In Zambia, the under-five mortality rate is about 75 per 1000 live births (Figure 1-2). Therefore, minimising the infant and child deaths that result from malnutrition and infections due to poor WASH facilities and practices would lead to Zambia making greater progress towards achieving the Sustainable Development Goal (SDG) number six of ensuring clean water and sanitation for all by 2030 (UN, 2017). A further aspect which impacts on infant and child malnutrition is the nutritional status of the mother. Since 1992, undernutrition among women has been between 9-10% in Zambia (CSO et al., 2014).

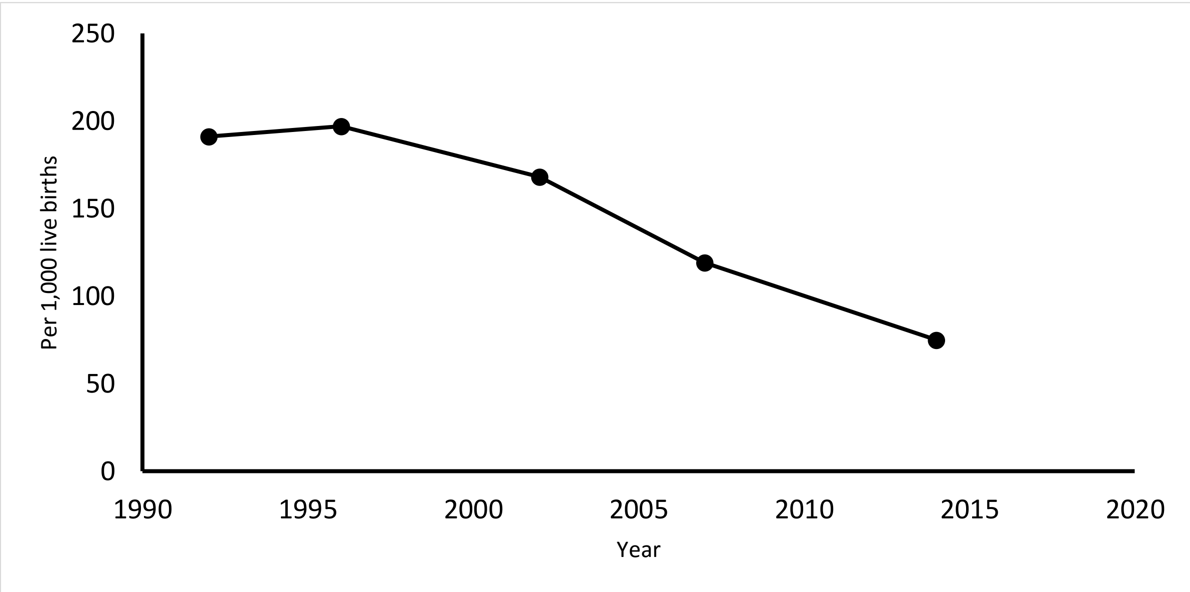


Figure 1-2: Trends in under-five mortality rate per 1,000 live births in Zambia. Source: CSO, MOH, 1996; CSO et al,. 2003; CSO, MOH, TDRC & UNZA, 2009; CSO et al., 2014).

1.1.4 Interventions

The Government of the Republic of Zambia, along with the Ministry of Local Government and Housing and various stakeholders, have implemented several interventions to address issues of poor WASH facilities and practices in Zambia. The main actions are to eradicate open defecation, ensure use of clean water and sanitation, and the promotion of good hygiene practices using various strategies (GRZ, 2007; GRZ, 2015; GRZ, 2016).

There are specific programmes meant to eradicate malnutrition implemented by various nutrition partners. The most notable ones are those that aim to improve the nutrtition and health of children such as such as the Mother, Adolescent, Infant and Young Child Nutrition programme, Child Health Week biannual campaigns, and the Roll Back Malaria and School Health and Nutrition Programme, implemented by various partners (NFNC, 2012, NFNC., 2017). The Infant and Young Child Feeding programme aims at addressing the feeding of the child from birth to about two years. The Child Health Week campaigns occur twice every year at six-month intervals. They provide an opportunity for integrating health and nutrition activities such as deworming of children, vitamin A supplementation, growth monitoring and promotion (GMP), provision of oral rehydration solution when necessary, treating of mosquito nets, and provision of health education in various areas of health and nutrition. The Roll Back Malaria programme involves promoting the use of insecticide-treated nets indoor residual spraying, and prophylaxis in pregnancy (Ministry of Health, 2016). The School Health programme is a Ministry of Education programme that addresses schistosomiasis in school-age children, and the increase of micronutrient intake to address anaemia and malnutrition in general (NFNC, 2017). One notable issue resulting from these policies is that the Ministry of Education has also revised the syllabus to include matters of nutrition and safe WASH facilities/ practices in primary and secondary learning. All these programmes promote infant/child survival along the life cycle. However, it is not clear how the programmes are integrated at the community level, and information on the impact of the integration of programmes is lacking.

It is also important to note that despite implementation of the above programmes, their impact on reducing stunting at the population level seems to be slow as malnutrition has stayed above 40% for several decades (Table 1-1). It is thus apparent that there is a need to accelerate the provision of improved drinking water and sanitation and good hygiene practices if Zambia is to make positive progress towards improving the health and nutritional status of the population, and to reduce mortality. Indirectly, improved water and sanitation, and good hygiene practices will enhance education and economic development of the nation. However, to conduct such an exercise requires commitment from policymakers and programme officers. They have to be furnished with adequate information to enable them to make policy and programme decisions. Since there have been few studies regarding the relationship of WASH factors in relation to the growth of infants/children in Zambia, this research will hopefully provide information that will fill this gap. The information would inform decision-making regarding the execution of programmes related to WASH factors and nutrition to improve infant and child survival and enhance achievement of the Sustainable Development Goals (MDGs).

1.2 Gaps

Although there is overwhelming global evidence on the association between disease and levels of access to WASH factors, evidence on WASH factors and nutrition are not well documented or adequately studied in Zambia. The country does not have adequate evidence highlighting the important relationship that exists between nutrition and WASH factors as child survival strategies, and yet it has been reported to save millions of infants and children's lives elsewhere. Lack of evidence which is well disseminated especially among policy makers, programme officers and communities make it difficult to source the resources required to address these key issues and to ensure demand for the programme by communities. It is for this reason that this study aims to assess the association between the two – WASH factors and nutrition among infants and children 6-23 months of age.

1.3 Statement of the Problem

Although Zambia has been implementing WASH programmes since the late 1980s when Government began policy and institutional reform of the water sector (GRZ, 2007), the coverage for improved water supply and sanitation is far from reaching Sustainable Development Goal (SDG) number 6. This SDG aims to achieve universal and equitable access to safe and affordable drinking water for all, access to adequate and equitable sanitation and hygiene for all, and an end to open defecation by 2030 (WHO & UNICEF, 2017; UNDP, 2017).

In Zambia, about two thirds of the population have improved access to safely managed water, while 44% have access to safely managed sanitation facilities (WHO & UNICEF, 2015). The country failed to meet the 2015 MDG of access for 88% and 77% of people for safe drinking water and sanitation, respectively (WHO & UNICEF, 2015). Also, stunting is still high at 40% (CSO et al., 2014) and is an underlying cause of death in about 50% of infants/children. According to UNICEF's conceptual framework (UNICEF, 1998), food insecurity, poor infant/child and maternal care, poor health services, and poor WASH practices are among the underlying causes of malnutrition. Poor WASH factors are responsible for most of the deaths from diarrhoeal diseases globally (UNICEF & the IYS, 2008) and contributes to over 54 million disability-adjusted life years (Howard & Bartram, 2003). Since both malnutrition and poor WASH practices are outcome factors of poverty, it is possible that they co-exist in a poor community, posing a danger of increasing mortality rate among children due to the synergistic relationship that exists between malnutrition and infections. Despite this knowledge, many people still do not have adequate access to a safe source of drinking water.

When poverty rates are high, as is the case for Zambia with an estimated over 50% population being poor (CSO, 2016; UNICEF Zambia, n.d.; UNDP, 2016), there is a strong likelihood of food insecurity, which increases the levels of malnutrition (CSO et al., 2009). In Zambia to date, there is insufficient scientific information to demonstrate the effects of poor WASH conditions on the growth of infants and children 6-23 months. Such scientific information is key to inform policy decisions intended to improve water and sanitation facilities. To date, WASH and nutrition programming have mostly depended on evidence from other countries, which may not reflect the Zambian culture and environmental conditions. For this reason, there is a need for detailed study of the relationship between poverty, malnutrition, infection and mortality in Zambia to direct policy and provide programme officers with relevant local information for programme planning and implementation.

1.4 Rationale for the Study

Zambia has witnessed high levels of malnutrition for over two decades (Tables 1-1 and 1-2), despite efforts that have been put in place to address the problem (CSO et al., 2003; CSO, MOH, TDRC et al., 2009; CSO et al., 2014). It is evident from Table 1-1 that malnutrition starts before six months of age. Although there is abundant literature detailing the effects of poor WASH practices on nutrition globally (UNICEF, 1998), there is insufficient evidence on the effects of poor WASH factors on the nutritional status of infants and children in Zambia. Similarly, no adequate programmes have been designed to integrate WASH factors and nutrition activities effectively. Zambia failed to meet the MDGs for both drinking water and sanitation, and is far from reaching the 2030 SDG of universal access to water and sanitation.

Table 1-2: Percentage of infants and children with anaemia from the Malaria Indicator Survey in Zambia

Age in months	2006	2008		2012		2014	
	Severe anaemia	Severe anaemia	Any anaemia	Severe anaemia	Any anaemia	Severe anaemia	Any anaemia
<12	15.2	6.2	62.4	7.2	70	7.45	72.6
12–23	18.4	6.7	60.5	9.9	66.7	6.9	71.2
24–35	13.6	3.9	46.7	6.9	53.8	9.1	62.5
36–47	9.8	3.4	41.2	6.0	45.2	3.9	52.4
48–59	8.3	1.1	30.7	3.9	42.4	3.8	43.1

Sources: (MOH et al., 2006, 2008; Ministry of Health, 2012, 2016). *Severe anaemia = less than 8 grams/decilitre

1.5 Significance of the Study

Considering the abundant literature which suggests that stunting has multiple causes and requires a multifaceted approach, the results obtained from this study will contribute to efforts to reduce stunting and many other forms of malnutrition. Additionally, the role of WASH factors in the incidence of infections and its impact on infant/child growth will be better understood. Consequently, findings of this study will contribute to policy formulations in promoting well-being among vulnerable populations. The integration of knowledge surrounding WASH factors into programmes and efforts to reduce any form of malnutrition, and the subsequent publishing in peer-reviewed medical journals will signify the addition of new information to the body of scientific knowledge.

1.6 How the Thesis is Organised

The thesis was written as a monograph, consisting of eight chapters. ***Chapter one*** introduces the thesis by detailing the prevalence of WASH factors globally, regionally and locally; identifying gaps in literature; providing a statement of the problem, rationale and significance for the study. ***Chapter two*** gives a review of relevant literature related to WASH factors and infant and child growth. This is of great importance to the thesis as it reveals how nutrition and WASH factors are key to child survival, as well as how WASH and other factors may combine to affect child survival. It also highlights various policies that are key in the nutrition and WASH sector. ***Chapter three*** highlights the processes used to obtain data to answer the research question and objectives of each chapter. It also describes the conceptual framework that guided the research. Further, the chapter explains the methods used for data handling (data collection, entry and analysis). ***Chapter four*** reports on the prevalence of various WASH factors such as availability of sanitation facilities, source and treatment of water for drinking and household use, hygiene practices of caregivers and infants/children, and of food preparation and storage. ***Chapter five*** addresses the prevalence of diseases, and the association of WASH factors with diseases. ***Chapter six*** concentrates on the nutrition situation of the two study areas, using the three nutritional indices of height-for-age z-score(HAZ), weight-for-age z-score (WAZ) and weight- for-height z-score (WHZ), with HAZ being the main outcome considered in most analysis due to its importance in terms of its prevalence in Zambia. Various nutritional practices that are likely to affect the outcome in addition to WASH factors are reported, including dietary diversity score (DDS), feeding practices, and responsive feeding factors. ***Chapter seven*** combines and analyses the results from Chapters four, five and six to try and answer the overall question of the study: whether WASH factors has an effect on the growth of infants/children or not. ***Chapter eight*** provides the conclusions, recommendations and limitations of the study. The ***Appendices*** include an article (Appendix 1) that was published in the Journal of Hunger and Environmental Nutrition and tools used during the survey.

1.7 References

Aboud, A.F.E. & Akhter, S. 2011. A cluster-randomized evaluation of a responsive stimulation and feeding intervention in Bangladesh. *Peadiatrics*. 127(5):1191–1197. DOI: 10.1542/peds.2010-2160.

Black, R.E., Allen, L.H., Bhutta, Z.A., Caulfield, L.E., de Onis, M., Ezzati, M., Mathers, C. & Rivera, J. 2008. Maternal and child undernutrition 1: maternal and child undernutrition: global and regional exposures and health consequences. *Lancet*. 371:5–22. DOI: 10.1016/S0140-6736(07)61690-0.

Bloomfield Sally F. and K.J Nath. 2006. *Home Hygiene in Developing Countries: Prevention of infection in the home and the peri-domestic setting. A training resource on hygiene for teachers, community nurses, community workers and other health professionals in developing countries*. Geneva, Switzerland

Brooker, S., Clements, A.C.A., Hotez, P.J., Hay, S.I., Tatem, A.J., Bundy, D.A.P. & Snow, R.W. 2006. The co-distribution of Plasmodium falciparum and hookworm among African schoolchildren. *Malaria Journal*. 5(99):1–8. DOI: 10.1186/1475-2875-5-99.

Colley, D.G., Bustinduy, A.L., Secor, E.W. & King, C.H. 2014. Human schistosomiasis. *Lancet*. 383(9936):2253–2264. DOI: 10.1016/S0140-6736(13)61949-2.Human.

CSO. 2016. *2015 Living Conditions Monitoring Survey (LCMS) Report*. Lusaka, Zambia.

CSO, UNZA & MOH. 1993. *Zambia Demographic and Health Survey, 1992*. Lusaka, Zambia. DOI: 10.2307/172255.

CSO, MOH & Inc., M. 1996. *Zambia Demographic and Health Survey - 1996*. Lusaka, Zambia.

CSO, CBoH & ORC Macro. 2003. *Zambia Demographic and Health Survey 2001-2002*. Lusaka, Zambia.

CSO, MOH, TDRC, UNZA & Inc., M. 2009. *Zambia Demographic and Health Survey*. Lusaka.

CSO, MOH, TDRC, UNZA & MACRO International. 2014. *Zambia Demographic and Health Survey 2013-14*. Lusaka, Zambia.

GRZ. 2007. *National Rural Water Supply and Sanitation 2006-2015*. Lusaka, Zambia: Ministry of Local Government and Housing (MLGH).

GRZ. 2015. *National Water Supply and Sanitation Capacity Development Strategy (2015 – 2020)*. Lusaka, Zambia.

GRZ. 2016. *Zambia National Open Defecation Free (ODF) Strategy (2016-2020)*. Lusaka, Zambia.

Harhay, M., Horton, J. & Ollliaro, P.L. 2010. Epidemiology and control of human gastrointestinal parasites in children. *Expert Review of Anti-infective Therapy*. 8(2):219–234. DOI: 10.1586/eri.09.119.Epidemiology.

Howard, G. & Bartram, J. 2003. *Domestic water quantity, service level and health*. (WHO/SDE/WSH/03.02). Geneva, Switzerland.

Luo, C., Nyumbu, M., Mwela, C. & Likwasi, P. 1998. *National survey on anaemia in Zambia: A random cluster study for children (0-5 years) and mothers*. Lusaka, Zambia.

Madise, N.J. & Mpoma, M. 1997. Child malnutrition and feeding practices in Malawi. *Food and Nutrition Bulletin*. 18(2). Available: http://archive.unu.edu/unupress/food/V182e/ch13.htm#b6-Discussion.

Ministry of Health. 2009. *Annual Health Statistical Bulletin 2008.* Lusaka, Zambia.

Ministry of Health. 2012. *Zambia National Malaria Indicator Survey 2012*. Lusaka, Zambia.

Ministry of Health. 2014. *Annual Health Statistical Bulletin 2012.* Lusaka, Zambia.

Ministry of Health. 2016. *Zambia National Malaria Indicator Survey 2015*. Lusaka,Zambia.

MOH, CSO, MACEPA, CDC, UNZA & WHO. 2006. *National Malaria Indicator Survey-2006*. Lusaka, Zambia.

MOH, CSO, MACEPA, CDC, UNZA & WHO. 2008. *National Malaria Indicator Survey-2008*. Lusaka, Zambia.

NFNC. 2012. *The First 1000 Most critical Days Three Year Programme- 2013 to 2015: Based on Strategic Direction One: Prevention of Stunting in Children less than two years of age in the National Food and Nutrition Strategic Plan (NFNSP) 2011-2015*. Lusaka, Zambia

NFNC. 2017. National Food and Nutrition Strategic Plan for Zambia 2017-2021: Toward eliminating all forms of malnutrition across the Zambian population by 2030. Lusaka, Zambia

Sokolow, S. & Chloe, R. 2016. *The history of Schistosomiasis control in Zambia*. Available: schisto.stanford.edu/pdf/Zambia.pdf.

UN. 2017. *Sustainable Development Goals: 17 Goals to Transform our World*. Available: http://www.un.org/sustainabledevelopment/sustainable-development-goals/ [2017, August 16].

UNDP. 2017. *Sustainable development goals; Goal 6: clean water and sanitation*. Available: http://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-6-clean-water-and-sanitation.html [2017, August 15].

UNICEF. 1998. *The State of the world's children 1998*. NewYork, USA: Oxford University Press. Available: https://www.unicef.org/sowc98/silent4.htm.

UNICEF. 2005. *Water, sanitation and hygiene, common water and sanitation-related diseases*. Available: http://www.unicef.org/wash/index_wes_related.html [2010, December 20].

UNICEF (2008) UNICEF and the International Year of Sanitation 2008: Why improved sanitation is important for children. Retrieved from [*https://www.unicef.org/wcaro/WCARO_WWD_UNICEF-IYS_why.pdf] Retrieved on 2013-07-12*

UNICEF & WHO. 2015. *25 Years Progress on drinking water and sanitation – 2015 update and MDG assessment.* NewYork, USA.

van Jaarsveld, A.S. Van, Biggs, R., Scholes, R.J., Bohensky, E., Reyers, B., Lynam, T., Musvoto, C. & Fabricius, C. 2005. Measuring conditions and trends in ecosystem services at multiple scales: the Southern African Millennium Ecosystem Assessment (SAfMA) experience. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*. (360):425–441. DOI: 10.1098/rstb.2004.1594.

Victora, C.G., Bahl, R., Barros, A.J.D., França, G.V.A., Horton, S., Krasevec, J., Murch, S., Sankar, M.J., et al. 2016. Breastfeeding in the 21st century: Epidemiology, mechanisms, and lifelong effect. *Lancet*. 387(10017):475–490. DOI: 10.1016/S0140-6736(15)01024-7.

WHO. 2017a. *Diarrhoeal disease: Fact Sheet*. Available: http://www.who.int/mediacentre/factsheets/fs330/en/ [2017, August 14].

WHO. 2017b. *Soil-transmitted helminth infections: Fact Sheet*. Available: http://www.who.int/mediacentre/factsheets/fs366/en/ [2017, August 14].

WHO. 2017c. *Number of malaria cases; Global Health Observatory (GHO) data*. Available: http://www.who.int/gho/malaria/epidemic/cases/en/ [2017, August 14].

WHO. 2017d. *Schistosomiasis: Fact Sheet*. Available: http://www.who.int/mediacentre/factsheets/fs115/en/ [2017, August 14].

WHO. 2017e. *Maternal, newborn, child and adolescent health: Malnutrition*. Available: http://www.who.int/maternal_child_adolescent/topics/child/malnutrition/en/ [2017, September 18].

WHO & UNICEF. 2015. *Progress on sanitation and drinking water: 2015 update and MDG assessment*. Geneva, Switzerland. DOI: ISBN 978 92 4 150914 5.

WHO & UNICEF. 2017. *Progress on drinking water, sanitation and hygiene 2017; update and SDG Baselines. Launch version*. Geneva, Switzerland. Available: https://www.unicef.org/publications/index_96611.html?utm_source=newsletter&utm_medium=email&utm_campaign=WASH

CHAPTER 2 : LITERATURE REVIEW

Chapter one provided an introduction to the thesis, outlining the concepts of WASH and nutrition, as well as gaps in the literature that the current study hopes to address. Chapter two examines the existing knowledge in the area of nutrition, WASH and infant and child growth and survival in more detail, while identifying the associations between nutrition, WASH and infant and child growth. Articles accessed from peer reviewed journals and various electronic databases form part of the review.

The chapter begins by highlighting the policy framework supporting WASH and nutrition programming in Zambia, emphasising the country's rural setting. This is followed by evidence on the growth process of children in the early years of life, linking it to WASH factors, disease and nutrition. The chapter goes on to explain the role of WASH factors in transmitting diseases via various transmission channels, and describes common diseases related to poor WASH conditions. The link between poverty, nutrition and WASH factors is explained to highlight the key role that poverty plays in nutrition and accessing WASH services. Similarly, the link between gender, nutrition and WASH factors is considered due to its role in equity and equal opportunities between men and women. The chapter then describes the issues of infant/child care and feeding practices, health-seeking behaviour among caregivers, and the immune system, as these relate to infant/child nutrition and WASH factors and are critical in impacting on nutrition outcomes. Finally, the chapter concludes with a summary.

2.1 Policy Framework Supporting Infant and Child Survival through WASH and Nutrition

Scaling up WASH activities in Zambia has overwhelming support from several government sectors at local and regional levels, as well as from international collaborators. It is viewed as a principal component for improving nutritional outcomes, considering that about 50% of infections that result from the use of unsafe water, inadequate sanitation or insufficient hygiene are linked to undernutrition (SHARE, LSHTM & WaterAid, 2015). WASH factors are also an important aspect in achieving the right to food. In order for food to be healthy, it should be provided in a hygienic way and with clean water (Humanium, n.d.). The realisation of this right therefore relies heavily on maintaining improved sanitation for households (Eisenberg, Scott & Porco, 2007). To achieve meaningful nutritional outcomes, interventions should combine both nutrition and WASH to ensure infection control and prevention (Teague, 2014).

A number of recommendations have been proposed to guide the implementation of WASH programmes and projects, including the UN 2015 MDGs and SDGs to be achieved by 2030 (UN., 2017), the International Nutrition Conference 2014 recommendations (FAO & WHO, 2014), and the Scaling Up Nutrition (SUN) targets

MDG Target 7 was intended to reduce the proportion of the population without sustainable access to safe drinking water and basic sanitation by 50% by the end of 2015 (UN, 2015). After a comprehensive review in 2015, it was discovered that globally the target was met five years ahead of schedule, however, that was not the case for Zambia in which 65% of the population had access to safely managed water (UN, 2015). Similarly, the SDGs address WASH in Goal 6, aiming to ensure access to basic water and sanitation services for all. The SDGs recognise access to water, sanitation and hygiene as a human right which should be provided to ensure good health and gender equality, to manage the production of food and energy, and to contribute to economic growth (UN, 2017). The major issues that are highlighted are ending open defecation, ensuring access to essential services, and safe and affordable drinking water and equitable sanitation and hygiene (WHO & UNICEF 2017). Underlining the importance of the issue, the International Nutrition Conference of 2014 recognised nutrition as a cross-sector issue and made recommendations to contribute to achieving the nutrition outcomes. Regarding WASH practices, the International Nutrition Conference emphasised the need to implement policies and programmes to improve water management in agriculture and food production, to improve access to safe drinking water and adequate sanitation, and to promote safe hygiene practices such as hand washing with soap (FAO & WHO, 2014).

Reaching such goals requires a multi-sectoral collaboration between the government, the private sector, civil society and communities. One such initiative is the SUN Movement. The SUN Movement is a global group of stakeholders including government, donor agencies, civil society, the research community, the private sector, and development banks (SUN Road Map Task Team, 2010; UNSCN, 2017). The stakeholders came together in 2009 with the aim of supporting developing countries to scale up nutrition actions that can improve maternal and infant/child nutrition. Scaling up nutrition strategies provides an opportunity to address malnutrition during the first 1000 days of an infant/child's life, when interventions provide higher benefits with regard to infant and child growth. The main target is to have a world free from malnutrition in all its forms by 2030 (SUN Movement, 2016), by implementing the *Framework for Scaling up Nutrition and SUN* Road Map (SUN Road Map Task Team, 2010), and WASH interventions are among the nutrition-sensitive interventions that are being advocated for by the movement. It is anticipated that the movement "would accelerate improvements in all nutrition targets set by the World Health Assembly (WHA) for 2025 and the achievement of the SDGs by 2030" (SUN Movement 2016:18).

In Zambia, the WASH interventions are drawn from various key government policy documents. The National Water Policy of 2010 governs the use of water bodies in the country. it is supported by other key documents such as the National Rural Water Supply and Sanitation Programme (2006-2015), Sanitation and Hygiene Component of the National Rural Water Supply and Sanitation Programme (2006-2015) and the Zambia National Open Defecation Free Strategy (2016-2020). Others include the National Urban Water Supply and Sanitation Programme 2011-2030, and National Water Supply and Sanitation Capacity Development Strategy (2015 – 2020).

The major policy documents of interest to the study are the National Open Defecation Free, National Rural Water Supply and Sanitation Programme and Sanitation and Hygiene Component of the National Rural Water Supply and Sanitation Programme. The goal of the National Open Defecation Free Strategy (2016-2020) is to eradicate open defecation (OD) nationwide by 2020, in both rural and urban areas. The primary strategy for addressing OD is community-based sanitation and hygiene promotion at schools, health centres, public institutions, markets, and other places where people congregate. Moreover, the programme involves traditional leaders in motivating behaviour change in their respective communities (GRZ, 2016).

As for the National Rural Water Supply and Sanitation Programme, the goal is to provide sustainable and equitable access to a safe water supply and proper sanitation to meet the basic needs for improved health and poverty alleviation for Zambia's rural population. The strategies included decentralisation of the management of water supply and sanitation to local authorities; the promotion of integrated plans for the development and management of water supply, sanitation and hygiene education; and ensuring that communities contribute to the process, to promote sustainability of services (GRZ, 2007).

Considering the important role WASH factors plays in improving the nutritional status of people through its role in reducing disease among infants and young children, the nutrition fraternity in Zambia has included WASH interventions in its policies and action plans. The Food and Nutrition Policy of 2006 recognises the need to address WASH practices to reduce diseases (GRZ, 2006). The policy was supported by both 2011-2015 and the draft 2017-2021 National Food and Nutrition Strategic Plans. The main objective is to reduce stunting among infants/children, and the policy therefore emphasises the interventions that tackle WASH (NFNC, 2017). A separate strategy, the "1000 most critical days programme", was developed to address stunting. It drew from the National Food and Nutrition Strategic Plan and was developed specially to adopt the recommendations of the SUN movement and implement the elements of its framework. A minimum package of interventions was agreed upon between actors in different sectors, and this included WASH interventions.

Some scholars have highlighted challenges in implementing WASH interventions, including policies being very ambitious and hard to fully translate into action, policies failing to reflect the needs and preferences of people, inadequate financing for sanitation, and a lack of technical capacity at various levels (Sanitation Updates, 2016). Teague (2014) further reported that staff capability and interest, poor coordination between sectors, and lack of evidence on the impact of integrated programmes were some of the challenges in the water sector. Since the above-mentioned policies are the foundation for programming, poor implementation will result in inadequate progress in the areas they cover.

2.2 The Growth Process in Infants and Children

The ultimate goal of this study is to measure and compare child growth in communities that have versus those that do not have access to WASH services. Evidence has shown that infants and children grow rapidly from birth through infancy, after which their growth slows down (Lartey et al., 2000). During the period of rapid growth, the nutrient needs are high; however, many infants/children live in adverse environments that do not favour growth, and this is particularly true in developing countries (Lassi et al., 2013). It follows that a disruption in supply of certain factors that are key to growth will therefore interfere with normal infant/child growth. For instance, poor diet (in utero, infancy and early childhood), lack of breastfeeding especially in the first six months of life, and high disease burden are some of the causative factors which are reported to interfere with healthy growth in infants/children

(Condon-Paoloni et al., 1977; Victora et al., 2010; Richard Richard, Black & Checkley, 2012; Nguyen et al., 2013; Lassi et al., 2013; Guerrant et al., 2014; Mahmud & Mbuya, 2016). In addition, Richard, Black & Checkley, (2012) and Waterlow (1993) explained that it is likely that there is a dependence relationship between low weight-for-height (wasting) and low height-for-age (stunting). In infants and children with low weight-for-height, the height-for-age of a child is not likely to improve until a child reaches a certain gain in weight for height, thus causing a lag in linear growth. Since the causes of both stunting and wasting are similar (poor diet and infections), but the duration of deprivation which results in stunting and wasting are different, careful programme planning is required to get the maximum benefit when addressing the two conditions.

The growth of infants/children is assessed or monitored using the WHO growth references (Wang & Chen, 2012). For public use, the growth references have been translated into an infant/child card (commonly called Child Clinic Card in Zambia). The weights of the children are plotted against the age of the infant/child, and using the reference curves (median and z-score or standard deviation lines) that have been permanently drawn on the card, the infant/child growth pattern is interpreted, and growth promotion counselling provided accordingly (Ministry of Health & NFNC, 2008). Since a z-score measurement indicates how far the measurement value deviates from the normal curve or population mean, it is used as a tool for counselling. It is also used to assess a change in nutritional status over time (Wang & Chen, 2012). The growth references are standardised by age and sex (Mei & Grummer-Strawn, 2007). The nutritional status is reported as HAZ, WAZ and WHZ. The cut-off points for growth assessments are discussed in Chapter three.

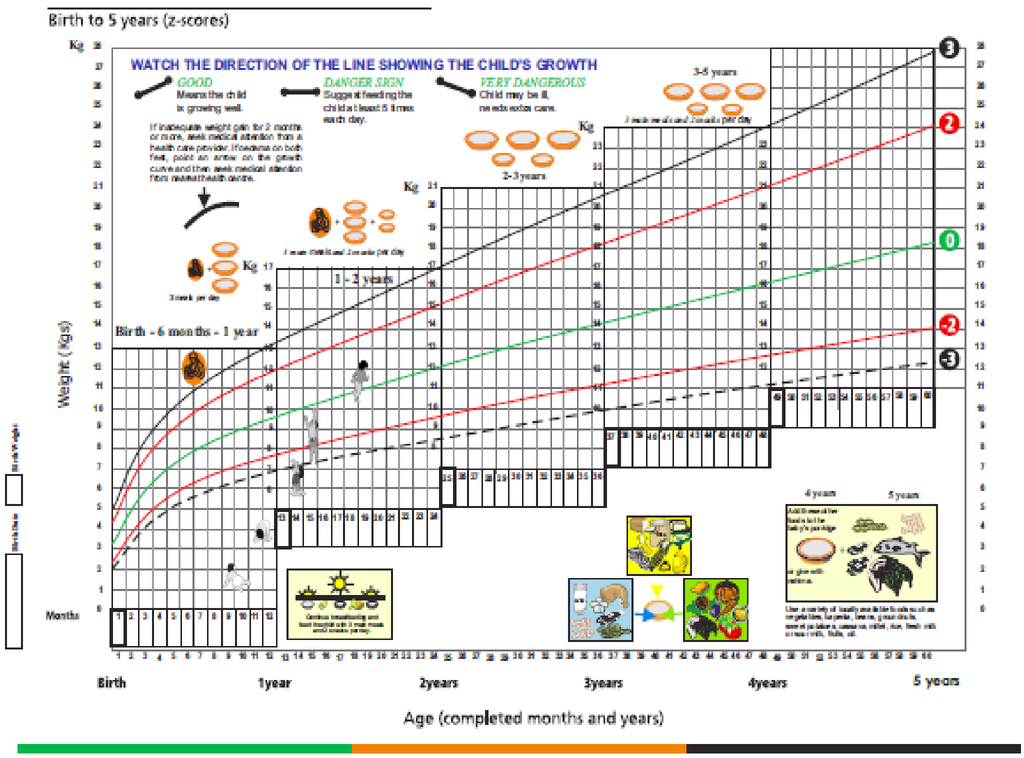


Figure 2-1: The infant/child growth monitoring card (child clinic card or under-five card) used in Zambia. The top part provides guidance to the counsellor and the caregiver on the kind of messages to give depending on the direction of growth. The curves indicate median or reference lines (middle) and the z-score lines or standard deviations (2, 3, -2 and -3)

The Growth Monitoring and Promotion (GMP) programme has been in existence for several decades. In Zambia, monitoring of growth is a monthly exercise for infants and children under two years, and bimonthly for those older than two years. It is a key component of the primary health care services in health facilities. The important point to note is that the current GMP programme does not routinely measure the heights of the infants/children, which is key in measuring stunting. Stunting is the most prevalent type of undernutrition in the country.

2.3 Transmission of Diseases Related to Poor Water, Sanitation and Hygiene Practices

Diseases which can be directly attributed to poor WASH factors are those which are transmitted via routes such as drinking, bathing, contaminated food, poor personal and household hygiene, and using unsanitary facilities (Mintz, Reiff, & Tauxe, 1995; Lindskog & Lindskog, 1998; Prüss et al., 2002; .Eisenberg, Scott & Porco, 2007). Poor hygiene and sanitation together contribute to about 88% of deaths from diarrhoeal diseases globally (UNICEF, 2008c).

A ***sanitation facility*** can be considered safe if it hygienically separates human excreta from human contact (WHO & UNICEF, 2006; Rand et al., 2015), hence preventing the contamination of the environment by removing breeding grounds for flies and other transmitters, reducing the carrying of faeces by animal and human feet, and the washing away of faeces by water runoff (Eisenberg, Scott & Porco, 2007).

The most common forms of unsanitary behaviour in developing countries include "open defecation" (the use of open areas by adults) and disposal of infant/child faeces on open ground or open garbage disposal areas. Globally, about 25% of the population in rural areas and 6% in urban areas practise open defecation (UNICEF & WHO, 2015). Along with this, an average of 50% or more households are likely to unsafely dispose of child faeces (Rand et al., 2015). High levels of pathogens have also been reported in domestic animals, making animal faeces a source of concern in pathogen transmission (Ngure et al., 2013). The above conditions have been linked to the incidence of diarrhoea and malnutrition (Ahmed et al., 2011; Headey et al., 2017). In Zambia, about 14% of the population still practice open defecation (UNICEF & WHO, 2015).

Open defecation by young children has received minimal attention at the regional and global level, and yet it is a common practice in most developing countries (Rand et al., 2015; Freeman et al., 2016; George et al., 2016;). The impact of open defecation by infants and children on human life and its transmission of pathogens to the host is not different from that which is caused by older members of the families, as shown in Figure 2-2. It has been reported that unsafe disposal of infant/child faeces was linked to poor growth in Bangladesh and elsewhere (Rand et al., 2015; George et al., 2016). The practice may pose a danger to health due to the proximity of waste disposal sites or open defecation areas to the household, compared to open defecation sites for adults which are often further away from the households (Majorin et al., 2014; Preeti et al., 2016). Such areas are easily accessed by other children and animals (dogs, pigs, chickens), exposing play areas to environmental contamination (Freeman et al., 2016).

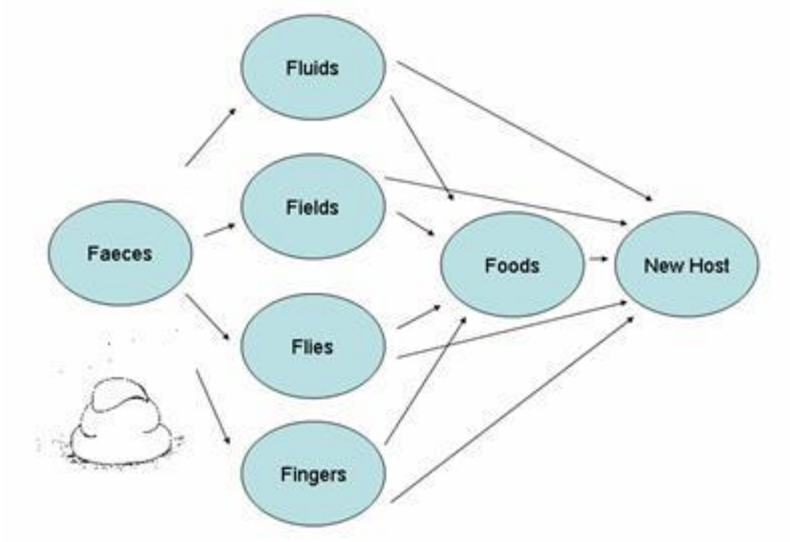


Figure 2-2: The F-diagram (after Wagner & Laniox, 1958 in Hunt, 2001) illustrating the major transmission pathways of faecal-oral diseases.

Some argue that the practice of safe disposal of faeces has been associated with the social and economic status of a population, with the unsafe practice being more common among the poor (Preeti et al., 2016). However, other scholars have argued that a high proportion of households with good sanitation facilities still dispose of infant/child faeces unsafely (Majorin et al., 2014; Preeti et al., 2016).

In areas with poor disposal of faeces, transmission of pathogens occurs through various factors resulting in diseases like diarrhoea (Figure 2-2). About 90% of diarrhoea cases are attributed to poor WASH practices, of which excreta are the main cause (Hill, Kirkwood & Edmond, 2004). Diarrhoea incidence is about 48–64% higher with poor WASH practices (Hill, Kirkwood & Edmond, 2004). However, if good sanitary conditions prevail, diarrhoea morbidity can be reduced by 26% and overall mortality by 55% (Hill, Kirkwood & Edmond, 2004). Several factors have been associated with infant/ child faeces disposal, such as education of mothers and household heads, availability of water, income, and the presence of a toilet (Freeman et al., 2016; Preeti et al., 2016). According to Freeman et al., (2016), interventions aimed at improving WASH should also include the development of behaviour changes related to safe infant/child faeces disposal. To address the challenge of open defecation, Zambia developed a National Open Defecation Free Strategy (2016-2020) with the goal of eradicating open defecation nationwide by 2020, in both rural and urban areas, as explained in section 2.1 (GRZ, 2016).

Water is one of the pathways through which pathogens from the faecal matter are transmitted to humans (Figure 2-2 and 2-3). The pathogens lead to enteric diseases such as diarrhoea, environmental enteropathy (EE) and intestinal worms which are known to weaken the immune system making malnourished individuals more susceptible to diseases (Dodos et al., 2017). Diseases are associated with poor nutrition through mechanisms that lead to reduced food absorption, loss of appetite, and anaemia (Croke, 2014). For instance, EE compromises the functioning of the gut in its ability to absorb and utilise nutrients (Guerrant et al., 2016; Mbuya & Humphrey, 2016; Kosek et al., 2017). Diarrhoea has also been associated with lower weight (Condon-paoloni et al., 1977) and lower HAZ (Moore et al., 2001, Humphrey, 2009). In addition, distance to the water source and cost of water may also indirectly affect nutrition. When women and girls spent much time fetching water, it limits time for economic activities and school reducing economic gain (IRIN, 2006, Bourne, 2014; Wells For The World, 2016) and capacity for adequate child care (UNICEF 2008a). Figure 2.3__ further shows that money spent on buying water may impact on the funds allocated for food leading to food insecurity particularly for the poor households. Purchasing water may also limit the amount a household can use compromising on hygiene practices.

According to Eisenberg, Scott and Porco (2007), treating water can prevent up to 75% of preventable diseases. Fewtrell, as illustrated in Pattanayak et al., (2010), showed that improved water and sanitation combined can lower diarrhoea prevalence rates by 30-50%. Furthermore, unsafe water and lack of basic sanitation contribute over 54 million disability-adjusted life years, a total equivalent of 3.7% of the global burden of diseases (Howard & Bartram, 2003).

Several methods have been used to treat water, particularly drinking water, to remove pathogens, chemicals and/or physical particles. These include heating water, disinfecting water (Solar disinfection, UV lamps disinfection, chemical disinfection (chlorination) and filtering the water (Laurent, 2005; UNICEF, 2008b) . Boiling of drinking water is the most common practice followed by chlorination (Rosa & Clasen, 2010). Treating drinking water is more common in the urban than rural areas (Rosa & Clasen, 2010)

Non-availability of water and sanitation facilities determines the level of one’s hygiene (Hassan et al., 2017) while the safety of water relies heavily on the level of community sanitation (Eisenberg, Scott & Porco, 2007). For instance, poor sanitation can cause contamination through water, hands, soil, pets and flies, all of which can affect areas where children play, and where food is prepared and cooked. Eisenberg, Scott and Porco (2007: 851) further explained that "when sanitation levels are poor, water quality projects may have a minimal public health effect." It is also important to note that access to WASH services varies according to the economic status of individuals, as described by Wagstaff et al., (2004) who reported on the Cebu study of 1991 which found that many factors of child health, including adequate hygiene, increased with maternal level of education. Maternal education is a one of the proxy indicator of social economic standing in society and knowledge acquisition that support child care.

On the basis of the above, it is important to consider interventions that address the key pathways of pathogen transmission starting with sanitation, water, and hygiene. To guarantee access to safe water, the country's water sector coined a vision to provide "clean and safe water supply and sanitation for all by 2030". The goal was to ensure access to clean water supply to 80% of the population by 2015 and 100% by 2030 (GRZ, 2015). The 2015 goal was not met, as only 65% of the population had access to safe water sources (UNICEF & WHO, 2015).

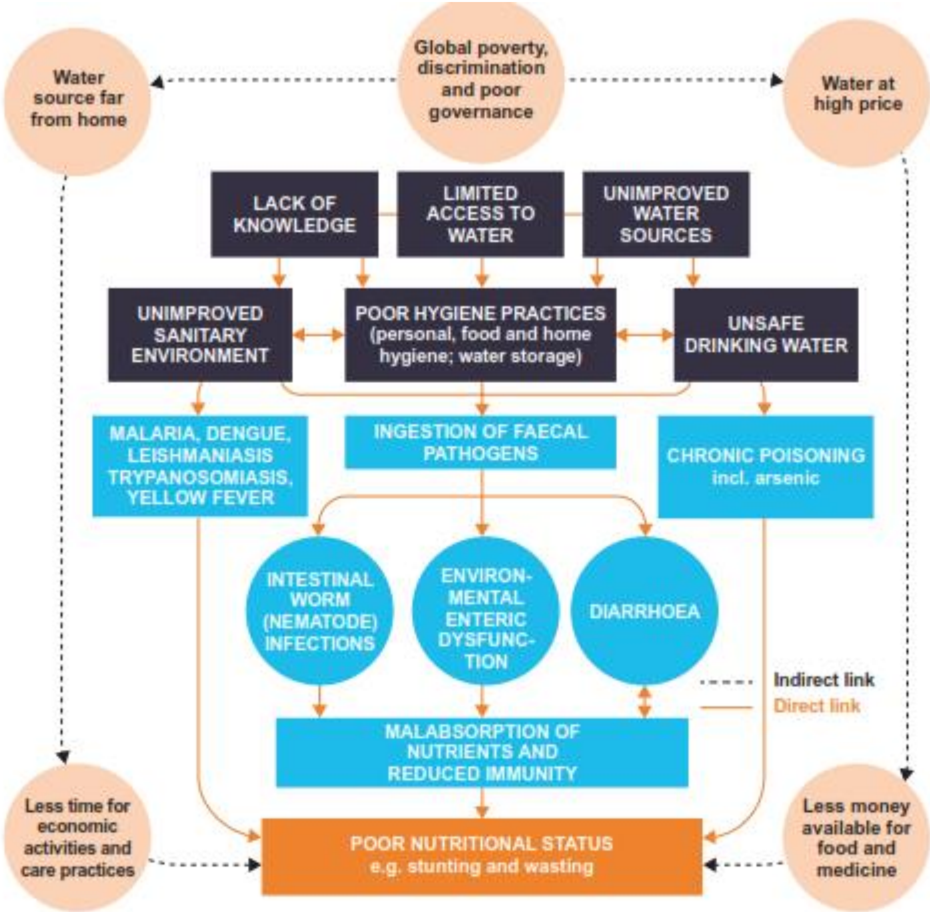


Figure 2-3: Relationship between poor WASH environment and poor nutritional status. *Source*: Dangour et al. (2013) in (Dodos et al., 2017)

Hand washing is the process of removing dirt from hands, a known means for controlling or preventing infections such as diarrheal or respiratory infections. In SSA, about 50% of the population practice handwashing using soap, with some variation between rural and urban areas (UNICEF & WHO, 2015). There are several views regarding handwashing practices. Some people view the practice of not washing hands as a disgusting behaviour. Others consider the practice to be a way of keeping the family healthy, or as a habit or norm in their communities (Contzen & Mosler, 2015).

Hand washing can reduce diarrhoea by about 35% (Hill, Kirkwood & Edmond, 2004). Ordinary hand washing alone without soap is not effective in controlling diseases, whereas washing with soap or ash and an adequate amount of water, combined with hand drying in the air or with a clean cloth, is considered the safest practice (Hill, Kirkwood & Edmond, 2004; Hassan et al., 2017). Hand washing is more critical after use of the toilet, cleaning babies, and before and after handling food. Although handwashing has been recognised as one of the necessary behaviours to block pathogen transmission to human beings, it is not common among caregivers and children (Ngure et al., 2013).

In light of this, hand washing with soap should be emphasised in areas not receiving adequate WASH services as a potential intervention to reduce the incidence of transmission of pathogens. In order to implement this behavioural aspect successfully, availability of adequate water and sanitation facilities is critical. Zambia addresses issues of hygiene through the various policy documents explained in section 2.1.

Complementary foods represent another pathway through which infections are transmitted to the host. Some authors reported that complementary feeding can be a source of contamination and a risk to infant/child health if not handled properly (Motarjemi et al., 1993). Therefore, inappropriate feeding practices can be considered a major cause of the onset of malnutrition in young children, especially if the food preparation and storage areas are in contact with faecal matter. Personal and home hygiene, safe water and sanitation and hand washing are key elements to consider when preparing food.

2.4 Role of Diseases Related to WASH Services and Practices in Malnutrition

Poor water supply, sanitation, and hygiene play a critical role in causing the enteric diseases which contribute to malnutrition. Most enteric diseases are predominantly diseases of the poor which are mostly found in developing countries (Spears, 2013; Watanabe & Petri, 2016; Owino et al., 2016). Some of the diseases include soil-transmitted helminthiases, environmental enteropathy (EE), diarrhoea, malaria, and respiratory tract infections.

Soil-transmitted helminthiases (STH) infections in humans are caused by worms. Four species of nematodes are collectively referred to as soil-transmitted helminths: Ascaris lumbricoides (the roundworm), Trichuris trichiura (the whipworm), Necator americanus or Ancylostoma duodenale (the hookworms). The most favourable environmental conditions for worms are warm temperatures, humidity, poor sanitation, dirty water, and substandard crowded housing (Harhay, Horton & Olliaro, 2010; Croke, 2014). The helminthiases are also known as "diseases of poverty" since they are most common in areas of high poverty (Costa et al., 1987; Brooker et al., 2006; Hotez, 2007; Hotez, 2008; Hotez et al., 2008; Harhay, Horton & Ollliaro, 2010).

STHs are associated with undernutrition, stunting, and micronutrient deficiencies. For example, in Guatemala, the high prevalence of underweight citizens was linked to the high prevalence of helminths (mostly trichuriasis and ascariasis) found among poor people lacking basic facilities (Hotez, 2008). Hall & Horton (2009) summarised the effects of STHs on humans as follows:

> *all species [STHs] can elicit* inflammatory responses that affect appetite and metabolic rate and they all can cause the diversion of perhaps scarce nutrients to mount responses to infection. By these various mechanisms worms may have effects on haemoglobin concentration and thus on anaemia, on physical fitness and work productivity, and on appetite and growth, both in terms of body weight and height *(2009:8).*

Women who are deprived of adequate WASH services and practices are prone to parasitic infestations such as STHs and malaria and are likely to have poor birth outcomes in the form of a decreased birth weight, intrauterine growth retardation, maternal anaemia, stunting, and cognitive deficits (Campbell et al., 2015).

It is also vital for infants and children to be dewormed regularly to prevent possible infections caused by STHs. Play areas which are likely to be contaminated with human and animal faeces should be out of reach of infants/children, as exposure to STH infections could occur if they do not wash their hands regularly (WHO, 2017a). As infants and children play and crawl, they are likely to come into contact with several STHs and other pathogens that can cause diseases such as diarrhoea and EE (Figure 2-4)(Ngure et al., 2013). Furthermore, Ngure et al. (insert date), reported that E.coli was present on nearly 82% of household kitchen floors either made of cow dung or cement. In contrast, Exum et al., (2016) reported a higher level of E. coli contamination on floors in the kitchen area in households with unimproved sanitation and dirt floors when compared to households with improved sanitation and cement floors (Beta: -1.18 log10 E. coli CFU/900 cm(2); [95%CI]: -1.77, -0.60)..

Environmental Enteropathy (EE) occurs in conditions of high poverty where poor sanitation and hygiene are prevalent (McCormick et al., 2017). EE is a concern due to its impact on nutrient availability and utilisation by the body, and can therefore contribute to poor growth and development in infants/children (McCormick & Lang, 2016; Kosek et al., 2017). Poor growth may occur due to reduced absorptive capacity, increased permeability of the small intestines leading to increased passage of microorganisms, and chronic intestinal and systematic inflammation that occur in the host (Ali, Iqba & Sadiq, 2015; Kosek et al., 2017). A review on associations between WASH factors, EE, nutrition, and early infant/child development demonstrated that growth failure, especially stunting, is caused by EE (Ngure et al., 2014) and/or small intestine bacterial overgrowth (Donowitz et al., 2016). Evidence shows that growth failure or faltering may start in utero continuing up to the age of two to three years (Maleta et al., 2003; Mamidi et al., 2011). A deviation from normal growth, especially linear growth, requires several months for an infant or child to recover or catch up (Briend, 1990). In spite of the documented negative effects on infant/child growth, EE has not received the needed attention in nutrition circles. This is due to its invisibility in terms of physical symptoms (Watanabe & Petri, 2016) and the lack of conclusive methods to diagnose it easily (Ali et al., 2015; Brown et al., 2015; Gilmartin & Petri, 2015).

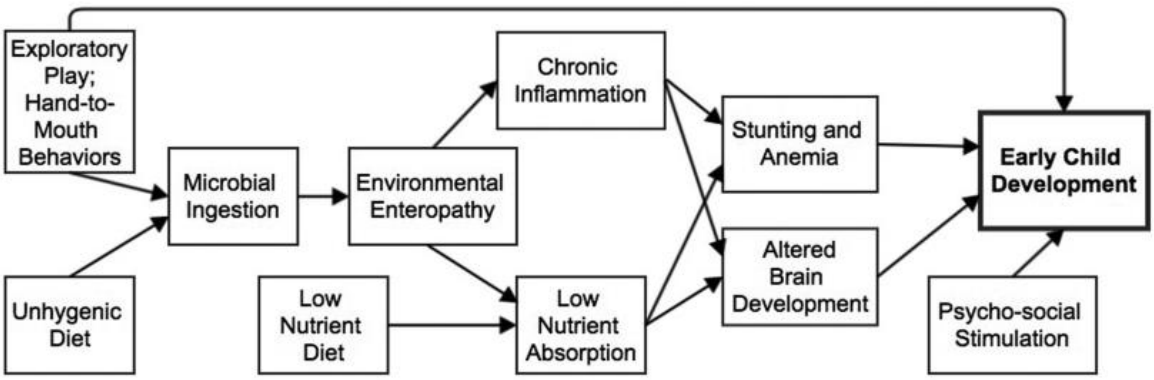


Figure 2-4: Summary of the relationships potentially linking poor hygiene in early childhood to infant and child development. Source: Ngure et al., 2014

Open defecation, poor sanitary facilities, poor disposal of infant/child faeces, and being in contact with animals may be responsible for EE. As shown in the F-diagram (Figure 2-2), the pathogens have numerous pathways through which to enter a new host. EE may also be present in an individual for a long time without their knowledge of its existence (Mbuya & Humphrey, 2016:109). McCormick and Lang (2016) reported that EE affects both linear and weight growth, while Owino et al. (2016) explain that EE in an infant or child may worsen the poor growth that could have occurred during pregnancy and early infancy, leading to stunting.

Diarrhoeal diseases are the main cause of preventable death among infants/children under-five years in developing countries (Keusch et al., 2006; WHO, 2017b). Diarrhoea is currently receiving attention in the nutrition sector due to the impact it has on the nutritional status of the population, especially infants/children. Frequent diarrhoea in an infant or child may lead to deterioration of their nutritional status, to a point where undernutrition is observed (SNDDC, 1992). The impact of diarrhoea is more likely to be severe among infants/children with poor nutritional status, as infection exacerbates nutritional losses arising from poor feeding during illness and lack of food in the home.

Poor sanitation in conjunction with unsafe infant/child faeces disposal practices increases the risk of diarrhoea (Cronin et al., 2016; George et al., 2016). In a study in rural India, Andres et al., (2014) reported a 10% reduction in diarrhoea prevalence among infants/children in households who had moved from unsafe sanitation or open defecation to safe sanitation. In addition, improved sanitation has the potential to offer extended protection from disease (Andres et al., 2014; Fuller et al., 2016). Andres et al., (2014) estimated that if a community improves sanitation from nothing to improved or full coverage, there is a likely benefit of reducing diarrhoea prevalence by 47.5%. However, the combined benefit accruing directly to an infant/ child is about 23% in terms of reduction of diarrhoea prevalence, while the indirect benefit (produced by the neighbourhood's access to sanitation infrastructure) accounted for about 77% of this total. Such benefits are dependent on an improvement of above 30% in sanitation coverage, while half of the gain can be reached with 75% coverage. This means that "a sufficient number of households must have access to safe sanitation in order to decontaminate the village to a level where everyone benefits" (Andres et al., 2014:15).

Other diseases such as ***malaria*** and ***respiratory tract infections*** are associated with malnutrition, poverty and mortality (Aboud & Akhter, 2011; Aishat et al., 2012; Olofin et al., 2013). Aishat et al. (2012), reported over 90% prevalence of malaria among malnourished infants/children, and very low prevalence among non-malnourished children in North Central Nigeria. The prevalence of malaria is higher in people of low socio-economic status (Aishat et al., 2012; Ministry of Health, 2016). The mild deficit ($-2 \leq Z < -1$) in anthropometric indices has also been associated with increased risk of mortality from respiratory tract infections (Olofin et al., 2013).

Repeated episodes of disease and continued exposure to poor WASH conditions have been linked with malnutrition, which commonly manifests as stunting in several countries. Infections are considered the primary cause of malnutrition (stunting, underweight, wasting and chronic anaemia) (Sakti et al., 1999; Ezeamama et al., 2005), together with inadequate food intake before and during the period of illness (UNICEF, 1998). A number of studies have reported an association between infections and nutrition. Nguyen et al. (2013) found an increased risk of poor weight gain among rural infants/children who reported more disease episodes in some rural and urban areas of Vietnam. Similarly, Lima et al., (2000) demonstrated that after one persistent episode of diarrhoea, an infant/ child's WAZ and WHZ decrease, indicating deteriorating nutritional status of the infant/child. This suggests that recurring bouts of diarrhoea may result in several episodes of poor growth, which may have a cumulative negative effect on growth. Pickering et al., (2015) showed that interventions around WASH improved infant/child growth by increasing the height of the children. If interventions are not put in place, infants/children with poor nutrition are likely to progress from the critical period (1st 1000 MCDs) with irreversible conditions such as stunting or poor cognitive development. Empirical evidence has shown that stunted infants/children are at higher risk of chronic diseases in adolescence and adulthood, in addition to there being a negative impact on productivity (Sawaya & Roberts, 2003; Krebs et al., 2007; Briana & Malamitsi-Puchner, 2009).

Poor water and sanitation facilities may also affect education and economic development due to the devastating effects of WASH-related infectious diseases. Several studies have reported diminished cognition (Sakti et al., 1999; Ezeamama et al., 2005), missed school days, and inability to work leading to reduced development and productivity (Hotez et al., 2009; Harhay, Horton & Ollliaro, 2010).

Furthermore, when infections are reduced due to improved water and sanitation, there is a saving on health costs for both families and the overall economy. Bleakley (in Hotez, 2007) estimated that chronic hookworm infection in the American South was responsible for a 43% reduction in future wage-earning. Similarly, studies conducted in Ghana and Pakistan showed that environmental risk factors worsened by "malnutrition adds more than 40% to the cost of directly caused infant/child mortality" (Acharya & Paunio, 2008, in Bartram & Cairncross, 2010). Providing adequate access to safe water and sanitation is likely to contribute to the reduction of gender inequality, allowing women to participate in other livelihood activities, as will be explained in more detail in 2.6.

The control of EE, helminths and diarrhoea infections requires the provision of safe water and adequate sanitation, community health education, observation of food hygiene, and maintenance of functioning sanitation systems (Harhay, Horton & Ollliaro, 2010) promoted mostly through the primary health care. Some scholars have noted that a high prevalence of STHs in an area or country is often associated with a poorly functioning primary health care system (Hotez et al., 2008).

2.5 Poverty and Poor WASH Conditions

In Zambia, over 50% of the population are considered to be poor, with rural areas accounting for 80% of those classified as living in poverty (CSO, 2016; UNICEF Zambia, n.d.; UNDP, 2016). Poverty deprives households of basic needs, and limits the affordability or accessibility of adequate food, safe environmental conditions, and adequate health and nutrition. Poverty among women is exacerbated to some extent by poor access to WASH services, since much of their time is spent fetching water and caring for the sick, instead of making a meaningful contribution to economic activities to earn an income (Jaarsveld et al., 2005; WHO, 2015). The situation promotes a poverty cycle that may be difficult to break.

Similarly, HIV/AIDS is most prevalent in areas where poverty is high, affecting the productivity potential of the poor, particularly vulnerable women, infants and children. However, safe water and good hygiene practices are known to prevent illnesses in infants and young children in areas where HIV-positive mothers use infant formula as a breast milk substitute (UNICEF, 2006).

2.6 Gender, Nutrition and WASH Services and Practices

Biologically, women and girls are already nutritionally vulnerable because of the reproductive processes (such as menstruation and childbearing) that take a toll on women's nutritional status (Oniang'o & Mukudi, 2002). Evidence has shown that the nutritional status of mothers affects the birth outcomes and growth of their infant/child (Maleta et al., 2003; Mamidi et al., 2011; Campbell et al., 2015).

Ensuring adequate WASH practices is just one among the many key tasks that women are expected to perform. Households need water for various uses, such as cooking, cleaning, and sanitation. Women are predominantly responsible for water collection, collecting 90% of the water that households use (Quisumbing et al., 1995), and water collection is estimated to require 40 billion hours a year in Africa (Campbell et al., 2015). In addition, women still need to spend their energy and time on other key household activities such as agriculture production, infant/child care and feeding, ensuring adequate WASH practices, food preparation, and reproductive roles (childbearing and rearing). In the agricultural sector, women provide over 40% of agriculture labour in developing countries (FAO & ADB, 2013), and provide 80% of food consumed in Ghana (Kunze & Drafor, n.d.). Girls are also affected due to time spent fetching water, limiting the time available for school (IRIN, 2006). In situations where safe water and sanitary facilities are not available, children may drop out of school prematurely, and this is more likely to affect girls who bear the burden of water collection, and have periods (UNICEF, 2006, 2008a). Furthermore, when female education levels are lower, economic development suffers (Bourne, 2014; Wells For The World, 2016). For instance, research shows that for every 10% increase in female literacy, a country's economy can grow by 0.3% (Pure Water Access Project, 2016). According to UNICEF (2008a), educated girls are more likely to raise healthy, well-nourished, educated children; are more able to protect themselves from exploitation and AIDS; and more able to develop skills that contribute to their societies.

A huge burden is created by the expectation that women carry out most of the home tasks, in addition to their other developmental activities (IRIN, 2006). When women undertake additional tasks, such as income generating activities, it tends to widen the inequality gap. When both gender inequality and poverty factors are present, the challenges for women to meet the nutritional needs of their families widen further. Despite recognition of the important role women play in sourcing water, women are usually not part of the decision-making when it comes to using water resources (IRIN, 2006). Although women may not be adequately supported, they are known to manage water projects more effectively than men, and to promote sustainability (UN Water & Interagency Network on Women and Gender Equality, 2006). This calls for programmes that will improve women's participation and decision-making in water resource management. Furthermore, providing adequate access to safe water and sanitation means that more time can be spent by women and children on productivity, and on reducing gender inequalities (Jaarsveld et al., 2005) while increasing income that can be used for the welfare of the family (Garcia, 1991; Quisumbing et al., 1995).

Gender issues have received global recognition due to the inequalities between men and women arising from differential treatment in society. MDG number 3 deals with promoting gender equality and the empowerment of women. Of all gender components, improvements have been recorded in elimination of gender disparity in primary, secondary and tertiary education, in participation of women in the labour force, and the number of women in parliament which has nearly doubled over the past 20 years. Nonetheless, there are still gaps regarding poverty, employment and wages, as well as in decision-making (UN, 2015). The SDGs have embraced the same goal advocating for less discrimination and violence against women and girls, and equal opportunity to various platforms (UN, 2017).

2.7 Infant, Child Care and Feeding Practices

Infant and child care refers to the behaviours and practices of caregivers (mothers, siblings, fathers, and child care providers) that promote the provision of food, health care, stimulation, and emotional support necessary for infants/children's healthy growth and development (FAO, n.d). Maternal education and intelligence influence nutritional status more than factors such as family economic status (Cebu study 1991, in Wagstaff et al., 2004; Wachs et al., 2005). It may influence the ability of the mother to make the best use of scarce family and community resources, as well as influence food choices, feeding strategies, and use of health services that promote infants/children's health and nutritional status (Engle, Lhotská, & Armstrong, 1997; Armar et al., 2000; Wachs et al., 2005; Sreeramareddy et al., 2006).

Studies have shown that mothers' infant and child-feeding practices influence the child's growth and development (Birch & Fisher, 2000). Introducing other foods besides breastmilk early in life (before six months) poses a danger to the baby due to possible contamination from poor WASH practices, whereas exclusive breastfeeding for the first six months of life provides benefits both to the baby and the mother. Breastmilk has protective effects against infections (Howie et al., 1990; Popkin et al., 1990; Lima et al., 2000) and enhances the motor development of the baby (Horwood, Darlow, & Mogridge, 2001; Mortensen et al., 2002; WHO, 2003). According to Jones et al., (2003), when breastfeeding is appropriately applied it can prevent about 13% of childhood deaths. The mother benefits in terms of weight loss and delayed onset of lactational amenorrhea (WHO, 2003). Saadehl and Benbouzid (1990) found that the longer the mother breastfeeds, the longer the delay of onset of postpartum amenorrhoea. This is achieved mostly in cases where the mother fully or nearly fully breastfeeds and remains amenorrhoeic. Delayed onset of postpartum amenorrhoea helps to space children, giving mothers more time and less work to take care of her infants/children. Good child spacing and having more time for children enhances infant survival and reduces maternal morbidity and mortality (Saadehl & Benbouzid, 1990).

For exclusive breastfeeding practices to be successful, early initiation should be promoted to mothers upon delivery. Early initiation of breastfeeding increases the duration of breastfeeding (Salariya, Easton & Cater, 1978), provides colostrum as the baby's first immunisation, allows the baby to learn to suckle more efficiently due to alertness in the first hour of birth (WHO & Wellstart International, 1996), and reduces exposure of infants to diseases. Also, "all-cause neonatal mortality could be reduced by 16.3% if all infants initiated breastfeeding on day 1 of life and 22.3% if initiation took place within the first hour" (Edmond et al., 2006:384).

From 6 months, complementary foods must be introduced while maintaining adequate sanitation and adhering to hygiene practices that prevent disease. Interventions focusing on complementary feeding along with nutrition education in food secure populations may lead to about 30% reduction in stunting (Lassi et al., 2013). Introducing foods too early or too late results in growth deficits and poor infant/child development (WHO, 2003). About 7% of breastfed infants/children in the age range of 2-3 months already receive some solid or semisolid food, and by 4-5 months of age 40% receive semisolid and solid food (CSO et al., 2014). Mothers are expected to consider energy density, meal frequency and adequacy, and to adhere to responsive feeding practices (WHO, 2005). As foods are introduced to the baby, more semi-solid foods are preferred, but food consistency and variety must be gradually increased such that by 12 months the baby can eat family foods. If mothers/caregivers appropriately conduct complementary feeding, it is known to prevent about 6% of childhood deaths (Jones et al., 2003). However, meeting adequate dietary diversity has remained a challenge for some communities. About 22% of breastfeeding infants and children aged 6-23 months consumed food from at least three food groups, while about 19% of breastfeeding and 34% of non-breastfeeding infants and children aged 6-23 months consumed four food groups (CSO et al., 2014). Along with this, about 56% of breastfeeding and 25% of non-breastfeeding infants and children aged 6-23 months in Zambia were able to eat the minimum number of recommended meals.

In addition to dietary quality, responsive feeding has also been positively associated with infant/child growth by improving food intake of infants and young children (WHO, 2003). Responsive feeding involves encouragement to eat to ensure the child takes adequate food to meet their caloric and nutrient needs. In Zambia, only about 25% of caregivers practise responsive feeding (NFNC unpublished report, 2011).

The quality of the diet of infants/children is linked to household and national food security. Although the National Food Balance Sheets for Zambia for four Agricultural Marketing Seasons (2011/2012, 2012/2013, 2013/2014 and 2014/2015) show surplus in the production of maize, cassava and wheat in Zambia (Ministry of Agriculture, 2017), the production does not seem to be equally distributed among the population (Figure 2-5). The National Food Balance Sheet also does not include foods that provide other nutrients like proteins, minerals and vitamins, which are sourced mostly from legumes, vegetables and animal source foods. About 47% of households experience hunger at least one month in a year, with hunger being highest from about November to March (Figure 2-5) (CSO, MAL & IAPRI, 2012). Food insecurity can lead to low quality and quantity of complementary foods failing to meet the nutrient requirement for infant and child growth (Richard, Black & Checkley, 2012). Storrs (1993) further elaborated that poor countries experience a more poor quality diet than a food shortage.

Attainment of household food security depends on the policies that prevail in the country. Addressing gender inequity and rural-urban inequalities, in addition to policies that encourage increased food production, storage and preservation while addressing post-harvest losses, would change the situation.

Figure 2-5: Months households (HHs) experience hunger in Zambia. Source: CSO, MAL & IAPRI, 2012

2.8 Health Seeking Behaviour and Women's Control of Resources

Health seeking behaviour is key to infant and child survival. Seeking prompt and appropriate care, can reduce infant/child mortality from acute respiratory infections by 20% (WHO, in Armar et al., 2000). Some studies have found that poor health-seeking behaviour may be responsible for about 6 -70% of infant/child deaths (WHO, 2004). Apart from maternal education, perceived severity of illness, family income, and number of symptoms of illness play a role in health-seeking behaviour (Sreeramareddy et al., 2006).

Women's control of resources and level of decision-making affect decisions made on infant and child health and care. Women who earn their own income are likely to use it for the welfare of their family, including purchasing food and paying school and home bills (Garcia, 1991; Quisumbing et al., 1995; Engle, Lhotská & Armstrong, 1997). Equally important is the time allocated to infant/child care. Women are often responsible for a range of activities such as raising income, agricultural labour, and household production and investment activities (such as learning and fostering social ties). However, they lack energy saving technology which results in limited time spent on infant/child care, thus affecting children's health and development (McGuire & Popkin, 1989; Engle, Lhotská & Armstrong, 1997). In addition, "women between the ages of 15 to 45 years are in a continuous state of pregnancy or lactation" (Paul & Moller,1979:105) causing nutritional stress on their bodies, which impacts on the time and effort spent on caring for infants and children.

2.9 Immune System, Malnutrition and Poor WASH Services and Practices

Recurrence of diseases leads to compromised nutritional status of the affected people, especially women, infants and children (Pronsky, Meyer & Gardner, n.d.), affecting their immune system. They are exposed not only to more infections, but also to malnutrition and increased morbidity and mortality (LSHTM, 2009). Studies show that poor WASH factors accounts for 50% of the consequences of underweight in infants/children and women (Mara et al., 2010). Infections arising from the interaction of malnutrition and poor WASH factors are even more pronounced when poverty is high among the affected population, as is the case in Zambia. The relationship is reinforcing between the impact of recurring diarrhoea on nutritional status strained by poverty, and the effects malnutrition has on susceptibility to infections, especially among young children (WHO, 2010). Also, due to high levels of poverty, the majority of vulnerable groups are not able to meet most of their nutrient requirements (micronutrients), resulting in deficiencies that compromise the immune system and increase infant/child morbidity and mortality. Periods of illness in an infant or child cause disruption in growth and development, which if not attended to promptly, can lead to malnutrition and/or death.

2.10 Theoretical Frameworks

Theories are used to understand complex relationships that exist between man and the environment. They also guide research and designing, implementation and evaluation of a health or nutrition or any other programme or process (NCI, 2005; Shikany, Bragg & Ritchie, 2009; Raingruber, 2016). There are various categories of theories that can be used to understand relationships including behavioural change theories, ecological theories and models, planning models, communication theories, evaluation models, nursing models and theories (Shikany, Bragg & Ritchie, 2009; Raingruber, 2016). Since this study is concerned more about practices (behaviours) on WASH and nutrition, the emphasis will be centred on theories and models that are applicable to nutrition.

2.10.1 Early theories of nutrition

The development of nutrition as a discipline has its roots among others in the Ancient Theory of Nutrition and the Classical Theory of a Balanced Diet. The struggle to understand how the body produces health or how to gain wellbeing may be as old as when man was created. One of the earliest recorded theories relating to nutrition dates back to as far as the time of Aristotle and Galen - the **Ancient theory of nutrition.** The Ancient theory recognises the role various body systems, particularly blood, digestive system and the liver play in nourishing the body to maintain it in a functioning state (Holy Diver, 2012; Tanaka, 2017). This knowledge influenced the development of various therapeutic diets to support body functions.

The **Classical Theory of a Balanced Diet** of the 19-20th century forms the basis for understanding food as key to human survival. It brought about the idea of ideal food and a balanced diet that is used in nutrition education today. According to this theory, there is a need for the body to be supplied with “molecular structure, that would compensate for their expense and loss from the metabolism, work, and for growth that also applies to the young organisms”(Holy Diver, 2012:1). The classical theory recognised the principle of the energy balance equation, utilisation of food in the body and that food is made up of various elements with different physiological significance. It further recognised how metabolism is aided by various nutritional elements (proteins, fats and carbohydrates) and how the elements satisfy the body's energy needs. Such principles became the foundation of diet formation. The theory contributed to the understanding of the food needs and nutrients according to age, type of work and living conditions (Holy Diver, 2012). The theory continued to be developed with the discovery of new nutrients that are in use today (Tanaka, 2017).

Understanding child growth takes an understanding of many facets of life including food, its origins and consumption, absorption and utilisation in the body. These are the elements that comes first in one's mind when talking about child growth and development. Therefore, it is important that as WASH factors are being discussed to take into consideration the issue of the condition of the body and quality of diet to support child growth as recognised as way back as ancient times. No factor is likely to work alone to bring the needed growth and development in a child. The two theories are a reminder that the body needs to have ideal food and a balanced diet for it to function and to attain wellness. For this, behaviour change is critical. Promoting positive behaviours toward wellness ensures quality diet and absence of disease, thus preventing malnutrition.

2.10.2 Behavioural risk factor theories

The nutrition challenges seen in communities have a large bearing on the behaviour of individuals in households and communities, therefore, an understanding of behaviours in communities is key to development of strategies that would bring impact in reduction of malnutrition. There are behaviours which seem simple but have enormous potential for addressing the nutritional problems that the country is facing currently such high levels of malnutrition. For instance, appropriate breastfeeding practices can prevent about 13% of childhood deaths (Jones et al., 2003). if good sanitary practices are adhered to can reduce diarrhoea morbidity by 26% and overall mortality by 55% (Hill, Kirkwood & Edmond, 2004). Improving household sanitation by more than 30% households in a community can offer not only direct benefits to child health in that particular home, but also has the potential to provide extended protection to neighbourhoods (Andres et al., 2014). Behaviour theories, though not used in this study, would assistance to understand how behaviour is shaped in a community and guide on how to help people adopt behaviours that will make positive differences in their lives.

There are several behavioural change theories and models used in research, nutrition and health programming. They include, but are not limited to, the Health Belief Model, Theory of Reasoned Action, Social Cognitive Theory, Theory of Planned Behaviour, Self Determination Theory, Stages of Change Model and the Precaution Adoption Process Model. The discussion will centre on the first three theories which are widely used (Davies & Macdowall, 2006).

The **Health Belief Model** was developed by Irwin Rosenstock in 1966. Davies & Macdowall (2006) and Raingruber (2016) explain that behaviour change is based on the perception that an individual has regarding susceptibility to disease, severity of disease, potential barriers to change and the cost of adhering to the intervention (NCI, 2005; Davies & Macdowall, 2006; Raingruber, 2016). For instance, in sanitation, the behaviour change may occur according to how people view the risk of poor sanitation in bringing about ill health or poor growth of infants and children, how they perceive the seriousness of the consequences of poor sanitation or diseases resulting from it on infant/child health, how much they believe that improving sanitation will improve infant/child health and growth and whether the cost of improving the sanitation will outweigh the health and growth of their children. According to Raingruber (2016) the model was later modified by Becker and colleagues to include illness behaviour, preventive health and health screening. It has been criticised for emphasising that health behaviour is based on rational, conscious choice. In addition, it focuses on negative factors, lacks strategies for change and it is based on individualistic approach, ignoring the socio-economic and environmental factors that affect decision-making (Raingruber, 2016).

Rainey & Harding (2005) used the constructs of the Health Belief Model to examine the acceptability of solar disinfection of drinking water (SODIS) in a village in Kathmandu Valley, Nepal, to identify local understanding of water, sanitation and health issues. Despite knowledge of the benefit of treating water to reduce stomach ailments, it was less valued than the perceived barriers of heavy domestic and agricultural workloads by women, and other cultural and knowledge barriers. In Haiti, sanitation was perceived as being a risk to cholera and malaria but improving sanitation was difficult due to lack funds (Williams et al., 2015).

The **Social Cognitive Theory** was developed by Bandura in 1977 (Hinyard & Kreuter, 2007). It is one of the most widely used theories in nutrition counselling and health (Davies &

Macdowall, 2006; Spahn et al., 2010). According to this theory, behaviour is shaped by observing, imitating and reinforcing others' social interactions (Spahn et al., 2010). It identifies role models as being important in shaping behaviour which others imitate (Davies & Macdowall, 2006; Hinyard & Kreuter, 2007; Raingruber, 2016). According to the model, the individual, behaviour, and environment influence one another in behaviour formation (Davies & Macdowall, 2006; Raingruber, 2016). Existence of the knowledge and skill needed to perform a behaviour, confidence in one's ability to take action (self-efficacy), and expected outcomes are also considered important elements of behaviour change (Raingruber, 2016). For instance, Hall et al., (2015) demonstrated higher behaviour scores (eat fruits, eat/drink dairy products, eat breakfast, help plan family meals at home, and summary behaviour scores) among school children with high self-efficacy than those with low self-efficacy. This suggests that self-efficacy may be more relevant than knowledge in terms of influencing children's eating behaviours.

There are other behaviour theories which are also useful in behavioural studies. According to the **Theory of Reasoned Action or Theory of Planned Behaviour**, an individual's behaviour is a reflection of his intention to perform that behaviour. This is influenced by behavioural attitudes i.e. beliefs about the outcomes of the behaviour and the value of these outcomes) and subjective norms (i.e., beliefs about what other people think the person should do, as well as the person's motivation to comply with the opinions of others). The **Trans-theoretical Model or Stages of Change Model** indicates that in addition to constructs of other models such as the social cognitive and health belief model, the intention to change in an individual evolves over time (NCI, 2005; Davies & Macdowall, 2006). It outlines the various stages of change, namely precontemplation, contemplation, determination, action and maintenance (Davies & Macdowall, 2006; LaMorte, 2016; Healthy Me, 2017).

The **Integrated Behavioural Model for Water, Sanitation, and Hygiene (IBM-WASH)** was developed due to criticism of most behaviour change models for focusing on individual behaviour with little consideration of the environment, policies, cultural and other external factors (Dreibelbis et al., 2013; Raingruber, 2016) that shape human behaviour, such as poverty. Dreibelbis et al., (2013) developed the IBM-WASH by combining various models previously used in WASH area and other programmes to understand WASH behaviours and behaviour change. The models include three dimensions (contextual, psychosocial and technological dimensions) and five levels (societal/structural, community level, interpersonal/household level, individual and habitual levels). The three dimensions "describes mutual interactions between the individual, the behaviour, and the environment in which the behaviour is practiced" (Dreibelbis et al., 2013:6).

Table 2-1 The Integrated behavioural model for water, sanitation, and hygiene (IBM-WASH)

Levels	Contextual factors	Psychosocial factors	Technology factors
Societal/structural	Policy and regulations, climate and geography	Leadership/advocacy, cultural identity	Manufacturing, financing, and distribution of the product, current and past national policies and promotion of products
Community	Access to markets, access to resources, built and physical environment	Shared values, collective efficacy, social integration, stigma	Location, access, availability, individual vs collective ownership/access, and maintenance of the product
Interpersonal /household	Roles, and responsibilities, household structure, division of labour, available space	Injunctive norms, descriptive norms, aspirations, shame, nurture	Sharing of access to product, modelling/demonstration of use of product
Individual	Wealth, age, education, gender, livelihoods/employment	Self-efficacy, knowledge, disgust, perceived threat	Perceived cost, value convenience, and other strengths and weaknesses of the product
Habitual	Favourable environment for habit formation, opportunity for and barriers to repetition of behaviour	Existing water and sanitation habits, outcome expectation	Ease/effectiveness of routine use of product

Source: (Dreibelbis et al., 2013)

Breithaupt, (2014) used the IBM-WASH in Zambia in Makungwa area to investigate WASH practices and their impact on infant/child well-being. Using the five levels, he found high political support and action for improving WASH practices (societal level) which were not actualised at community level due to lack of capacity to handle the technology, inconsistent availability of supplies such as chlorine, congestion at boreholes and lack of ownership of boreholes among many other challenges. At household level, women's workload reduced the capacity to adequately observe the WASH practices to save time for other activities. At individual level, a low perceived threat from poor sanitary practices, high costs of hand-washing soap, chlorine for water treatment, and cement for building improved sanitation facilities hindered behaviour change though individuals were aware of their key role in infant and child survival.

2.10.3 Early infancy/childhood development theories

The study recognises that in an effort to address child growth and survival, it is almost impossible to divorce one's self from factors that address child development. A child's life is surrounded by the systems that affect their health and nutritional status. In particular, the discussions may centre on environmental, biological, preventive and social factors as they affect child growth, development and survival. A review of theories on child development makes it easier to understand the arguments that come late regarding the above factors.

Early childhood development theories are some of the notable theories that support child growth and development. They may include, among others, the Ecological Systems Theory, Preventive Model and Behaviourist Theory. The **Ecological Systems Theory** by Urie Bronfenbrenner (1979) describes systems that influence development. It considers both environmental and biological factors to shape development and child outcomes and term them as risk and protective factors (Armstrong et al., 2014). The biological risk factors may include prenatal exposure to substances, premature birth, temperament, developmental delays, and chronic medical conditions. Environmental risk factors may include poor feeding and care practices, poverty, abuse, and neglect. Protective factors may improve self-regulation and behaviour and include child factors (health and wellness, high cognitive skills, and strong adaptive skills) and external factors (warm and predictable caregiving relationships, safe experiences and environments, and firm and consistent discipline, community supports, health services, schools, and laws (Armstrong et al., 2014).

The **Preventive Model** seeks to promote preventive action to decrease risk factors and reduce ill health to bring about well-being. Nurturing of the environment to bring about infant/child survival is one of the key factors in the model (Armstrong et al., 2014). Examples of prevention activities in Zambia would include the "Open Defecation Free Kingdoms" to promote behavioural change practices that lead to construction of toilets and eliminate using the bush to defecate, or "Roll Back Malaria" aimed at reducing malaria prevalence among infants/children under five and SUN strategy to reduce stunting among children under five by focusing interventions in the first 1000 days of an infant/child's life.

The **Behaviourist Theory** explains that the infant's mind from birth is shaped by the environment especially through the process of association and positive reinforcement (Cherry, 2017). Development is a response to elements such as praise, punishment, stimuli and rewards (Armstrong et al., 2014: Cherry, 2017). For instance, if desirable behaviour is rewarded it is more likely to be sustained. Some of the notable behaviourists were John B. Watson, Ivan Pavlov and, B.F. Skinner (Armstrong et al., 2014; Cherry, 2017).

2.10.4 Infant and child growth conceptual frameworks

The **UNICEF Conceptual Framework** is among the most widely used conceptual frameworks to understand infant and child growth. The framework recognises food consumption, care, health, and environment as key factors that influence infant/child growth (UNICEF, 1998; Warsito et al., 2012). Inadequacy of any or all of the three elements above, results in inadequate food intake and disease which ultimately lead to undernutrition. However, the above elements should be supported by sound policies, social and economic systems, infrastructure and recognition of the important role women play in bringing and maintaining health. The framework is used as a planning guide for nutrition activities at all levels (national, district and community) for assessing and analysing causes of malnutrition.

Some scholars have used other models to understand some component of the framework such as infant and child care. Child care consists of infant/child feeding and caregiver-child interactions. For instance, the **Transactional Model of Care** tends to expand on the care element of the UNICEF conceptual framework. The model suggests that the infant/child's health, growth and development depend on mutual interactions that occur between the infant/child and the caregiver (Ruel & Arimond, 2003). The interactions are influenced by the character of the child (such as age, gender) and influencing caregiver behaviour or vice versa. The state of health, temperament, and social and language development influence the level of an infant or child's stimulation for care services and how caregivers responds to infants/children's needs thus influencing-growth (Ruel & Arimond, 2003). The IBM-WASH model above addresses the environmental factors of infant/child growth while the early theories of nutrition address in part food security (nutrient intake) of the conceptual framework.

There are several theories and frameworks that have been used to understand various areas of health that can be adapted for use in nutrition. One such framework is the **Proximate Determinant Framework.** The framework was developed to use in studies on the determinants of fertility and infant/child survival (Boerma & Weir, 2005). The study will use this model to explain the findings and a more detailed explanation is given in Chapter 3.

The chapter has highlighted the various policy documents that are foundational to programming in WASH and nutrition sectors in Zambia. It has explained how infant/child growth occurs, and key elements that may hinder growth. The role that some of these elements (such as WASH, diseases, and complementary food) play in infant and child growth have been covered in more detail. Poverty, gender, infant/child care and feeding practices, and health seeking behaviour have been linked to WASH, nutrition and infant/child growth. The relationships between the immune system and malnutrition is explained. The chapter ends by highlighting the various theories commonly used in nutrition and WASH.

2.12 References

Aboud, A.F.E. & Akhter, S. 2011. A cluster-randomized evaluation of a responsive stimulation and feeding intervention in Bangladesh. *Peadiatrics*. 127(5):1191–1197. DOI: 10.1542/peds.2010-2160.

Ahmed, A., Al-Mekhlafi, H.M., Choy, S.H., Ithoi, I. & Al-Adhroey, A.H. 2011. The burden of moderate-to-heavy soil- transmitted helminth infections among rural malaysian aborigines: an urgent need for an integrated control programme. *Parasites & Vectors*. 4(242):1–7. DOI: 10.1186/1756-3305-4-242.

Aishat, S.O., Saka, M.J., Adeboye, M.A.N., Mokuolu, O.A., Buhari, A.M. & Kamaldeen, A. 2012. Malaria Parasitaemia in Children with Protein Energy Malnutrition in North Central Nigeria: A case control study . *Journal of Pharmacy and Biological Sciences*. 1(3):49–53. Available: www.iosrjournals.org.

Ali, A., Iqbal, N.T. l & Sadiq, K. 2015. Environmental enteropathy. *Gastrointestinal Infections*. 32(November):1–6. DOI: 10.1097/MOG.0000000000000226.

Andres, L.A., Briceño, B., Chase, C. & Echenique, J.A. 2014. *Sanitation and externalities Evidence from early childhood health in rural India: Policy research working paper*. Washington DC.

Armar-Klemesu M., Ruel, M.T., Maxwell, D.G., Levin, C.E. & Morris, S.S. 2000. Community and international nutrition poor maternal schooling is the main constraint to good child care practices in Accra 1. *Journal of Nutrition*. 130(January):1597–1607.

Armstrong, K.H., Ogg, J.A., Sundman-Wheat, A.N. & St. John Walsh, A. 2014. *Evidence-Based Interventions for Children with Challenging Behavior*. New York, NY: Springer New York. DOI: 10.1007/978-1-4614-7807-2.

Bartram, J. & Cairncross, S. 2010. Hygiene, sanitation, and water: forgotten foundations of health. *PloS Med*. 7(11):1–9. DOI: 10.1371/journal.pmed.1000367.

Birch, L.L. & Fisher, J.O. 2000. Mothers ' child-feeding practices influence daughters ' eating and weight. *American Journal of Clinical Nutrition*. 71:1054–1061.

Boerma, J.T. & Weir, S.S. 2005. Integrating demographic and epidemiological approaches to research on HIV / AIDS: The Proximate-Determinants Framework. *Journal of Infectious Diseases*. 191(Suppl 1):61–67.

Bourne, J. 2014. *Why educating girls makes economic sense*. Available: http://www.globalpartnership.org/blog/why-educating-girls-makes-economic-sense [2017, October 05].

Breithaupt, L. 2014. Household-level water, sanitation, and hygiene behaviours and the impact on chld Health in the Makungwa Region of the Eastern Province of Zambia. University of Norrth Carolina.

Briana, D.D. & Malamitsi-Puchner, A. 2009. Intrauterine growth restriction and adult disease : the role of adipocytokines. *European Journal of Endocrinology*. 160:337–347. DOI: 10.1530/EJE-08-0621.

Briend, A. 1990. Is diarrhoea a major cause of malnutrition among the under-fives in developing countries? A review of available evidence. *European Journal of Clinical Nutrition*. 44:611–628.

Brooker, S., Clements, A.C.A., Hotez, P.J., Hay, S.I., Tatem, A.J., Bundy, D.A.P. & Snow, R.W. 2006. The co-distribution of Plasmodium falciparum and hookworm among African schoolchildren. *Malaria Journal*. 5(99):1–8. DOI: 10.1186/1475-2875-5-99.

Brown, E.M., Wlodarska, M., Willing, B.P., Vonaesch, P., Han, J., Reynolds, L.A., Arrieta, M., Uhrig, M., et al. 2015. Diet and specific microbial exposure trigger features of environmental enteropathy in a novel murine model. *Nature Communications*. 6:1–16. DOI: 10.1038/ncomms8806.

Campbell, O.M.R., Benova, L., Gon, G., Afsana, K. & Cumming, O. 2015. Getting the basic rights – the role of water, sanitation and hygiene in maternal and reproductive health: a conceptual framework. *Tropical Medicine and International Health*. 20(3):252–267. DOI: 10.1111/tmi.12439.

Cherry, K. 2017. *Child Development Theories and Examples: Some Key Ideas About How Children Grow and Develop*.

Condon-Paoloni, D., Cravioto, J., Johnston, F.E., Licardie, E.R.D.E. & Scholl, T. 1977. Morbidity and growth of infants and young children in a Rural Mexican Village. *American Journal of Public Health*. 67(7):651–656.

Contzen, N. & Mosler, H. 2015. Identifying the psychological determinants of handwashing: results from two cross-sectional questionnaire studies in Haiti and Ethiopia. *American Journal of Infection Control*. 43(8):826–832. DOI: 10.1016/j.ajic.2015.04.186.

Costa, L.E.M.F.F., Magalhaes, M.H.A., Rocha, R.S. & Antunes, C.M.F. 1987. Water-contact patterns and socioeconomic variables in the epidemiology of schistosomiasis mansoni in an endemic area in Brazil. *Bulletin of the World Health Organization*. 65(1):57–66.

Croke, K. 2014. *The long run effects of early childhood deworming on literacy and numeracy : Evidence from Uganda*.

Cronin, A.A., Sebayang, S.K., Torlesse, H. & Nandy, R. 2016. Association of safe disposal of child feces and reported diarrhea in Indonesia: Need for stronger focus on a neglected risk. *International Journal of Environmental Research and Public Health*. 13(3):1–13. DOI: 10.3390/ijerph13030310.

CSO, MAL & IAPRI. 2012. *2012- Rural Agricultural Livelihood Surveys (RALS)*. Lusaka, Zambia.

CSO, MOH, TDRC, UNZA & MACRO International. 2014. *Zambia Demographic and Health Survey 2013-14*. Lusaka, Zambia.

Davies, M. & Macdowall, W. 2006. *Health promotion theory: Understanding public health*. M. Davies & W. Macdowall, Eds. Glasgow, UK: Bell & Bain Ltd,. Available: http://www.sanjeshp.ir/phd_91/Pages/Refrences/health education and promotion/[Maggie_Davies,_Wendy_Macdowall]_Health_Promotion_(BookFi.or.pdf .

Dodos, J., Mattern, B., Lapegue, J., Altmann, M. & Aissa, M.A.I.T. 2017. Relationship between water, sanitation, hygiene, and nutrition: what do Link NCA nutrition causal analyses say? *Waterlines*. 36(4):285–304. DOI: http://dx.doi.org/10.3362/1756-3488.17-00005.

Donowitz, J.R., Haque, R., Kirkpatrick, B.D., Alam, M., Lu, M., Kabir, M. & Kakon, H. 2016. Small intestine bacterial overgrowth and environmental enteropathy in Bangladeshi children. *mBio*. 7(1):1–7. DOI: 10.1128/mBio.02102-15.Editor.

Dreibelbis, R., Winch, P.J., Leontsini, E., Hulland, K.R.S., Ram, P.K., Unicomb, L. & Luby, S.P. 2013. The Integrated Behavioural Model for Water, Sanitation, and Hygiene: a systematic review of behavioural models and a framework for designing and evaluating behaviour change interventions in infrastructure-restricted settings. *BioMed Central Public Health*. 13(1):1015. DOI: 10.1186/1471-2458-13-1015.

Edmond, K.M., Zandoh, C., Quigley, M.A., Amenga-etego, S. & Owusu-agyei, S. 2006. Delayed breastfeeding initiation increases risk of of neonatal mortality. *Peadiatrics*. 117(3). DOI: 10.1542/peds.2005-1496.

Eisenberg, J.N.S., Scott, J.C. & Porco, T. 2007. Integrating disease control strategies: balancing water sanitation and hygiene interventions to reduce diarrheal disease burden. *American Journal of Public Health*. 97(5):846–852. DOI: 10.2105/AJPH.2006.086207.

Engle, P., Lhotská, L. & Armstrong, H. 1997. *The care initiative: assessment, analysis and action to improve care for nutrition*. NewYork, USA. Available: http://www.sidalc.net/cgi-bin/wxis.exe/?IsisScript=BINCA1.xis&method=post&formato=2&cantidad=1&expresion=mfn=001084.

Exum, N., Olortegui, M., Yori, P., Davis, M., Heaney, C., Kosek, M. & Schwab, K. 2016. Floors and Toilets: Association of floors and sanitation practices with faecal contamination in Peruvian Amazon Peri-Urban households [Abstract]. *Enviromental Science and Technology*. 50(14).

Ezeamama, A.E., Friedman, J.F., Acosta, L.P., Bellinger, D.C., Langdon, G.C., Manalo, D.L., Olveda, R.M., Kurtis, J.D., et al. 2005. Helminth infection and cognitive impairment among Filipino children. *American Journal of Tropical Medicine and Hygiene*. 72(5):540–548.

FAO & ADB. 2013. *Gender equality and food security: women's empowerment as a tool against hunger*. Manila, Philippines: Asian Development Bank.

FAO & WHO. 2014. *Second International Conference on Nutrition Rome, 19-21 November 2014 Conference Outcome Document: Framework for Action*. Rome, Italy.

Freeman, M.C., Majorin, F., Boisson, S. & Routray, P. 2016. The impact of a rural sanitation programme on safe disposal of child faeces: a cluster randomised trial in Odisha, India. *Transactions of the Royal Society of Tropical Medicine and Hygiene*. 110:386–392. DOI: 10.1093/trstmh/trw043.

Fuller, J.A., Villamor, E., Cevallos, W., Trostle, J. & Eisenberg, J.N.S. 2016. I get height with a little help from my friends: herd protection from sanitation on child growth in rural Ecuador. *International Journal of Epidemiology*. 45(2):460–469. DOI: 10.1093/ije/dyv368.

Garcia, M. 1991. Impact of female sources of income on food demand among rural households in the Philippines. *Quarterlv Journal of International Agriculture*. 30(2):108–124.

George, C.M., Oldja, L., Biswas, S., Perin, J., Sack, R.B., Ahmed, S., Shahnaij, M., Haque, R., et al. 2016. Unsafe child feces disposal is associated with Environmental Enteropathy and impaired growth. *Journal of Pediatrics*. 176:43–49. DOI: 10.1016/j.jpeds.2016.05.035.

Gilmartin, A.A. & Petri, W.A.J. 2015. Exploring the role of environmental enteropathy in malnutrition, infant development and oral vaccine response. *Philosophical Transactions of the Royal Society B: Biological Sciences*. 370. DOI: http://dx.doi.org/10.1098/rstb.2014.0143.

GRZ. 2006. *National Food and Nutrition Policy*. (1). Lusaka, Zambia.

GRZ. 2007. *National Rural Water Supply and Sanitation 2006-2015*. Lusaka, Zambia: Ministry of Local Government and Housing (MLGH).

GRZ. 2015. *National Water Supply and Sanitation Capacity Development Strategy (2015 – 2020)*. Lusaka, Zambia.

GRZ. 2016. *Zambia National Open Defecation Free (ODF) Strategy (2016-2020)*. Lusaka, Zambia.

Guerrant, R.L., Deboer, M.D., Moore, S.R., Scharf, R.J. & Aldo, A.M. 2014. The impoverished gut - a triple burden of diarrhoea, stunting and chronic disease. *Nature Reviews Gastroenterology & Hepatology*. 10(4):220–229. DOI: 10.1038/nrgastro.2012.239.The.

Guerrant, R.L., Leite, A.M., Pinkerton, R., Medeiros, P.H.Q.S., Cavalcante, P.A., Deboer, M., Kosek, M., Duggan, C., et al. 2016. Biomarkers of environmental enteropathy, inflammation, stunting, and impaired growth in children in Northeast Brazil. *PLoS ONE*. 11(9):1–20. DOI: 10.1371/journal.pone.0158772.

Hall, A. & Horton, S. 2009. *Best practice paper: Deworming: new advice from cc08*. Copenhagen.

Hall, E., Chai, W., Koszewski, W. & Albrecht, J. 2015. Development and validation of a social cognitive theory-based survey for elementary nutrition education program. *International Journal of Behavioral Nutrition and Physical Activity*. 12(1):47. DOI: 10.1186/s12966-015-0206-4.

Harhay, M., Horton, J. & Ollliaro, P.L. 2010. Epidemiology and control of human gastrointestinal parasites in children. *Expert Review of Anti-infective Therapy*. 8(2):219–234. DOI: 10.1586/eri.09.119.Epidemiology.

Hassan, F., Asim, M., Salim, S. & Humayun, A. 2017. House ownership, frequency of illness, fathers' education: the most significant socio-demographic determinants of poor nutritional status in adolescent girls from low income households of Lahore, Pakistan. *International Journal for Equity in Health*. 16(1):122. DOI: 10.1186/s12939-017-0621-z.

Headey, D., Nguyen, P., Kim, S., Rawat, R., Ruel, M. & Menon, P. 2017. Is exposure to animal feces Harmful to child nutrition and health outcomes ? a multicountry observational analysis. *American Journal of Tropical and Hygiene*. 96(4):961–969. DOI: 10.4269/ajtmh.16-0270.

Healthy Me. 2017. *The Transtheoretical Model of Change (The Stages of Change Model)*. Available: https://www.healthymeflorida.com/model.htm.

Hill, Z., Kirkwood, B. & Edmond, K. 2004. *Family and community practices that promote child survival, growth and development: A review of the evidence*.

Hinyard, L.J. & Kreuter, M.W. 2007. Using Narrative Communication as a Tool for Health Behavior Change: A Conceptual, Theoretical, and Empirical Overview. *Health Education & Behavior*. 34(5):777–792. DOI: 10.1177/1090198106291963.

Holy Diver. 2012. *Theory of Nutrition*. Available: http://blog.dlahn.com/theory-of-nutrition/ [2017, November 16].

Horwood, L.J., Darlow, B.A. & Mogridge, N. 2001. Breast milk feeding and cognitive ability at 7 – 8 years. *Archies of Disease in Childhood Fetal Neonatal Education*. 84:F23–F25.

Hotez, P.J. 2007. Neglected diseases and poverty in "'the other America'": the greatest health disparity in the United States? 1(3):1–3. DOI: 10.1371/journal.pntd.0000149.

Hotez, P.J. 2008. Holidays in the sun and the Caribbean's forgotten burden of neglected tropical diseases. *PLoS Neglected Tropical Diseases*. 2(5):1–2. DOI: 10.1371/journal.pntd.0000239.

Hotez, P.J., Bottazzi, M.E., Franco-paredes, C., Ault, S.K. & Periago, M.R. 2008. The neglected tropical diseases of Latin America and the Caribbean: a review of disease burden and distribution and a roadmap for control and elimination. *PLoS Neglected Tropical Diseases*. 2(9):1–11. DOI: 10.1371/journal.pntd.0000300.

Hotez, P.J., Fenwick, A., Savioli, L. & Molyneux, D.H. 2009. Rescuing the bottom billion through control of neglected tropical diseases. *Lancet*. 373:1570–75.

Howard, G. & Bartram, J. 2003. *Domestic water quantity, service level and health*. (WHO/SDE/WSH/03.02). Geneva, Switzerland.

Howie, P.W., Forsyth, S.J., Ogston, S.A., Clark, A. & du Florey, C. V. 1990. Protective effect of breast feeding against infection. *British Medical Journal*. 300(January):11–16.

Humanium. n.d. *Right to food: understanding children's right to food*. Available: http://www.humanium.org/en/fundamental-rights/food/ [2017, August 17].

Humphrey, J.H. 2009. Child undernutrition, tropical enteropathy, toilets, and handwashing. *Lancet*. 374(9694):1032–1035. DOI: 10.1016/S0140-6736(09)60950-8.

IRIN. 2006. *The gender dimensions of water access*. Available: http://www.irinnews.org/report/61125/global-gender-dimensions-water-access [2017, July 17].

Jones, G., Steketee, R.W., Black, R.E., Bhutta, Z.A., Morris, S.S. & Survival, C. 2003. Child survival II How many child deaths can we prevent this year? *Lancet*. 362:65–71.

Keusch, G.T., Fontaine, O., Bhargava, A., Boschi-Pinto, C., Bhutta, Z.A., Gotuzzo, E., Rivera, J., Chow, J., et al. 2006. Diarrheal Diseases. In *Disease control priorities in developing countrites*. 2nd ed. D. Jamison, J. Breman, & A. Measham, Eds. Washington DC: Oxford University Press, USA. Available: https://www.ncbi.nlm.nih.gov/books/NBK11764/.

Kosek, M.N., Ahmed, T., Bhutta, Z., Caulfield, L., Guerrant, R., Houpt, E., Kang, G., Kosek, M., et al. 2017. Causal pathways from enteropathogens to environmental enteropathy: eindings from the MAL-ED Birth Cohort Study. *EBioMedicine*. 18:109–117. DOI: 10.1016/j.ebiom.2017.02.024.

Krebs, N.F., Himes, J.H., Jacobson, D., Nicklas, T.A. & Guilday, P. 2007. Assessment of child and adolescent overweight. *Peadiatrics*. 120(Suppl. 4):S193–S228. DOI: 10.1542/peds.2007-2329D.

Kunze, D. & Drafor, I. n.d. Gender roles in ensuring food security Available: ftp://ftp.fao.org/upload/Agrippa/612_en.doc.

LaMorte, W.W. 2016. *The Transtheoretical Model (Stages of Change)*. Available: http://sphweb.bumc.bu.edu/otlt/MPH-Modules/SB/BehavioralChangeTheories/BehavioralChangeTheories6.html [2017, November 23].

Lartey, A., Manu, A., Brown, K.H., Peerson, J.M. & Dewey, K.G. 2000. Predictors of growth from 1 to 18 months among breast-fed Ghanaian infants. *European Journal of Clinical Nutrition*. 54(1):41–9. DOI: 10.1038/sj.ejcn.1600891.

Lassi, Z.S., Das, J.K., Zahid, G., Imdad, A. & Bhutta, Z.A. 2013. Impact of education and provision of complementary feeding on growth and morbidity in children less than 2 years of age in developing countries : a systematic review. *BioMed Central Public Health*. 13(Suppl 3):1–10.

Laurent, P. 2005. *Household drinking water system and their impact on people with weakened immunity*.

Lima, A.A.M., Moore, S.R., Barboza, M.S., Soares, A.M., Schleupner, M.A., Newman, R.D., Sears, C.L., Nataro, J.P., et al. 2000. Persistent diarrhea signals a critical period of increased diarrhea burdens and nutritional shortfalls: A prospective cohort study among children in Northeastern Brazil. *Journal of Infectious Diseases*. (181):1643–1651.

Lindskog, R.U. & Lindskog, P.A. 1998. Bacteriological contamination of water in rural areas: an intervention study from Malawi [Abstract]. *Journal of Tropical Medicine and Hygiene*. 91(1):1–7. Available: https://www.ncbi.nlm.nih.gov/pubmed/3346930.

LSHTM. 2009. Available: http://conflict.lshtm.ac.uk/page_139.htm.

Mahmud, I. & Mbuya, N. 2016. *Water, sanitation, hygiene, and nutrition in Bangladesh; nan Building toilets affect children's growth?* Washington DC: The World Bank Group.

Majorin, F., Freeman, M.C., Barnard, S., Routray, P., Boisson, S. & Clasen, T. 2014. Child Feces Disposal Practices in Rural Orissa: A Cross Sectional Study. *PLoS ONE*. 9(2):1–7. DOI: 10.1371/journal.pone.0089551.

Maleta, K., Virtanen, S., Espo, M., Kulmala, T. & Ashorn, P. 2003. Timing of growth faltering in rural Malawi. *Archies of Disease in Childhood*. 88(7):574–578. DOI: 10.1136/adc.88.7.574.

Mamidi, R.S., Shidhaye, P., Radhakrishna, K. V, Babu, J.J. & Reddy, P.S. 2011. Pattern of growth faltering and recovery in under five children in India using WHO Growth Standards - A Study on first and third national family health survey. *Indian Pediatrics*. 48:855–60. Available: http://www.ncbi.nlm.nih.gov/pubmed/21555805.

Mara, D., Lane, J., Scott, B. & Trouba, D. 2010. Sanitation and health. *PloS Med*. 7(11):1–7. DOI: 10.1371/journal.pmed.1000363.

Mbuya, M.N.N. & Humphrey, J.H. 2016. Preventing environmental enteric dysfunction through improved water, sanitation and hygiene: an opportunity for stunting reduction in developing countries. *Maternal & Child Nutrition*. 12 Suppl 1:106–20. DOI: 10.1111/mcn.12220.

McCormick, B.J.J. & Lang, D.R. 2016. Diarrheal disease and enteric infections in LMIC communities: how big is the problem? *Tropical Diseases, Travel Medicine and Vaccines*. 2(1):11. DOI: 10.1186/s40794-016-0028-7.

McCormick, B.J.J., Lee, G.O., Seidman, J.C., Haque, R., Mondal, D., Quetz, J., Lima, A.A.M., Babji, S., et al. 2017. Dynamics and trends in fecal biomarkers of gut function in children from 1-24 months in the MAL-ED study. *American Journal of Tropical Medicine and Hygiene*. 96(2):465–472. DOI: 10.4269/ajtmh.16-0496.

McGuire, J.M. & Popkin, B. 1989. Beating the zero-sum game: women and nutrition in the third world_ Part 1. *Food and Nutrition Bulletin*. 11(4).

Mei, Z. & Grummer-Strawn, L.M. 2007. Standard deviation of anthropometric Z-scores as a data quality assessment tool using the 2006 WHO growth standards: a cross country analysis. *Bulletin of the World Health Organization*. 85(6):441–448. DOI: 10.2471/BLT.06.034421.

Ministry of Agriculture. 2017. *National Food Balance Sheets*. Available: http://www.agriculture.gov.zm/index.php?option=com_jdownloads&Itemid=1576&view=viewcategory&catid=20 [2017, October 05].

Ministry of Health. 2016. *Zambia National Malaria Indicator Survey 2015*. Lusaka,Zambia.

Ministry of Health & NFNC. 2008. *Infant and young child feeding counselling: An intergreted course; Participants manual*. Lusaka, Zambia: NFNC.

Mintz, E.D., Reiff, F.M. & Tauxe, R. V. 1995. Safe water treatment and storage in the home: a practical new strategy to prevent waterborne disease. *Journal of the American Medical Association*. 273(12):948–953.

Moore, S.R., Lima, A.A.M., Conaway, M.R., Schorling, J.B., Soares, A.M. & Guerrant, R.L. 2001. Early childhood diarrhoea and helminthiases associate with long-term linear growth faltering. *International Journal of Epidemiology*. 30(6):1457–1464. DOI: 10.1093/ije/30.6.1457.

Mortensen, E.L., Michaelsen, K.F., Sanders, S.A. & Reinisch, J.M. 2002. The association between duration of breastfeeding and adult intelligence. *Journal of the American Medical Association*. 287(18):2365–2372.

Motarjemi, Y., Kaferstein, F., Moy, G. & Quevedo, F. 1993. Reviews/analyses contaminated weaning food : a major risk factor for diarrhoea and associated malnutrition. *Bulletin of the World Health Organization*. 71(1):79–92.

NCI. 2005. *Theory at a glance: A guide for health promotion practice*. Second ed. U.S. Department of health and human services.

NFNC. 2017. National Food and Nutrition Strategic Plan for Zambia 2017-2021: Toward eliminating all forms of malnutrition across the Zambian population by 2030. Lusaka, Zambia

Ngure, F.M., Humphrey, J.H., Mbuya, M.N.N., Majo, F., Mutasa, K., Govha, M., Mazarura, E., Chasekwa, B., et al. 2013. Formative research on hygiene behaviors and geophagy among infants and young children and implications of exposure to fecal bacteria. *American Journal of Tropical and Hygiene*. 89(4):709–716. DOI: 10.4269/ajtmh.12-0568.

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

Nguyen, H.T., Eriksson, B., Petzold, M., Bondjers, G. & Tran, T.K. 2013. Factors associated with physical growth of children during the first two years of life in rural and urban areas of Vietnam. *BioMed Central Peadiatrics*. 13(149):1–10. DOI: 10.1186/1471-2431-13-149.

Olofin, I., McDonald, C.M., Ezzati, M., Flaxman, S., Black, R.E., Fawzi, W.W., Caulfield, L.E., Danaei, G., et al. 2013. Associations of suboptimal growth with all-cause and cause-specific mortality in children under five years: A pooled analysis of ten prospective studies. *PLoS ONE*. 8(5):1–10. DOI: 10.1371/journal.pone.0064636.

Oniang' o, R. & Mukudi, E. 2002. *Nutrition and gender." In nutrition: a foundation for development*. (12). Geneva, Switzerland: ACC/SCN.

Owino, V., Ahmed, T., Freemark, M. & Kelly, P. 2016. Environmental Enteric Dysfunction and growth gailure: Stunting in global child health. *Pediatrics*. 138(6):1–10. DOI: 10.1542/peds.2016-0641.

Pattanayak, S.K., Poulos, C., Yang, J.C. & Patil, S. 2010. How valuable are environmental health interventions? evaluation of water and sanitation programmes in india. *Bulletin of the World Health Organization*. 88(7):535–542. DOI: 10.2471/BLT.09.066050.

Paul, A.A. & Moller, E.. 1979. Seasonal variation in dietary intake in pregnant and lactating women in a rural Gambian Village.

Pickering, A.J., Djebbari, H., Lopez, C., Coulibaly, M. & Alzua, M.L. 2015. Effect of a community-led sanitation intervention on child diarrhoea and child growth in rural Mali: A cluster-randomised controlled trial. *Lancet Global Health*. 3(11):e701–e711. DOI: 10.1016/S2214-109X(15)00144-8.

Popkin, B.M., Adair, L., Akin, J.S., Black, R., Briscoe, J. & Flieger, W. 1990. Breast-feeding and diarrheal. *Peadiatrics*. 86(6):874–882.

Preeti, P., Sahoo, S.K., Biswas, D. & Dasgupta, A. 2016. Unsafe Disposal of Child Faeces: A Community-based Study in a Rural Block in West Bengal, India. *Journal of Preventive Medicine and Public Health*. 49:323–328.

Pronsky, Z.M., Meyer, S.N. & Gardner, C.F. n.d. *Nutrition in HIV disease: excerpt from HIV medication-food interactions Handbook*. 2nd ed. J.P. Crowe, V.S.. Young, T.N. Kakuda, & W. Roberts, Eds.

Prüss, A., Kay, D., Fewtrell, L. & Bartram, J. 2002. Estimating the burden of disease from water, sanitation, and hygiene at a Global Level. *Environmental Health Perspectives*. 110(5):537–542.

Pure Water Access Project. 2016. *Water and women: An intersection of water accessibility and feminism*. Available: http://www.purewateraccessproject.com/the-pwap-blog/2016/11/4/water-and-women-an-intersection-of-water-accessibility-and-feminism [2017, October 05].

Quisumbing, A.R., Brown, L.., Hilary, S.., Haddad, L. & Pena, C. 1995. *Women: The key to food security*. Washington D.C: International Food Research Policy Institute.

Rainey, R.C. & Harding, A.K. 2005. Acceptability of solar disinfection of drinking water treatment in Kathmandu Valley, Nepal [Abstract]. *International Journal of Environmental Health Research*. 15(5):361–372. DOI: http://dx.doi.org/10.1080/09603120500289168.

Raingruber, B. 2016. Health Promotion Theories. In *Contemporary Health Promotion in Nursing Practice*. Jones and Bartlett Learning. 53–94.

Rand, E.C., Loughnan, L., Maule, L. & Reese, H. 2015. *Scaling Up rural sanitation and hygiene: management of child feces; current disposal practices. research brief*. Available: https://www.wsp.org/sites/wsp.org/files/publications/WSP-CFD-Summary-Brief.pdf.

Richard SA, Black RE & Checkley W. 2012. Revisiting the relationship of weight and Height in early childhood. *Advances in Nutrition*. 3(2):250–254. DOI: 10.3945/an.111.001099.250.

Rosa, G. & Clasen, T. 2010. Estimating the scope of household water treatment in low- and medium-income countries. *American Journal of Tropical Medicine and Hygiene*. 82(2):289–300. DOI: 10.4269/ajtmh.2010.09-0382.

Ruel, M.T. & Arimond, M. 2003. *Measuring childcare practices: approaches, indicators,and implications for programs*. Washington, D.C.

Saadehl, R. & Benbouzid, D. 1990. Breast-feeding and child-spacing: importance of information collection for public health policy. *Bulletin of the World Health Organization*. 631(5117):625–631.

Sakti, H., Nokes, C., Hertanto, W.S., Hendratno, S., Hall, A., Bundy, D.A.P. & Satoto. 1999. Evidence for an association between hookworm infection and cognitive function in Indonesian school children. *Tropical Medicine and International Health*. 4(5):322–334.

Salariya, E.M., Easton, P.M. & Cater, J.I. 1978. Duration of breastfeeding after early initiation and frequent feeding. *Lancet*. (November):1141–1143.

Sanitation Updates. 2016. *Comparative assessment of sanitation and hygiene policies and institutional frameworks in Rwanda, Uganda and Tanzania*. Available: https://sanitationupdates.wordpress.com/2016/06/15/comparative-assessment-of-sanitation-and-hygiene-policies-and-institutional-frameworks-in-rwanda-uganda-and-tanzania/ [2017, August 16].

Sawaya, A.L. & Roberts, S. 2003. Stunting and future risk of obesity : principal physiological mechanisms Baixa estatura nutricional e risco de obesidade futura : principais mecanismos fisiológicos. *Cad. Saúde Pública, Rio de Janeiro*. 19(suppl. 1):21–28.

SHARE, LSHTM & WaterAid. 2015. Available: www.wateraid.org/ppa.

Shikany, J.M., Bragg, C.S. & Ritchie, C.S. 2009. *Handbook of Clinical Nutrition and Aging*. 2nd ed. C.W. Bales & C.S. Ritchie, Eds. Totowa, NJ: Humana Press. DOI: 10.1007/978-1-60327-385-5.

Subcommittee on Nutrition and Diarrheal Diseases Control (SNDDC), Subcommittee on Diet Physical Activity, and P.O., Committee on International Nutrition Programmes, Food and Nutrition Board & Institute of Medicine. 1992. *Nutrition issues in developing countries: Part I: diarrheal diseases Part II: diet and activity during pregnancy and lactation*. Washington D.C: National Academy Press.

Spahn, J.M., Reeves, R.S., Keim, K.S., Laquatra, I., Kellogg, M., Jortberg, B. & Clark, N.A. 2010. State of the Evidence Regarding Behavior Change Theories and Strategies in Nutrition Counseling to Facilitate Health and Food Behavior Change. *Journal of the American Dietetic Association*. 110(6):879–891. DOI: 10.1016/j.jada.2010.03.021.

Spears, D. 2013. *The nutritional value of toilets: How much international variation in child height can sanitation explain?a*. Delhi, India.

Sreeramareddy, C.T., Shankar, R.P., Sreekumaran, B. V, Subba, S.H., Joshi, H.S. & Ramachandran, U. 2006. Care seeking behaviour for childhood illness- a questionnaire survey in western Nepal. *BioMed Central International Health and Human rights*. 6(7). DOI: 10.1186/1472-698X-6-7.

Storrs, A.L. 1993. Nutritional influences on linear growth: A general review. In *Causes and Mechanisms of Linear Growth Retardation: Proceedings of an I/D/E/G/C Workshop*. J.C. Waterlow & B. Schrch, Eds. London, UK. Available: http://archive.unu.edu/unupress/food2/UID06E/UID06E00.HTM#Contents.

SUN Movement. 2016. *Scaling Up Nutrition: SUN movement strategy and roadmap (2016-2020)*. Available: scalingupnutrition.org/about-sun/the-sun-movement-strategy/.

SUN Road Map Task Team. 2010. *A Road Map for Scaling-Up Nutrition*.

Tanaka, T.H. 2017. Dietary tradition, nutritional theories and science. *Mathews Journal of Nutrition & Dietetics*. 2(1):8–10.

Teague, J. 2014. DOI: 10.1007/s00038-014-0580-8.1506.

UN. 2015. *We can end poverty: Millenium Development Goals and Beyond 2015*. Available: http://www.un.org/millenniumgoals/environ.shtml [2017, August 16].

UN. 2017. *Sustainable Development Goals: 17 Goals to Transform our World*. Available: http://www.un.org/sustainabledevelopment/sustainable-development-goals/ [2017, August 16].

UN Water & Interagency Network on Women and Gender Equality. 2006. *Gender, Water and Sanitation: A Policy Brief*.

UNDP. 2016. *Zambia Human Development Report 2016: Industrialisation and human development; poverty reduction through wealth and employment creation*. Lusaka, Zambia.

UNICEF. 1998. *The State of the world's children 1998*. NewYork, USA: Oxford University Press. Available: https://www.unicef.org/sowc98/silent4.htm.

UNICEF. 2006. *Human Development Report 2006 Human Development Report Office, Occasional Paper*. Available: hdr.undp.org/sites/default/files/reports/267/hdr06-complete.pdf.

UNICEF. 2008a. *Food prices increases/nutrition Security: action for children -July 4th 2008*. Available: unicef.org/eapro/Food_Prices_Technical_Note_-july_4th.pdf [2010, July 18].

UNICEF. 2008b. *Promotion of household water treatment and safe storage in unicef wash programmes*. New York, NY.

UNICEF. 2008c. *UNICEF and the International Year of Sanitation 2008; Why improved sanitation is important for children*. Available: www.sanitationyear2008.org [2013, July 12].

UNICEF & WHO. 2015. *25 Years Progress on drinking water and sanitation – 2015 update and MDG assessment.* NewYork, USA.

UNICEF Zambia. n.d. *UNICEF Zambia*. Available: https://www.unicef.org/zambia/children_5157.html [2017, May 31].

UNSCN. 2017. *Scaling Up Nutrition Movement*. Available: https://www.unscn.org/en/forums/Relevant-Platforms?idnews=1280 [2017, August 19].

Van Jaarsveld, A.S., Biggs, R., Scholes, R.J., Bohensky, E., Reyers, B., Lynam, T., Musvoto, C. & Fabricius, C. 2005. Measuring conditions and trends in ecosystem services at multiple scales: the Southern African Millennium Ecosystem Assessment (SAfMA) experience. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*. (360):425–441. DOI: 10.1098/rstb.2004.1594.

Victora, C.G., de Onis, M., Hallal, P.C., Blössner, M. & Shrimpton, R. 2010. Worldwide timing of growth faltering: revisiting implications for interventions. *Pediatrics*. 125(3):e473–e480. DOI: 10.1542/peds.2009-1519.

Wachs, T.D., Creed-Kanashiro, H., Cueto, S. & Jacoby, E. 2005. Maternal education and intelligence predict offspring diet and nutritional status. *Journal of Nutrition*. 135(January):2179–2186.

Wagstaff, A., Bustreo, F., Bryce, J., Claeson, M., Bank, W. & Health, C. 2004. Child health: reaching the Poor. *American Journal of Public Health*. 94(5):726–736. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1448326/.

Wang, Y. & Chen, H. 2012. Use of percentiles and Z -Scores in anthropometry. In *Handbook of Anthropometry: Physical Measures of Human Form in Health and Disease*. V.R. Preedy, Ed. Baltimore: Springer. 21–48. DOI: 10.1007/978-1-4419-1788-1.

Warsito, O., Khomsan, A., Hernawati, N. & Anwar, F. 2012. Relationship between nutritional status, psychosocial stimulation, and cognitive development in preschool children in Indonesia. *Nutrition Research and Practice*. 6(5):451–457.

Watanabe, K. & Petri, W.A. 2016. Environmental Enteropathy : elusive but significant subclinical abnormalities in developing countries. *EBioMedicine*. 10:25–32. DOI: 10.1016/j.ebiom.2016.07.030.

Waterlow, J.C. 1993. Relationship of gain in height to gain in weight. In *Causes and Mechanisms of Linear Growth Retardation: Proceedings of an I/D/E/G/C Workshop*. J.C. Waterlow & B. Schrch, Eds. London, UK.

Wells For The World. 2016. *The impact of water scarcity and economic growth*. Available: https://www.wellsfortheworld.org/water-scarcity-and-economic-growth/ [2017, October 05].

WHO. 2003. *Guiding principles for complementary; feeding of the breast fed child. Geneva, Switzerland*. Geneva, Switzerland.

WHO. 2005. *Guiding principles for feeding non-breastfed children 6-24 months of age*. Geneva, Switzerland.

WHO. 2010. *Water sanitation and health*. Available: http://www.who.int/water_sanitation_health/diseases/malnutrition/en/ [2017, July 01].

WHO. 2015. *Water sanitation & hygiene for accelerating and sustaining progress on neglected tropical diseases: A global strategy 2015-2020*. Geneva, Switzerland.

WHO. 2017a. *Soil-transmitted helminth infections: Fact Sheet*. Available: http://www.who.int/mediacentre/factsheets/fs366/en/ [2017, August 14].

WHO. 2017b. *Child mortality: Millenium Development Goal (MDG) 4*. Available: http://www.who.int/pmnch/media/press_materials/fs/fs_mdg4_childmortality/en/ [2017, November 14].

WHO & UNICEF. 2006. *Core questions on drinking-water and sanitation for household surveys*. Geneva, Swizerland.

WHO & UNICEF. 2017. *Progress on drinking water, sanitation and hygiene 2017; update and SDG Baselines. Launch version*. Geneva, Switzerland. Available: https://www.unicef.org/publications/index_96611.html?utm_source=newsletter&utm_medium=email&utm_campaign=WASH.

WHO & Wellstart International. 1996. Promoting breast-feeding in health facilities: A short course for administrators and policy-makers. Geneva, Switzerland

Williams, H.A., Gaines, J., Patrick, M., Berendes, D., Fitter, D. & Handzel, T. 2015. Perceptions of Health Communication, Water Treatment and Sanitation in Artibonite Department, Haiti, March-April 2012. *PLos ONE*. 10(11):e0142778. DOI: 10.1371/journal.pone.0142778.

CHAPTER 3: RESEARCH QUESTION, OBJECTIVES, DESIGN AND METHODOLOGY

Chapter 2 presented a systematic review of the literature on infant/child growth, highlighting the association between WASH Services and practices with diseases, and nutritional status in infants and children. Chapter 3 focuses on the research methodology, describing the research question, aim and objectives. This chapter provides an overview of the population and study setting, including the distance between study areas, livelihoods of those involved, and the sampling process. The tools for data analysis and methods are described, along with the conceptual framework guiding the study.

3.1 Research Question

What are the effects of poor water quality, poor sanitation facilities, and poor hygiene practices on the nutritional status and incidence of diseases and parasitic infestations in infants and young rural children, aged 6-23 months, in Monze, Zambia?

3.2 Aims and Objectives

Aim

The study seeks to determine the effect of poor quality water, poor sanitation, and poor hygiene practices on growth and the prevalence and incidence of infectious diseases and parasitic infestations in infants and young rural children aged 6-23 months in Monze, Zambia.

Specific objectives

1. To determine and compare the level of access to safe water, sanitation facilities, and good hygiene practices in two areas, one area having good WASH facilities and practices (experimental) and one having poor WASH facilities and practices (control), over 12 months.
2. To determine and compare the nutritional status of infants and children aged 6-23 months in an area having good WASH facilities and practices (experimental) and in an area having poor WASH facilities and practices (control).
3. To assess and compare the prevalence and type of infectious diseases in infants and children aged 6-23 months in an area having good WASH facilities and practices (experimental) and in an area having poor WASH facilities and practices (control).

4. To determine the relationship between poor WASH facilities and practices and nutritional status and incidence of diseases.

3.3 Population and Setting

The study setting included areas in Monze district which are about 200 km from the capital city of Lusaka. Two study areas, Njolamwanza and Hamangaba, were selected by the District Medical Office and are relatively far apart and fall under different chiefs. Njolamwanza (40km east of Monze) is under Chief Mwanza, while Hamangaba (74Km west of Monze) falls under Chief Hamusonde (Figure 3-1). Njolamwanza was the experimental area (because of its better WASH facilities as indicated by the District Medical Office) and Hamangaba was the control area (poor WASH facilities according to the District Medical Office).

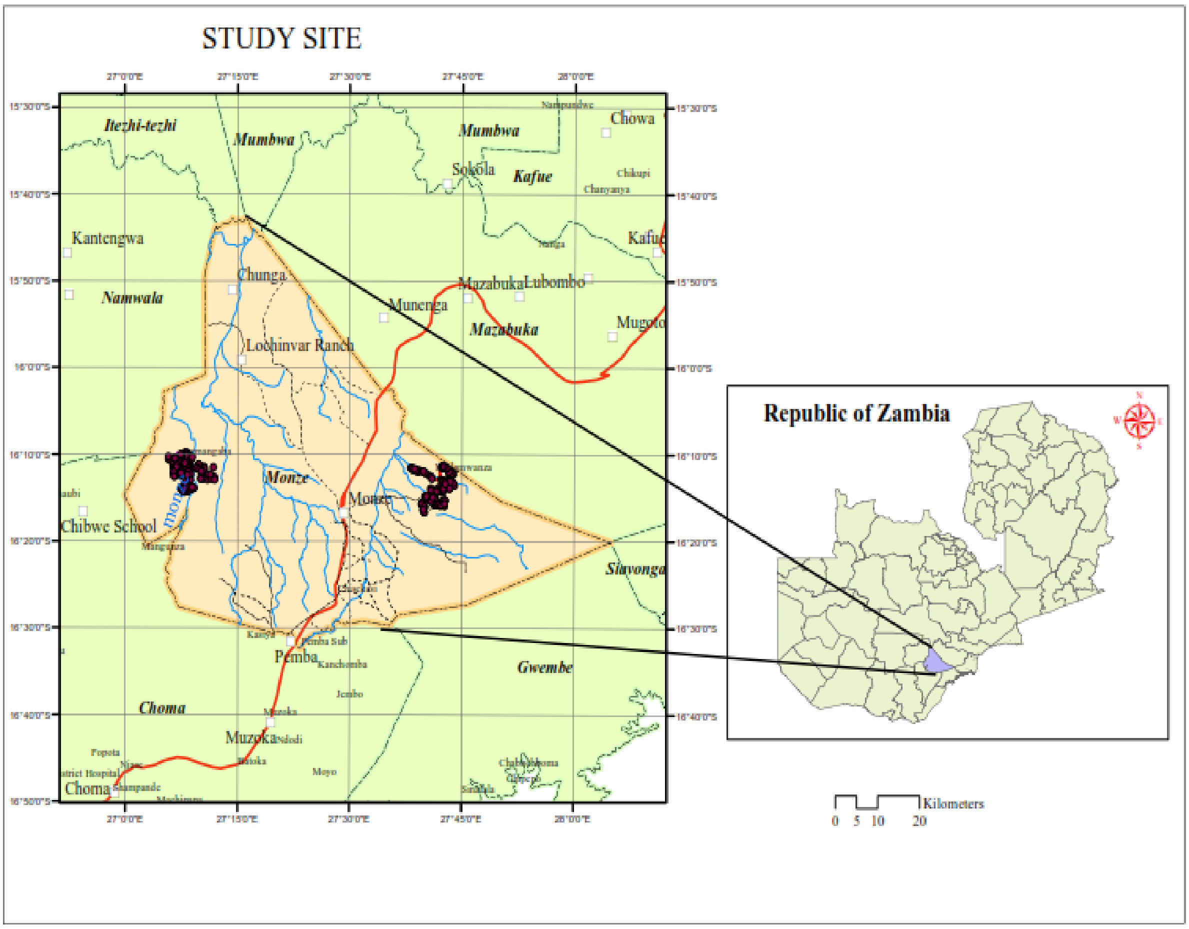


Figure 3-1: Map of the location of the study sites - Hamangaba and Njolamwanza, Monze District

Note: The special database map used is from Google earth system - GCS_WGS_1984.

Both chiefdoms depend on agriculture, combining crop and animal production for livelihoods. Although Tonga is the common tribe, the two communities are distinguished as plateau Tongas (Njolamwanza) and Ilas (Hamangaba). At the time of the study, it was harvest time in both areas. In Hamangaba, animal production is so intensified that during the period of the survey, many men were absent as they were taking care of animals at "*Lutanga*"- a swamp area near Kafue River (flats) - where they camp while allowing animals to graze. From observations, both males and females participated in agricultural activities. Harvesting, especially of maize, was done by all household members except infants and young children, while groundnuts were harvested mainly by women. Women also owned most of the vegetable gardens near the rivers and were responsible for infant/child care and feeding. Based on the flow of people at the health facilities, it was primarily women who were responsible for seeking health care for their infants/children, while qualitative data revealed that in some cases men were the decision-makers in health care seeking behaviour.

The target group were households with infants and children aged 6-23 months of age. Mothers or caregivers were respondents since they undertake the task of child care more than other members of the households. Disabled or sick children at the time of the study were excluded. Table 3-1 shows the population for each of the two areas as extracted from the health facility's notice boards.

Table 3-1: Catchment population for health facilities in the study areas

			Control Hamangaba	Experimental Njolamwanza
Item		**Percent of the population**	**Number**	**Number**
Population		100	4767	14304
Infants/children	0-11 months	4	191	287
	12-59 months	20	955	
	0-59 months	20		1431
	5-15 years	49	2340	3505
Women 15-49 years		22	1030	1374
Expected pregnancies		5.4	257	387
Expected deliveries		5.2	248	372
Expected live births		5	238	358
Adults 15 year+		51		3648
Total males- all ages		49		3505
Total females- all ages		51		3648

Source: Data collected from MCDMCH health facilities' notice boards in the two study areas. The second column (Percent of the population) indicates the proportion of that age group in the total population. The third and fourth column indicates numbers in the age category as indicated on the notice boards of the two health facilities.

3.4 Study Design

The study was a cohort study with a group of infants and children aged 6-23 months at baseline being followed for 12 months to monitor their growth. The cohorts were in two groups. The first group was the experimental group (because the area received WASH facilities as indicated by the District Medical Office) and the second was the control group (as the area had not received WASH interventions either by the district or any other organisation at the time of the study according to the District Medical Office). Both the baseline and follow-up were conducted at the same period each year, that is, from April to May.

3.5 Sampling

The sample size calculation was based on the prevalence of malnutrition and infectious diseases occurring in the area, and the size of the population. However, since there is no data for the village, health statistics from the region (Southern province) in which the district falls were used to calculate the sample size. It showed a prevalence of stunting of 36.2%, underweight of 12.8%, and wasting of 4.8%.

$N= Z^2 pq/d^2$

N= desired sample size if population is greater than 10 000

Z= the normal standard deviation= 1.96

P= the proportion of the target population estimated to have characteristics being measured, i.e. underweight in population=13%

q= 1-p = 1- 0.13= 0.87

d=level of significance =0.05

$N=1.96^2 \times 0.13(1-0.13)/0.05^2$

=168.96 plus 10% for dropouts

= 186 (per group)

Study sites were selected by the District Health Office by first grouping the areas into those with WASH intervention and those with non and then randomly selected one which was serviced predominantly with safe water and sanitary facilities (Njolamwanza-exposure/ experimental area) and one which was poorly serviced (Hamangaba - control)(Figure 3-2).

The areas were in two different constituencies: Moomba (Njolamwanza) and Bweengwa (Hamangaba) respectively. Since the constituencies consisted of some wards that were outside of the two study areas, wards were selected purposely to include areas falling under Njolamwanza and Hamangaba. Census Standard Areas and Standard Enumeration Areas were used to sample households. Households in the study were listed using a listing sheet (Appendix 2) to enable selection of those in the area with infants and children 6-23 months of age. A total of 295 households with infants/children between 6-23 months were listed and assessed in both areas, out of the calculated sample of 372. The number was smaller because the only 295 households with children below 24 months of age were found and listed, therefore, they all became part of the research.(see also figure 3-2). Only one infant/child per household was chosen. In households found with more than one child meeting the selection criteria, children were randomly sampled. The listing of the households was conducted in April 2014 before the commencement of the study. The same households were interviewed and measured at baseline (phase 1) and at follow-up (phase 2). No intervention took place between the two phases except for continued support by the District Office to the experimental area.

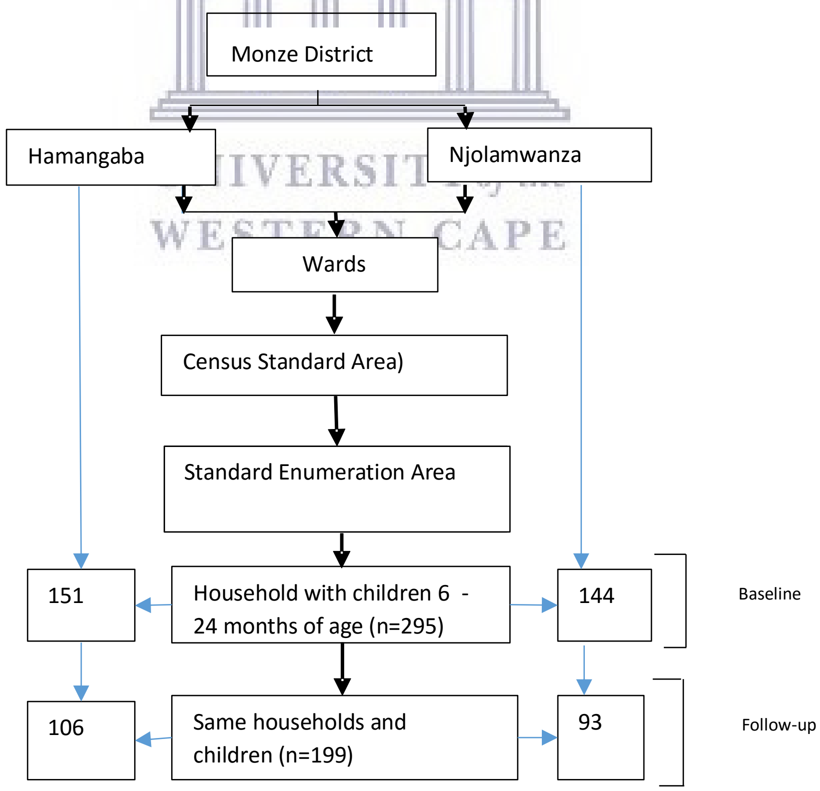


Figure 3-2: Schematic diagram of the sampling process in the study area

3.6 Data Management

3.6.1 Interviews and observations

Interviews and observations were conducted using a questionnaire (Appendix 3) and observation checklist (Appendix 4). The questionnaire, completed by means of face to face interviews the mother/caregiver, was used to collect information on social, economic and demographic factors, quality of the house, wealth factors, and infant/ child nutrition factors, namely: water, sanitation and hygiene; food security; and disease. The questions in the questionnaire were divided into five sections:

- *Socio-demographics:* included information about the respondent, such as age, educational level, the occupation of the spouses, housing characteristics, and wealth of household.
- *Water, sanitation and hygiene*: Included quality, quantity, storage and handling of the water source; food preparation, storage and handling practices; garbage and waste water disposal; toilet and sanitation facilities; and channels of communication.
- *Infant/child health*: Covered diseases suffered by the infant/child in the two weeks before the survey, access to a health facility, and health-seeking behaviour.
- *Infant/child nutrition*: This focused on breastfeeding and complementary feeding practices, factors of responsive feeding practices, dietary diversity, and food security.
- *Anthropometric measurements:* Gathered for the infant/child. These included sex, age, weight, length/height, MUAC and oedema of infants and children.

The observation checklist was used to observe issues related to WASH practices at each visit. At the end of each interview, the enumerator asked for permission to observe several places. The areas of observation included the household's toilet structure and use, food and utensil storage areas, infant/child play areas, hand washing place, waste disposal places, and presence of faeces in the yard, as well as the cleanliness of the mother and infant/child. Using the checklist, the interviewer could tick what they observed. Almost all areas of the checklist provided items to look for, and ticking was appropriate to each household.

3.6.2 Extraction of data from health records

Information on diseases suffered by infants and children was extracted from the child health records for the enrolled infants and children using a recording tool by a health staff in addition to asking whether the child suffered any illness two before the survey. The health records were collected at follow-up period and the information covered the health seeking visit the previous one year. Data on diseases related to WASH factors were later teased out for analysis.

3.6.3 Field Workers

Eight field workers received training on how to complete the questionnaire and collect data from the households. The training initially included a bigger group, but only those who showed understanding of the scope of work were selected. The field workers were from the same district and some from the same area as the study sites, and therefore understood the local language. The field workers were provided with the the questionnaire (Appendix 3), the observation checklist (Appendix 4), age calendars (Appendix 5), and a list of households selected for the interview. The list contained the name and age of the household head, the name and age of the infant or child, and the village they were residing in. The listing exercise was conducted before the commencement of the study.

Other data management techniques are described in individual chapters as follows:

i.	Wealth components	Chapter 4
ii.	Water, Sanitation and Hygiene	Chapter 4
iii.	Anthropometric measures	Chapter 6
iv.	Food consumption score	Chapter 6

3.7 Data Analysis

Detailed analysis is provided in each chapter. Data was entered using EpiData software developed by the EpiData Association™, a non-profit organisation (EpiData Software, n.d.). It has field properties that assist in minimising errors. Data cleaning and analysis was conducted using SPSS software.

Before data analysis, normality testing was conducted using Kolmogorov-Smirnov and Shapiro-Wilk. Three nutritional indices (WAZ, HAZ and WHZ) were considered. A Shapiro-Wilk's test ($p>0.05$) (Field, 2009) showed that the WAZ scores were normally distributed for both phases, with a skewness of 0.25 (SE = 0. 14) and a kurtosis of -0.10 (SE = .288) at baseline, and a skewness of 0.46 (SE = 0.17) and kurtosis of -.20 (SE = 0.34) for follow up. WHZ was also normally distributed for both phases with a skewness of -0.01 (SE = 0.14) and a kurtosis of -0.10 (SE = 0.29) for baseline, and a skewness of -0.05 (SE =0.17) and kurtosis of -0.02 (SE = 0.34) for follow-up, with a Shapiro-Wilks test of $p>0.05$. The HAZ scores were not normally distributed at both baseline and follow-up, with a skewness of 0.93 (SE = 0.14) and a kurtosis of 3.92 (SE = 0.29) for the baseline, and a skewness of 0.73 (SE = .17) and kurtosis of 1.33 (SE = 0.34) for follow-up. In this case, the HAZ variable was log transformed and was reported back on the original scale of measurement.

The Emergency Nutrition Assessment (ENA) for Standardized Monitoring and Assessment of Relief and Transitions (SMART) programme (SMART Methodology, n.d.) was used to make further calculations for the infant/child age, weight, and height variables into the z scores, used to determine the nutritional status of infants and children using the three anthropometric indices (weight-for-height, height-for-age and weight-for-age). These were compared against the WHO growth standards for 2006 (SMART Methodology, n.d.). Malnutrition was determined as a proportion of infants or children below -2 and -3 standard deviations (SDs) (z-scores) of all of the three indices, while overweight was the percentage of infants or children with weight-for-height above +2 z-scores (De Onis & Blössner, 1997; CDC and WFP, 2005; Dewey & Khadija, 2010).

Data analysis was conducted as follows:

a) The outcome variables (HAZ and WAZ) were first tested for normality using the Shapiro-Wilks test, which is described in detail in Chapter 6.
b) Descriptive analysis was done by means of frequency distributions for social, economic and demographic variables; water, sanitation and hygiene; infant/child illness; nutrition status; and other key variables. Significance testing was done using the chi-square value of the crosstabulation.
c) Cross-tabulations were performed on predictor variables with the outcome variables to find those with statistical significance. Significant variables, and other variables

which were not significant but important to the study, were put in the logistic regression model to find associations between predictors and outcome variable.

d) Some variables such as infant/child and mother's hygiene practices were reduced to composites to make it easier to use them when determining personal hygiene levels. Most of the continuous variables were also categorised to interpret the data meaningfully.

e) To address the main theme of the research, namely whether the community with WASH services had better nutritional status than the one with none, the ANCOVA test was used. More details are provided in Chapter 7.

3.8 Ethics

The protocol was approved by the ethics committee of the University of the Western Cape (Appendix 6-1) and Biomedical Ethics committee of the University of Zambia, Ridgeway Campus (Appendix 6-2). Permission was also granted by the Ministry of Health (Appendix 6-3) and the District Medical Office in Monze.

Before commencement of interviews for each household, participants were provided with information about the research both verbally and through the use of the Participant Information Sheet (Appendix 7). The information was provided by the enumerators in the local language that could easily be understood by the respondents. The participants were informed that a) the information collected from them would be kept confidential and would not be given to any partner or project for further analysis; and b) that their participation in the research was voluntary and if they opted to be interviewed, they were free to withdraw anytime they felt they could not continue with the interview. Informed consent (Appendix and 8-1) was obtained from household members such as the infant/child's mother or father before collecting any information. The research presented no known risks associated with participating in the study, and neither were there any direct benefits to the participants.

3.9 Proximate Determinant Conceptual Framework

To meet the objectives of this study, it was necessary to develop a conceptual framework of determinants. Figure 3-3 shows how various factors including WASH factors work to influence infant or child growth, using the proximate determinant framework methodology. Davis and Blake first developed the framework in studies on the determinants of fertility and infant/child survival (Boerma & Weir, 2005). It was also used to "advance research on social policy and medical interventions to improve infant/child survival" (Mosley & Chen, 1984:140). According to the framework, proximate determinants are the media through which social, economic and cultural factors must operate to impact on infant/child growth and cause malnutrition (Mosley & Chen, 1984; Boerma & Weir, 2005). Several diseases and conditions interact to cause malnutrition.

The modified framework in Figure 3-3 shows that the underlying causes or distal factors, such as social and economic factors, have to operate through proximate determinants (behavioural and biological) to influence the growth of the infant or child. When the distal factors are not optimally provided to the population, the resultant condition is the inability of households and communities to maintain behaviours that promote health. In the case of Zambia, poor socioeconomic conditions influence the risk of disease due to poor WASH practices and services, and poor feeding practices (behavioural factors). The conditions lead to diseases (biological factors) which ultimately affect the growth of infants and children (outcome). For example, if water is treated it can prevent up to 75% of preventable diseases (Eisenberg, Scott & Porco, 2007), while hygiene and safe disposal of faeces can reduce about 35% and 26% of diarrhoea incidence respectively (Hill, Kirkwood & Edmond, 2004). The research to be undertaken will therefore address how proximate determinants of WASH practices affect the growth of infants and children.

Howard and Bartram (2003:3) indicated that the quality of "water for consumption and hygiene, has direct consequences for health both in relation to physiological needs and in the control of diverse infectious and non-infectious water-related diseases". Poor WASH facilities and practices can result in diseases such as diarrhoea, schistosomiasis, trachoma, ascariasis, trichuriasis, hookworm disease, and malaria, which contribute to the burden of diseases of poor communities (Jaarsveld et al., 2005; Harhay, Horton & Ollliaro, 2010; WHO, 2016).

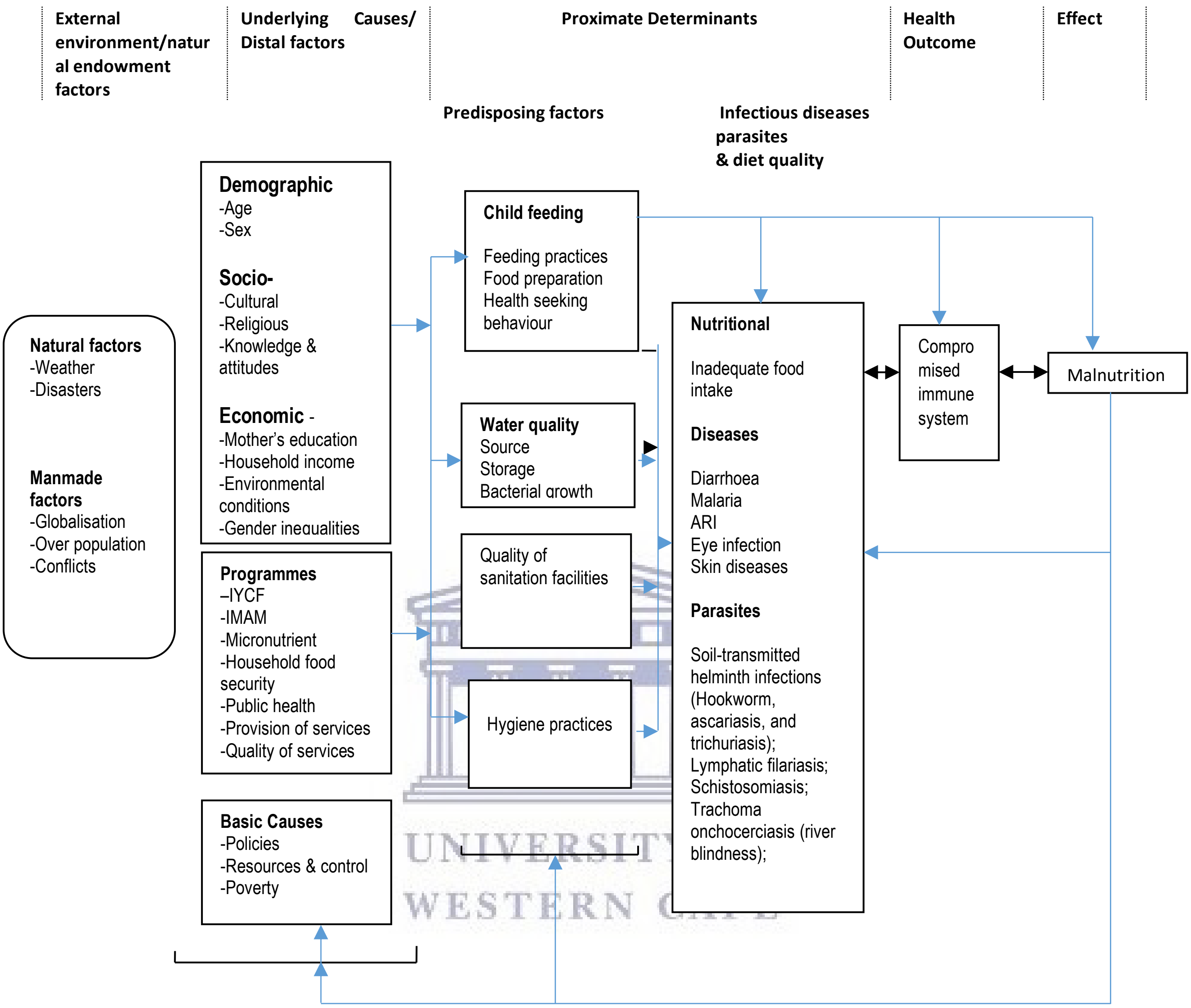


Figure 3-3: Proximate determinants conceptual framework: How factors of water, sanitation and hygiene influence infant and child growth. Adapted from Mosley & Chen, 1984; Victora et al., 1997; Boerma et al., 2000

3.10 References

Boerma, J.T. & Weir, S.S. 2005. Integrating demographic and epidemiological approaches to research on HIV / AIDS: The Proximate-Determinants Framework. *Journal of Infectious Diseases*. 191(Suppl 1):61–67.

Boerma, T., Pisani, E., Mertens, T. & Hill, C. 2000. *A framework for the evaluation of national aids programmes*. (99–17). Washington D.C.

CDC & WFP. 2005. *A manual: measuring and interpreting malnutrition and mortality*. Rome.

De Onis, M. & Blössner, M. 1997. *Database on child growth and malnutrition*. Geneva.

Dewey, K.G. & Begum, K. 2010. *Why stunting matters*. Washington D.C.

Eisenberg, J.N.S., Scott, J.C. & Porco, T. 2007. Integrating disease control strategies: balancing water sanitation and hygiene interventions to reduce diarrheal disease burden. *American Journal of Public Health*. 97(5):846–852. DOI: 10.2105/AJPH.2006.086207.

EpiData Software. n.d. *EpiData Association 2000-2017*. Available: http://www.epidata.dk/about.htm#about.

Field, A. 2009. *Discovering Statistics using spss*. 3rd ed. London, UK: SAGE.

Harhay, M., Horton, J. & Olliaro, P.L. 2010. Epidemiology and control of human gastrointestinal parasites in children. *Expert Review of Anti-infective Therapy*. 8(2):219–234. DOI: 10.1586/eri.09.119.Epidemiology.

Hill, Z., Kirkwood, B. & Edmond, K. 2004. *Family and community practices that promote child survival, growth and development: A review of the evidence*.

Howard, G. & Bartram, J. 2003. *Domestic water quantity, service level and health*. (WHO/SDE/WSH/03.02). Geneva, Switzerland.

Mosley, H.W. & Chen, L.C. 1984. An analytical framework for the study of child survival in developing countries. *Population and Development Review*. 81(2):140–145.

SMART Methodology. n.d. *ENA for SMART - Software for emergency nutrition assessment*. Available: http://www.nutrisurvey.de/ena_beta/ena-epiinfo/index.htm.

Van Jaarsveld, A.S., Biggs, R., Scholes, R.J., Bohensky, E., Reyers, B., Lynam, T., Musvoto, C. & Fabricius, C. 2005. Measuring conditions and trends in ecosystem services at multiple scales: the Southern African Millennium Ecosystem Assessment (SAfMA) experience. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*. (360):425–441. DOI: 10.1098/rstb.2004.1594.

Victora, C.G., Huttly, S.R., Fuchs, S.C. & Olinto, M.T.A. 1997. The role of conceptual frameworks in epidemiological analysis: a hierarchical approach. *International Journal of Epidemiology*. 26(1):224–227.

WHO. 2016. *Water sanitation and health*.

CHAPTER 4: ACCESS TO SAFE WATER, SANITATION, HYGIENE

4.1 Introduction

This chapter addresses the first objective of the study which involves determining the levels of access to safe water, sanitation facilities, and good hygiene practices in households where the target infants and children lived. The chapter commences with a description of the methodology used, moving on to present findings on social and demographic information of the infants and children, level of access to safe sanitary facilities, and water and hygiene practices and feeding practices. In the discussion, the meaning and interpretation of the WASH practices findings with regard to the effects on infant/child nutrition and health are explored. Furthermore, the chapter provides insights into the environmental conditions in the study area to make a meaningful interpretation of the results in the latter chapters.

Objective:

*To determine the level of access to safe water, sanitation facilities and good hygiene practices in two areas (one area having good WASH services (*experimental*) and one having poor WASH services (control) over 12 months.*

4.2 Materials and Methods

Basic information about access to safe water, sanitation facilities, and good hygiene practices and attitudes were collected through face to face interviews, using a validated household questionnaire (Appendix 3) and a checklist (Appendix 4), as described in Chapter 3, section 3.6. Following the cleaning of the data, a descriptive analysis was made of the major variables to derive the number and proportions of infants/ children according to variable categories. Cross-tabulation was used to obtain the p values used to determine statistical significance. P values of less than 0.05 were used to reject the null hypothesis.

4.2.1 Sanitation, water and hygiene variables

Safe sanitation means that no contact with human excreta is expected. Participants were asked whether they had a toilet, the type of toilet, and how often the toilet was cleaned. The results were classified according to whether the toilet facility was safe or unsafe (Table 4-1).

Sanitary disposal of infants and children's faeces ensures the protection from faecal contamination of children under 3 years of age. Respondents were asked how they dispose of the infant/child's faeces. Sanitary disposal of infants/children's faeces includes child using toilet or latrine, placing or rinsing faeces into the toilet or latrine, or burying the faeces; while unsanitary disposal of infants/children's faeces includes placing or rinsing faeces into a drain or ditch, throwing faeces into the garbage, and faeces left or buried in the open.

Questions on water quality were used to classify drinking water based on the WHO/UNICEF (2006) classification. Respondents were asked to indicate the main source of drinking water for their household and were grouped either as "safe water source" or "unsafe water sources" (Table 4-1). This was based on two factors: i) Water supply as either able to supply adequate and safe drinking water or not and ii) the distance to the water source and how the participants treated the water to make it safe.

Table 4-1: Classification of safe and unsafe drinking water and sanitation facilities in the two study areas

Safe	Unsafe
1. Water sources	
Piped water supply into the dwelling	An unprotected dug well
Piped water to a yard/plot	An unprotected spring
A public tap/standpipe	A cart with a small tank/drum
A tube well/borehole	A water tanker-truck
A protected dug well	Surface water
A protected spring	
Rainwater	
2. Sanitation	
Flush to piped sewer system	Flush/pour flush elsewhere
Flush to septic tank	Pit latrine without a slab/open pit
Flush/pour flush to pit	Bucket; and a hanging toilet
Composting toilet	No facilities/bush/field
VIP latrine	
Pit latrine with a slab	

Source: VAM: WFP, n.d., WHO & UNICEF, 2006

The personal hygiene data of both the mother (and guardian) and the infant/child were processed to make them more user-friendly. The hygiene status was determined separately for the mother and infant/child, by means of five key areas which included hands, face, nails, clothes and skin indicating whether each of these was clean or not at the time of the interview. The following steps were used to construct composites using the SPSS package:

Step 1: All five key hygiene variables for mother and infant/child were recorded, and coded 0 and 1 based on the prescribed method (Field, 2009), where “0” denoted the undesired situation and “1” denoted the desired situation.

Step 2**:** This involved choosing the most sensitive variable by reducing the code of variables into desirable and undesirable outcomes as explained above. Frequencies were always run to ensure correctness in recoding of variables. The second most sensitive variable was also recoded into desirable and undesirable levels, but given different codes from those of the most sensitive for ease of analysis.

Step 3**:** This involved computing by adding the first sensitive indicator variable and second sensitive indicator variable to obtain the first composite variable. The composite variable was then tested by running a frequency and recoded into desirable and undesirable outcomes. The first composite was computed with the third variable. The process continued until all the variables were made into one composite.

4.2.2 Wealth components of households

The wealth index was used to classify households according to their relative wealth (Barros et al., 2010). The wealth component is a composite index composed of key asset ownership variables. It is used as a proxy indicator of household level wealth. Wealth is the value of all natural, physical and financial assets owned by a household. The respondents were asked to list the assets owned by the household as guided by the interviewer. The variables used in the creation of the wealth components are found in Appendix 3: Section 1, b and c; and part of section 2, a and b. The creation of the wealth index was conducted using the steps below:

Step 1: The variables were grouped to show how they are used and the services they offer in the household, such as for relaxation, production, or amenities (Table 4-2).

Table 4-2: Factors collected (grouped) to be used for illustrating wealth components in the experimental and control groups

Productive assets	Non-productive assets	Household amenities	Other factors
Plough	Radio	Electricity	Large livestock
Grain grinder	Television	Toilet available	Small livestock
Tractor	Mobile phone	Water source	Land subsistence farming
Hammer mill	Bed	Floor quality	Land cash crop
Oxcart	Chair	Roof quality	
	Table	Wall quality	
	Cupboard		
	Sofa		
	Clock		
	Fan		
	Cassette		
	VCR/DVD		
	Vehicle		
	Bicycle		
	Motorcycle		
	Refrigerator		
	Cooker		

Source: Adapted from VAM: WFP, n.d.

***Step** 2:* Variables with a prevalence below 3-5% or higher than 95-97% were excluded from the analysis (Table 4-3) as they did not make it easy to distinguish relatively "rich" and relatively "poor" households (VAM: WFP, n.d.).

Table 4-3: Variables excluded for analysis using proportion of use prevalence

Variable	Proportion ownership
Tractor	1.4%
Fan	1.4%
Vehicle	4.7%
Motorcycle	3.7%
Refrigerator	3.1%
Cooker	2.7%
Land for subsistence farming	95.3%

The second elimination of variables was done after the first run of the principal component analysis using the communalities matrix (how2stats, 2011). Variables with an extraction value of less than three were removed, with the understanding that they do not share (contribute) much with the extracted components or (Table 4-4).

Table 4-4: Variables eliminated using the communalities matrix of the Principal Component Analysis

Variable	Extraction value
Hummer mill	.027
Chair	.011
Bed	.103
Sofa	.396
Grain grinder	.125
Mobile phone	.289
Table	.165
Clock	.292
Cassette player	.192
Toilet	.196
Water source	.147
Land for cash crop	.064
Small livestock	.193

Step 3: Variables with more than one category (including the WASH practices variables of sanitation facilities and source of water) were recoded into binary variables either as safe or unsafe according to UNICEF/WHO standards of categorisation (VAM: WFP, n.d.; WHO & UNICEF, 2006The Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity were used to verify whether the data were suitable for Principle Component Analysis. The analysis showed a p-value of less than 0.0001 for Bartlett's Test and 0.783 for Kaiser-Meyer-Olkin.

A scree plot was used to give an idea of how many representative components (Eigen values) would be extracted from the data by inspecting where the inflexion point occurred on the graph. In this case, the break was after the first three components as legitimate components.

Step 4: Three Eigen values were extracted as guided by the scree plot and the rotation method (Oblimin with Kaiser Normalization). Three components which accounted for 55.14% of the variation of the original 32 variables were extracted (Table 4-5). The final analysis produced 12 components with only 12 variables which went into the principal component analyses after the two elimination processes mentioned above. The three highest components loading were: non-productive assets, productive assets, and quality of the house. The three components were named according to what was in the group (Table 4.5) as follows.

a. Component one (non-productive assets): This was the first group explaining 28.498% of the variation in the wealth of the group. The group loaded heavily on items for relaxation and one household amenity-electricity.
b. Component two (productive assets): This explained 14.344% of the variation in the wealth of the group. The items in this component seem to be tools for food production, which is a common livelihood activity in the study areas, and availability of the tools to some extent determined food production.
c. Component 3 (quality of the house): This accounted for 12.302% of the variation. Component three loaded heavily on the quality of the houses or infrastructure.

The Oblimin with Kaiser Normalization rotation method was used to have reduced correlation between the factors (Field, 2009; how2stats, 2011). The factors were then saved as variables in the data set and were placed in either the non-productive, productive, or quality of the house index.

Table 4-5: Rotated components of the wealth of households in the study areas

	Component		
	1 Non-productive assets	2 Productive assets	3 Quality of the house
VCRDVD	.780	-.171	
Electricity solar	.722	.221	
Television	.722	-.178	-.198
Radio	.639		
Cupboard	.427		-.329
Large livestock		.766	
Plough		.742	
Oxcart		.607	-.204
Bicycle	.411	.469	
Quality of the roof			-.829
Quality of the floor			-.823
Quality of the wall			-.747

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

Step 5: The Kruskal-Wallis test, a nonparametric test, was used to compare the three groups of non-productive assets, productive assets, and quality of the house components derived from the PCA analysis highlighted above. Dunn's Multiple Comparison Test was used to test whether there was a difference between those who owned non-productive assets, productive assets, and quality of the house. The analysis was conducted for overall data and also separately for control and experimental areas.

4.3 Loss to Follow-Up

At baseline of the study, 295 households with infants and children aged 6 to 23 months participated (Figure 4-1). At follow-up, a total of 199 (74.2%) households participated, with loss to follow-up of 25.8%. Of those lost to the study, 69 (23.7%) were either absent for a long time or relocated to other places, five (1.7%) refused to participate, while one (0.4%) died. The participants lost were not any different to the rest of the participants in the study. Regarding the area of study, the loss to follow-up was 29.8% (45) in the control and 35.4% (51) in the experimental groups.

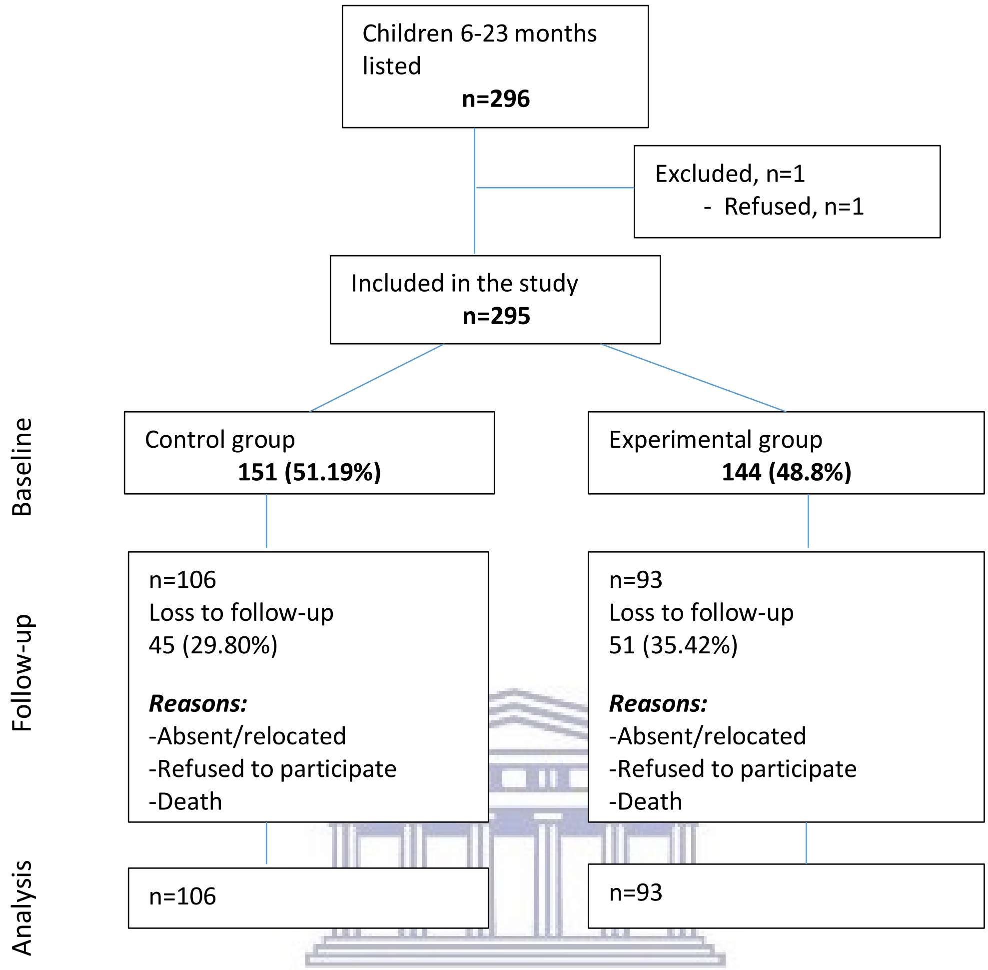


Figure 4-1: Loss to follow-up between baseline and follow-up for infants and children in the control and experimental groups

4.4 Results

The results are reported according to themes: Social and demographic data, wealth, level of access to sanitary facilities, sanitation practices for households, access to safe water sources and hygiene, and food preparation, storage, and handling practices of the households.

4.4.1 Social and demographic data

The average age of household heads at baseline was 38.2 years (SD 13.66), which rose to 40.3 years at follow-up (SD 13.57) (data not shown). The average age of the mother/caregivers was 30.3 years (SD 10.35) and 31.7 years (SD 11.64) at baseline and follow-up stages respectively. Primary education was the most common form of education for both household heads and caregivers, followed by a secondary level of education in both phases and areas (Table 4-6). However, the experimental group had marginally more educated people at follow-up than the control group.

Comparing the two-data set at baseline (Table 4-6), mother's level of education at (p =0.05), and the age group of the infant or child at baseline (p=0.01) were statistically different between the experimental and control group.

At follow-up stage, household head (p=0.03), mother's level of education (p =0.05), marital status of household head (p=0.01), and the occupation of the household head (p=0.01), age of the infant or child at follow-up (p=0.01), and household size (p=0.01) differed significantly between the experimental and control groups.

Regarding ***occupation***, almost all participants were farmers growing mostly maize as a cash crop and for home consumption, and rearing animals. Small gardens were common along the river banks and in some dumbo areas (wetlands where animals graze, and households make small gardens during dry seasons). However, occupation differed significantly between the study areas at follow-up (p =0.04). The majority of the households earned between K101.00 ($10) and K1000.00 ($100) in both phases, with an average of K590.50 (SD 1071.79) at baseline and K1840.25 (SD 11954.86) at follow-up. Majority of the households being farmers, income levels could have been affected by the size of the harvest each year which similarly depended on the rainfall patterns.

The ***household size*** differed significantly at follow-up (p=0.01). The average household sizes were 5 (SD 2.34) at baseline, and 6.3 (SD 2.62) at follow up. The average number of infants/children under five years in a household was 1.6 (SD 1.75) at baseline and 1.5 (SD 1.06) at follow up. There were more households (67.8%) with one child below five years at baseline compared to follow-up (43.3%).

A total of 295 infants and children were enrolled in the study. Slightly more female infants/children were enrolled in the study in both areas and phases (53.7% baseline and 54% follow-up). About half of the children were in the age range 12-24 and 25-36 months at baseline and follow-up respectively. The average age of the infants/children was 14.4 months (SD 5.92) and 26.1 months (SD 6.01) at baseline and follow-up respectively.

Table 4-6: Socio-demographic data of households with infants and children 6-23 months living in the control and experimental groups

Variable	Baseline Overall No. (%)	Baseline Control No. (%)	Baseline Exper.. No. (%)	P	Follow-up Overall No. (%)	Follow-up Control No. (%)	Follow-up Exper.. No. (%)	P
Age of household head								
15-30 years	96 (33.0)	51 (33.1)	45 (32.8)	0.97	54 (25.5)	23 (20.5)	31 (31.0)	0.07
31-45 years	126 (43.3)	66 (42.9)	60 (43.8)		95 (44.8)	49 (43.8)	46 (46.0)	
>45 years	69 (23.7)	37 (24.0)	32 (23.4)		63 (29.7)	40 (35.7)	23 (23.0)	
Sex of household head								
Female	42 (14.3)	24 (15.5)	18 (12.9)	0.64	26 (12.3)	11 (10.0)	15 (14.7)	0.30
Male	252 (85.7)	131 (84.5)	121 (87.1)		186 (87.7)	99 (90.0)	87 (85.3)	
Marital status of household head								
Not married	40 (13.7)	17 (11.1)	23 (16.5)	0.13	16 (7.8)	7 (6.7)	9 (8.9)	**0.01**
Married	252 (86.3)	136 (88.9)	116 (83.5)		189 (92.2)	97 (93.3)	92 (91.1)	
Education level of household head								
None	9 (3.1)	2 (1.3)	7 (5.1)	0.06	7 (3.3)	1 (0.9)	6 (5.9)	**0.03**
Primary	158 (54.1)	92 (59.7)	66 (47.8)		102 (47.7)	62 (54.9)	40 (39.6)	
Secondary	112 (38.4)	53 (34.4)	59 (42.8)		102 (47.7)	49 (43.4)	53 (52.5)	
Tertiary	13 (4.5)	7 (4.5)	6 (4.3)		3 (1.4)	1 (0.9)	2 (2.0)	
Age of mother/caregiver								
15-30 years	186 (63.7)	96 (63.2)	90 (64.3)	0.26	109 (53.4)	52 (48.6)	57 (58.8)	0.34
31-45 years	93 (31.8)	51 (33.6)	42 (30.0)		75 (36.8)	43 (40.2)	32 (33.0)	
>45 years	13 (4.5)	5 (3.3)	8 (5.7)		20 (9.8)	12 (11.2)	8 (8.2)	
Education of mother/caregiver								
None	6 (2.5)	1 (0.8)	5 (4.4)	**0.05**	6 (2.9)	2 (1.8)	4 (4.1)	0.05
Primary	139 (58.4)	81 (64.8)	58 (51.3)		111 (53.6)	67 (61.5)	44 (44.9)	
Secondary	89 (37.4)	42 (33.6)	47 (41.6)		90 (43.5)	40 (36.7)	50 (51.0)	
Tertiary	4 (1.7)	1 (0.8)	3 (2.7)		0	0	0	
Occupation household head								
Farmer	235 (86.4)	126 (89.4)	109 (83.2)	0.10	194 (93.3)	109 (97.3)	85 (88.5)	**0.04**
Teacher	8 (2.9)	3 (2.1)	5 (3.8)		5 (2.4)	1 (.9)	4 (4.2)	
Businessman	15 (5.5)	9 (6.4)	6 (4.6)		9 (4.3)	2 (1.8)	7 (7.3)	
House/farmer worker	7 (2.6)	1 (0.7)	6 (4.6)		0	0	0	
Driver/conductor	3 (1.1)	1 (0.7)	2 (1.5)		0	0	0	
Other occupations	4 (1.5)	1 (0.7)	3 (2.3)		0	0	0	
Household size								
≤ 5	200 (67.8)	101 (65.2)	99 (70.7)	0.40	93 (43.3)	36 (31.9)	57 (55.9)	**0.01**
>5	95 (32.2)	54 (34.8)	41 (29.3)		122 (56.7)	77 (68.1)	45 (44.1)	
Total income of household (K)								
<100	83 (28.4)	45 (29.2)	38 (27.5)	0.77	67 (32.1)	36 (33.6)	31 (30.4)	0.45
101-1000	169 (57.9)	89 (57.8)	80 (58.0)		106 (50.7)	56 (52.3)	50 (49.0)	
>1000	40 (13.7)	20 (13.0)	20 (14.5)		36 (17.2)	15 (14.0)	21 (20.6)	
Sex of infant/child								
Female	158 (53.7)	88 (56.8)	70 (50.4)	0.17	116 (54.0)	66 (58.9)	49 (48.0)	0.10
Male	136 (46.3)	67 (43.2)	69 (49.6)		99 (46.0)	46 (41.1)	53 (52.0)	
Age of infant/child								
Below 6 months	13 (4.4)	7 (4.5)	6 (4.3)	**0.01**	-	-	-	
6 & 11 month	108 (36.7)	68 (44.2)	40 (28.6)		-	-	-	
12 & 24 month	170 (57.8)	76 (49.4)	94 (67.1)		95 (45.2)	61 (56.5)	34 (33.3)	**0.01**
25 – 36 months	3 (1.0)	3 (1.9)	0		105 (50.0)	41 (38.0)	64 (62.7)	
> 36 months	-	-	-		10 (4.8)	6 (5.6)	4 (3.9)	
Total infants/children under five in household								
One	189 (64.1)	98 (63.2)	91 (65.0)	0.97	149 (69.3)	71 (62.8)	78 (76.5)	0.07
Two	93 (31.5)	50 (32.3)	43 (30.7)		45 (20.9)	30 (26.5)	15 (14.7)	
≥3	13 (4.4)	7 (4.5)	6 (4.3)		21 (9.8)	12 (10.6)	9 (8.8)	

Baseline 1 = N-295**||** **Follow-up 2** = N-215|| Control group – Hamangaba, experimental group – Njolamwanza||Tertiary means education above secondary school; % Percent; exper. experimental , K kwacha. P values obtained using Pearson Chi-square test

4.4.2 Measuring the wealth of the households in the study groups

Proportionally, there was widespread ownership of land for subsistence farming (95.5%) and limited ownership (less than 5%) of a tractor, fan, motorcycle, refrigerator and cooker (Table 4-3). About 93.4% of households owned their dwelling. Ownership of the rest of the assets not reported in the table ranged from 5% to 95%.

According to the Kruskal-Wallis test, the wealth index did not differ between the control and experimental groups (1.27, $p = 0.53$); neither did it differ between the wealth components; non-productive vs productive (-22.94, $p>0.05$); non-productive vs quality of house (-11.53, $p>0.05$); and productive vs quality of house (11.41, $p>0.05$). This could indicate that the two areas did not differ much in economic status and development.

However, the Kruskal-Wallis test showed a significant difference between the three group medians (24.5, $P < 0.01$) of the control group. Comparing the three component factors (Figure 4-2), the control group showed a significant difference between non-productive vs productive assets (-47.3, $p< 0.01$), and non-productive assets vs quality of house component factors (-69.5, $p< 0.01$). Nonetheless, a non-significant difference was observed between those owning productive assets and better-quality houses (-22.2, $p >0.05$). In this area, people who owned non-productive assets were less likely to own the productive asset and better quality households (non-productive asset p-value <0.05 for both productive assets and quality of the house). However, those who owned productive assets were likely to have good quality houses.

Similarly, in the experimental group asset ownership varied significantly (14.5, $p< 0.01$). Comparing the three asset groups shows that there were no significant differences between households owning non-productive assets and productive assets (23.6, $p>0.05$); and between those owning productive assets and having better quality houses (31.1, $p>0.05$). However, those owning non-productive assets differed significantly from those who owned better quality houses (54.6, $p<0.01$).

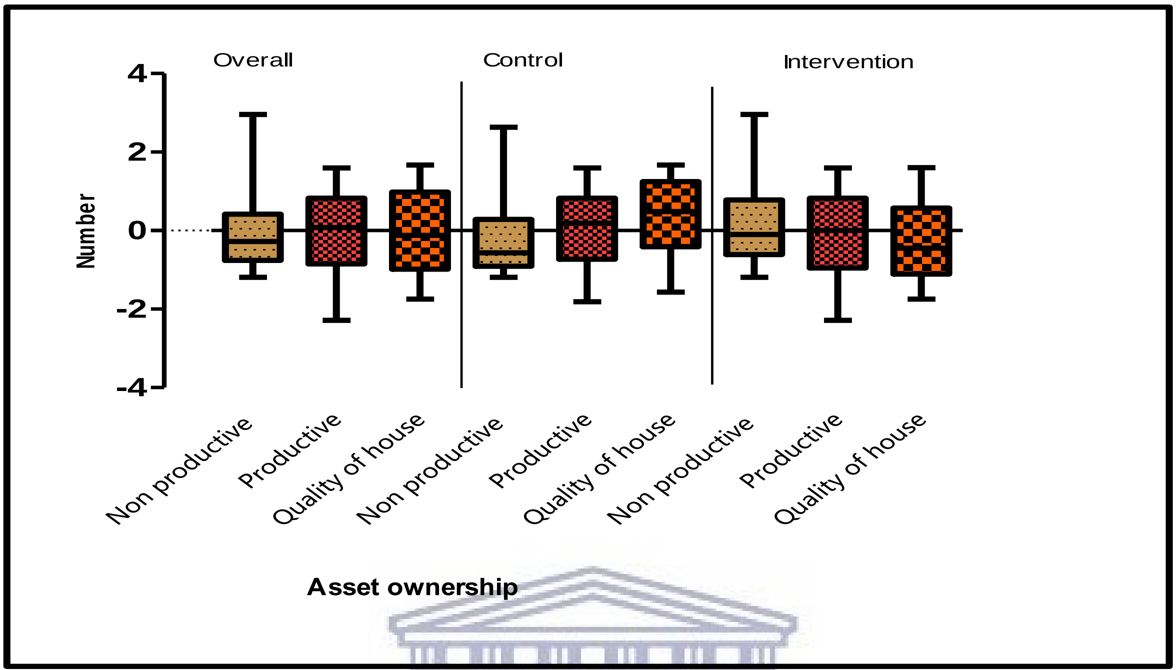


Figure 4-2: Measuring the wealth of households in the control and experimental groups

4.4.3 Level of access to sanitary facilities in the two areas over 12 months

The results for toilet facilities in the control and experimental groups are highlighted in Table 4-7. Overall, 45% of households had access to a toilet facility at baseline, compared to 30.9% at follow up. The type of toilet facility ($p=0.02$) at baseline differed significantly with the control group having better type of toilets. The disposal of infant/child faeces at both phases ($p<0.01$) also differed significantly for the two groups with the experimental group disposing of child faeces better than the control group.

Lack of toilet facilities was more common in the control than experimental group in both phases ($p <0.01$). Of the households which had toilet facilities, about 38.8% and 41.9% did not use safe facilities, instead using pit latrines without slab at baseline and follow-up respectively (1.7% change).

Table 4-7: Sanitation practices for households with infants and children 6-23 months in the control and experimental groups at baseline and follow-up

Variable	Baseline Overall No. (%)	Baseline Control No. (%)	Baseline Exper. No. (%)	p	Follow-up Overall No. (%)	Follow-up Control No. (%)	Follow-up Exper. No. (%)	p
Availability of toilet facility								
Yes	133 (45.4)	30 (19.5)	103 (74.1)	**<0.01**	148 (69.2)	52 (46.0)	96 (95.0)	**<0.01**
No	160 (54.6)	124 (80.5)	36 (25.9)		66 (30.8)	61 (54.0)	5 (5.0)	
Type of toilet facility used								
VIP	2 (1.5)	2 (6.7)	0		5 (3.4)	4 (7.5)	2 (2.1)	0.30
Pit latrine with slab	80 (59.7)	19 (63.3)	61 (58.7)	**0.02**	81 (54.7)	28 (52.8)	53 (55.2)	
Pit latrine without slab	52 (38.8)	9 (30.0)	43 (41.3)		62 (41.9)	21 (39.6)	41 (42.7)	
Distance of the toilet from the household								
<=50 Meters	118 (90.8)	25 (96.2)	93 (89.4)	0.46	130 (100.0)	46 (100.0)	84 (100.0)	n/a
>50 Meters	12 (9.2)	1 (3.8)	11 (10.6)					
When toilet facility cleaned last								
Today		8 (26.7)	29 (27.9)	0.20	57 (38.8)	17 (33.3)	40 (41.7)	0.88
Yesterday		8 (26.7)	43 (41.3)		55 (37.4)	18 (35.3)	37 (38.5)	
Less than 1 week ago		10 (33.3)	27 (26.0)		29 (19.7)	14 (27.5)	15 (15.6)	
Several weeks ago		3 (10.0)	4 (3.8)		2 (1.4)	1 (2.0)	1 (1.0)	
Never		0	0		3 (2.0)	1 (2.0)	2 (2.1)	
Other		1 (3.3)	0		1 (0.7)	0	1 (1.0)	
Don't remember			1 (1.0)					
Presence of faecal matter inside the facility, on floor or wall								
Yes	17 (13.4)	5 (19.2)	12 (11.9)	0.57	10 (6.9)	5 (8.9)	5 (5.7)	0.**03**
No	96 (75.6)	19 (73.1)	77 (76.2)		127 (88.2)	45 (80.4)	82 (93.2)	
Is there faecal matter clearly visible in the pit at less than 30 cm								
Yes	33 (26.2)	6 (23.1)	27 (27.0)	0.45	11 (7.6)	4 (7.0)	7 (8.0)	**<0.01**
No	80 (63.5)	19 (73.1)	61 (61.0)		128 (88.3)	47 (82.5)	81 (92.0)	
Cannot assess toilet	13 (10.3)	1 (3.8)	12 (12.0)		6 (4.1)	6 (10.5)	0	
Place for washing hands after using the toilet								
In or near toilet facility	39 (13.5)	11 (7.3)	28 (20.3)	**0.04**	46 (21.5)	15 (13.4)	31 (30.4)	**<0.01**
In or near the kitchen	20 (6.9)	11 (7.3)	9 (6.5)		12 (5.6)	1 (0.9)	11 (10.8)	
Elsewhere on premises	96 (33.3)	51 (34.0)	45 (32.6)		68 (31.8)	48 (42.9)	20 (19.6)	
Outside premises	34 (11.8)	21 (14.0)	13 (9.4)		23 (10.7)	6 (5.4)	17 (16.7)	
No specific place	89 (30.9)	47 (31.3)	42 (30.4)		51 (23.8)	29 (25.9)	22 (21.6)	
Don't wash hands	10 (3.5)	9 (6.0)	1 (0.7)		14 (6.5)	13 (11.6)	1 (1.0)	
Availability of a hand washing facility in the toilet facility or within *10 meters*								
Yes	71 (57.3)	11 (44.0)	60 (60.6)	0.13	51 (44.3)	13 (31.0)	38 (52.1)	**0.03**
No	53 (42.7)	14 (56.0)	39 (39.4)		64 (55.7)	29 (69.0)	35 (47.9)	
Availability of water in or around hand washing basin?								
Had handwashing place	65 (92.9)	8 (80.0)	57 (95.0)	**0.03**	45 (88.2)	11 (84.6)	34 (89.5)	0.64
Brought within 1 minute	3 (4.3)	2 (20.0)	1 (1.7)		0 (0.0)	0 (0.0)	0 (0.0)	
No	2 (2.9)		2 (3.3)		6 (11.8)	2 (15.4)	4 (10.5)	
Availability of soap or detergent or ash?								
Had handwashing place	33 (47.8)	6 (60.0)	27 (45.8)	0.16	38 (77.6)	10 (76.9)	28 (77.8)	0.68
Brought within 1 minute	9 (13.0)	3 (30.0)	6 (10.2)		6 (12.2)	1 (7.7)	5 (13.9)	
No	27 (39.1)	1 (10.0)	26 (44.1)		5 (10.2)	2 (15.4)	3 (8.3)	
Infants/children under five using the toilet facility								
Yes		7 (23.3)	21 (20.2)	0.71	43 (29.5)	13 (26.0)	30 (31.3)	0.60
No		23 (76.7)	83 (79.8)		103 (70.6)	37 (74.0)	66 (68.7)	
Disposal of infant/child faeces								
Sanitary	122 (41.8)	29 (19.1)	93 (66.4)	**<0.01**	165 (78.2)	78 (70.3)	87 (87.0)	**0.001**
Unsanitary	170 (58.2)	123 (80.9)	47 (33.6)		46 (21.8)	33 (29.7)	13 (13.0)	

Baseline = N-295**||** **Follow-up** = N-215|| P values obtained using Pearson Chi-square test||Control group – Hamangaba, experimental group – Njolamwanza || % Percent; exper. experimental, K kwacha

Faecal matter on the toilet facility floor and/or walls was observed in 13.4% and 6.9% of the households at baseline and follow-up respectively (Table 4-7). Faecal matter was also clearly visible in the pits at less than 30cm depth for 26.2% (p=0.45) and 7.6% (p<0.01) of the households at baseline and follow-up. The proportion of households with full toilet facilities (faeces seen at less than 30 cm depth) were higher in the experimental than the control group with a significant difference at follow-up (p=0.03). Presence of faecal matter on the walls and/or floor was higher in control than experimental group, and there was a significant difference between the two areas at follow-up (p=0.03).

There was a remarkable shift in the disposal of infant/child faeces. Unsanitary disposal of infant/child faeces occurred in more than half (58.2%) of households at baseline and 21.8% at follow-up. The practice differed between two study areas at baseline (p <0.01) and follow up (p <0.001) with the control having more households practising unsanitary disposal of infant/child faeces.

Availability of hand washing facility at baseline (p=0.04) and follow up (p<0.01) differed significantly (p<0.01) between the control and experimental groups. More household in the experimental group hand washing facilities particularly near the toilet facility and kitchen at both baseline and follow-up. The overall availability of hand washing places reduced considerably by 13% points from baseline to follow-up. Although the availability of hand washing facility situation within the toilet or less than 10 meters from toilet was similar at the start of the programme, it became significantly different at follow-up (p=0.03) with experimental group being in a better situation. There were more households in the experimental group (p=0.03) who had water in or around the hand washing basin/facility at baseline. At follow-up the difference was not significant (p=0.64). Availability of soap around the hand washing facility did not differ at baseline or follow-up between the two groups.

4.4.4 Access to improved water sources and hygiene practices

The drinking water situation in the experimental group did not change much compared to the control group who reported increased use of protected wells (Table 4-8), but differed significantly between the two groups at baseline (p<0.01) and follow up (p<0.01) with the experimental group having more households with better quality source. Of the 29.3% of households using unsafe water (unprotected dug well, surface water) at baseline, more than three-quarters were from the control group (p <0.01). Also, treatment of water for general household use was conducted by 28.1% while 26.1% treated water for infants and children to drink.

Table 4-8: Access to safe water for households with infants and children 6-23 months in the experimental and control groups at baseline and follow-up

………………………. Variable	Baseline Overall No. (%)	Control No. (%)	Exper. No. (%)	P	Follow-up Overall No. (%)	Control No. (%)	Exper. No. (%)	P
Source of drinking water for household								
Piped	1 (0.3)	0	1 (0.7)	**<0.01**	0	0	0	**<0.01**
Stand piped	1 (0.3)	1 (0.6)	0		2 (0.9	1 (0.9)	1 (1.0)	
Borehole	161 (54.8)	56 (36.1)	105 (75.5)		121 (56.5)	43 (38.4)	78 (76.5)	
Protected dug well	45 (15.3)	30 (19.4)	15 (10.8)		40 (18.7)	29 (25.9)	11 (10.8)	
Unprotected dug well	76 (25.9)	58 (37.4)	18 (12.9)		47 (22.0)	35 (31.3)	12 (11.8)	
Protected spring						2 (1.8)	0	
Surface water	10 (3.4)	10 (6.5)	0		2 (0.9)	2 (1.8)	0	
Household water treatment								
Yes	81 (28.1)	53 (35.3)	28 (20.3)	**<0.01**	43(20.6)	25 (22.5)	18 (18.4)	0.57
No	207 (71.9)	97 (64.7)	110 (79.7)		165 (78.9)	86 (77.5)	80 (81.6)	
Source of water to drink for the infant/child								
Main source	282 (97.6)	147 (96.7)	135 (98.5)	0.52	184 (86.8)	89 (79.5)	95 (95.0)	**<0.01**
Special baby container	4 (1.4)	3 (2.0)	1 (0.7)		28 (13.2)	23 (20.5)	5 (5.0)	
Others	3 (1.0)	2 (1.3)	1 (0.7)		0	0	0	
Treating water safe for the infant/child to drink								
Boil	32 (11.6)	15 (10.3)	17 (13.1)	0.59	11 (5.5)	6 (5.9)	5 (5.1)	0.13
Chlorinate	40 (14.5)	24 (16.6)	16 (12.3)		17 (8.5)	9 (8.8)	8 (8.2)	
Nothing	203 (73.9)	106 (73.1)	97 (74.6)		172 (86.0)	87 (85.3)	85 (86.7)	

Baseline = N-295||**Follow-up** = N-215|| P values obtained using Pearson Chi-square test||Control group – Hamangaba, experimental group – Njolamwanza || % Percent; Exper. experimental , K kwacha

4.4.5 Hygiene practices in households

Most mothers had good hygiene practices in both phases of the study (Table 4-9), although this was only significant at follow up (p<0.02) with the experimental group having better hygiene. At baseline, 71% of mothers/caregivers had good hygiene practices. Although more than 60% of infants and children had good hygiene practices in both phases, it was lower than that of the mother's hygiene practices. Sixty-six percent and 78% of infants and children at baseline (p=0.59) and follow-up (p=0.01) had good hygiene practices respectively and the difference was significant between the groups at follow up suggesting better hygiene for the experimental group.

Forty-three percent of households at baseline and 72.4% at follow-up disposed of their garbage in pits either in their yards or somewhere in the community, while the rest either threw rubbish in the open, burnt it, or fed it to animals. There was no significant difference in the way garbage was disposed of in the two areas in both phases (p >0.05).

Fifty-four percent of households at baseline and 29% at follow-up were observed to be unswept where infants and children played (Table 4-9). There were more households with unswept places in the experimental group than the control groups in both phases, with a significant difference at follow up (p=0.05). Garbage lying open in the house or yard was observed in 41.4% at baseline, and 46.9% at follow-up. More garbage was observed lying in the open in-households in the control group compared with the experimental group at both phases, but this was not significant.

Table 4-9: Hygiene practices in households with infants and children 6-23 months in the experimental and control groups at baseline and follow-up

Variable	Baseline Overall No. (%)	Control No. (%)	Exper. No. (%)	P	Follow-up Overall No. (%)	Control No. (%)	Exper. No. (%)	P
Mother's hygiene								
Good hygiene	191 (71.3)	102 (72.3)	89 (70.1)	0.71	174 (85.7)	84 (80.0)	90 (91.8)	**0.02**
Poor hygiene	77 (28.7)	39 (27.7)	38 (29.9)		29 (14.3)	21 (20.0)	8 (8.2)	
Infant/child personal hygiene								
Good hygiene	185 (66.1)	94 (64.8)	91 (67.4)	0.59	164 (78.1)	78 (70.9)	86 (86.0)	**0.01**
Poor hygiene	95 (33.9)	51 (35.2)	44 (32.6)		46 (21.9)	32 (29.1)	14 (14.0)	
Garbage disposal								
Pit in the yard	126 (43.0)	60 (39.0)	66 (47.5)	0.22	152 (72.4)	79 (71.2)	73 (73.7)	0.90
Pit nearby in community	7 (2.4)	4 (2.6)	3 (2.2)		1 (0.5)	1 (0.9)	0	
No pit	104 (35.5)	58 (37.7)	46 (33.1)		51 (24.3)	28 (25.2)	23 (23.2)	
Burning	43 (14.7)	21 (13.6)	22 (15.8)		-	-	-	
Fed to animals	7 (2.4)	5 (3.2)	2 (1.4)		0	2 (1.8)	2 (2.0)	
Others	6 (2.0)	6 (3.9)	0		6 (2.9)	1 (0.9)	1 (1.0)	
Livestock kept in living quarters at night								
Yes	213 (78.0)	111 (78.7)	102 (77.3)	0.97	92 (44.4)	47 (44.3)	45 (44.6)	0.98
No	60 (22.0)	30 (21.3)	30 (22.7)		115 (55.6)	59 (55.7)	56 (55.4)	
House swept in area where infant/child plays								
Yes	126 (46.0)	67 (49.3)	59 (42.8)	0.28	131 (67.9)	69 (68.3)	62 (67.4)	**0.04**
No	148 (54.0)	69 (50.7)	79 (57.2)		56 (29.0)	26 (25.7)	30 (32.6)	
Don't know					6(3.1)	6(5.9)	0	
Garbage lying in the open in-house or yard								
Yes	113 (**41.5**)	64 (46.7)	49 (36)	0.08	90 (46.9)	50 (50.5)	40 (43.0)	0.30
No	159 (58.5)	73 (53.3)	87 (64)		102 (53.1)	49 (49.5)	53 (57.0)	
Faeces visible in the house or in the yard								
Yes	137 (63.4)	71 (65.7)	66 (61.1)	0.48	71 (78.9)	35 (76.1)	36 (81.8)	0.51
No	79 (36.6)	37 (34.2)	42 (38.9)		19 (21.1)	11 (23.9)	8 (18.2)	

Control group – Hamangaba, experimental group – Njolamwanza; No. Number; % Percent; Exper. experimental , K kwacha || P values obtained using cross tabulation

4.4.6 Food preparation, storage, and handling practices

When asked what steps they (caregivers) go through before, during and after food preparation at baseline, the majority mentioned washing of utensils and containers for preparation of food (Table 4-10). Less than half mentioned cooking food thoroughly as an important element in food preparation. There was a significant difference ($p<0.01$) regarding washing of utensils and containers between the two groups at baseline but not at follow-up. At follow-up, the response to the four steps improved with significant differences regarding washing ($p<0.01$) and cooking ($p=0.03$) the food thoroughly. The improvement was more for the experimental group. It was also observed that it was common to keep infant/child feeding utensils (such as spoons and plates) clean in both phases of the study and this was significant ($p=0.03$) at follow-up indicating a better practice for the experimental than control group. More than 70% and 48% of the households kept the food-containers used by infants/children on the floor at baseline and follow-up respectively. Overall, only 25.4% at baseline and 39.6% at follow-up had all the infants/children's feeding-containers covered.

Table 4-10: Food preparation, storage, and handling practices in households in the study areas

Variable	Baseline Overall No. (%)	Baseline Control No. (%)	Baseline Exper. No. (%)	P	Follow-up Overall No. (%)	Follow-up Control No. (%)	Follow-up Exper. No. (%)	P
Steps taken before, during and after food preparation?								
a. Wash hands before preparation								
Yes	179 (60.9)	95 (62.9)	84 (58.7)	0.46	189 (95.0)	99 (93.4)	90 (96.8)	0.28
No	115 (39.1)	56 (37.1)	59 (41.3)		10 (5.0)	7 (6.6)	3 (3.2)	
b. Wash food thoroughly								
Yes	196 (66.7)	96 (63.6)	100 (69.9)	0.25	174 (87.4)	82 (77.4)	92 (98.9)	**<0.01**
No	98 (33.3)	55 (36.4)	43 (30.1)		25 (12.6)	24 (22.6)	1 (1.1)	
c. Wash utensils before preparation								
Yes	263 (89.5)	127 (84.1)	136 (95.1)	**0.01**	172 (86.4)	93 (87.7)	79 (84.9)	0.57
No	31 (10.5)	24 (15.9)	7 (4.9)		27 (13.6)	13 (12.3)	14 (15.1)	
d. Cook food thoroughly								
Yes	143 (48.6)	80 (53.0)	63 (44.1)	0.13	160 (80.4)	79 (74.5)	81 (87.1)	**0.03**
No	150 (51.0)	71 (47.0)	80 (55.9)		39 (19.6)	27 (25.5)	12 (12.9)	
Place where infants/children's feeding utensils kept								
On a stand	143 (52.2)	78 (56.1)	65 (48.1)	0.19	127 (65.1)	61 (59.2)	66 (71.7)	0.07
On the floor	131 (47.8)	61 (43.9)	70 (51.9)		68 (34.9)	42 (40.8)	26 (28.3)	
Feeding utensils left clean								
Clean	194 (70.8)	96 (69.1)	98 (72.6)	0.52	159 (81.5)	78 (75.7)	81 (88.0)	**0.03**
Not clean	80 (29.2)	43 (30.9)	37 (27.4)		36 (18.5)	25 (24.3)	11 (12.0)	
Food Containers covered								
All are	70 (25.4)	29 (20.7)	41 (30.1)	0.07	78 (39.6)	38 (36.5)	40 (43.0)	0.25
None are	9 (3.3)	7 (5.0)	2 (1.5)		9 (4.6)	7 (6.7)	2 (2.2)	
Some are	197 (71.4)	104 (74.3)	93 (68.4)		110 (55.8)	59 (56.7)	51 (54.8)	
Where the food containers are placed								
On the floor	191 (70.5)	96 (69.1)	95 (72.0)	0.60	91 (47.9)	42 (42.0)	49 (54.4)	0.09
Elevated place	80 (29.5)	43 (30.9)	37 (28.0)		99 (52.1)	58 (58.0)	41 (45.6)	

Control group – Hamangaba, experimental group – Njolamwanza; No. Number, % Percent; exper. experimental , K kwacha|| P values obtained using Pearson Chi-square test|| Utensils are items used for food preparation spoons, plates, pots, knifes,

4.5 Discussion

This study has highlighted some significant differences at follow-up in the level of WASH practices favouring the experimental group. The sanitation factors included toilet availability, disposal of infant/child faeces, hand washing facility, and presence of faecal matter inside the toilet facility walls and visible in the pit. Source of drinking water for the household and the infant/child also differed significantly among the control and experimental groups. Hygiene practices which were significantly different included hygiene of the mother, infant and child hygiene and cleanliness of the areas where the infants/children play. Food preparation, storage and handling differed in three factors, namely washing and cooking the food thoroughly, and keeping the eating utensils of the infant or child clean.

Although the control group was lagging behind in almost all WASH factors, several improvements were noticed, especially availability of toilets, disposal of infant or child faeces, availability of hand washing devices, access to safe water, and hygiene practices. These practices are some of the pathways known to affect infant/child nutritional status and development, either directly or through some mediating factors (Casanovas et al., 2013). The improvements in the control group are difficult to explain, however it should be noted that the cohort group was not under strict observation, nor was the movement between communities restricted. The improvement could have been due to spill-over of practices from other communities or populations having the WASH interventions.

Some factors worsened during the study period especially in the control group, although these were not significant. These included ownership of unsanitary facilities, households not treating drinking water for both the infant/child and households, garbage being thrown in the open, and faeces visible in the yard. These practices may have counteracted the improvements seen regarding improvements in other factors such as availability of toilet facilities, disposal of infant/child faeces, infant/child/mother hygiene, and contact with animals in the home between baseline and follow-up as reported in this study. These factors are the pathways that provide important routes for transmission of pathogens, especially since the improvements in the sanitation variables were not all that remarkable (Eisenberg, Scott & Porco, 2007; George et al., 2016).

The presence of ***faecal matter*** in infant/child play areas and toilet facilities increases the risk of developing diarrhoea. Based on empirical studies, faecal-oral contamination is more likely as infants or children ingest the faecal bacteria and other pathogens from the soil and animal faeces in the course of play and exploration (Humphrey, 2009; Ngure et al., 2014; Crane, Jones & Berkley, 2015; Baker et al., 2016). Diarrhoea (most common), soil-transmitted helminths, trachoma, schistosomiasis, and acute respiratory infections are some of the diseases caused by the pathogens (Mara et al., 2010; Owino et al., 2016; Kosek et al., 2017). In Zimbabwe, Ngure et al. (2013) reported that all soil within reach of a crawling infant was highly contaminated with E. coli which may cause bloody stools. Similarly, in the Peruvian Amazon, Exum et al., (2016) found floors in the kitchen area contaminated with E. coli, and the level of contamination was high among households with poor sanitation and dirt floors.

Diarrhoeal diseases may be as high as 48–64% in areas where faecal matter are not properly deposited of (Hill, Kirkwood & Edmond, 2004). Therefore, the presence of faecal matter could potentially be responsible for the high levels of diarrhoea cases reported among infants and children in both the experimental and control groups (which will be discussed in more detail in Chapter 5). Black et al., (1984) speculated that the duration of diarrhoea might depend on the small intestine. In these communities, the duration of disease was not part of the study, but one could predict the possibility of recurrent and prolonged diarrhoea episodes due to compromised hygiene status, unsafe water sources and low treatment levels, poor garbage disposal and poor conditions of sanitation facilities, in addition to the presence of faecal matter. In good sanitary conditions, the prevalence of diarrhoea can be reduced by 26% and overall mortality by 55% (Hill, Kirkwood & Edmond, 2004).

The lack of sanitation facilities in many households, especially in the control group, may have been the reason for the high rate of ***open defecation*** and **unsanitary disposal of infant/child faeces**. Analysing data from the Multiple Indicator Cluster Survey, Child Module or Demographic and Health Survey (DHS), the Joint Monitoring Programme for Water Supply and Sanitation found that the highest levels of unsafe infant/child faeces disposal were among households practicing open defecation, and this practice was more common among households with younger infants and children (Rand et al., 2015). This is likely to be the reason why the control group reported higher levels of diseases (Chapter 5). In their review of the biological, ecological and epidemiological evidence concerning the role of specific hygiene behaviours in the transmission of diarrhoeal disease, Curtis, Cairncross & Yonli (2000) explained that increased diarrhoeal diseases are an outcome of unsanitary disposal of infant/child faeces. In this study more than half of the households in the control group disposed unsafely of infant/child faeces and practiced open defecation. Faeces left in the bush or open would be carried into the rivers and other unprotected water sources, carrying with them the pathogens that would contaminate water and cause diseases (Bhavnani et al., 2014a; Carlton et al., 2014). Disposal of infant/child faeces is also a possible source of contamination, with George et al., (2016) in Bangladeshi and Preeti et al., (2016) in West Bengal reporting high rates of unsafe disposal of infant/child faeces.

Faecal contamination may also come from animal faeces such as chickens, goats, sheep, cattle and pigs, which are reared by households. Although this study did not aim to observe whether infants or children ingested faeces of any animals, the data shows a high proportion of households keeping animals in the house at night and with faeces visibly found in the yard or house. These are often places where infants and children play, and are therefore likely to promote faecal-oral transmission of pathogens. Presence of animals in the house creates a risk for exposure to animal faecal matter or other livestock-related disease vectors (Headey & Hirvonen, 2016). Ngure et al., (2013) reported infants/children ingesting soil and chicken faeces which were all contaminated with E. Coli. George et al., (2016) further reported the presence of significantly greater environmental enteropathy disease among those who unsafely disposed of infant/ child faeces. Similarly, Freeman et al., (2016) indicated that infant/child faeces and animal faeces left in the open are usually picked up by other infants/children and animals such as dogs, pigs, goats, sheep and chickens and transferred to child play areas, thereby risking transmission of pathogens to the host. For the above reasons, it would be beneficial to communities to promote WASH interventions, especially those focusing on hygiene practices and knowledge, while ensuring improvement in livestock management practices to reduce infants/children's exposure to animals and animal faeces (Headey & Hirvonen, 2016) Furthermore, our finding that about half of our population conduct open defecation is not in line with the finding from the UNICEF report on Zambia showing that only 15% practice open defecation (WHO & UNICEF, 2017) It shows a serious environmental risk in the study areas, and particularly in the control group, which requires immediate intervention.

Pathogens from either contaminated water, food, utensils, or flies likewise find their way into the body and cause disease. Recurrent and/or prolonged disease can lead to under nutrition, especially stunting, through a condition known as environmental enteropathy (EE) (sometimes referred to as environmental enteric dysfunction), among others. According to

Crane, Jones & Berkley (2015), poor environmental conditions including lack of sanitary facilities, unsafe water, and unclean homes are among factors responsible for causing EE. Kosek et al., (2013) reported that intestinal inflammation, likely resulting from frequent enteric infection (which results mostly from diarrhoea) was associated with deficits in linear growth in infants. Donowitz et al., (2016) also found that small intestine bacterial overgrowth which was associated with poor environmental conditions - was associated with growth faltering (stunting). In India, over 70% of households reported not having a toilet facility or to practice open defecation (Spears et al., 2013; Rah et al., 2015). Open defecation explained about 99.5% of the variation in infant/child height comparing five different wealth groups indicating that the higher the rate of open defecation, the higher the levels of stunting (Spears, Ghosh, & Cumming,, 2013). Furthermore, both Baltazar & Solomon (1989) and Mertens et al., (1992) reported a 54% greater risk of diarrhoeal disease in areas where unsafe disposal of faeces was reported. Mertens et al., (1992) further deducted that if the practices of unsafe disposal of stool were reduced from 91% to 50% of the population in Sri Lanka, then 12% of diarrhoeal episodes could be prevented. Furthermore, improvement in household sanitation offers not only direct benefits to infant/child health in that particular home, but also has the potential to provide extended protection to neighbourhoods with a coverage of certain levels, with benefits starting to be observed at a coverage of 30% or more (Andres et al., 2014).

Hand washing facilities, which are key in reducing faecal-oral transmission of pathogens and consequently reducing infections (Hill, Kirkwood & Edmond, 2004; Ngure et al., 2013), were rare in this study, especially in the control group. This poses a danger to the community. Households who do not have sanitation facilities may also not have hand washing facilities, risking use of dirty hands to touch food, children and other utensils. For instance, a study in Zimbabwe showed that half of mothers' hands and a quarter of infants' hands were contaminated with E. coli among households studied (Ngure et al., 2013). Hand washing is recognised as a key means to reduce the contamination that occurs as result of poor environmental conditions, such as those reported in this research. Transmission of pathogens from faecal matter (both human and animal) can be reduced partly by adequate hand washing techniques. Hill, Kirkwood & Edmond (2004) reported a reduction of diarrhoea by about 35% with adequate hand washing using soap and water. Hand washing is more critical after use of the toilet, cleaning babies, and before and after handling food.

There were a large number of infants and children and mothers/caregivers who reported having poor hygiene. Maintaining good hygiene is critical in reducing the effects of unsafe sanitation on infant and child disease. However, to maintain good hygiene calls for adequate availability of safe water sources for households (Mellor et al., 2016). Workload also seems to affect the hygiene status of household members and fluctuates at different times of the day depending on household activities. It should be noted that the data collection exercise was made at the peak of the harvest, and most households were being interviewed upon returning from the field, looking dirty. The findings may be different during the cold or hot seasons when farming activities are low, and household members are resting more.

It is not surprising that there was a significant difference in source of water, especially for drinking between the study areas. It is evidence of the efforts by the district to provide WASH services in the experimental group. However, the presence of some households (29% of the population) not using safely managed water in both control and experimental groups is a concern, as water is a vehicle for transmission of disease. ***Treating water*** offers an opportunity to control pathogens that are transmitted through water from the contaminated environment due to improper disposal of faeces. Both communities were not adequately treating the household water and the water that was given to infants/children to drink, although this was more prevalent in the control group. In these communities, households do not have a 24-hour water service, have to store water in the home, have low access to sanitary facilities, and open defecation was a common norm. In such a scenario, the risk of transmission of pathogens may be increased. Water may be contaminated from handling during transportation and storage. Strong evidence of water contamination exists. In Ecuador, higher *Escherichia coli* was reported in surface and stored water (Bhavnani et al., 2014b). It was further reported that after five days of rainfall, unsafe water sources were found to be associated with increased risk of diarrhoea (Bhavnani et al., 2014b). The increased risk of diarrhoea is likely explained by the role of rainfall in flushing enteric pathogens into the unsafe water source, thus increasing the risk (Bhavnani et al., 2014b). Contamination of water sources may also be the result of dry conditions and drought, which is likely to lead to sharing of water sources with animals (Mellor et al., 2016), thus increasing pathogen transmission. Promoting water treatment (a rare practice in the study areas) at the point of use throughout the year could reduce or eradicate the pathogens that contaminate the water. Mellor et al., (2016) explained that different pathogens flourish during different conditions at various times of the year, such as rotavirus (cooler and drier weather), norovirus (winter months), cryptosporidiosis (warmer and wetter weather), campylobacter (springtime), and *Shigella* (warmer weather). However, treatment of water modifies the relationship of the water condition and the incidence of diarrhoea (Carlton et al., 2014).

Treating water can prevent up to 75% of preventable diseases (Eisenberg, Scott & Porco, 2007). Other studies have shown 30-50% lower diarrhoea prevalence rates when interventions to improve water and sanitation are combined (Fewtrell et al., 2005, in Pattanayak et al., 2010). Esrey (1996) found that improvements in water alone had little or no impact, but improvements in water and sanitation together had a higher impact on health, especially infant and child growth.

It can also be speculated that the response in the health and growth of infants and children may depend mostly on what the key source of pathogens or contamination is. Behavioural change interventions should therefore be concentrated on the identified pathways. If the pathway is water, food or child playing places, that is where programme design should focus. Similarly, if contamination is due to poor hygiene practices such as poor food storage, unsafe keeping of leftovers and cooking utensils, or poor hygiene of caregivers infants and children, that is where the impact is expected to be seen in the community, and where interventions in this regard should be aimed. This could explain why in some studies, sanitation may have a higher effect on infant/child growth than water alone, but better achievements when combined (Esrey, 1996).

The experimental and control areas were comparable regarding the level and type of wealth they owned, as depicted by the ***wealth components and income***. Nonetheless, there was a wide range in the income of households. The reason could have been that there are few people in these rural areas who earned a high income, compared to urban areas which offer both formal and informal employment. The majority in rural areas were peasant farmers. The low income could have been from crop and animal sales or other small jobs. The finding is interesting because issues of poor WASH practices and related disease have been linked to poverty (Costa et al., 1987; Brooker et al., 2006; Hotez, 2007, 2008; Hotez et al., 2008; Harhay, Horton & Ollliaro, 2010a). Given the WASH practices situation in the two areas and the levels of income, it is suggested that interventions related to poverty reduction would improve the well-being of the community regarding various aspects of life (social, economic and health), including WASH services and practices. Barros et al. (2010:7) linked poverty and WASH conditions, writing that:

> children from poor households are at consistently higher risk of being exposed to inadequate water and sanitation, crowding, and indoor pollution than are children from wealthy families. Their caretakers are also less likely to adopt behaviours, such as hand washing or safe disposal of stools that are associated with reduced risk of exposure to infectious agents. There is also evidence on higher exposure of poor children to Anopheles mosquitoes. Greater risk of exposure will likely lead to increased disease incidence.

Although it is appreciated that economic development is taking place in Africa, it has also been noted that it is slow and the impact on poverty is much less than expected because of the high levels of inequality (World Bank, 2013). Camdessus (1995:1) indicated that "excessively unequal income distribution may itself be detrimental to sustainable growth" therefore, poverty and income inequality should be addressed. Similarly, poverty levels in Zambia differ significantly between the rural and the urban areas, and even between households within the same area. Since a bigger proportion of the population live in rural areas, efforts should be accelerated to address the problem if Zambia is to attain better economic development (Camdessus, 1995).

Income determines the ability of the household to acquire food, and is often used to determine poverty levels in a community or country. It is the anchor of development at any level of society. Wealth inequality reduces the chances of individuals to have equal access to social or economic opportunities, thus limiting their educational and occupational choices (Dabla-Norris et al., 2015). In rural households, as is the case for the two study areas, households need financial resources to address the social, economic and educational needs of the family, such as paying school fees for their children, and other bills. Improving environmental conditions in the areas of infant and child care; water, sanitation and hygiene; and other social amenities also require financial resources. Households in study areas reported low-income levels, with 86% earning less than K1000 ($100) as annual income. The finding is not surprising considering that about 86% of households depend on farming. Such low income levels may limit access to items that the farmers cannot grow themselves, but which are important aspects in improving diet and furthering economic growth. Even in instances where the farmers have an opportunity to grow diverse crops, one farmer may not grow every food crop required to improve the household diet, and may thus need to buy additional food. However, some studies have noted that income may not translate into improved nutrition as it depends on who has power regarding income control. Income controlled by women is more likely to be used for the benefit of the family with regard to accessing needs such as family foods, infant and child health and nutrition (Quisumbing et al., 1995).

There are implications of ***poor WASH practices and facilities for women***. The existence of poor WASH *practices and facilities* has a different impact on men and women. When water is inadequate, women as the main water collectors in the households will have to walk long distances to fetch water for cooking, bathing and drinking. Along the way, they face various risks of violence, such as rape, attack, and even of hurting themselves (WaterAid, 2017). Fetching water adds to many of the women's activities, allowing them little time to undertake economic activities that would promote their social and economic conditions, thus widening inequality. As noted in Chapter 2, women collect 90% of the household water (Quisumbing et al., 1995) which takes up to 40 billion hours a year (Campbell et al., 2015) and 8 hours per day, carrying up to 40.8 kg of water on their heads or hips (World Vision Water Process, n.d.). Moreover, because the demand for water may be too much for the family, the girls may miss school, report late or even drop out of school to help with such family chores (IRIN, 2006).

Similarly, lack of toilets mean that women sometimes have to walk to dangerous or unhealthy places to defecate, which is especially risky for girls and women (Tratschin, n.d.). Lack of toilets at school can demotivate girls and result in them dropping out (Kov et al., 2008). It is important to ensure that factors hindering women's progress are addressed, otherwise women will continue to have fewer social and economic opportunities due to poor education and limited time to do other activities. Since women are the main users of water for domestic and food production, and since they suffer the most when water is not properly managed, they should be empowered through greater participation in water management programmes (UN, 2005). After all, according to UN-Water & Interagency Network on Women and Gender Equality (2006), women can manage water projects more effectively and promote sustainability.

The study suggests that there are still high levels of poor WASH practices in both the experimental and control communities, leading to a concern about the effects on infant and child growth and development. The findings show differences in the levels of WASH practices between the two groups. The experimental group showed better WASH practices in most of the factors, including key ones such as the source of drinking water, toilet availability and type. The poor practices that are the likely causes of diseases in the communities are exposure to faecal matter from poor sanitary facilities, poor disposal of infant/child faeces, and open defecation. Pathogens from these are likely to contaminate the food, water, cooking, and infant/child play areas, or result in direct consumption through dirty fingers and other dirty surfaces.

4.6 References

Andres, L.A., Briceño, B., Chase, C. & Echenique, J.A. 2014. *Sanitation and externalities Evidence from early childhood health in rural India: Policy research working paper*. Washington DC.

Baker, K. k, O'Reilly, C., Levine, M.M., Kotloff, K.L., Nataro, J.P., Ayers, T.L., Farag, T.H., Nasrin, D., et al. 2016. Sanitation and Hygiene-Specific Risk Factors for Moderate-to-Severe Diarrhea in Young Children in the Global Enteric Multicenter Study , 2007 – 2011 : Case-Control Study. *PloS Medicine*. 13(5):1–19. DOI: 10.1371/journal.pmed.1002010.

Baltazar, J.C. & Solomon, F.S. 1989. Disposal of faeces of children under two years old and diarrhoea incidence: a case-control study [Abstract]. *International Journal of Epidemiology*. 18(4 Suppl 2):S16-9. Available: https://www.ncbi.nlm.nih.gov/pubmed/2621044.

Barros, F.C., Victora, C.G., Scherpbier, R. & Gwatkin, D. 2010. Socioeconomic inequities in the health and nutrition of children in low / middle income countries Iniqüidades sociais na saúde e nutrição de crianças em países de renda baixa e média. *Rev Saúde Pública*. 44(1):1–16.

Bhavnani, D., Goldstick, J.E., Cevallos, W., Trueba, G. & Eisenberg, J.N.S. 2014a. Impact of Rainfall on Diarrheal Disease Risk Associated with Unimproved Water and Sanitation. *American Journal of Tropical and Hygiene*. 90(4):705–711. DOI: 10.4269/ajtmh.13-0371.

Bhavnani, D., Goldstick, J.E., Cevallos, W., Trueba, G. & Eisenberg, J.N.S. 2014b. Impact of rainfall on diarrheal disease risk associated with unimproved water and sanitation. *American of Tropical Medicine and Hygiene*. 90(4):705–711. DOI: 10.4269/ajtmh.13-0371.

Black, E., Brown, H. & Becker, S. 1984. Malnutrition is a determining factor in diarrheal duration, but not incidence, among young children in a longitudinal study in rural. *American Journal of Clinical Nutrition*. 39(January):87–94.

Brooker, S., Clements, A.C.A., Hotez, P.J., Hay, S.I., Tatem, A.J., Bundy, D.A.P. & Snow, R.W. 2006. The co-distribution of Plasmodium falciparum and hookworm among African schoolchildren. *Malaria Journal*. 5(99):1–8. DOI: 10.1186/1475-2875-5-99.

Camdessus, M. 1995. *Income distribution and sustainable growth: the perspective from the IMF at Fifty -- Opening remarks by Michel Camdessus*. Available: https://www.imf.org/en/News/Articles/2015/09/28/04/53/spmds9509 [2017, August 21].

Campbell, O.M.R., Benova, L., Gon, G., Afsana, K. & Cumming, O. 2015. Getting the basic rights – the role of water, sanitation and hygiene in maternal and reproductive health: a conceptual framework. *Tropical Medicine and International Health*. 20(3):252–267. DOI: 10.1111/tmi.12439.

Carlton, E.J., Eisenberg, J.N.S., Goldstick, J., Cevallos, W., Trostle, J. & Levy, K. 2014. Heavy rainfall events and diarrhea incidence: The role of social and environmental factors. *American Journal of Epidemiology*. 179(3):344–352. DOI: 10.1093/aje/kwt279.

Casanovas, C., Lutter, C.K., Mangasaryan, N., Mwadime, R., Hajeebhoy, N., Aguilar, A.M., Kopp, C., Rico, L., et al. 2013. Multi-sectoral interventions for healthy growth. *Maternal & Child Nutrition*. 9:46–57. DOI: 10.1111/mcn.12082.

Costa, L.E.M.F.F., Magalhaes, M.H.A., Rocha, R.S. & Antunes, C.M.F. 1987. Water-contact patterns and socioeconomic variables in the epidemiology of schistosomiasis mansoni in an endemic area in Brazil. *Bulletin of the World Health Organization*. 65(1):57–66.

Crane, R.J., Jones, K.D.J. & Berkley, J.A. 2015. Environmental enteric dysfunction: An overview. *Food and Nutrition Bulletin*. 36(1):76–87.

Curtis, V., Cairncross, S. & Yonli, R. 2000. Domestic hygiene and diarrhoea – pinpointing the problem. *Tropical Medicine and International Health*. 5(1):22–32.

Dabla-Norris, E., Kochhar, K., Suphaphiphat, N., Ricka, F. & Tsounta, E. 2015. *Causes and consequences of income inequality: A global perspective*. DOI: DOI:

Donowitz, J.R., Haque, R., Kirkpatrick, B.D., Alam, M., Lu, M., Kabir, M. & Kakon, H. 2016. Small intestine bacterial overgrowth and environmental enteropathy in Bangladeshi children. *mBio*. 7(1):1–7. DOI: 10.1128/mBio.02102-15.Editor.

Eisenberg, J.N.S., Scott, J.C. & Porco, T. 2007. Integrating disease control strategies: balancing water sanitation and hygiene interventions to reduce diarrheal disease burden. *American Journal of Public Health*. 97(5):846–852. DOI: 10.2105/AJPH.2006.086207.

Esrey, S.A. 1996. Water, waste, and well-Being: A multicountry study. *American Journal of Epidemiology*. 143(6):608–623.

Exum, N., Olortegui, M., Yori, P., Davis, M., Heaney, C., Kosek, M. & Schwab, K. 2016. Floors and Toilets: Association of floors and sanitation practices with faecal contamination in Peruvian Amazon Peri-Urban households [Abstract]. *Enviromental Science and Technology*. 50(14).

Field, A. 2009. *Discovering statistics using SPSS*. 3rd ed. London, UK: SAGE Publications.

Freeman, M.C., Majorin, F., Boisson, S. & Routray, P. 2016. The impact of a rural sanitation programme on safe disposal of child faeces: a cluster randomised trial in Odisha, India. *Transactions of the Royal Society of Tropical Medicine and Hygiene*. 110:386–392. DOI: 10.1093/trstmh/trw043.

George, C.M., Oldja, L., Biswas, S., Perin, J., Sack, R.B., Ahmed, S., Shahnaij, M., Haque, R., et al. 2016. Unsafe child feces disposal is associated with Environmental Enteropathy and impaired growth. *Journal of Pediatrics*. 176:43–49. DOI: 10.1016/j.jpeds.2016.05.035.

Harhay, M., Horton, J. & Ollliaro, P.L. 2010. Epidemiology and control of human gastrointestinal parasites in children. *Expert Review of Anti-infective Therapy*. 8(2):219–234. DOI: 10.1586/eri.09.119.Epidemiology.

Headey, D. & Hirvonen, K. 2016. Is exposure to poultry harmful to child nutrition? An observational analysis for rural Ethiopia. *PLoS ONE*. 11(8):1–16. DOI: 10.1371/journal.pone.0160590.

Hill, Z., Kirkwood, B. & Edmond, K. 2004. *Family and community practices that promote child survival, growth and development: A review of the evidence*.

Hotez, P.J. 2007. Neglected diseases and poverty in "'the other America'": the greatest health disparity in the United States? 1(3):1–3. DOI: 10.1371/journal.pntd.0000149.

Hotez, P.J. 2008. Holidays in the sun and the Caribbean's forgotten burden of neglected tropical diseases. *PLoS Neglected Tropical Diseases*. 2(5):1–2. DOI: 10.1371/journal.pntd.0000239.

Hotez, P.J., Bottazzi, M.E., Franco-paredes, C., Ault, S.K. & Periago, M.R. 2008. The neglected tropical diseases of Latin America and the Caribbean: a review of disease burden and distribution and a roadmap for control and elimination. *PLoS Neglected Tropical Diseases*. 2(9):1–11. DOI: 10.1371/journal.pntd.0000300.

how2stats. 2011. *Principal Components Analysis - SPSS (part 1,2,3,4) [Video file]*. YouTube. Available: https://www.youtube.com/watch?v=qu4la8K212M.

Humphrey, J.H. 2009. Child undernutrition, tropical enteropathy, toilets, and handwashing. *Lancet*. 374(9694):1032–1035. DOI: 10.1016/S0140-6736(09)60950-8.

IRIN. 2006. *The gender dimensions of water access*. Available: http://www.irinnews.org/report/61125/global-gender-dimensions-water-access [2017, July 17].

Kosek, M., Haque, R., Lima, A., Babji, S., Shrestha, S., Qureshi, S., Amidou, S., Guerrant, R.L., et al. 2013. Fecal Markers of Intestinal Inflammation and Permeability Associated with the Subsequent Acquisition of Linear Growth Deficits in Infants. *American Journal of Tropical Medicine and Hygiene*. 88(2):390–396. DOI: 10.4269/ajtmh.2012.12-0549.

Kosek, M.N., Ahmed, T., Bhutta, Z., Caulfield, L., Guerrant, R., Houpt, E., Kang, G., Kosek, M., et al. 2017. Causal pathways from enteropathogens to environmental enteropathy: eindings from the MAL-ED Birth Cohort Study. *EBioMedicine*. 18:109–117. DOI: 10.1016/j.ebiom.2017.02.024.

Kov, P., Sok, H., Roth, S., Chhoeun, K. & Hutton, G. 2008. *Economic impacts of sanitation in Cambodia: A five-country study conducted in Cambodia, Indonesia, Lao PDR, the Philippines and Vietnam under the Economics of Sanitation Initiative (ESI)*. Jakarta. DOI: 10.1193/1.1585864.

Mara, D., Lane, J., Scott, B. & Trouba, D. 2010. Sanitation and health. *PloS Med*. 7(11):1–7. DOI: 10.1371/journal.pmed.1000363.

Mellor, J.E., Levy, K., Zimmerman, J., Elliott, M., Bartram, J., Carlton, E., Clasen, T., Dillingham, R., et al. 2016. Planning for climate change: the need for mechanistic systems-based approaches to study climate change impacts on diarrheal diseases. *Science of the Total Environment*. 82–90. DOI: 10.1016/j.scitotenv.2015.12.087.Planning.

Mertens, T.E., Jaffar, S., Fernando, M., Cousens, S.N. & Feachem, R.G. 1992. Excreta disposal behaviour and latrine ownership in relation to the risk of childhood diarrhoea in Sri Lanka. [Abstract]. *International Journal of Epidemiology*. 21(6):1157–64. Available: https://www.ncbi.nlm.nih.gov/pubmed/1483822.

Ngure, F.M., Humphrey, J.H., Mbuya, M.N.N., Majo, F., Mutasa, K., Govha, M., Mazarura, E., Chasekwa, B., et al. 2013. Formative research on hygiene behaviors and geophagy among infants and young children and implications of exposure to fecal bacteria. *American Journal of Tropical and Hygiene*. 89(4):709–716. DOI: 10.4269/ajtmh.12-0568.

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

Owino, V., Ahmed, T., Freemark, M. & Kelly, P. 2016. Environmental Enteric Dysfunction and growth gailure: Stunting in global child health. *Pediatrics*. 138(6):1–10. DOI: 10.1542/peds.2016-0641.

Pattanayak, S.K., Poulos, C., Yang, J.C. & Patil, S. 2010. How valuable are environmental health interventions? evaluation of water and sanitation programmes in india. *Bulletin of the World Health Organization*. 88(7):535–542. DOI: 10.2471/BLT.09.066050.

Preeti, P., Sahoo, S.K., Biswas, D. & Dasgupta, A. 2016. Unsafe Disposal of Child Faeces: A Community-based Study in a Rural Block in West Bengal, India. *Journal of Preventive Medicine and Public Health*. 49:323–328.

Quisumbing, A.R., Brown, L.., Hilary, S.., Haddad, L. & Pena, C. 1995. *Women: The key to food security*. Washington D.C: International Food Research Policy Institute.

Rah, J.H., Cronin, A.A., Badgaiyan, B., Aguayo, V.M., Coates, S. & Ahmed, S. 2015. Household sanitation and personal hygiene practices are associated with child stunting in rural India : a cross-sectional analysis of surveys. *British Medical Journal Open*. 5:1–10. DOI: 10.1136/bmjopen-2014-005180.

Rand, E.C., Loughnan, L., Maule, L. & Reese, H. 2015. *Scaling Up rural sanitation and hygiene: management of child feces; current disposal practices. research brief*. Available: https://www.wsp.org/sites/wsp.org/files/publications/WSP-CFD-Summary-Brief.pdf.

Spears, D. 2013. *The nutritional value of toilets: How much international variation in child height can sanitation explain?a*. Delhi, India.

Spears, D., Ghosh, A. & Cumming, O. 2013. Open defecation and childhood stunting in India : an ecological analysis of new data from 112 districts b. *PLoS ONE 8*. 8(9):1–9. DOI: 10.1371/journal.pone.0073784.

Tratschin, R. n.d. *Water, sanitation and dignity*. Available: http://www.sswm.info/content/water-sanitation-and-dignity [2017, August 21].

UN. 2005. *Women and water: published to promote the goals of the Beijing Declaration and the platform for action*. NewYork, USA.

WHO & UNICEF. 2017. *Progress on drinking water, sanitation and hygiene 2017; update and SDG Baselines. Launch version*. Geneva, Switzerland. Available: https://www.unicef.org/publications/index_96611.html?utm_source=newsletter&utm_medium=email&utm_campaign=WASH.

UN Water & Interagency Network on Women and Gender Equality. 2006. *Gender, Water and Sanitation: A Policy Brief*.

VAM: WFP. n.d. Available: https://resources.vam.wfp.org/sites/default/files/5. Wealth Index.ppt.

WaterAid. 2017. *Gender aspects of water and sanitation*. UK. Available: www.wateraid.org.

WHO and UNICEF. 2006. *Core questions on drinking-water and sanitation for household surveys*. Geneva, Swizerland.

World Bank. 2013. *The World Ban. Africa Continues to Grow Strongly but Poverty and Inequality Remain Persistently High*. Available: http://www.worldbank.org/en/news/press-release/2013/10/07/africa-continues-grow-strongly-poverty-inequality-persistently-high [2017, October 29].

World Vision Water Process. n.d. *Mainstreaming gender in water resources management: why and how*.

CHAPTER 5 : DISEASES RELATED TO POOR WASH PRACTICES

5.1 Introduction

The previous chapter provided insight into the level of WASH facilities/practices in the study areas, discussing WASH factors which are adequately practised among the study population, and those which are not. In this chapter, an attempt has been made to respond to the objective below by broadening the understanding of the association between WASH practices and disease. The chapter begins with an account of the methodology and materials that have been utilised to collect the data. The diseases that children suffered during the study period (from baseline to follow up) and two weeks before the study will be presented. Further, the chapter explains the associations between WASH factors and the infections children suffered. The data are then interpreted, and the implications of the findings are discussed, along with recommendations for further actions.

***Objective*:**

To assess the prevalence and type of infectious diseases of infants aged 6-23 months in an area provided with WASH services (experimental) and in an area not provided with WASH services (control).

5.2 Materials and Methods

The data in this chapter was gathered in two ways: through face to face interviews using a structured household questionnaire, and extraction from the health facility records for the enrolled infants and children using a recording tool by a health staff member. Infant and child records were used to extract the type of diseases the infants and children presented with at the health facility during the one year of follow up period. This was from baseline when the lowest age of infants was 6 months to follow up when the oldest children were-36 months old. An aggregate of the number of visits an infant or child made per disease was calculated by adding the number of times the infant or child visited the health facility for the same illness.

The risk difference, which is a difference between proportions, was calculated by subtracting the cumulative incidence in the unexposed group (control group) from that of the exposed group (experimental group).

Stunting is failure (in case of a child) to reach linear growth potential because of inadequate nutrition or poor health. It's Measured as height-for-age z-scores (HAZ) z-score that describes how far and in what direction a child's anthropometric measurement deviates from the median in the 2006 WHO Child Growth Standards for his or her sex (USAID & FANTA 2, 2011). Stunted children are more than two standard deviations below the median value of the reference group. Usually a good indicator of long-term undernutrition among young children (Mahmud & Mbuya, 2016). The height for age is one of the three most commonly used anthropometric indices to assess infant and child growth status in addition to weight-for-height and weight-for-age. The HAZ is calculated as a compound of height and age of the child (FANTA, 2011).

A food consumption score (FCS) was calculated by adding the frequency of consumption of different food groups by the infant/child during the seven days before the survey (Appendix 3, section 4(C)). The FCS has been validated by the World Food Programme (WFP, 2008) for use in community household surveys as a proxy indicator of food security. Mothers/caregivers were asked to recall how many days in a week the infant or child was given the listed foods, which were arranged in eight groups (Table 5-1). Each group was multiplied by its weight to create a score (WFP, 2008).. The weighted score ranges from 0 to 112. Three categories (as defined by WFP), namely: poor (0-21), borderline (21.5-35) and acceptable (>35) food intake were used to determine levels of food intake. Infants or children with a score of 21 and below were considered as having very poor food consumption (WFP, 2008).

Table 5-1: Food groups and weights used to calculate the food consumption score

Group number	Group name	Weight of food
Group1	Maize, maize porridge, rice, sorghum, millet, cassava, potatoes, sweet potatoes, yams, plantains	2
Group2	Legumes: Beans, cowpeas, Bambara nuts, pea, lentils groundnuts	3
Group3	Vegetables	1
Group 4	Fruits	1
Group 5	Meats: beef, goat, poultry, pork, eggs, fish	4
Group 6	Milk and milk products: cheese, sour milk, yoghurt	4
Group 7	Sugar, honey, chocolates, sweets	0.5
Group 8	Oils	0.5

Source: WFP, 2008

Following the cleaning of the data, descriptive analysis was carried out for key variables (diseases). Logistic regression was used to find relationships between diseases that the infants/children suffered during the study period and WASH factors; and between diseases and other factors. Odds ratios and confidence intervals were reported along with the predictors. Linear regression was used to find associations between the number of diseases the infants and children suffered during the study period and other variables.

The data were checked to determine if there were any differences between the baseline and follow-up period regarding water, sanitation and hygiene practices. The data were first subjected to the Wilcoxon signed rank test (non-parametric equivalence of the dependent t-test) to test whether the medians of the differences between baseline and follow-up periods were equal (equals to zero). The Wilcoxon sign rank test showed that there was a difference (Table 5-2) in the source of water ($z = -3.280$, $p <0.01$) and sanitation ($z = -3.320$, $p < 0.01$) between baseline and follow-up periods. However, the hygiene status was not significantly different ($z = -0.605$. $p =0.55$).

Table 5-2: Comparison of the median values of control and experimental groups using the Wilcoxon signed rank test to test equality of medians

	Negative Ranks (Sum of Ranks)	Positive Ranks (Sum of Ranks)	Ties	Z (p-value)
Source of drinking water	10 (210.00)	31 (651.00)	156	-3.28 (<0.01)
Hygiene composite of infant/child and mother	112 (7652.00)	58 (6883.00)	0	-.61 (0.55)
Sanitation composite (type of toilet & disposal of infant/child faeces)	15 (936.00)	65 (2304.00)	0	-3.32 (<0.01)

The questions used to collect data for this chapter are in Appendix 3, section 3 of the questionnaire.

5.3 Results

The results are categorised into two sections: the prevalence of diseases, and factors associated with each of the diseases.

5.3.1 Prevalence of water, sanitation and hygiene related diseases

Two weeks preceding the baseline study, more than two-thirds (69.2%) of the infants and children had suffered from coughing episodes (Table 5-3). About half (51.9%) had a fever (an indication of the possibility of malaria and/or other infections), 40.7% had diarrhoea, and 36.9% had sore eyes. It is important to note that all diseases except for respiratory diseases and skin diseases were suffered by more than 20% of the infants/ children. There was a differential share of the burden of some diseases between the two areas, both at baseline (coughing ($p<0.01$), fever ($p<0.02$), eye infections ($p<0.01$) malaria ($p<0.01$)) and follow-up (eye infections ($p<0.01$), and respiratory infections ($p=0.05$),, malaria ($p=0.05$), skin diseases ($p=0.02$)). The control group had a higher prevalence of all diseases. At follow-up, the proportion of infants and children suffering from the listed diseases reduced in a similar order to baseline but were still above 20%, except for malaria, respiratory diseases, and skin diseases. The control group still reported a higher prevalence of all the diseases except for diarrhoea and fever.

Calculating the risk difference between the experimental and control group at baseline shows that infants and children in the control group had a 4.8% higher proportion of having diarrhoea than those in the experimental group (Table 5-2). They also had a 17%, 20% and 46% higher proportion of suffering from coughing, malaria and eye infections, respectively. However, at follow-up, the control group had a 5% reduction in the risk of diarrhoea and fever. The percent risk difference for all diseases reduced at follow up, although the risk difference for eye infections (37.2%), malaria (10.6%) and skin infection (10.3%) was still high affecting more of the population in the control group.

In both phases, a similar proportion (16% baseline and 7.2% follow-up) of caregivers did not seek medical care when the infant/child was sick from any of the diseases reported (Table 5-3). Respondents gave various reasons for not seeking treatment. Some of the major reasons advanced for not seeking prompt treatment were that the infant/child was not critically ill, or it was a weekend or holiday when health facilities could have been closed. Some felt that they still wanted to observe the infant/child to see whether the illness would become more severe or not. The respondents also gave reasons regarding the quality of health services received from the health facility, indicating that the facility was too far, the drugs were not available at times, or health staff were not available to provide the service (data not shown). Socially, some indicated that they wanted to attend church if the illness occurred on a worshipping day, or caregivers were busy with harvesting or other activities. Some infants and children were given traditional or own medicine. There was also a gender dimension, such as the decision maker (father) not being around.

Table 5-3: Prevalence of water, sanitation and hygiene-related diseases among infants and children 6-23 months in the study areas, two weeks before baseline and at follow-up

Disease	Baseline				Follow-up			
	All infants/children No. (%)	Control No. (%)	Experimental No. (%)	P (%RD)	All infants/children No. (%)	Control No. (%)	Experimental No. (%)	P (%RD)
Diarrhoea								
Yes	1120 (40.7)	65 (43.0)	55 (38.2)	0.40 (4.8)	56 (28.4)	27 (26.0)	29 (31.2)	0.42 (-5.2)
No	175 (59.3)	86 (57.0)	89 (61.8)		141 (71.6)	77 (74.0)	64 (68.8)	
Coughing								
Yes	204 (69.2)	117 (77.5)	87 (60.4)	**<0.01 (17.1)**	96 (49.0)	52 (50.5)	44 (47.3)	0.66 (3.2)
No	91 (30.8)	34 (22.5)	57 (39.6)		100 (51.0)	51 (49.5)	49 (52.7)	
Malaria								
Yes	73 (24.7)	52 (34.4)	21 (14.6)	**<0.01 (19.8)**	32 (16.3)	22 (21.4)	10 (10.8)	**0.05 (10.6)**
No	222 (75.3)	99 (65.6)	123 (85.4)		164 (83.7)	81 (78.6)	83 (89.2)	
Eye infections								
Yes	109 (36.9)	90 (59.6)	19 (13.2)	**<0.01 (46.4)**	51 (26.0)	45 (43.7)	6 (6.5)	**<0.01 (37.2)**
No	186 (63.1)	61 (40.4)	125 (86.8)		145 (74.0)	58 (56.3)	87 (93.5)	
Respiratory infection								
Yes	26 (8.8)	18 (12.0)	8 (5.6)	0.05 (6.4)	15 (7.7)	10 (9.7)	5 (5.4)	0.26 (4.3)
No	268 (91.2)	132 (88.0)	136 (94.4)		181 (92.3)	93 (90.3)	88 (94.6)	
Fever								
Yes	153 (51.9)	88 (58.3)	65 (45.1)	**0.02 (13.2)**	75 (38.3)	37 (35.9)	38 (40.9)	0.48 (-5)
No	142 (48.1)	63 (41.7)	79 (54.9)		121 (61.7)	66 (64.1)	55 (59.1)	
Skin disease								
Yes	35 (11.9)	23 (15.2)	12 (8.3)	0.07 (6.9)	19 (9.7)	15 (14.6)	4 (4.3)	**0.02 (10.3)**
No	260 (88.1)	128 (84.8)	132 (91.7)		177 (90.3)	88 (85.4)	89 (95.7)	
Other								
Yes	14 (4.8)	7 (4.7)	7 (4.9)		5 (6.8)	2 (4.9)	3 (9.4)	
No	280 (95.2)	143 (95.3)	137 (95.1)		68 (93.2)	39 (95.1)	29 (90.6)	
Seek medical advice or treatment when the infant/child was sick								
Yes	217 (84.1)	123 (87.2)	94 (80.3)		128 (92.8)	64 (88.9)	64 (97.0)	
No	41 (15.9)	18 (12.)	23 (19.7)		10 (7.2)	8 (11.1)	2 (3.0)	
Prompt seeking of medical attention (how long after the illness started the infant/child was taken to health facility)								
Within a day	129 (59.4)	69 (56.1)	60 (63.8)		62 (51.7)	31 (50.0)	31 (53.4)	
>1 day	88 (40.6)	54 (43.9)	34 (36.2)		58 (48.3)	31 (50.0)	27 (46.6)	

P=P value|| % - Percent || No. – Number || %RD= Percent risk difference between the control and experimental ||

Surprisingly, the majority of infants and children who reported illness suffered more than one type of disease two weeks before the survey (Figures 5-1 & 5-2). At baseline, 22.2%, 19.4%, and 13.3% suffered from two, three and four diseases respectively, while this reduced to 21.1%, 14.6% and 10.3% at follow-up respectively. Again, the control group had the worst scenario ranking higher as the number of diseases increased.

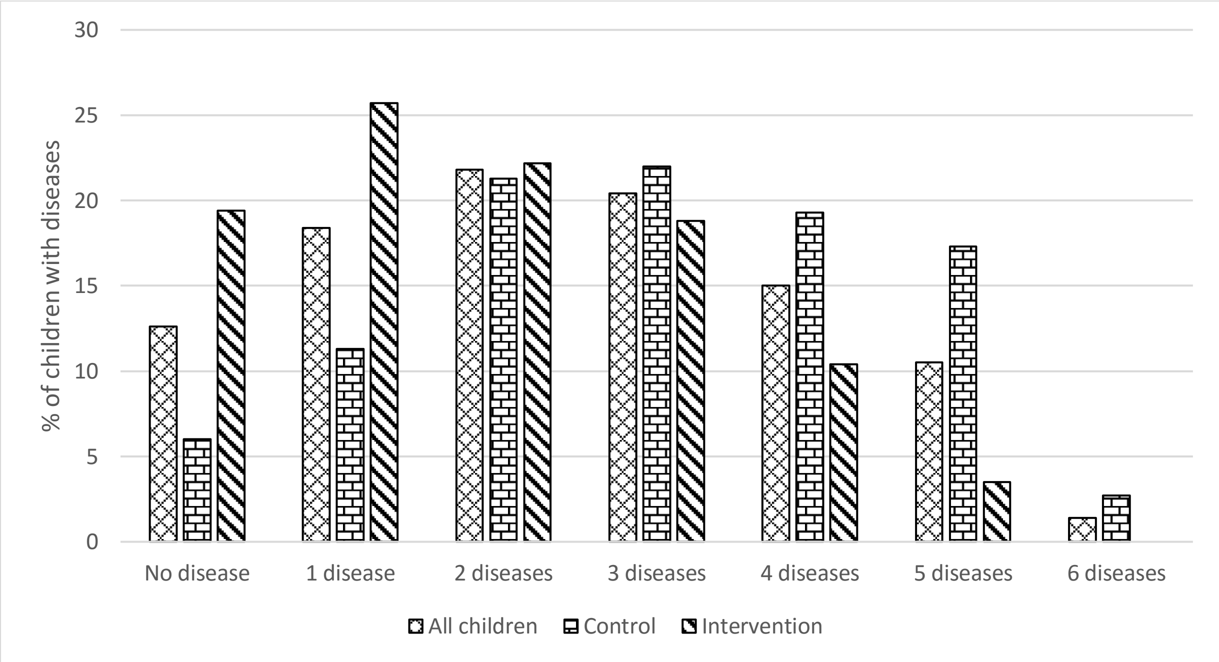


Figure 5-1: Total number of diseases suffered by infants and children in the two weeks before the baseline survey

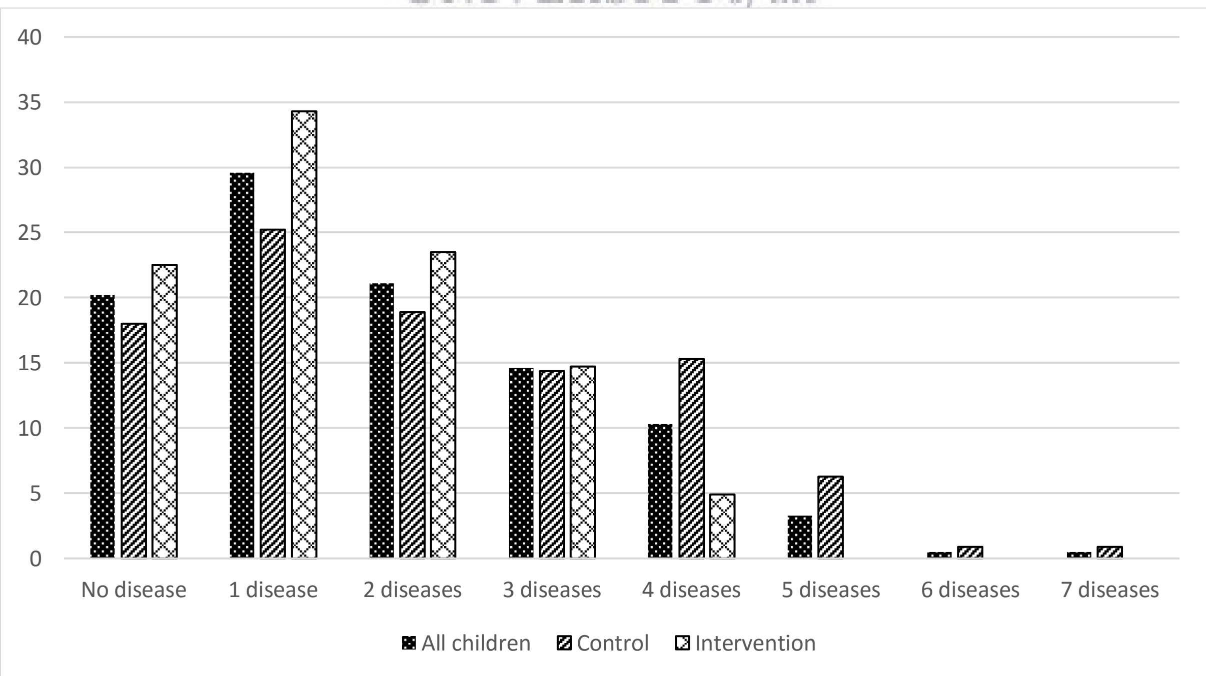


Figure 5-2: The total number of diseases suffered by infants and children in the two weeks before the follow-up survey

The reported prevalence of illness was high among infants below 12 months of age, and reduced between 12-18 months (Figures 5-3 & 5-4). Specifically noted differences in disease prevalence between the two groups at baseline, according to age were diarrhoea (p=0.02), coughing (p=0.04), eye-infections (p<0.01), and fever (p<0.01) (data not shown). Similarly, at follow-up the younger children (<23 months) had a higher prevalence of disease. The risk difference for malaria and eye infections was still high at follow-up.

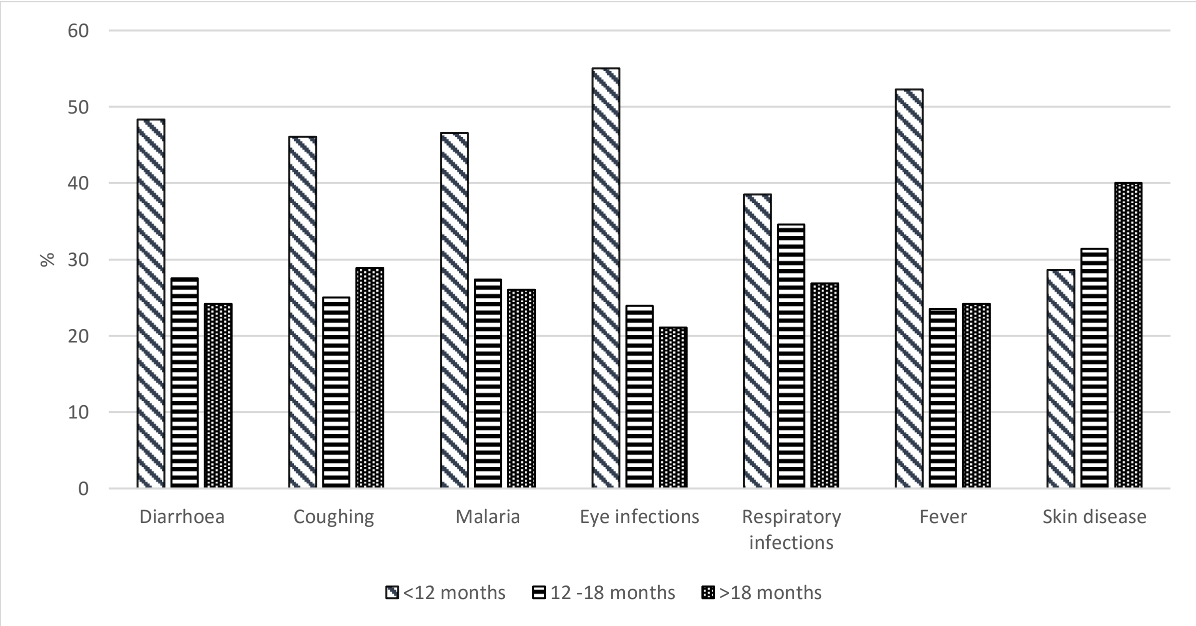


Figure 5-3: Prevalence of diseases according to age category among infants and children 6-23 months in the two weeks before the baseline survey

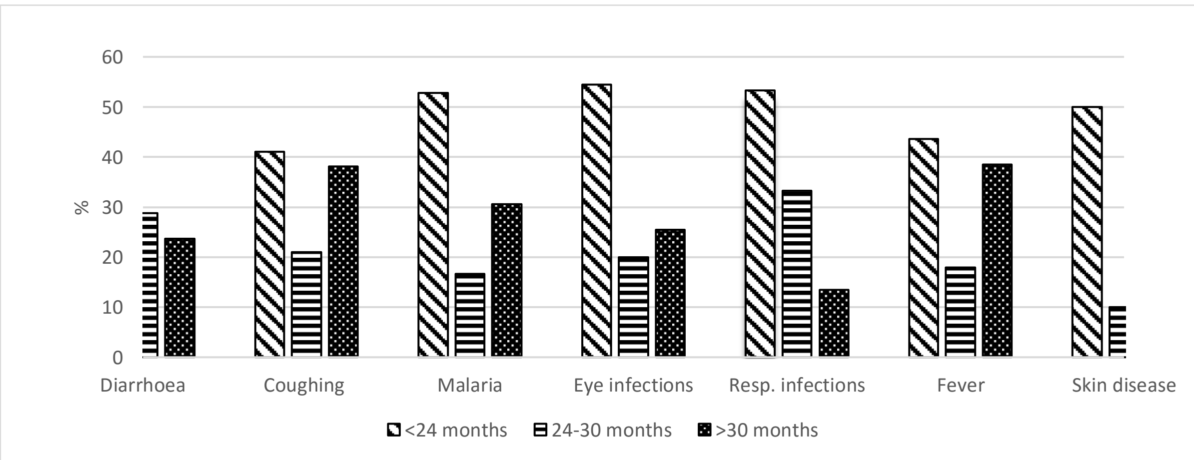


Figure 5-4: Prevalence of diseases according to age group among infants and children 6-23 months in the two weeks before the follow-up survey

Of the 293 infants and children admitted to the study at baseline, 203 made one visit to the health facilities for various illnesses. Of the 203 who made first visits, 108 made a second visit, 63 a third visit and two made eight visits (Figure 5-5). The most common complaints were coughing, diarrhoea, body hotness, sneezing, sore eyes, vomiting, sore mouth, respiratory tract infection (RTI), abdominal pain, loss of appetite, body rash, and conditions such as bilharzia or skin infection. Only one visit reported a worm infestation.

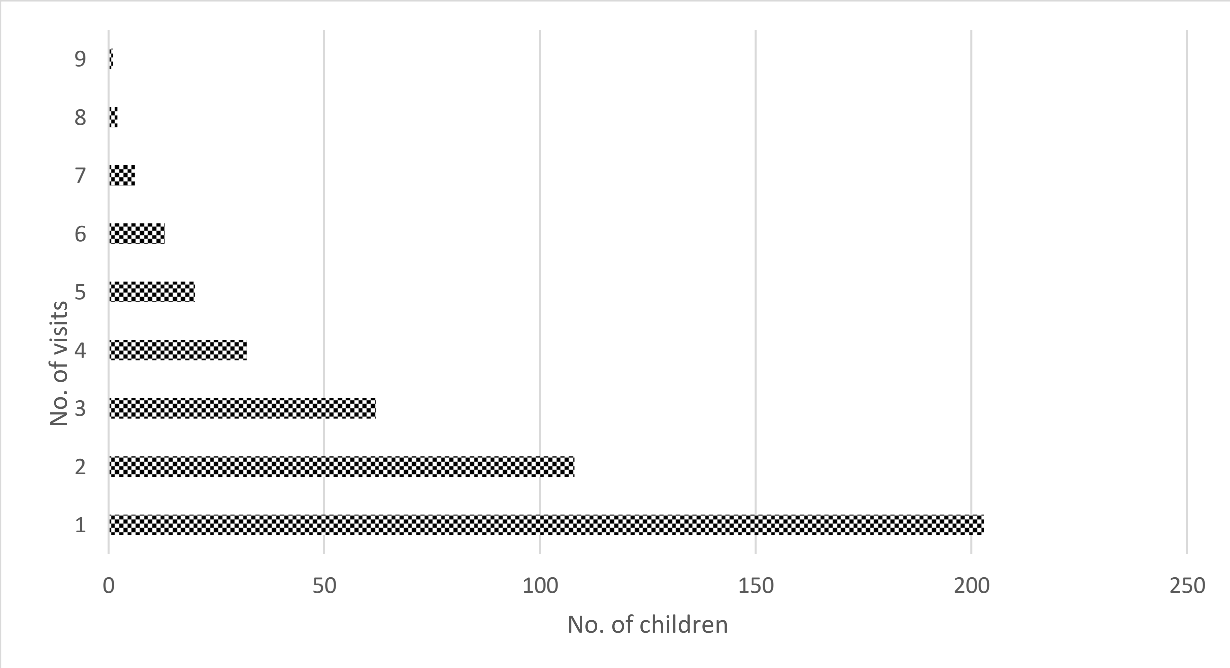


Figure 5-5: Number of visits made by infants and children to a health facility between baseline (April 2014) and follow-up (May 2015), using infant/child outpatient hospital records

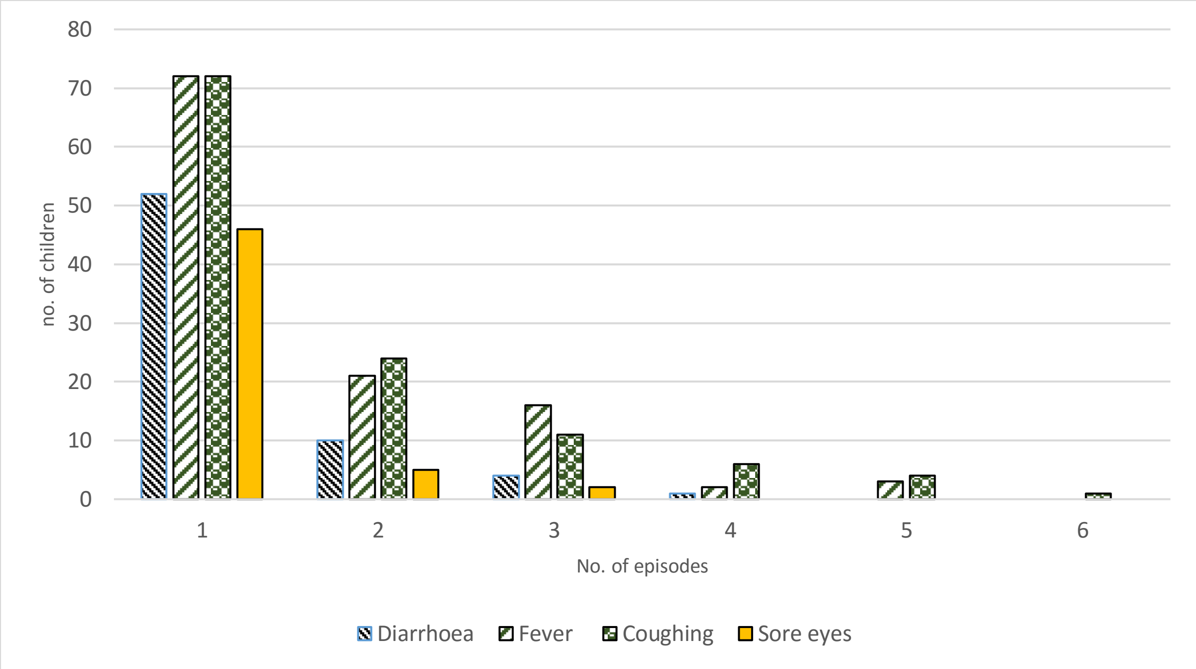


Figure 5-6: Number of disease episodes the infants and children suffered, as extracted from the outpatient health facility records in the study areas

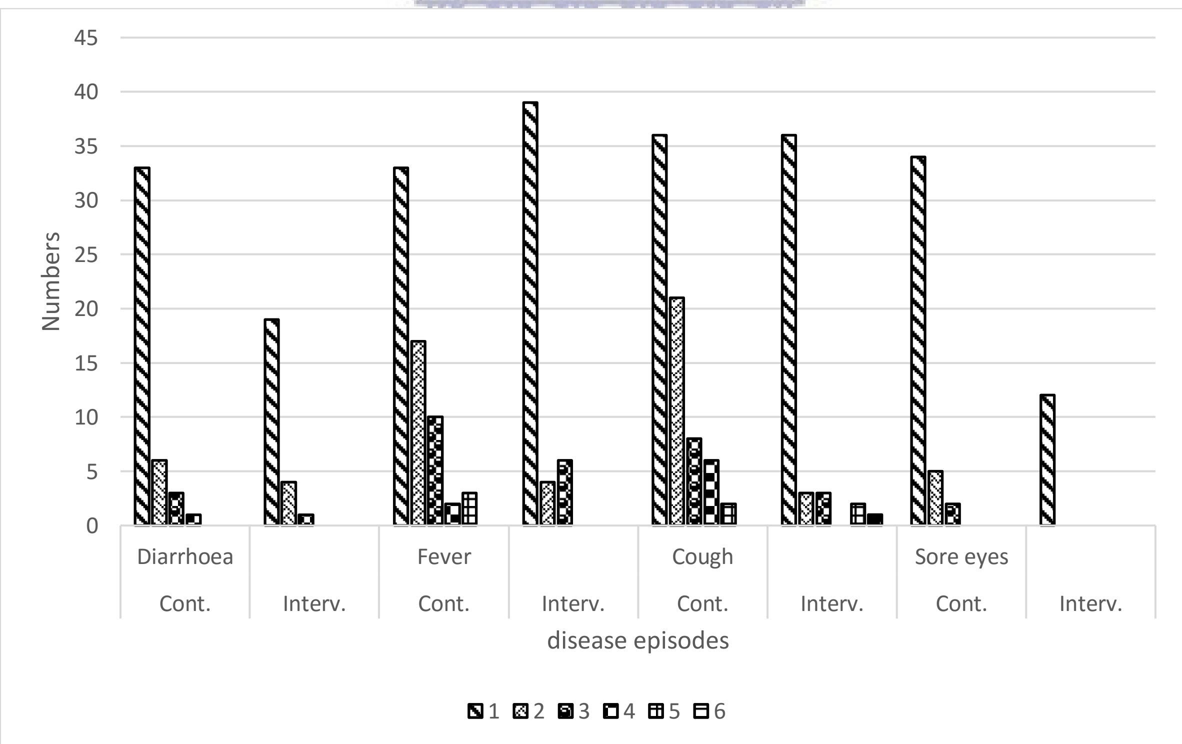


Figure 5-7: Number of disease episodes infants and children suffered according to disease and area of study

The data on the number of episodes infants and children suffered in the one year of follow up was collected from baseline when the lowest age of infants was 6 months to follow up when the oldest children were-36 months old (Table 5-6). Mean episodes of the four most common diseases among infants and children in the study area were: diarrhoea (1.31, SD 0.66), fever (1.62, SD 0.97), coughing (1.72, SD 1.13) and sore eyes (1.17. SD 0.47). Of those who reported having suffered from diarrhoea, 77.6% visited the health facility once, and only one (1.5%) made four visits (four episodes). Fever (63.2%) and coughing (61.0%) resulted in the highest number of infants and children visiting the health facility for one episode. Some infants/children visited the health facility for as many as six episodes of coughing. The control group had the highest mean number of episodes for all diseases, implying a higher burden of disease (Figure 5-7).

Table 5-4: Comparison between the experimental and control groups among infants and children 6 to 36 months of the number of disease episodes an infant or child suffered in the one year study period

No. of episode/visits	Diarrhoea			Fever			Cough			Sore eyes		
	Overall N (%)	Control N (%)	Exper. N (%)	Overall N (%)	Control N (%)	Exper. N (%)	Overall N (%)	Control N (%)	Exper. N (%)	Overall N (%)	Control N (%)	Exper. N (%)
1	52 (77.6)	33 (76.7)	19 (79.2)	72 (63.2)	33 (50.8)	39 (79.6)	72 (61.0)	36 (49.3)	36 (80.0)	46 (86.8)	34 (82.9)	12 (100.0)
2	10 (14.9)	6 (14.0)	4 (16.7)	21 (18.4)	17 (26.2)	4 (8.2)	24 (20.3)	21 (28.8)	3 (6.7)	5 (9.4)	5 (12.2)	
3	4 (6.0)	3 (7.0)	1 (4.2)	16 (14.0)	10 (15.4)	6 (12.2)	11 (9.3)	8 (11.0)	3 (6.7)	2 (3.8)	2 (4.9)	
4	1 (1.5)	1 (2.3)		2 (1.8)	2 (3.1)		6 (5.1)	6 (8.2)	0 (0.0)			
5				3 (2.6)	3 (4.6)		4 (3.4)	2 (2.7)	2 (4.4)			
6							1 (.8)		1 (2.2)			
Mean(SD)	1.31 (0.66)	1.35 (0.72)	1.25 (0.53)	1.62 (0.97)	1.85 (1.09)	1.33 (0.69)	1.72 (1.13)	1.86(1.08)	1.49 (1.18)	1.17 (0.47)	1.22(0.52)	1.00 (.00)

Mean=Mean number of episodes in the study period. SD= Standard deviation|| Exper. = experimental group||

5.3.2 Factors associated with disease among infants and children 6-23 months

a) Association of WASH factors with infections

Logistic regression analysis showed no association in either phase between the four variables of WASH (source of drinking water, mother's hygiene, infant/child's hygiene, and whether the toilet was safe or not) and four diseases (diarrhoea, coughing, fever, and sore eyes) (Table 5-5).

Table 5.5: Relationship between disease of infant or child and key factors of water, sanitation and hygiene

	Phase	Drinking water source OR (95%CI) p	Mother's hygiene OR (95%CI) p	Infant/child's hygiene OR (95%CI) p	Toilet status OR (95%CI) p
Diarrhoea	1	1.65 (0.45,6.06) 0.45	1.45 (0.29,7.19) 0.65	0.68 (0.15,3.11) 0.62	0.72 (0.24,2.18) 0.56
	2	0.35 (0.08,1.46) 0.15	2.38 (0.32,17.75) 0.40	0.87 (0.168,4.50) 0.87	1.50 (0.53,4.28) 0.45
Fever	1	3.46 (0.38,31.35) 0.27	0.53 (0.09,3.31) 0.499	0.89 (0.15,5.29) 0.89	4.02 (0.77,20.98) 0.10
	2	1.44 (0.31,6.68) 0.64	0.27 (0.03,2.29) 0.23	1.82 (0.26,12.667) 0.55	1.82 (0.55,6.03) 0.327
Coughing	1	-	0.26 (0.05, 1.42) 0.12	0.39 (0.076,2.03) 0.27	1.10 (0.27,4.46) 0.89
	2	1.13 (0.25,5.14) 0.88	1.56 (0.17,14.39) 0.70	0.45 (0.08,2.53) 0.36	1.67 (0.52,5.39) 0.39
Sore eyes	1	0.44 (0.08, 2.43) 0.35	0.51 (0.08,3.40) 0.49	2.34 (0.48,11.35) 0.29	2.40 (0.70,8.21) 0.17
	2	1.94 (0.48, 7.78) 0.35	1.40 (0.18,10.77) 0.75	1.53 (0.27,8.66) 0.63	0.63 (0.19,2.05) 0.44

1 = Baseline, 2 = Follow up, OR = Odds ratio, CI = Confidence intervals, % = Percent, p = p value

b) Factors associated with various diseases

Models using logistic and linear regression of the top four diseases with the highest prevalence (diarrhoea, coughing, fever, sore eyes) were undertaken.

Diarrhoea

Three different models were compiled to assess factors associated with diarrhoea among infants and children (Tables 5-6 & 5-7). The first and second models of logistic regression assessed the factors associated with diarrhoea at baseline and at follow-up (Table 5-6). The predictors included variables other than the WASH variables. The logistic regression analyses showed that household size and the number of infants/children under five in the household were predictors of diarrhoea. At baseline, infants/children living in households with a lower number people were less likely to suffer from diarrhoea at baseline (AOR 0.12, 95% CI: 0.02, 0.81 but this did not persist at follow up. On the other hand, the diarrhoea episodes at follow-up were more common if households had one infant or child under five (AOR 5.34 95% CI: 1.26, 22.59compared to those with more children.

Table 5-6: Factors associated with diarrhoea among infants and children who reported having diarrhoea from April 2014 to April 2015 in the study areas.

Variable	Baseline Pooled Adjusted OR (95%CI) P	Follow-up Pooled Adjusted OR (95%CI) P
Infant/ child age		
<=12 Months	1	1
>12 Months	0.20 (0.03,1.44) 0.11	1.40 (0.38,5.20) 0.62
Infant/child sex		
Female	1	1
Males	0.16 (0.02,1.12) 0.06	0.58 (0.19, 1.83) 0.36
WAZ difference	0.12* (0.57,2.22) 0.74	0.49* (0.94, 2.86) 0.08
Household size		
>5 People	1	1
≤5 People	**0.11 (0.02,0.81)** **0.03**	1.79 (0.52, 6.21) 0.36
Infant/child dewormed		
No	1	1
Yes	0.30 (0.06,1.57) 0.15	0.38 (0.09, 1.67) 0.20
Still breastfeeding		
No	1	1
Yes	0.37 (0.06, 2.31) 0.29	1.23 (0.28, 5.38) 0.78
No. under five infants/children in HH		
≥2	1	1
One	0.68 (0.13,3.60) 0.65	**5.34 (1.26, 22.59)** **0.02**
Toilet Type		
Unsafe	1	1
Safe	4.25 (0.71,25.34) p 0.11	1.71 (0.55, 5.32) p 0.35
HLT	0.055	0.013
CSR	0.272	0.158
NRS	0.363	0.211

HLT = Hosmer and Lemeshow Test || CSR = Cox & Snell R Square || NRS = Nagelkerke R Square|| AOR = Adjusted odds ratio, CI = Confidence intervals, % = Percent, P = p-value. No. = Number, HH = household, *β =beta sign

Note: Analysis by study area could not be computed because the data become too small to fit the model according to study area (overfitting of the model)

The multiple linear regression analysis of the number of diarrhoea episodes an infant or child had in the one year of study with other variables in the model other than WASH variables showed that the mother's hygiene status at the time of the visit was a significant predictor of the number of diarrhoea episodes at baseline (AOR -0.89, 95%CI -1.74,-0.05)(Table 5-7). None of the predictors were significant at follow up.

Table 5-7: Linear regression of diarrhoea according to number of diarrhoea episodes among infants and children from April 2014 to April 2015 in the study areas

Predictor	Baseline			Follow-up		
	Pooled Adjusted β (95%CI) *P*	Control β (95%CI) *P*	Experimental β (95%CI) *P*	Pooled Adjusted β (95%CI) *P*	Control β (95%CI) *P*	Experimental β (95%CI) *P*
No. of infants/children under five in household						
≥2	1	1	1	1	1	1
One	-0.17 (-0.49,0.143)0.259	0.08 (-0.92,1.09) 0.81	-0.34 (-2.09,1.41) 0.62	-0.17 (-0.18,0.08) 0.44	-0.44 (-0.37,0.18) 0.39	-0.14 (-0.38,0.24) 0.61
Infant/child age group						
≤12 Months	1	1	1	1	1	1
>12 Months	-0.05 (-0.13,0.03) 0.16	-0.11 (-.57,0.35) 0.50	-0.07 (-.20,0.07) 0.25	-0.37 (-0.08,0.01) 0.08	-0.65 (-0.22,0.05) 0.16	-0.13 (-0.07,0.04) 0.61
Infant/child deworming						
No	1	1	1	1	1	1
Yes	0.25 (-0.69,1.19) 0.58	2.16 (-5.36,9.69) 0.43	0.21 (-1.23,1.64) 0.71	0.07 (-0.56,0.77) 0.75	-0.01 (-1.76,1.73) 0.99	-0.31 (-1.68,0.52) 0.28
Infant/child drinking water source						
Main source	1	1	1	1	1	1
Others	-.07 (-0.69,0.55) 0.82	-0.06 (-1.81,1.69) 0.92	-	0.40 (-.22, 1.62) 0.13	0.47 (-1.57,2.80) 0.48	-
Infant/child hygiene status						
Poor	1	1	1	1	1	1
Good	-0.18 (-0.93,0.57) 0.62	1.32 (-2.71,5.34) 0.38	-0.41 (-1.47,0.65) 0.35	-0.02 (-0.85,0.78)-0.85	-0.12 (-1.85,1.51) 0.79	-
Mother hygiene status						
Poor	1	1	1	1	1	1
Good	**-0.89 (-1.74,-0.05) 0.04**	-	-1.10 (-2.84, 0.64) 0.15	0.11 (-0.87, 1.30) 0.87	0.11 (-2.07,2.42) 0.84	0.03 (-1.32,1.49) 0.90
Toilet (safe or not)						
Unsafe	1	1	1	1	1	1
Safe	-38 (-0.96, 0.20) 0.18	0.62 (-2.31,3.56) 0.55	-0.49 (-1.56,0.58) 0.27	-0.25 (-0.82, 0.23) -0.82	0.18 (-1.79,2.22) 0.78	-0.54 (-1.32,0.07) 0.08

Baseline: Overall-R = .697, R^2 = .486, ΔR^2 = .209, p < 0.181 || **Control** R = .586, R^2 = .344, ΔR^2= -.968, p < 0.92|| experimental R = .915, R^2 = 0.838, ΔR^2 = 0.595., p < 0.125, CI=Confidence interval, p-value

Follow up: Overall-R = .498, R^2 = .248, ΔR^2 = .009., p < 0.434|| **Control** R = .741, R^2 = .550, ΔR^2 = -.238, p < .683|| experimental R = .550[d], R^2 = .302, ΔR^2 = .011., p < .438, CI=Confidence interval, p-value

Coughing

As for other diseases, a multivariate analysis was conducted to find predictors of coughing in the two weeks before the survey at baseline and follow-up (Table 5-8) and the predictors for the number of episodes an infant/ child suffered during the study period were examined with linear regression (Table 5-8). At baseline, infants and children living in households where mothers exhibited good hygiene (AOR 0.05, 95% CI 0.00, 0.60) and those living in households with a shorter distance to the toilet facility (AOR 0.07, 95%CI 0.01, 0.98) were likely to suffer less coughing episodes than those with poor hygiene and long distance to the toilet facility. The relationship did not persist at follow up (Table 5-8).

Linear regression with the number of coughing episodes an infant or child had in the one-year study period with several predictors showed infant/child age group, sex of the infant/child, household size, vaccination status, and mother's age group to be predictors of coughing (Table 5-9) at baseline. Larger household size was associated with infants/children suffering from more coughing episodes indicating increased risk of coughing (β 0.25; 95% CI: 0.25, 0.03), while infants/children looked after by older mothers had less risk of coughing (β 0.28, 95% CI: 0.06, 0.01). For a child, being older than 12 months of age (β -0.29; 95% CI: -0.02,-0.10) and being male (β -0.29; 95% CI: -0.22,-1.16) offered some protection against the number of coughing episodes the child may have suffered. When the infant/child was vaccinated, the number of coughing episodes were likely to be less (β -0.29; 95% CI: -0.24,-1.33). No predictors were significant at follow up.

Table 5-8: Factors associated with coughing among infants and children who reported coughing episodes at baseline and follow-up in the study areas

Variable	Baseline Pooled Adjusted OR (95%CI) p	Follow-up Pooled Adjusted OR (95%CI) p
Infant/child sex		
Female	1	1
Male	0.20 (0.03, 1.42) 0.11	0.89 (0.32, 2.45) 0.82
Household size		
>5 People	1	1
≤5 People	0.22 (0.04, 1.34) 0.10	0.70 (0.25, 1.97) 0.50
Mother hygiene		
Poor	1	1
Good	**0.05 (0.00, 0.60) 0.02**	2.65 (0.30, 23.68) 0.38
*Infant/child age group**		
≤12 Months	1	1
>12 Months	0.17 (0.02, 1.52) 0.11	0.78 (0.28, 2.16) 0.64
HAZ z score		
Stunted	1	1
Not stunted	0.11 (0.01, 1.16) 0.07	0.82 (0.30, 2.24) 0.70
Food consumption score		
≤35 Point score	1	1
>35 Point score	0.36 (0.04, 3.51) 0.38	-
Distance to toilet		
>50 Meters	1	1
≤50 Meters	**0.07 (0.01, 0.98) 0.05**	No data on HH with toilets > 50 meters
HLT	0.160	0.613,
CSR	0.298	0.075
NRS	0.437	0.115

Abbrev. HLT = Hosmer and Lemeshow Test; CSR = Cox & Snell R Square; NRS = Nagelkerke R Square ||*Follow-up time was ≤24 months and >24 months, HH = Household head, OR=Odds ratio, CI=Confidence interval, p=p value

Table 5-9: Linear regression of the number of coughing episodes an infant or child had from April 2014 to April 2015 in the study areas

Predictor	Baseline Pooled Adjusted β (95% CI) ρ	Follow-up Pooled Adjusted β (95% CI) ρ
Household size		
>5	**1**	1
≤5	**0.25 (0.25,0.03) 0.02**	0.27 (-0.05,0.33) 0.14
Infant/child stool disposal		
Not Safe	1	1
Safe	-0.14 (0.15-0.89) 0.16	0.06 (-0.67,1.02) 0.68
*Infant/child age group**		
≤12 Months	**1**	1
>12 Months	**-0.29 (-0.02,-0.10) 0.01**	-0.08 (-0.08,0.04) 0.61
Sex of the Infant/child		
Female	**1**	1
Male	**-0.29 (-0.22,-1.16) 0.01**	0.01 (-0.66, 0.72) 0.94
Mother hygiene		
Poor	1	1
Good	0.20 (1.23,-0.02) 0.06	0.13 (-0.52,1.42) 0.36
Mother age group		
≤30 Years		
>30 Years	**0.28 (0.06,0.01) 0.01**	-0.01 (-0.05,0.05) 0.98
Marital status-household head		
Single	**1**	1
Married	-0.03 (0.59,-0.83) 0.74	0.01 (-0.96,1.06) 0.93
Infant/child vaccinated		
No		
Yes	**-0.29 (-0.24,-1.33) 0.01**	0.10 (-1.26, 2.55) 0.50
Distance to water source time		
Minutes	**1**	1
On the premises	-0.16 (0.00,-0.02) 0.11	0.02 (-0.02, 0.02) 0.91
	R = 0.651, R^2 = 0.424, ΔR^2 = 0.348, $p < 0.01$	R = 0.346, R^2 = 0.120, ΔR^2 = -0.036, $p < 0.64$

CI = confidence intervals ||*Follow-up time was ≤24 months and >24 months, p=p value, B=

Fever

Overall, multivariate analysis showed that mother's hygiene, together with household size, and WAZ were predictors of fever (Table 5-10) at baseline. Infants and children whose mothers exhibited good hygiene at baseline had less likelihood of fever occurring, but this was more evident in the control group (AOR 0.25, 95%CI: 0.07, 0.95) than the experimental group (AOR 0.34, 95%CI: 0.07, 1.70). At follow-up, the relationship with the mother's hygiene was not significant. Household size was protective against fever (AOR 0.16, 95%CI: 0.04, 0.68) if the size was small at follow-up. Also, the data indicate that the more underweight the infant or child was, the more likely he or she was to suffer from a fever at both baseline (AOR 0.27 95%CI: 0.09, 0.85) and follow-up (AOR 0.18, 95%CI: 0.04, 0.78). The relationship was stronger for the control group at baseline, and for the experimental group at follow-up.

Table 5-10: Logistic regression of factors associated with fever among infants and children who reported having had fever in the two weeks before study at baseline and follow-up

Predictor	Baseline			Follow-up		
	Pooled Adjusted OR (95%CI)	**Control OR (95%CI) P**	**Experimental OR (95%CI) P**	**Pooled Adjusted OR (95%CI)**	**Control OR (95%CI) P**	**Experimental OR (95%CI) P**
Drinking water source						
Not Safe	1	1	1	1	1	1
Safe	1.58 (0.59,4.22)0.37	1.28 (0.35,4.62) 0.71	-0.999	0.78 (0.22,2.73) 0.70	0.46 (0.10,2.23) 0.34	6.42(0.16,258.50)0.32
Mother's hygiene						
Poor	1	1	1	1	1	1
Good	**0.34 (0.13,0.89)0.03**	**0.25 (0.07,0.95) 0.04**	0.34 (0.07, 1.70) 0.19	0.63 (0.12,3.14) 0.57	0.92 (0.11,7.99) 0.94	0.04 (0.00,2.91) 0.14
Mother age group						
≤30 Years	1	1	1	1	1	1
>30 Years	0.40 (0.15,1.08) 0.07	0.47 (0.12,1.83) 0.27	0.23 (0.04,1.22) 0.08	4.04 (0.92,17.79) 0.07	1.88 (0.28,12.85) 0.520	-
Infant/child sex						
Female	1	1	1	1	1	1
Male	0.67 (0.29, 1.55)0.34	1.06 (0.32, 3.51) 0.93	0.55 (0.15,2.01) 0.37	0.44 (0.14,1.34) 0.150	0.24 (0.04, 1.60) 0.14	0.39 (0.05,3.02) 0.37
Infant/child age group						
≤12 Months	1	1	1	1	1	1
>12 Months	1.39 (0.59,3.28) 0.46	1.91 (0.58,6.27) 0.29	1.02 (0.24,4.39) 0.98	0.69 (0.23,2.10) 0.52	0.21 (0.03, 1.44) 0.11	3.73 (0.26, 53.15) 0.33
Household size						
>5	1	1	1	1	1	1
≤5	0.56 (0.23,1.35) 0.20	0.33 (0.09,1.22) 0.10	0.96 (0.26, 3.59) 0.95	**0.16 (0.04,0.68) 0.01**	0.49 (0.07, 3.65) 0.49	0.00 (0.00,) 0.10
WAZ						
Underweight	1	1	1	1	1	1
Not underweight	**0.27 (0.09,0.85) 0.03**	**0.14 (0.02,0.75) 0.02**	0.46 (0.08, 2.61) 0.38	**0.18 (0.04,0.78) 0.02**	0.14 (0.01,3.21) 0.22	**0.08 (0.01, 0.98) 0.05**
HLT	0.856	0.579	0.820		0.743	0.166,
CSR	0.104	0.136	0.160	0.198	0.140	0.407
NRS	0.151	0.199	0.230	0.296	0.226	0.571

Abbrev. HLT = Hosmer and Lemeshow Test; CSR = Cox & Snell R Square; NRS = Nagelkerke R Square || HH = Household head, OR=Odds ratio, CI=Confidence interval, p=p value

Sore eyes

Multivariate logistic analysis showed that mother's age group and availability of a toilet were associated with sore eyes (Table 5-11). No factors were found to be significantly associated with sore eyes in the control group, however, the child's sex **and** deworming status showed an association with sore eyes in the experimental group only. Children whose mothers were older were less likely to suffer from sore eyes compared to those with younger mothers (AOR 0.24, 95%CI: 0.10, 0.62) but protection from sore eyes was more evident if the household had a toilet facility (AOR 0.40, 95%CI: 0.17, 0.94) for pooled data and was living in the experimental group area (AOR 0.06, 95%CI: 0.00, 0.63). Being a male child (AOR **18.02 95%CI 1.99, 163.57)** and having been dewormed (AOR **9.04 95%CI 1.30, 63.00)** offered more benefits if the child lived in the experimental area.

Table 5-11: Factors associated with sore eyes among infants and children who reported having sore eyes in the two weeks before the study at baseline and follow-up

Variable	Pooled Adjusted OR (95%CI) p	Control OR (95%CI) p	Experimental OR (95%CI) p
Infant/child sex			
Female	1	1	**1**
Males	1.95 (0.87, 4.34) 0.10	1.20 (0.40, 3.56) 0.75	**18.02 (1.99,163.57) 0.01**
Total number under five years			
Two+	1	1	1
One	1.91 (0.81,4.54) 0.14	2.44 (0.76, 7.85) 0.13	3.98 (0.60, 26.23) 0.15
Deworming			
No	1	1	**1**
Yes	1.91 (0.85,4.27) 0.12	0.95 (0.32, 2.84) 0.93	**9.04 (1.30, 63.00) 0.03**
Mother age group			
≤30	**1**	1	**1**
>30	**0.24 (0.10, 0.62) <0.01**	0.35 (0.11, 1.15) 0.08	**0.06 (0.01, 0.63) 0.02**
Mother hygiene			
Poor	1	1	1
Good	0.46 (0.16, 1.29) 0.14	0.44 (0.11, 1.79) 0.25	0.72 (0.10, 5.46) 0.75
Drinking water source			
Not safe	1	1	1
Safe	0.76 (0.31, 1.88) 0.55	0.43 (0.15, 1.27) 0.13	13.21 (0.50,347.37) 0.12
Toilet availability			
No	**1**	1	1
Yes	**0.40 (0.17, 0.94) 0.04**	0.36 (0.10, 1.23) 0.12	2.95 (0.43, 20.34) 0.27
Household size			
>5	1	1	1
≤5	0.75 (0.31, 1.84) 0.54	0.91 (0.27, 3.07) 0.88	0.21 (0.03, 1.68) 0.14
HLT	.089	.681	.937
CSR	.145	.148	.234
NRS	.198	0.198	.381

Abbrev.: HLT = Hosmer and Lemeshow Test; CSR = Cox & Snell R Square; NRS = Nagelkerke R Square ||two+ = two or more, CI = Confidence intervals, OR = Odds ratio, p=p value

Figure 5-8 provides a summary of findings on the level of the key WASH factors described in chapter four and prevalence of diseases as described in chapter five. It shows how poor sanitation particulary feaces from adults, children and animals increases the risk for morbidity. In the study areas, 33% of households used unimproved water source and 71.9% did not treat their drinking water increasing the risk of contaminating water and food with pathogens from the faeces. More than half of children from households with dirty child play places and faeces visible in the the house and more than a quarter from househilds with garbage in the yard, were also likely to pick pathogens from feaces brought by human and animal movements leading to diseases. About 30% of mothers/caregivers with poor personal hygiene were likely to contaminate children's food increasing the risk to morbidty. The high prevalence of poor WASH factors shown below, may have contributed to the disease outcome.

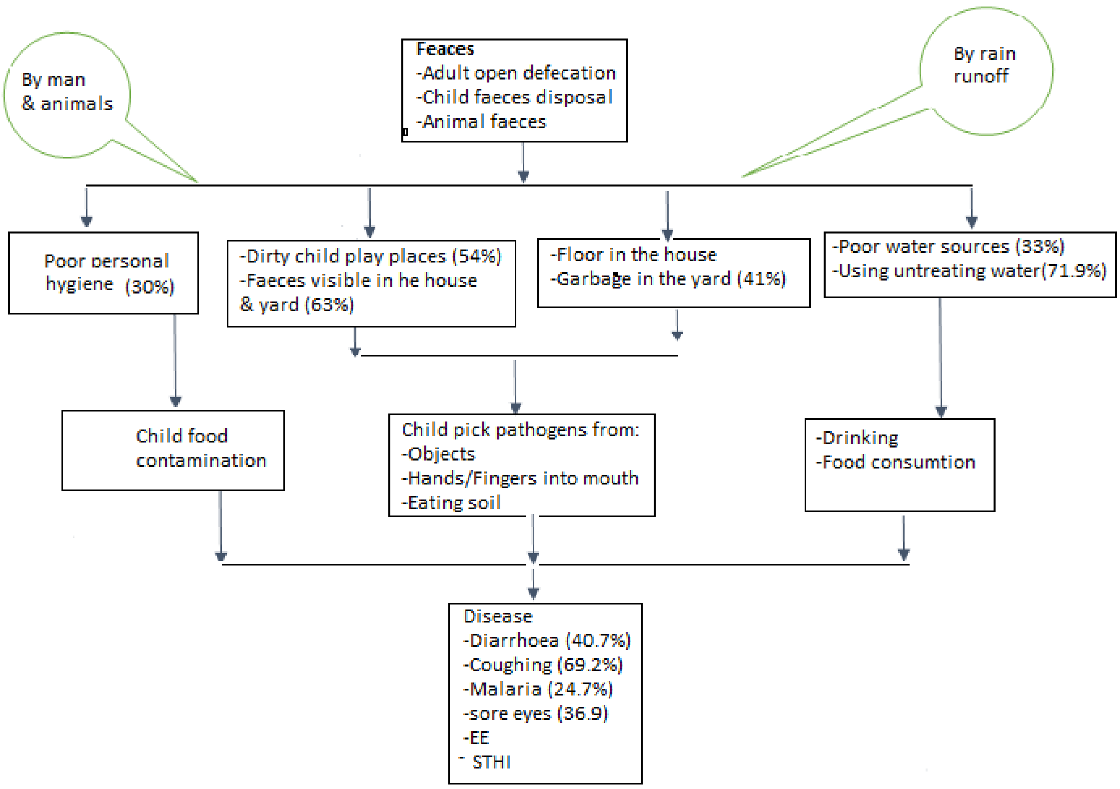


Figure 5-8: Possible transmission routes of pathogens across WASH factors with overall prevalence of the study areas

5.4 Discussion

The findings show that the prevalence of WASH facilities and practices –related diseases was high in both areas, with significant differences in coughing, malaria, eye infection, fever, and skin disease between the two areas. Although there were improvements in disease prevalence between the baseline and follow-up, data still revealed a high prevalence of diseases in both the experimental and the control groups, most likely indicating serious and persistent exposure to environmental pathogens. The improvements may also be attributed to other factors, such as increasing age of the infant or child.

It was unexpected that disease prevalence would be that high in the experimental group since the district health office had indicated that the experimental area was supplied with good WASH services. However the survey did show that facilities were still poor in many households of the experimental area. The high disease prevalence was possibly also due to the fact that the programme may not have included behavioural change interventions (WHO, 2017a; Mosler, 2012). Sustaining modified behaviour is challenging and requires carefully designed programmes to achieve the desired behaviour or goal (Shordt & Cairncross, 2004). The WASH infrastructure may not have yielded expected results because it did not take into consideration the social and cultural aspects of the communities (Egreteau, 2017). Other possible factors could be poor management of the projects (James, 2013), policies lacking clear focus and consistency, and lack of adequate capacity for monitoring and evaluation of the policy (Organization for Economic Cooperation and Development, 2012).

5.4.1 Association of age with disease prevalence

Infant and child age group was associated with higher disease prevalence, as younger children were more likely to suffer from diseases related to WASH factors / practices. Several scholars have reported similar findings on the relationship between ***age and diseases*** in developing countries (Traore et al., 1994). Evidence show that disease prevalence is greatest between 6 and 35 months (Lima et al., 2000; Siziya et al., 2013; Richard et al., 2014).

The finding that younger infants and children suffered more diseases than the older ones could be explained in several ways. Age affects diseases through intermediary life cycle processes or factors such as poor infant/child feeding and care practices, poor environments, and poor availability and accessibility of food. Breastfeeding, especially exclusive breastfeeding in the first six months of life, offers protection by reducing the risk of pathogens from foods and water which may be contaminated (Howie et al., 1990; Popkin et al., 1990; Lima et al., 2000), and enhances the motor development of the baby (Horwood, Darlow, & Mogridge, 2001; Mortensen et al., 2002). In some instances, the complementary foods introduced may lack quality and adequacy, and may be provided at the wrong time (Saaka et al., 2016; Manikam et al., 2017). In addition, older infants and younger children who play in dirty places are also prone to diseases (Crane, Jones & Berkley, 2015; Baker et al., 2016) that are carried into such places through human and animal feet from open defecation and infant/child faeces disposal (Curtis, Cairncross & Yonli, 2000).

The causes of high levels of illness can also be attributed to ***gestational diseases*** that affect foetal growth and early life. Poor birth outcomes such as low birth weight and small for gestational age are also contributors to early susceptibility to diseases (De Beaudrap et al., 2016), growth failure, and death (Blössner et al., 2005; Cosmi et al., 2011; Campbell et al. 2015). In Zambia, about 10% of mothers are underweight (CSO, 2014), which may impact on the birth outcomes. Poor nutritional status during pregnancy accounts for 14% of foetuses with intrauterine growth retardation, and maternal stunting explains a further 18.5% in developing countries (ACC/SCN, 2000a). Poor growth in utero account for about 20% - 25% stunting seen after birth (Owino et al., 2016; Mbuya & Humphrey, 2016). Poor growth is likely to continue after birth due to poor feeding and care practices (Black et al., 2013; de Onis & Branca, 2016). This echoes the global call to concentrate interventions on infant and child survival in the gestation period and first 24 months of life (1000 days) which offers an opportunity to reverse foetal and early infant/child stunting (Black et al., 2013). The majority of stunting occurs during this period when it is a time of highest nutrient needs (Onis & Branca, 2016), meaning that growth and development is slowed down (Blössner et al., 2005).

5.4.2 Effect of disease on infant and child growth

The diseases that infants and children suffered in the present study have known impacts on infant/child growth and survival. ***Respiratory infection*** was the most common disease at both phases of the study, and was higher in the control group. Respiratory infection is the most common cause of morbidity and mortality, with an average of three to six episodes of acute respiratory infections (ARIs) occurring annually at global level, with severity being worse in developing countries (Simoes et al., 2006). The study prevalence of 69.2% was higher than the national prevalence of 4% of children under age 5 years and 5% for infants and children 6-23 months (CSO et al., 2014). An average of two episodes per year was reported in the present study using health facility records. In Uganda, 51% of infants had at least one ARI during the first year of life (Beaudrap et al., 2016).

Studies elsewhere have reported some associations between ARIs and nutritional status (Wamani et al., 2006; Olofin et al., 2013). Even mild anthropometric deficit increases the risk of mortality (Olofin et al., 2013). Rowland, Rowland, & Cole (1988) and Yoon et al., (1997) both reported a negative effect of ARIs on weight gain. Hand washing interventions are necessary for the control of ARIs (Cairncross & Valdmanis, 2006). Hands and clothing get contaminated during sneezing and coughing, and cross contamination also occurs through air and dust. Hand washing with soap can reduce the risk of ARIs by 23% (Brown, Cairncross & Ensink, 2013).

The trend in prevalence of ***fever*** (a proxy for prevalence of malaria) regarding age group shows an opposite pattern to the national prevalence of malaria. The national prevalence of malaria in Zambia peaks after infancy (Ministry of Health, 2016). In the present study, the levels peaked in infancy and reduced thereafter. However, the present survey used reports of fever while the national malaria survey used biomedical tests, which are a more reliable method of testing for malaria. Fever could have been the result of any other infection. Malaria, especially in infancy, has been associated with the presence of malaria during pregnancy, which is the likely contributor to infant and child mortality and incidence of malaria in early childhood (Bardají et al., 2011; Beaudrap et al., 2016).

In the present study, fever was associated with poor infant and child growth, the risk being higher in the control group in those who were underweight. Other scholars reported a similar relationship of malaria to infant/child growth using stunting, underweight, wasting, and in pregnancy as outcomes (Kalanda et al., 2005; Wamani et al., 2006; Aishat et al., 2012; De Beaudrap et al., 2016) and malaria to death or recovery with neurological deficits (Olumese et al., 1997). In Zambia, the incidence of malaria is about 339 per 1,000 population, while the malaria case fatality rate for children less than five years old is about 34 per 1,000 admissions (Ministry of Health, 2014). Interventions that help to reduce malaria among pregnant women should continue to be promoted or implemented (such as indoor residual spraying (IRS), use of long-lasting insecticidal nets (LLINs), and larval source management) while accompanied by effective behaviour change and communication strategy.

Diarrhoea is one of the disease outcomes of poor WASH practices that is also associated with undernutrition. There was no significant difference in the proportion of diarrhoea in the two areas in the present study, and the prevalence was high in both. However, significant differences were noted in the pathways to diarrhoea, such as source and treatment of drinking water, availability and type of toilet facility, and disposal of infant/child faeces. Pickering et al., (2015) noted similar findings in Mali regarding prevalence of diarrhoea and source of drinking water. The average number of diarrhoea episodes in the present study was 1.35 per infant/child based on hospital records. The number is lower than that which has been reported by the WHO, namely an average three episodes of diarrhoea per year for developing countries (WHO, 2017a). The average episodes in the present study could be an underestimation, as the data depended on health facility records which may have lacked completeness due to missed episodes by caregivers who did not seek medical attention when their infants or children were sick (Amouzou et al., 2013). This view is supported by the fact that one fifth of caregivers did not seek health care when their infants or children were sick.

Interventions to control diarrhoea are key to infant and child survival because of its association with anthropometric outcomes in a child. Some studies have reported lower weight (Condon-Paoloni et al., 1977) and lower HAZ (Moore et al., 2001) while attributing 25% of all stunting by 24 months old to having five or more episodes of diarrhoea in the first two years of life (Humphrey, 2009).

Associations exist between environmental-related diseases such as malaria and diarrhoea (Beaudrap et al., 2016) and between STHs and malaria (Degarege et al., 2016). Although this study did not include such an analysis, there is an indication of such an association as most of the infants/children reported multiple diseases both at baseline and follow-up. What is also surprising is that the prevalence of diarrhoea in this study was more than double the national prevalence of 16% for children under five (CSO et al., 2014)

Deworming has been associated with fever and sore eyes in this study. The prevalence of deworming was higher in the control group, who had higher levels of poor WASH services and practices, and health facility records showed treatment of a few cases for helminths. Deworming is an intervention to control STHs in developing countries who have a high prevalence, including Zambia, through CHWs and routine services. STHs are associated with stunting through mechanisms that lead to reduced food absorption, loss of appetite, and anaemia (Croke, 2014). STHs result from poor environments, especially of inadequate sanitation and unsafe water (Samuel, 2015) and are also an element of poverty (Costa et al., 1987; Brooker et al., 2006; Hotez, 2007; Samuel, 2015).

Some studies have shown an association between deworming with child growth and health (Moore et al., 2001; Awasthi et al., 2008; Papier et al., 2014). Alderman et al., (2006) reported an increase in weight gain among children 1-7 years old dewormed during CHWs, while Stoltzfus et al., (2004) reported decreased mild wasting among preschool children with deworming. Similarly, Wamani et al., (2006) found deworming to be a factor when regressed with stunting among rural children. However, some studies have reported limited or lack of association between deworming and child growth (Dickson et al., 2000; Joseph et al., 2015).

STHs and micronutrients have a synergetic relationship which weakens the immune system (Stephensen, 1999; Hesham, Edariah & Norhayati,, 2004; Shenkin, 2006). For example, the prevalence of ascariasis in children with marginal vitamin A was found to cause a vitamin A deficiency in those children (Hesham, Edariah & Norhayati, 2004). Deworming has also been reported to improve cognitive performance and school attendance (Croke, 2014). However, Dickson et al., (2000) reported insufficient evidence available on the effect of deworming on cognitive performance.

Although there was no direct relationship seen when analysing the four main diseases in the present study with the variables of WASH services and practices, there is some indication of a relationship as shown by the four logistic regression analyses done for diarrhoea, cough, fever, and sore eyes which showed various environmental-related associations. This supports the notion of associations of WASH factors with other factors to cause ill health. Such factors may include household size (overcrowding), mother's hygiene and poor infant and child feeding practices.

The finding that ***coughing*** was associated with infant and child ***vaccination*** is not surprising, but rather confirms and adds to the body of knowledge on the role vaccinations play in infant and child survival, such as reducing mortality and the cost of illness (Mirelman, Ozawa & Grewal, 2014; Lewis, 2016; CDC, 2017). The benefits of vaccines include economic growth. According to WHO, about 86% of infants and children are vaccinated globally (WHO, 2017c).. Vaccines prevent 2.5 million infant and child deaths and can prevent a further 2 million annually (WHO, 2017a). Infants/children are vaccinated against tuberculosis and pertussis (whooping cough) (WHO, 2017d). Zambia supports infant and child immunisation as a way of improving infant/child survival through the Health Policy (Government of Zambia,

2012) and the sixth National Health Strategic Plan 2017 – 2021 (Ministry of Health, 2017). As a result of efforts to date, the average immunisation coverage is about 80% for Zambia and was as high as 90% in 2015 (Ministry of Health, 2017) .

The association between ***hygiene and diseases*** was shown by the examples of coughing and diarrhoea. Chapter 4 discussed the role that open defecation and poor quality of water play in hygiene practices. Hygiene practices may not be favourable where water is not sufficient for household use, or is contaminated. It limits the practice of protective actions such as washing hands, cleaning, cooking, and infant/child play places, and thorough washing of food. In Kenya, Karambu et al., (2013) found that caretaker's hygiene and unsafe sources of infant/child drinking water were associated with diarrhoea. The evidence supports our findings which show that mother's hygiene was associated with a number the diarrhoea episodes, having a fever and coughing. Although there was no direct link between diarrhoea and WASH, , the findings still reveal that environmental factors such as household size and the number of children in the household are associated with disease.

Health seeking behaviours are actions that families take to have their health problems attended to (Mahejabin, Parveen & Ibrahim, 2014). This study reported about 16% and 7% of caregivers not seeking prompt treatment at baseline and follow-up respectively, though this is much lower compared to communities in other countries such as in India, with 27.9% of caregivers not seeking prompt treatment (Chandwani & Pandor, 2015). Delayed health care places infants and children at risk of longer duration of disease and/or death, accounting for about 6 - 70% of infant and child mortality in developing countries (O'Donnell, 2007; Awasthi et al., 2015). However, when received promptly, health care can reduce infant/child mortality by 20% in the case of ARIs (WHO in Armar-Klemesu, 2000). As in the present study, several studies have reported perceived severity of illness, distance to health facility, availability of drugs at health facility, cost related to illness, and family income as some of the driving factors for health-seeking behaviour (Shaikh & Hatcher, 2005; Sreeramareddy et al., 2006; Mahejabin, Parveen & Ibrahim, 2014; Musoke et al., 2014; Chandwani & Pandor, 2015). Barriers to accessing health services limit the benefits infants and children would receive from primary health care services (Musoke et al., 2014; Aigbokhaode, Isah & Isara, 2015) which are key in the attainment of well-being.

Household size is related to WASH services and practices, diseases, food intake and nutritional status through various pathways. Too many young infants and children in a household may compromise child care, which is conducted in addition to other chores in the household that the mother/caregiver is expected to perform, limiting the care task. As a result, the infants/children may be exposed to an adverse environment leading to disease.

Overcrowding is an element of poverty (Hassan, 2017) known to reduce access to essential amenities including WASH services and practices, and access to health services, thus increasing infant and child morbidity and undernutrition. Lima et al., (2000) in Brazil found that the number of persons sleeping in the home was a significant factor associated with persistent diarrhoea burdens during the first two years of life. Similary, large families entail increased expenditure on household food, resulting in a lower quality diet which increases the risk of nutrient deficits among infants and children (Ajao et al., 2010).

The finding that the ***mother's age*** was associated with illness for some diseases such as sore eyes and cough is interesting. Mother's age determines her experience in child care, and her ability to access resources and services. Age at first birth is associated with length of schooling and wage level, as delayed first birth is likely to allow for further education. The average age at first birth for developed countries is 30 years or more (Kato et al., 2017), compared to developing countries where over 25% of girls under age 18 already have children (Finlay, Emre & Canning, 2011). This could result from the low social and economic status prevailing among women (Finlay, Emre & Canning, 2011; Ribeiro et al., 2014; Yu et al., 2016; Kato et al., 2017). There is a high prevalence of poor infant/child health outcomes (undernutririon, morbidity, and infant mortality) in younger age mothers (Finlay, Emre & Canning, 2011); Ribeiro et al., 2014; Yu et al., 2016). However, some study showed positive behaviour from younger mothers (Gelaw, Biks & Alene, 2014)

The results from Chapters 4 and 5 suggest that improvements in WASH factors may lead to a reduction in disease which is likely to improve growth outcomes. Infant and child survival is dependent on combined interventions of WASH factors to cause an impact on both disease reduction and undernutrition (Esrey, 1996; Harhay, Horton & Ollliaro, 2010; De Buck et al., 2017) as depicted by the conceptual framework in Chapter 3. Poor WASH behaviours/practices may lead to diseases such as diarrhoea, schistosomiasis, trachoma, helminths, and malaria which contribute to the burden of diseases of poor communities (Jaarsveld et al., 2005; Harhay, Horton & Ollliaro, 2010; WHO, 2016). This is ultimately likely to influence infant and child growth negatively, among other reported causal factors.

However, the impact of WASH factors is also influenced by other factors such as the infant/ child and mother’s age, household size, and income (occupation).

5.5 References

ACC/SCN. 2000. *4th Report on the world nutrition situation: Nutrition through the life cycle*. Geneva, Swizerland.

Aigbokhaode, A.Q., Isah, E.C. & Isara, A.R. 2015. Health seeking behaviour among caregivers of under-five children in Edo. *South Eastern European Journal of Public Health*. (February):1–10. DOI: 10.12908/SEEJPH-2014-41.

Aishat, S.O., Saka, M.J., Adeboye, M.A.N., Mokuolu, O.A., Buhari, A.M. & Kamaldeen, A. 2012. Malaria Parasitaemia in Children with Protein Energy Malnutrition in North Central Nigeria: A case control study . *Journal of Pharmacy and Biological Sciences*. 1(3):49–53. Available: www.iosrjournals.org.

Ajao, K., Ojofeitimi, E., Adebayo, A., Fatusi, A. & Afolabi, O. 2010. Influence of family size, household food security status, and child care practices on the nutritional status of under-five. *African Journal of Reproductive Health*. 14(December):123–132. DOI: 10.2307/41329750.

Alderman, H., Konde-lule, J., Sebuliba, I., Bundy, D. & Hall, A. 2006. Effect on weight gain of routinely giving albendazole to preschool children during child health days in Uganda: cluster randomised controlled trial. *British Medical Journal*. (June):1–5. DOI: 10.1136/bmj.38877.393530.7C.

Amouzou, A., Kachaka, W., Banda, B., Chimzimu, M., Hill, K. & Bryce, J. 2013. Monitoring child survival in "real time" using routine health facility records: results from Malawi. *Tropical Medicine & International Health*. 18(10):1231–1239. DOI: 10.1111/tmi.12167.

Awasthi, S., Peto, R., Pande, V.K., Fletcher, R.H., Read, S. & Bundy, D.A.P. 2008. Effects of deworming on malnourished preschool children in India: an open-labelled, cluster-randomized trial. *PLoS Neglected Tropical Diseases*. 2(4):2–7. DOI: 10.1371/journal.pntd.0000223.

Awasthi, S., Nichter, M., Verma, T., Srivastava, N.M., Agarwal, M., Singh, J.V., Mishra, A.P., Sami, G., et al. 2015. Revisiting community case management of childhood pneumonia: Perceptions of caregivers and grass root health providers in Uttar Pradesh and Bihar, Northern India. *PLoS ONE*. 10(4):1–18. DOI: 10.1371/journal.pone.0123135.

Baker, K. k, O'Reilly, C., Levine, M.M., Kotloff, K.L., Nataro, J.P., Ayers, T.L., Farag, T.H., Nasrin, D., et al. 2016. Sanitation and Hygiene-Specific Risk Factors for Moderate-to-Severe Diarrhea in Young Children in the Global Enteric Multicenter Study , 2007 – 2011 : Case-Control Study. *PloS Medicine*. 13(5):1–19. DOI: 10.1371/journal.pmed.1002010.

Bardají, A., Sigauque, B., Sanz, S., Maixenchs, M., Ordi, J., Aponte, J.J., Mabunda, S., Alonso, P.L., et al. 2011. Impact of Malaria at the End of Pregnancy on Infant Mortality and Morbidity. *Journal of Infectious Diseases*. 203(5):691–699. DOI: 10.1093/infdis/jiq049.

Black, R.E., Victora, C.G., Walker, S.P., Bhutta, Z.A., Christian, P., de Onis, M. & Ezzati, M. 2013. Maternal and child nutrition 1: Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet*. 6736(13):1–25. DOI: 10.1016/S0140-6736(13)60937-X.

Blössner, M., de Onis, M., Prüss-üstün, A., Campbell-lendrum, D., Corvalán, C. & Woodward, A. 2005. *Malnutrition quantifying the health impact at national and local levels*.

Brooker, S., Clements, A.C.A., Hotez, P.J., Hay, S.I., Tatem, A.J., Bundy, D.A.P. & Snow, R.W. 2006. The co-distribution of Plasmodium falciparum and hookworm among African schoolchildren. *Malaria Journal*. 5(99):1–8. DOI: 10.1186/1475-2875-5-99.

Brown, J., Cairncross, S. & Ensink, J.H.J. 2013. Water, sanitation, hygiene and enteric infections in children. *Archives of Disease in Childhood*. 98(8):629–634. DOI: 10.1136/archdischild-2011-301528.

Cairncross, S. & Valdmanis, V. 2006. Chapter 41 Water supply, sanitation and hygiene promotion. In *Disease Control Priorities in Developing Countries*. 2nd ed. D.T. Jamison, J.G. Breman, A.R. Measham, G. Alleyne, M. Claeson, D.B. Evans, P. Jha, A. Mills, & P. Musgrove, Eds. Washington DC: Oxford University Press, USA. 1–22. Available: https://www.ncbi.nlm.nih.gov/books/NBK11728/.

Campbell, O.M.R., Benova, L., Gon, G., Afsana, K. & Cumming, O. 2015. Getting the basic rights – the role of water, sanitation and hygiene in maternal and reproductive health: a conceptual framework. *Tropical Medicine and International Health*. 20(3):252–267. DOI: 10.1111/tmi.12439.

CDC. 2017. *Five important reasons to immunize your child*. Available: https://www.cdc.gov/media/subtopic/matte/.../cdcfivereasonstovaccinateyourchild.pdf [2017, September 11].

Chandwani, H. & Pandor, J. 2015. Healthcare-seeking behaviors of mothers regarding their children in a tribal community of Gujarat, India. *Electronic 'Physician*. 7(1):990–997. DOI: 10.14661/2015.990-997.

Condon-Paoloni, D., Cravioto, J., Johnston, F.E., Licardie, E.R.D.E. & Scholl, T. 1977. Morbidity and growth of infants and young children in a Rural Mexican Village. *American Journal of Public Health*. 67(7):651–656.

Cosmi, E., Fanelli, T., Visentin, S., Trevisanuto, D. & Zanardo, V. 2011. Consequences in infants that were intrauterine growth restricted. *Journal of Pregnancy*. 2011:1–6. DOI: 10.1155/2011/364381.

Costa, L.E.M.F.F., Magalhaes, M.H.A., Rocha, R.S. & Antunes, C.M.F. 1987. Water-contact patterns and socioeconomic variables in the epidemiology of schistosomiasis mansoni in an endemic area in Brazil. *Bulletin of the World Health Organization*. 65(1):57–66.

Crane, R.J., Jones, K.D.J. & Berkley, J.A. 2015. Environmental enteric dysfunction: An overview. *Food and Nutrition Bulletin*. 36(1):76–87.

Croke, K. 2014. *The long run effects of early childhood deworming on literacy and numeracy : Evidence from Uganda*.

CSO, MOH, TDRC, UNZA & MACRO International. 2014. *Zambia Demographic and Health Survey 2013-14*. Lusaka, Zambia.

Curtis, V., Cairncross, S. & Yonli, R. 2000. Domestic hygiene and diarrhoea – pinpointing the problem. *Tropical Medicine and International Health*. 5(1):22–32.

de Beaudrap, P., Turyakira, E., Nabasumba, C., Tumwebaze, B., Piola, P., Boum Ii, Y. & McGready, R. 2016. Timing of malaria in pregnancy and impact on infant growth and morbidity: a cohort study in Uganda. *Malaria Journal*. 15(1):92. DOI: 10.1186/s12936-016-1135-7.

de Buck, E., Hannes, K., Van Remoortel, H., Govender, T., Vande Veegaete, A., Musekiwa, A., Lutje, V., Cargo, M., et al. 2017. Approaches to Promote Handwashing and Sanitation Behaviour Change in Low- and Middle Income Countries: A Mixed Method Systematic Review. *Campbell Systematic Reviews*. 7:1–46. DOI: 10.4073/csr.2017.7.

Degarege, A., Veledar, E., Degarege, D., Erko, B., Nacher, M. & Madhivanan, P. 2016. Plasmodium falciparum and soil-transmitted helminth co-infections among children in sub-Saharan Africa: a systematic review and meta-analysis. *Parasites & Vectors*. 9(1):344. DOI: 10.1186/s13071-016-1594-2.

de Onis, M. & Branca, F. 2016. Childhood stunting: A global perspective. *Maternal and Child Nutrition*. 12(Suppl.1):12–26. DOI: 10.1111/mcn.12231.

Dickson, R., Awasthi, S., Williamson, P., Demellweek, C. & Garner, P. 2000. Effects of treatment for intestinal helminth infection on growth and cognitive performance in children : systematic review of randomised trials. *British Medical Journal*. 320(June):1697–1701.

Egreteau, D. 2017. *Behaviour change determinants, the key to successful WASH strategies*. Available: http://www.urd.org/Behaviour-change-determinants-the#nb6 [2017, August 22].

Esrey, S.A. 1996. Water, waste, and well-Being: A multicountry study. *American Journal of Epidemiology*. 143(6):608–623.

Finlay, J.E., Emre, O. & Canning, D. 2011. The association of maternal age with infant mortality , child anthropometric failure , diarrhoea and anaemia for first births : evidence from 55 low- and middle-income countries. *British Medical Journal Open*. 1:1–25. DOI: 10.1136/bmjopen-2011-000226.

Gelaw, Y.A., Biks, G.A. & Alene, K.A. 2014. Effect of residence on mothers ' health care seeking behavior for common childhood illness in Northwest Ethiopia : a community based comparative cross – sectional study. *BioMed Central Research Notes*. 7(705):1–8.

Government of Zambia. 2012. *National Health Policy*. Lusaka, Zambia. Available: https://www.healthresearchweb.org/files/National_Health_Policy_1999.pdf.

Harhay, M., Horton, J. & Ollliaro, P.L. 2010. Epidemiology and control of human gastrointestinal parasites in children. *Expert Review of Anti-infective Therapy*. 8(2):219–234. DOI: 10.1586/eri.09.119.Epidemiology.

Hassan, F., Asim, M., Salim, S. & Humayun, A. 2017. House ownership, frequency of illness, fathers' education: the most significant socio-demographic determinants of poor nutritional status in adolescent girls from low income households of Lahore, Pakistan.

Hesham, M.S., Edariah, A.B. & Norhayati, M. 2004. Intestinal parasitic infections and micronutrient deficiency: A review. *Medical Journal of Malaysia*. 59(2):284–293.

Horwood, L.J., Darlow, B.A. & Mogridge, N. 2001. Breast milk feeding and cognitive ability at 7 – 8 years. *Archies of Disease in Childhood Fetal Neonatal Education*. 84:F23–F25.

Hotez, P.J. 2007. Neglected diseases and poverty in "'the other America'": the greatest health disparity in the United States? 1(3):1–3. DOI: 10.1371/journal.pntd.0000149.

Howie, P.W., Forsyth, S.J., Ogston, S.A., Clark, A. & du Florey, C. V. 1990. Protective effect of breast feeding against infection. *British Medical Journal*. 300(January):11–16.

Humphrey, J.H. 2009. Child undernutrition, tropical enteropathy, toilets, and handwashing. *Lancet*. 374(9694):1032–1035. DOI: 10.1016/S0140-6736(09)60950-8.

James, J. 2013. *Sanitizing the truth - when WASH Fails*. Available: http://www.irinnews.org/analysis/2013/09/17/sanitizing-truth-when-wash-fails [2017, October 23].

Joseph, S.A., Casapía, M., Montresor, A., Rahme, E., Ward, J., Marquis, G.S., Pezo, L., Blouin, B., et al. 2015. The effect of deworming on growth in one- year-old children living in a soil-transmitted helminth-endemic area of Peru: a randomized controlled trial. *PLoS Neglected Tropical Diseases*. 9(10):1–20. DOI: 10.1371/journal.pntd.0004020.

Kalanda, B.F., van Buuren, S., Verhoeff, F.H. & Brabin, B.J. 2005. Catch-up growth in Malawian babies, a longitudinal study of normal and low birthweight babies born in a malarious endemic area. *Early Human Development*. 81(10):841–50. DOI: 10.1016/j.earlhumdev.2005.06.006.

Karambu, S., Matiru, V., Kiptoo, M. & Oundo, J. 2013. Characterization and factors associated with diarrhoeal diseases caused by enteric bacterial pathogens among children aged five years and below attending Igembe District Hospital, Kenya. *Pan African Medical Journal*. 16(37):1–8. DOI: 10.11604/pamj.2013.16.37.2947.

Kato, T., Yorifuji, T., Yamakawa, M. & Inoue, S. 2017. Association of maternal age with child health: A Japanese longitudinal study. *PLoS ONE*. 12(2):1–11. DOI: 10.1371/journal.pone.0172544.

Lewis, L. 2016. *Economic Benefits of Vaccines in Developing Countries*. Available: http://www.borgenmagazine.com/vaccines-in-developing-countvaccines-in-developing-countries/ [2017, September 11].

Lima, A.A.M., Moore, S.R., Barboza, M.S., Soares, A.M., Schleupner, M.A., Newman, R.D., Sears, C.L., Nataro, J.P., et al. 2000. Persistent diarrhea signals a critical period of increased diarrhea burdens and nutritional shortfalls: A prospective cohort study among children in Northeastern Brazil. *Journal of Infectious Diseases*. (181):1643–1651.

Mahejabin, F., Parveen, S. & Ibrahim, M. 2014. Mother' s/care Giver's health seeking behaviour during childhood illness in an urban slum of Dhaka city. *Pulse*. 7:5–15.

Manikam, L., Robinson, A., Kuah, J.Y., Vaidya, H.J., Alexander, E.C., Miller, G.W., Singh, K.K., Dawe, V., et al. 2017. A systematic review of complementary feeding practices in South Asian infants and young children: the Bangladesh perspective. *BioMed Central Nutrition*. 3(1):56. DOI: 10.1186/s40795-017-0176-9.

Mbuya, M.N.N. & Humphrey, J.H. 2016. Preventing environmental enteric dysfunction through improved water, sanitation and hygiene: an opportunity for stunting reduction in developing countries. *Maternal & Child Nutrition*. 12 Suppl 1:106–20. DOI: 10.1111/mcn.12220.

Ministry of Health. 2014. *Annual Health Statistical Bulletin*. Lusaka.

Ministry of Health. 2016. *Zambia National Malaria Indicator Survey 2015*. Lusaka,Zambia.

Ministry of Heatlh. 2017. Final draft National Health Strategic Plan, Lusaka, Zambia

Mirelman, A.J., Ozawa, S. & Grewal, S. 2014. The economic and social benefits of childhood vaccinations in BRICS. *Bulletin of the World Health Organization*. 92:454–456. DOI: http://dx.doi.org/10.2471/BLT.13.132597.

Moore, S.R., Lima, A.A.M., Conaway, M.R., Schorling, J.B., Soares, A.M. & Guerrant, R.L. 2001. Early childhood diarrhoea and helminthiases associate with long-term linear growth faltering. *International Journal of Epidemiology*. 30(6):1457–1464. DOI: 10.1093/ije/30.6.1457.

Mortensen, E.L., Michaelsen, K.F., Sanders, S.A. & Reinisch, J.M. 2002. The association between duration of breastfeeding and adult intelligence. *Journal of the American Medical Association*. 287(18):2365–2372.

Mosler, H.-J. 2012. A systematic approach to behavior change interventions for the water and sanitation sector in developing countries: a conceptual model, a review, and a guideline [Abstract]. *International Journal of Environmental Health Research*. 22(5). Available: http://www.tandfonline.com/doi/full/10.1080/09603123.2011.650156?scroll=top&needAccess=true.

Musoke, D., Boynton, P., Butler, C. & Musoke, M.B. 2014. Health seeking behaviour and challenges in utilising health facilities in Wakiso district , Uganda. *Africa Health Services*. 14(4):1046–1055.

O'Donnell, O. 2007. Access to health care in developing countries: breaking down demand side barriers. *Cad. Saúde Pública, Rio de Janeiro*. 23(12):2820–2834. DOI: 10.1590/S0102-311X2007001200003.

Olofin, I., McDonald, C.M., Ezzati, M., Flaxman, S., Black, R.E., Fawzi, W.W., Caulfield, L.E., Danaei, G., et al. 2013. Associations of suboptimal growth with all-cause and cause-specific mortality in children under five years: A pooled analysis of ten prospective studies. *PLoS ONE*. 8(5):1–10. DOI: 10.1371/journal.pone.0064636.

Olumese, P.E., Sodeinde, O., Ademowo, O.G. & Walker, O. 1997. Protein Energy Malnutrition and Cerebral Malaria in Nigerian Children. *Journal of Tropical Pediatrics*. 43(August):211–219.

Organization for Economic Cooperation and Development. 2012. *Rural water and sanitation: assessing impacts*. (6). the Netherlands. Available: http://www.oecd.org/dac/evaluation/Evaluation insights WASH final draft.pdf.

Owino, V., Ahmed, T., Freemark, M. & Kelly, P. 2016. Environmental Enteric Dysfunction and growth gailure: Stunting in global child health. *Pediatrics*. 138(6):1–10. DOI: 10.1542/peds.2016-0641.

Papier, K., Williams, G.M., Luceres-catubig, R., Ahmed, F., Olveda, R.M., Mcmanus, D.P., Chy, D., Chau, T.N.P., et al. 2014. Childhood malnutrition and parasitic helminth interactions. *Clinical Infectious Diseases*. 59(2):234–243. DOI: 10.1093/cid/ciu211.

Pickering, A.J., Djebbari, H., Lopez, C., Coulibaly, M. & Alzua, M.L. 2015. Effect of a community-led sanitation intervention on child diarrhoea and child growth in rural Mali: A cluster-randomised controlled trial. *Lancet Global Health*. 3(11):e701–e711. DOI: 10.1016/S2214-109X(15)00144-8.

Popkin, B.M., Adair, L., Akin, J.S., Black, R., Briscoe, J. & Flieger, W. 1990. Breast-feeding and diarrheal. *Peadiatrics*. 86(6):874–882.

Ribeiro, F.D., Aparecida, R., Ferrari, P., Lopes, F., Anna, S., Dalmas, J.C. & Girotto, E. 2014. Extremes of maternal age and child mortality: analysis between 2000 and 2009. *Revista Paulista Pediatric*. 32(4):381–388.

Richard, S.A., Black, R.E., Gilman, R.H., Guerrant, R.L., Kang, G., Rasmussen, Z.A., Sack, R.B., Valentiner-branth, P., et al. 2014. Catch-Up Growth Occurs after Diarrhea in Early. *Journal of Nutrition*. 144:965–971. DOI: 10.3945/jn.113.187161.experiences.

Rowland, G.M., Rowland, G.J.G. & Cole, J. 1988. Impact of infection on the growth of children from 0 to 2 years in an urban West African community ” 2. *American Journal of Clinical Nutrition*. 47:134–138.

Saaka, M., Larbi, A., Mutaru, S. & Hoeschle-Zeledon, I. 2016. Magnitude and factors associated with appropriate complementary feeding among children 6–23 months in Northern Ghana. *BioMed Central Nutrition*. 2(1):2. DOI: 10.1186/s40795-015-0037-3.

Samuel, F. 2015. Status of Soil-Transmitted Helminths Infection in Ethiopia. *American Journal of Health Research*. 3(3):170–176. DOI: 10.11648/j.ajhr.20150303.21.

Shaikh, B.T. & Hatcher, J. 2005. Health seeking behaviour and health service utilization in Pakistan: challenging the policy makers. *Journal of Public Health*. 27(1):49–54. DOI: 10.1093/pubmed/fdh207.

Shenkin, A. 2006. Micronutrients in health and disease. 559–567. DOI: 10.1136/pgmj.2006.047670.

Shordt, K. & Cairncross, S. 2004. *Sustainability of hygiene behaviour and the effectiveness of change interventions: Findings of a multi-country research study and implications for water and sanitation programmes*. Delft, the Netherlands: Meester en de Jonge, Lochem, the Netherlands.

Simoes, E.A.F., Cherian, T., Chow, J., Shahid-Salles, S.A., Laxminarayan, R. & John, T.J. 2006. Acute respiratory infections in children. In *Disease Control Priorities in Developing Countries*. 2nd ed. D.T. Jamison, J.G. Breman, A.R. Measham, G. Alleyne, M. Claeson, D.B. Evans, P. Jha, A. Mills, & P. Musgrove, Eds. Washington DC: Oxford University Press, USA. 483–497. Available: https://www.ncbi.nlm.nih.gov/books/NBK11786/.

Siziya, S., Muula, A. & Rudatsikira, E. 2013. Correlates of diarrhoea among children below the age of 5 years in Sudan. *African Health Sciences*. 13(2):376–383. DOI: http://dx.doi.org/10.4314/ahs.v13i2.26.

Sreeramareddy, C.T., Shankar, R.P., Sreekumaran, B. V, Subba, S.H., Joshi, H.S. & Ramachandran, U. 2006. Care seeking behaviour for childhood illness- a questionnaire survey in western Nepal. *BioMed Central International Health and Human rights*. 6(7). DOI: 10.1186/1472-698X-6-7.

Stephensen, C.B. 1999. Symposium: causes and etiology of stunting; burden of infection on growth failure 1. *Journal of Nutrition*. 129:534–538.

Stoltzfus, R.J., Chway, H.M., Montresor, A., Tielsch, J.M., Jape, J.K., Albonico, M. & Savioli, L. 2004. Low dose daily iron supplementation Improves Iron Status and appetite but not anemia, whereas quarterly anthelminthic treatment improves growth, appetite and anemia in Zanzibari Preschool Children. *Journal of Nutrition*. 134:348–356.

Traore, E., Cousens, S., Curtis, V., Mertens, T., Tall, F., Traore, A., Kanki, B., Diallo, I., et al. 1994. Child defecation behaviour, stool disposal practices, and childhood diarrhoea in Burkina Faso: results from a case-control study. 270–275.

USAID & FANTA 2. 2011. Anthropometry: Children under 5. Available on: https://www.fsnnetwork.org/sites/.../fanta_anthro_children_under_5__032120121.pdf [2018, August 01]

van Jaarsveld, A.S. Van, Biggs, R., Scholes, R.J., Bohensky, E., Reyers, B., Lynam, T., Musvoto, C. & Fabricius, C. 2005. Measuring conditions and trends in ecosystem services at multiple scales: the Southern African Millennium Ecosystem Assessment (SAfMA) experience. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*. (360):425–441. DOI: 10.1098/rstb.2004.1594.

Wamani, H., Nordrehaug, A.S., Peterson, S., Tumwine, J.K. & Tylleska, T. 2006. Predictors of poor anthropometric status among children under two years of age in rural Uganda. *Public Health Nutrition*. 9(3):320–326. DOI: 10.1079/PHN2005854.

World Food Programme (WFP). 2008. *Food consumption analysis - calculation and use of the food consumption score in food security analysis*. Rome. Available: http://home.wfp.org/stellent/groups/public/documents/manual_guide_proced/wfp197216.pdf.

WHO. 2016. *Water sanitation and health*.

WHO. 2017a. *Importance of immunization programmes: Module 1: Introduction to vaccine safety*. Available: http://vaccine-safety-training.org/Importance-of-immunization-programmes.html [2017, September 11].

WHO. 2017b. *Diarrhoeal disease: Fact Sheet*. Available: http://www.who.int/mediacentre/factsheets/fs330/en/ [2017, August 14].

WHO. 2017c. *Immunization coverage: Fact sheet*. Available: http://www.who.int/mediacentre/factsheets/fs378/en/ [2017, September 11].

WHO. 2017d. *Table 2: Summary of WHO Position Papers - Recommended Routine Immunizations for Children*. Available: www.who.int/immunization/policy/Immunization_routine_table2.pdf [2017, September 11].

Yoon, P.W., Black, R.E., Moulton, L.H. & Becker, S. 1997. The effect of malnutrition on the risk of diarrheal and respiratory mortality in children < 2 y of age in Cebu ,. *American Journal of Clinical Nutrition*. 65:1070–7.

Yu, S.H., Mason, J., Crum, J., Cappa, C. & Hotchkiss, D.R. 2016. Differential effects of young maternal age on child growth. *Global Health Action*. 9.

CHAPTER 6 : NUTRITIONAL STATUS

6.1 Introduction

The previous chapters explored the findings of poor WASH factors and disease among the children involved in the study, providing the prevalence rates and associations between various factors. This chapter gives an overview of the overall nutritional status of infants and young children in the experimental and control groups at baseline and follow-up. It further shows the data stratified by the age group and sex of infants and children. It continues by explaining the feeding practices in the two groups, which were likely to affect the outcome variable (infant/child growth). Differences in linear growth (HAZ) and weight gain (WAZ) are compared using proportions and incidence rates. The findings are then discussed and are related to existing findings by other scholars.

Objective:

To determine the nutritional status of infants and children aged 6 to 23 months in an area having a good WASH services (experimental) and in an area having a poor WASH services (Control).

6.2 Materials and Methods

Descriptive statistics were conducted on the main variables of nutrition to provide the prevalence of various forms of malnutrition. To derive gender and age differences in infant and child growth, the nutritional status data were stratified by sex and age.

To quantify the differences in the rate of stunting in the two study areas, the incidence rate was computed. Incidence rate is the number of people who get a disease in a specific period divided by the sum of the length of time during which each person is at risk. First, incidence rates were calculated for each of the two study areas and were later used to calculate incidence rate ratio (IRR). IRR is the ratio of the incidence rate in an exposed group divided by the incidence rate in an unexposed (or less exposed) comparison group. To compute the IRR, only infants and children who were event-free at baseline were included.

Anthropometric measures for measuring infant and child growth indices were calculated as z-scores. The difference in growth between the experimental and control groups were calculated by subtracting the mean z-scores between the experimental and control group to get the mean differences by each of the nutritional indices both at baseline and follow-up. Percent change in infant/child growth between baseline and follow-up was calculated by subtracting the overall z-scores of the control from the experimental group at baseline and follow-up periods.

Anthropometric measurements were taken during data collection at household visits. The figures were recorded in part 7 of the questionnaire (Appendix 3). Infant's and c*hildren's weights* were measured to the nearest 100g using a mother-baby electronic scale. Weight measurements require minimum clothing to be worn. To take weight, mothers were first asked to stand on the scale, and their weight was taken. Without getting off the scale, the scale was reset to zero, and then the baby was given to the mother to hold. The weight was recorded on the questionnaire.

The length (measurement in a recumbent position) was measured to the nearest 0.1cm using a length measuring board, as recommended for infant and children 0-23 months or less than 85 cm (Onis & Blössner, 1997), while height for children above 23 months and able to walk was measured on a height board while standing. For *height measurement*, a measurer and assistants were required. The mother ensured that shoes were removed from the child, and walked the child to the height standing board. The child's feet were placed flat and together in the centre of and against the back and base of the board/wall (Cogill, 2003). To measure *length,* the measuring board was placed on a hard flat surface such as the ground, floor, or table. The infants/children were laid on the length board with the mothers' help (Cogill, 2003), ensuring the infant/child was lying flat and in the centre of the board.

To measure the *mid-upper arm circumference* (MUAC), the mother was asked to remove any clothing covering the child's left arm. The midpoint measurement was found by first locating the tip of child's shoulder and measuring all the way to the tip of the elbow. The figure was then divided in two to find the midpoint. The infant/child's arm was extended, the tape was put around the midpoint and the measurement were taken.

Oedema measurement is critical to avoid including infants or children with kwashiorkor in the healthy infant/children category. Infants and children with oedema were excluded when calculating WAZ and WHZ. Oedema should be present on both feet for it to be considered as a sign of kwashiorkor. The infant's/child's feet were held in the hand of the field worker with the thumb on top of the foot. The thumb was pressed gently for a few seconds, and a dent was considered to be a sign of oedema.

Infant/child's age was calculated by subtracting the date of birth from the date of the survey. The ENA for SMART programme enabled accurate calculations. However, during data collection, age was calculated using the aid of the age calendar (Appendix 5) which helped to quickly calculate the age, ensuring that the infants and children being selected were of the right age. Mothers were asked to produce under five growth cards to verify the verbal age and to ensure accuracy. Wrong age would lead to the wrong calculation of nutrition indices, making interpretion of the data difficult. The anthropometric measurements (height, weight, MUAC) and age were later used to calculate the z-scores to determine growth status.

To calculate the incidence rate ratio, the incidence rates for each of the two groups (control and experimental) were calculated. The incidence rate ratio was then calculated by dividing the incidence rate of the control group by the incidence rate of the experimental group (McGrady, 2014).

A food consumption score is described in detail in chapter five.

Regarding sample statistics, a Shapiro-Wilk's test ($p<0.05$) (Field, 2009) showed that the HAZ scores were not normally distributed for the experimental and control groups, with a skewness of -.075 (SE = 0.236) and a Kurtosis of 2.937 (SE = 0.467) for the control group, and a skewness of -.106 (SE = 0.253) and kurtosis of .668 (SE = 0.500) for experimental group. However, a visual inspection of their histograms, normal Q-Q plots and box plots showed normality. Given this, the outcome variable was log transformed and was reported back on the original scale of measurement.

6.3: Results

6.3.1 Prevalence of malnutrition in the experimental and control group

Overall prevalence of infant and child malnutrition among infants and children 6-23 months

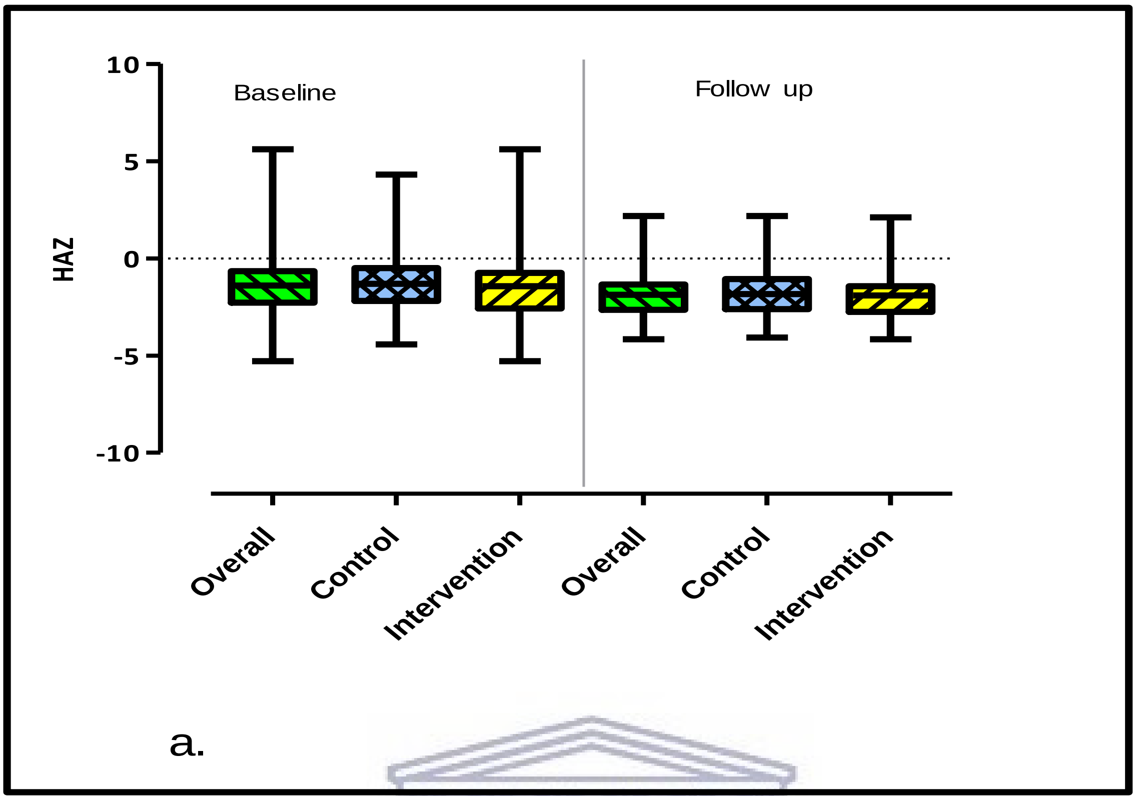
The findings show that there were some, but not significant difference in malnutrition patterns between the two study areas (Table 6-1, Figure 6-1). The combined moderate and severe percentages show that stunting was higher in the experimental group compared to the control group in both phases (35.2% vs 32.0%, p = 0.56 at baseline, respectively and 46.0% vs 42.7%, p = 0.44 at follow-up, respectively), but wasting was higher in the control group (8.2% vs 5.0%, p = 0.70) at baseline while higher for experimental group at follow-up (0.9% vs 2.9%,, p = 0.49). However the differences were not significant. Underweight was higher in the control group at the baseline study (12.9% vs 10.6%) and lower in the control group at follow-up (11.8% vs 14.7%). The difference was not significant (p=0.58).

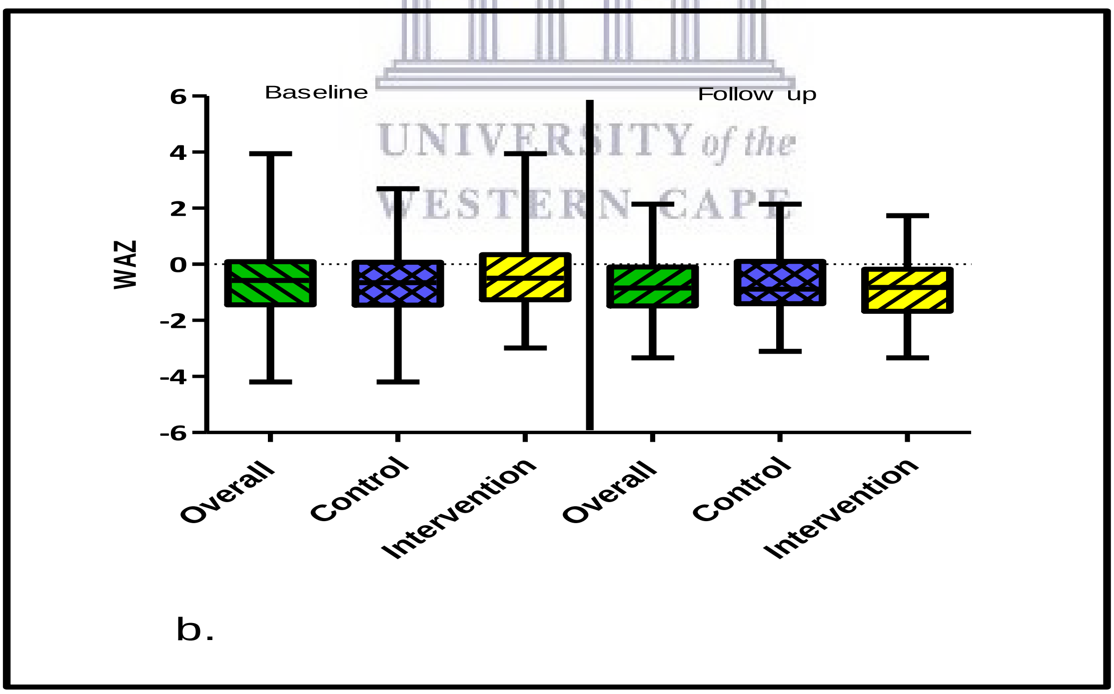
Overall, stunting increased by 10.8% from 33.6% at baseline to 44.4% at follow-up. Similarly, underweight rose by 1.5% while wasting reduced by 4.7%, indicating that as children are getting older, they more become malnourished, and are more affected by chronic than by acute food deprivation.

Notably, overweight/obesity was higher in the experimental group at baseline (7.1% vs 6.8%) but higher in the control group at follow-up (4.5% vs 2%). However, overall overweight/obesity also reduced by a 2.6% margin. Although the levels of stunting worsened in both areas by 10.7% and 12.7% in control and experimental groups respectively, the control group had a consistently lower proportion of infants and children who were stunted in both phases of the study when compared to the experimental group. However, malnutrition increased at a faster rate in the control group. Although wasting was not very common, it decreased by a 7.3% and 2.1% margin in the control and experimental groups respectively. Underweight decreased by a smaller margin in both areas.

Table 6-1: Overall prevalence of child malnutrition among infants and children 6-23 months living in experimental and control groups, at baseline and follow-up

	Baseline					Follow -up					
	Severe (<-3 z-score)	Moderate (>= -3 and <-2 z-score)	Normal (> = -2 z score)	Overweight >2 WHZ	P value	Severe (<-3 z-score)	Moderate (>= -3 and <-2 z-score)	Normal (> = -2 z score)	Overweight >2 WHZ	% change (<-2 z-score)	P value
	No. (%)	No. (%)	No. (%)	No. (%)		No. (%)	No. (%)	No. (%)	No. (%)		
Severe wasting based on weight-for-height z-scores											
Overall	7 (2.4)	12 (4.2)	249 (86.5)	20 (6.9)		0 (0)	4 (1.9)	203 (94.9)	7 (3.3)	-4.7	
Control	6 (4.1)	6 (4.1)	126 (85.1)	10 (6.8)	0.70	0	1 (0.9)	106 (94.6)	5 (4.5)	-7.3	0.49
Experimental	1 (0.7)	6 (4.3)	123 (87.9)	10 (7.1)		0	3 (2.9)	97 (95.1)	2 (2.0)	-2.1	
Stunting based on height-for-age z-scores											
Overall	33 (11.3)	65 (22.3)	194 (66.4)	-	0.56	30 (14.2)	64 (30.2)	118 (55.7)	-	10.8	
Control	12 (8.0)	36 (24.0)	102 (68.0)	-		12 (10.9)	35 (31.8)	63 (57.3)	-	10.7	0.44
Experimental	21 (14.8)	29 (20.4)	92 (64.8)	-		18 (17.6)	29 (28.4)	55 (53.9)	-	12.7	
Underweight based on weight-for-age z-scores											
Overall	3 (1.0)	32 (10.7)	255 (88.3)	-	0.55	4 (1.9)	24 (11.3)	184 (86.8)	-	1.5	
Control	2 (1.4)	17 (11.5)	129 (87.2)	-		2 (1.8)	11 (10.0)	97 (88.2)	-	-1.1	0.58
Experimental	1 (0.7)	14 (9.9)	127 (89.4)	-		2 (2.0)	13 (12.7)	87 (85.3)	-	4.1	


10
5
0
-5
-10
HAZ
Baseline
Follow up
Overall
Control
Intervention
Overall
Control
Intervention
a.


6
4
2
0
-2
-4
-6
WAZ
Baseline
Follow up
Overall
Control
Intervention
Overall
Control
Intervention
b.

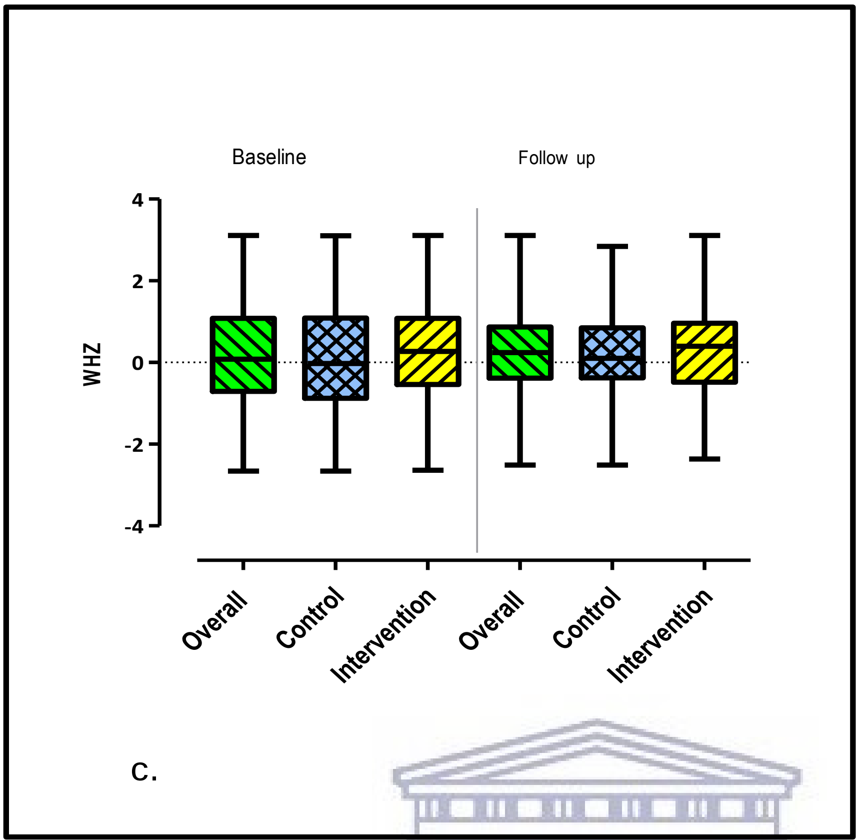


Figure 6-1: Prevalence of undernutrition (HAZ and WAZ) using the median: a) HAZ median at baseline and follow-up, b) WAZ median for baseline and follow-up, and c) WHZ median at baseline and follow-up.

Prevalence of malnutrition by age and sex among infants and children 6-23 months

When malnutrition data was disaggregated into age categories, it showed a higher proportion (45.9%) of infants and children above one year as being stunted compared to those who were one year and below (15.8%) and the difference was significant ($p<0.01$) (Table 6-2, Figure 6-2). At follow-up, the scenario changed showing an increase in malnutrition, as a smaller proportion (42.6%) of older than young children (45.3%) were stunted, but there was no statistical difference ($p=0.89$). A similar scenario occurred for underweight, with no statistical differences. This shows that some infants and children who were well nourished when below one year fell into malnutrition categories in the second year of life, while those in their 2nd to 3rd year could have started to recover from malnutrition. This is also confirmed in Figure 6-1 a and b as the median moved further away from zero at follow-up for HAZ and WAZ. Wasting was similar in both age groups, with the median showing improvement (Figure 6-1c).

Stratified data according to the sex of the cohort infants and children show that at baseline, more males than females were overweight (Table 6-2) in both phases, but this was not significant. More males (36%) than females (31.6%) were stunted at baseline, and at follow-up (males at 45.7%, females at 43.0%, $p = 0.45$). Regarding underweight, more females (14.8%) than males (8.2%, $p=0.10$) were underweight at baseline (Table 6-2). As infants and children grew older, more males (14.3%) became underweight than females (12.3%, $p=0.10$) at follow-up, however, this was not significant.. Wasting was negligible, especially at follow-up.

Table 6-2: Prevalence of child malnutrition by age and sex among infants and children 6-23 months living in experimental and control areas at baseline and follow-up

	Baseline						Follow-up					
Variable	**Severe (<-3 z-score)**	**Moderate (≥ -3 and <-2 z-score)**	**Normal (≥ -2 z score)**	**Over-weight >2 WHZ**	**P value**	**Variable**	**Severe (<-3 z-score)**	**Moderate (≥ -3 and <-2 z-score)**	**Normal (≥ -2 z score)**	**Over-weight >2 WHZ**	**P value**	**% chg (<-2 z score)**
	No. (%)	**No. (%)**	**No. (%)**	**No. (%)**			No. (%)	**No. (%)**	**No. (%)**	**No. (%)**		
Acute malnutrition by age, based on weight-for-height z-scores												
a) By Age												
≤12 months	2 (1.7)	6 (5.1)	98 (83.8)	11 (9.4)	0.61	≤24 months	0 (0.0)	2 (2.1)	92 (96.8)	1 (1.1)	0.69	
>12 months	5 (2.9)	6 (3.5)	151 (88.3)	9 (5.3)		>24 months	0 (0.0)	2 (1.7)	107 (93.0)	6 (5.2)		
b) By sex												
Male	2 (1.5)	4 (3.0)	118 (88.1)	10 (7.5)	0.34	Male	0 (0.0)	3 (3.0)	91 (91.9)	5 (5.1)	0.43	
Female	5 (3.3)	8 (5.2)	130 (85.0)	10 (6.5)		Female	0 (0.0)	1 (0.9)	112 (97.4)	2 (1.7)		
Stunting by age based on height-for-age z-scores												
a) By Age												
≤12 months	3 (2.5)	16 (13.3)	101 (84.2)	-	**<0.01**	≤24 months	13 (13.7)	30 (31.6)	52 (54.7)	-	0.89	
>12 months	30 (17.4)	49 (28.5)	93 (54.1)	-		>24 months	17 (14.8)	32 (27.8)	66 (57.4)	-		
b) By sex												
Male	17 (12.5)	32 (23.5)	87 (64.0)	-	0.45	Male	16 (16.3)	29 (29.6)	53 (54.1)	-	1	
Female	16 (10.3)	33 (21.3)	106 (68.4)	-		Female	14 (12.3)	35 (30.7)	65 (57.0)	-		
Underweight by age, based on weight-for-age z-scores												
a) By Age												
≤12 months	0 (0.0)	11 (9.4)	106 (90.6)	-	0.31	≤24 months	0 (0.0)	14 (14.7)	81 (85.3)	-	0.57	
>12 months	3 (1.7)	20 (11.6)	150 (86.7)	-		>24 months	4 (3.5)	9 (7.8)	102 (88.7)	-		
b) By sex												
Male	1 (0.7)	10 (7.5)	123 (91.8)	-	0.10	Male	0 (0.0)	14 (14.3)	84 (85.7)	-	0.40	
Female	2 (1.3)	21 (13.5)	132 (85.2)	-		Female	4 (3.5)	10 (8.8)	100 (87.7)	-		
N (Baseline ≤1 year 118, >1 years 171) p = p value between sex and ages of children using cross section| | chg = change						N (Follow-up ≤1 year 95, >1 years 115), p = p value between sex and ages of children using cross section						

Baseline **Follow up**

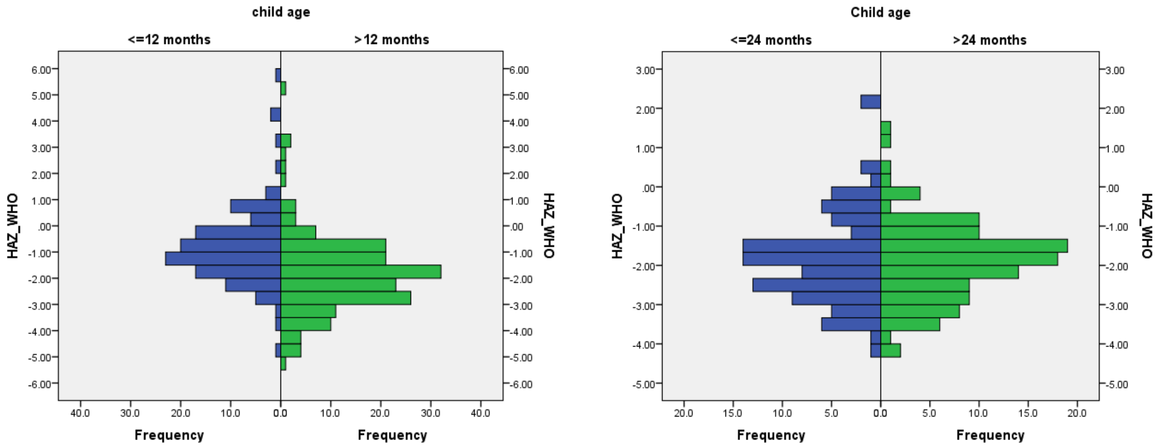


Figure 6-2: Prevalence of stunting by age according to z-scores among infants and children 6-36 months

6.3.2 Prevalence of infant and child feeding practices in the experimental and control groups

Meals and food consumption score

The FCSs show that overall 4.2% and 10.2% of infants and children have poor and borderline food diversity respectively, at baseline, but the difference was not significant (p=0.68) (Table 6-3). However, there was a slight shift at follow up, with 0.5% having poor and 3.3% borderline FCSs overall and the difference was significant between the two areas (p=0.01).

Nearly 14% of infants and children ate less than three meals a day at baseline, while 2.8% did so at follow-up (percent change of 11.1%). In the control group 18.9 % of infants/children ate less than three meals a day at baseline and 8.3% of the experimental group p = 0.01). However, the scenario changed at follow-up, with the control group having only one child (0.9%) eating less than three meals a day, compared with 5% in the experimental group (p = 0.10).

Snacking was relatively rare in both areas. About 89.6% of infants/children ate one snack or none in a day at baseline. This was more common in the control group (91.8%) than in experimental group (87.1%, p<0.01). At follow-up, the numbers of children consuming one or no snacks reduced by 29.5%. The reduction was higher in the control group (69.9%) than the experimental group (49.0%, p<0.01).

The tendency to reduce portion sizes of food for infants and children when food became scarce was also uncommon. The proportion of households reporting reduced meal sizes decreased from 22.7% at baseline to 15.4% at follow-up. The reduction was higher in the control group, from 25.5% at baseline to 14.7% at follow-up. About 19.5% had reduced portion sizes in the experimental group, which reduced to 16.2% at follow-up. Similarly, the proportion of infants and children not eating the whole day reduced by 2.8% from 6.7% at baseline to 3.9% at follow-up. The change was more in the control than the experimental group, but was not significant (p>0.05).

The mean duration of breastfeeding was 16.9 months in the control group and 17.6 months in the experimental group (Table 6-3). At baseline, 99% of all infants and children were breastfed up to some point after birth, while 1% were not breastfed at all (data not shown). Of those who breastfed, only 7% were given prelacteal feeds, while 92.3% were not. The most common prelacteal feed was milk, and a few received water. Regarding initiation of breastfeeding, 82.6% put the infant to the breast within one hour of birth, 13.9% between 1-3 hours, and 3.5% more than three hours after birth. About 27% of the infants were given liquids before the age of six months, while 61.6% started at six months, and 7.6% after six months. The liquids given were water, formula milk, and soups. By five months, 9.4% of infants were already eating solid foods, while 62.8% started at six months, and 27.8% started after six months. The most common solid food was maize porridge (97.1%). Other foods were cassava porridge (0.4%), fish (0.4%), eggs (0.7%), milk products (1.1%) and fruits (0.4%).

Disaggregating the data by age shows that infants less than one year had a slightly better poor food intake than those above one year (Table 6-4). The number of main meals (87.2% ≤12 months vs 70.1% >12 months, p<0.01), and snacks per day (17.2% ≤12 months vs 82.8% >12 months, p<0.02) differed significantly between the two age groups, with older children having better food consumption patterns. Similarly, the FCS > 35 (70.7% ≤12 months vs 66.7% >12 months, p<0.02) was significantly different between the two age groups. At the commencement of the study, only 2.5% of-infants below 12 months were not breastfeeding compared with 46% of those above 12 months.

Table 6-3:-Food security status of infants and children 6-23 months living in the experimental and control group areas, (Baseline and Follow-up)

Variable	Baseline				Follow-up			
	Overall No. (%)	Control No. (%)	Experimental No. (%)	P	Overall No. (%)	Control No. (%)	Experimental No. (%)	P
No. of main meals/ day								
<3 Meals/day	39 (13.9)	28 (18.9)	11 (8.3)	**0.01**	6 (2.8)	1 (0.9)	5 (5.0)	0.10
≥3 Meals/day	241 (86.1)	120 (81.1)	121 (91.7)		207 (97.2)	112 (99.1)	95 (95.0)	
No. of Snacks/day								
<2 Snacks	250 (89.6)	135 (91.8)	115 (87.1)	**0.01**	128 (60.1)	79 (69.9)	49 (49.0)	**<0.01**
≥2 Snacks	29 (10.4)	12 (8.2)	17 (12.9)		85 (39.9)	34 (30.1)	51 (51.0)	
Reduced infant/child meals sizes								
Yes	62 (22.7)	37 (25.5)	25 (19.5)	0.25	32 (15.4)	16 (14.7)	16 (16.2)	0.77
No	211 (77.3)	108 (74.5)	103 (80.5)		176 (84.6)	93 (85.3)	83 (83.8)	
Not eat the whole day								
Yes	18 (6.7)	12 (8.4)	6 (4.8)	0.19	8 (3.9)	5 (4.7)	3 (3.1)	0.72
No	250 (93.3)	131 (91.6)	119 (95.2)		196 (96.1)	102 (95.3)	94 (96.9)	
Food Consumption Score								
Poor ≤21	12 (4.2)	6 (4.0)	6 (4.5)	0.68	1 (0.5)	1 (0.9)	0	**0.01**
Borderline 21.5-35	29 (10.2)	15 (9.9)	14 (10.5)		7 (3.3)	0	7 (7.1)	
Acceptable >35	243 (85.6)	130 (86.1)	113 (85.0)		204 (96.2)	112 (99.1)	92 (92.9)	
Mean duration of breastfeeding	17.31 SD 2.95	16.97 SD 3.312	17.60 SD 2.600					

Main meals: N = 280, mean = 2.96, SD 0.789||Snacks: N = 279, mean 0.62, SD 0.748||FCS_Baseline, N = 284, mean 66.23, SD 25.081|| FCS_Follow-up, N = 212, mean 73.39, median 75.25, SD 19.71847, Percentiles 25^{th} 59.63, 50^{th} 75.25, 75^{th} 88.25||

Table 6-4: Feeding practices of infants and children 6-23 months in the experimental and control groups at baseline

Variable	Baseline			
	Overall No. (%)	<=12 months No. (%)	>12 months No. (%)	P
No. of main meals/ day				
<3 Meals/day	39 (13.9)	34 (29.9)	5 (12.8)	**<0.01**
≥3 Meals/day	241 (86.1)	72 (87.2)	169 (70.1)	
No. of Snacks/day				
<2 Snacks	250 (89.6)	100 (40.0)	150 (60.0)	**0.02**
≥2 Snacks	29 (10.4)	5 (17.2)	24 (82.8)	
Reduced infant/child meals sizes				
Yes	62 (22.7)	21 (33.9)	41 (66.1)	0.66
No	211 (77.3)	78 (37.0)	133 (63.0)	
Does not eat the whole day				
Yes	18 (6.7	7 (38.9)	11 (61.1)	0.78
No	250 (93.3)	89 (35.6)	161 (64.4)	
Food Consumption Score				
<=35 point score	41 (14.4)	29 (33.3)	12 (29.3)	**<0.01**
>35 point score	243 (85.6)	81 (70.7)	162 (66.7)	
Still breastfeeding				
No	80 (27.8)	(3) 2.5	(77) 45.6	
Yes	208 (72.2)	(116) 97.5	(92) 54.4	

Food consumption over seven days

The main source of energy in both communities for infants and children were cereals and tubers (79% at baseline and 94.8% at follow-up) which were eaten almost every day (Table 6-5 and 6-6). Sixty-five point five percent and 48.8% ate vegetables every day at baseline and follow-up, respectively.

Milk (48.4%), legumes (37.7%), and meat (37.1%), which are the main sources of protein, were consumed by less than 50% of households, within the past seven days, at follow-up. Meat consumption was lower at baseline, while milk consumption increased.

About 28.2%, 15.1%, 14.1% and 12.7% had not eaten fruits, legumes, meat or milk respectively, in the past seven days of the study at follow-up. The scenario for these four food groups was better than at baseline probably was due to the fact that they were younger at baseline and therefore not eating solid foods yet. Sugar and oils were rarely consumed in both phases.

Table 6-5: Percent infants and children (6-23 months) who consumed foods from the listed food groups over seven days before the baseline survey

Number of days	Cereals, tubers	Legumes	Vegetables	Fruits	Meats, fish & eggs	Milk & milk products	Sugars	Oils
0	5.3	19.9	8.9	40.7	15.1	16.7	35.2	29.6
1	1.4	10.5	3.6	8.5	9.4	7.1	15.9	5.4
2	2.8	8.6	3.6	10.0	10.8	9.6	17.8	9.3
3	3.5	7.9	5.0	9.3	7.6	6.7	8.5	5.4
4	1.8	4.5	4.3	8.9	12.9	5.3	6.3	8.6
5	2.5	3.4	3.9	5.2	6.8	6.7	1.5	5.4
6	3.5	6.8	5.3	4.4	6.8	5.7	3.7	11.4
7	79.1	38.3	65.5	13.0	30.6	42.2	11.1	25.0

Table 6-6: Percent infants and children (18-36 months) who consumed foods from the listed food groups over seven days before the follow up

Number of days	Cereals, tubers	Legumes	Vegetables	Fruits	Meats, fish & eggs	Milk & milk products	Sugars	Oils
0	0.9	15.1	4.2	28.2	14.1	12.7	32.1	15.0
1	0	7.1	3.3	8.9	8.0	4.7	15.1	7.5
2	0.5	4.7	5.6	7.0	5.6	8.9	15.1	8.9
3	1.4	17.5	11.3	15.5	10.8	8.0	13.7	18.3
4	0.9	6.6	11.3	7.5	10.3	8.0	7.5	14.6
5	0.5	4.7	9.9	5.2	7.0	5.2	4.7	10.8
6	0.9	6.6	5.6	3.8	7.0	4.2	4.7	4.7
7	94.8	37.7	48.8	23.9	37.1	48.4	7.1	20.2

Responsive feeding practices

Responsive feeding practices were poor in both areas (Table 6-7). The most commonly-practised responsive feeding practice was caregivers helping their infants and children to eat (35.1%), followed by trying other foods if the infant/child refused the food (26.1%), and by not forcing them to eat (6.7%). Feeding the child slowly was a rare practices in the two communities

Table 6-7: Responsive feeding practices of mothers/caregivers of infants and children 6-23 months in the study areas

	Baseline			Follow-up		
Responsive feeding practices	**Overall No. (%)**	**Control No. (%)**	**Experimental No. (%)**	**Overall No. (%)**	**Control No. (%)**	**Experimental No. (%)**
Helps infant/child to eat						
Yes	99 (35.1)	48 (33.1)	51 (37.2)	83 (42.6)	46 (44.2)	37 (40.7)
No	183 (64.9)	97 (66.9)	86 (62.8)	112 (57.4)	58 (55.8)	54 (59.3)
Forces the infant/ child to eat						
Yes	19 (6.7)	9 (6.2)	10 (7.3)	33 (16.8)	18 (17.1)	15 (16.5)
No	264 (93.3)	137 (93.8)	127 (92.7)	163 (83.2)	87 (82.9)	76 (83.5)
Tries another food						
Yes	74 (26.1)	39 (26.7)	35 (25.5)	118 (60.2)	61 (58.1)	57 (62.6)
No	209 (73.9)	107 (73.3)	102 (74.5)	78 (39.8)	44 (41.9)	34 (37.4)
Feeds slowly						
Yes	29 (10.2)	21 (14.4)	8 (5.8)	77 (39.3)	47 (44.8)	30 (33.0)
No	254 (89.8)	125 (85.6)	129 (94.2)	119 (60.7)	58 (55.2)	61 (67.0)
Asks another person to feed the Infant/child						
Yes	17 (6.0)	5 (3.4)	12 (8.8)	4 (2.0)	2 (1.9)	2 (2.2)
No	266 (94.0)	141 (96.6)	125 (91.2)	192 (98.0)	103 (98.1)	89 (97.8)

Baseline N = 295; Follow-up N = 196| | No. = number

6.3.3 Evaluation of infant and child growth

Figure 6-3 shows the pattern of change of z-scores regardless of the HAZ category they fell into. Overall, 68.7% of the children had a decreased z-score showing growth faltering, while 30.8% improved and 0.5% maintained the same z-score. The difference between those who lost and gained HAZ was significant (p<0.01), while the children who maintained could not be computed due to the small number of cases. The control group comprised a higher proportion of children with decreased z scores (70.9%) than the experimental group (66.3%, p>0.05) but this was not significant. The previous chapter indicated that the control group had the highest level of disease, which could possibly be attributed to high levels of malnutrition among other factors. It is possible that malnutrition worsened between the baseline and follow-up which could result from the cumulative effect of disease and poor conditions reported in Chapter 4.

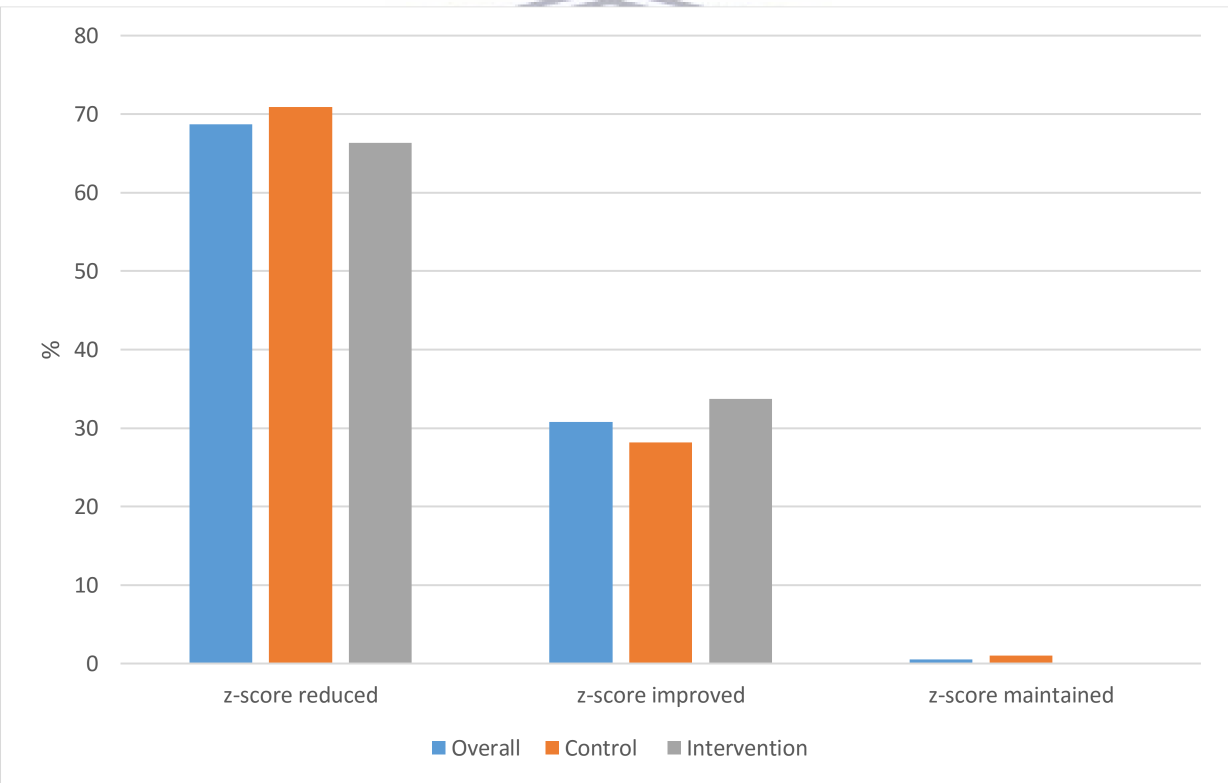


Figure 6-3: Proportion change of height-for-age z-scores of children 18-36 months in the two study areas

There was a shift up and down of the HAZ categories of children in the study. Twenty-five point three percent of children's nutritional status deteriorated as they moved from lying above ≥-2 at baseline to <-2 at follow-up (Figure 6-4). Twenty three point two of children who were stunted at baseline persisted with stunting up to follow-up. Of the children who were less than 12 months at baseline and had a z-score ≥-2, 60% had their z-score decrease to <-2, 49.4% had a z-score which remained above or equal to -2, 27.9% remained in the -2 region, and 20% improved to >-2. About 40% of children above 24 months deteriorated to the worse condition of below -2 z-score (p<0.01). More children in the experimental (52%) than the control group (48%) fell <-2 during the study period (p = 0.93), meaning that their nutrition status deteriorated.

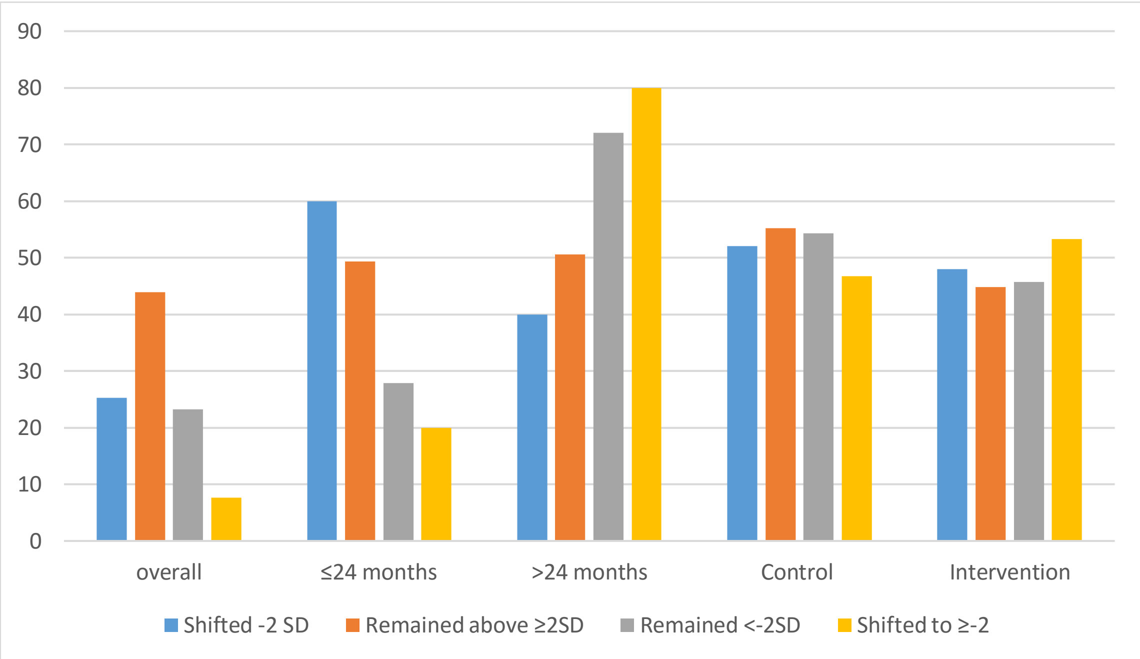


Figure 6-4: Change in height-for age z score status among children over the one year study period

Incidence rate and relative risk of malnutrition

Infants and children were followed up at one year (May 2015) in the two study areas to see whether stunting had occurred among the children who originally had a normal HAZ status. In the control group, 74 infants and children had a normal HAZ status at the start of the study and 26 of them developed stunting during the year. Infants/children contributed 74 years to the study (0.35 incidence rate of stunting per year) (data not shown). The experimental group had 63 infants and children with a normal HAZ status at the start and 24 of them became stunted, with a total contribution of 63 years to the study (0.38 incidence rate of stunting per year). With a total of 137 infants and children with a normal HAZ at start of the study and 50 developing stunting during the year (contributing 137 years to the study), the overall incidence rate was 0.37 of stunting per year. The incidence rates were similar between control (0.35 stunting/year) and experimental groups (0.38 stunting/year).

Furthermore, the *incidence rate ratio* (dividing the rate of control group into the rate of the experimental group) showed that infants/children not stunted at baseline who lived in the experimental area that had 1.09 times the risk of developing stunting compared to the infants and children in the control area, meaning a 9% higher risk of developing stunting.

Difference between the means of anthropometric measurements between the baseline and follow-up

Table 6-8 provides the difference between the means of anthropometric measurements between the two phases. The data show that stunting was worse in the experimental group while wasting was worse in the control group. At the commencement of the study, the experimental group had better WAZ compared to the control group (0.02 difference), but was worse at follow-up (-0.18). Linear growth was better for the control than the experimental at baseline (-0.46 difference), and this persisted at follow-up (-0.29 difference). WHZ for the control group was worse at baseline (0.21 difference) but improved to be better than the experimental group at follow-up (0.03).

Table 6-8: Mean anthropometric measurements of infants and children 6-23 months in the control and experimental groups;

Variable	Baseline				Follow up			
	Overall Mean (SD)	Control Mean (SD)	Exper. Mean (SD)	C-I	Overall Mean (SD)	Control Mean (SD)	Exper. Mean (SD)	C-I
Infant/ Child Age	14.28(6.09)	13.31 (5.91)	15.31 (6.13)	-2.0	26.11(6.01)	25.06 (6.06)	27.24 (5.76)	-2.18
Weight (kg)	9.02 (1.60)-	8.79 (1.62)	9.26 (1.56)	-0.47	11.13(1.69)	11.02 (1.69)	11.26 (1.69)	-0.24
Height (cm)	72.88(5.79)	72.35 (5.90)	73.44 (5.65)	-1.09	82.00(5.29)	81.57 (5.37)	82.48 (5.179)	-0.91
MUAC (cm)	14.31(1.71)	14.49 (2.08)	14.13 (1.19)	0.36	15.06(1.43)	14.86 (1.25)	15.29 (1.58)	-0.43
WAZ	-0.64 (1.18)	-0.65 (1.19)	-0.63 (1.17)	0.02	-0.81 (1.00)	-0.72 (1.03)	-0.90 (0.97)	-0.18
HAZ	-1.41 (1.55)	-1.19 (1.67)	-1.64 (1.40)	-0.46	-1.86 (1.08)	-1.72 (1.14)	-2.01 (1.01)	-0.29
WHZ	0.106(1.41)	-0.03 (1.47)	0.24 (1.33)	0.21	0.24 (0.99)	0.25 (0.97)	0.22 (1.02)	0.03

C-I = control minus experimental || Exper. = Experimental || p = p value

6.4 Discussion

The findings show that undernutrition was high and deteriorated (in terms of stunting and underweight) over the one-year study period in both areas, indicating that as the infants/children became older, they became more malnourished. The fact that stunting was high in both groups suggests that chronic, rather than sudden, food deprivation may be responsible for the poor nutrition situation. Proportionally, the increase was higher in the experimental group than the control group, but the difference was not significant. Similarly, a reduction in wasting and overweight was noticed, and the lack of severely wasted children at follow-up confirms the existence of chronic hunger and not acute deprivation.

The high levels of stunting found in the two areas are comparable to the national levels of 40% (CSO et al., 2014). Infants and children who are stunted have a low probability of growing to their fullest potential (Richard et al., 2014), resulting in a negative effect on the economy. The negative effect emanates from the impact malnutrition has on the learning capacity of children, negatively affecting future gain, the risk of several diseases (communicable and non-communicable) in both childhood and adulthood, and physical capacity and energy for work. Even in its mild form, undernutrition is associated with a higher risk of dying in childhood (Olofin et al., 2013). Zambia's under five mortality (75 deaths per 1,000 live birth) is currently higher (CSO et al., 2014) than the global under five mortality rate of 42.5 per 1000 live births (CSO et al., 2014; World Bank Group, 2017). Evidence shows that undernutrition is responsible for 45% of under five deaths (WHO, 2016). In addition, Zambia is far from reaching the SDG target goal of reducing the under five mortality rate to below 25 per 1000 live births by 2030 (WHO, 2017). This is the reason why Zambia has fought for several decades to address the factors associated with poor growth, and particularly stunting (NFNC, 2011, 2012).

6.4.1 Why did more infants and children become malnourished as they got older?

The findings from the study show that malnutrition increased with age in the infants and children. The reasons for this can be speculated using the scenarios from the study data and what other researchers with similar findings have reported. The situation could have been worsened by long-term exposure to adverse environmental factors that limit growth.

These may include persistent high prevalence and seasonality of diseases, long-term exposure to poor WASH conditions, poor quality diets and care practices, and poor social and economic conditions in the country (Condon-Paoloni et al., 1977; De Onis & Blössner, 1997; Victora et al., 2010; Nguyen et al., 2013; Guerrant et al., 2014; Mahmud & Mbuya, 2016).

Quality of diet determines the amount of energy and nutrients the infant/ child would access for either catch-up or general growth. There was evidence of poor diet quality in the study areas, as the major food group was starchy foods which were consumed by almost all infants and children every day in the form of porridge or nshima (paste made from maize meal). In addition, the number of main meals and snacks consumed per day were quite low. The combination of high starchy food consumption and few main meals and snacks suggest poor consumption of nutrient-dense foods, and even starvation in some periods of the infant's/children's lives. Poor diets (sometimes accompanied by other poor complementary feeding practices) may be deficient in one or more nutrients, limiting child growth. For instance, catch-up growth occurs quickly in between intervals of illness, which may allow the infant/child to grow to their height trajectory, but the growth may not occur fully with persistent inadequate diet and disease (Richard et al., 2014). Briend, Khara & Dolan, 2015:S18) stated that, for infants and children with undernutrition, growth in height "takes place only when the body has a minimum of energy reserves".

The fact that poor diet was reported at the time of data collection is worrying since the end of the rainy season (when data was being collected) is a period of food abundance when optimal diet is expected. In Zambia, food consumption reduces in dryer seasons (CSO, MAL & IAPRI, 2012) affecting the DDS. Similarly, Abizari et al., (2017) reported significantly higher DDS in the rainy season than in the dry season in Ghana. Arsenault et al., (2014) reported differences in micronutrient intake during the lean and post-harvest rain seasons in rural Burkina Faso, favouring the post-harvest season. Since periods of dry weather are longer in Zambia and that is when food is scarcer, it is possible that infants and children continued in a situation of diet stress for a longer period, limiting growth and even catch-up growth after an illness. The evidence calls for promotion of quality and adequate diets and low disease burden to meet the energy requirement for growth.

High prevalence of diseases could have worsened undernutrition in infants/children. Lima et al., (2000) reported worsening nutritional status among infants/children with persistent diarrhoea. Diseases may lead to temporary growth faltering or undernutrition

(Briend, 1990). However, sometimes diseases result in a higher cumulative growth failure as reported by Checkley et al., (2008) that diarrhoea before 24 months is associated with greater odds of being stunted at 24 months. It is therefore possible that recurring diseases throughout the first two years of life could worsen undernutrition due to less chance for catch-up growth, especially in the presence of poor diets, as the two reinforce each other.

This is supported by a considerable number of infants and children reporting recurrent diseases, and more than 20% of them suffering from two or three diseases at one time, with some experiencing as many as six episodes within the two weeks before the survey. It can be argued that these two scenarios support the notion of the presence of a cumulative disease burden among the infants and children in the study areas.

Long-term exposure to poor WASH conditions may have led to persistent disease, as explained above (Crane, Jones & Berkley, 2015; Donowitz et al., 2016), and evidence exists of its negative impact on infant and child nutrition (Kosek et al., 2013; Donowitz et al., 2016). The data collected shows poor WASH services and practices both at baseline and follow-up, especially in the control group. The situation is likely to be similar even in other seasons of the year.

Other factors such as ***child care practices*** could have been major factors in worsening undernutrition. Apart from the meal quality and quantity, responsive feeding practices were not optimal in the study groups, indicating poor care or support for infants and children during feeding which is likely to result in lower food consumption among them. Responsive feeding is necessary to promote more intake of food in infants and children (Satter, 1986).

Therefore, it can be reasoned that the combined effect of poor diets, prolonged exposure to poor WASH conditions, poor child care practices, and other factors which may not have been included in the study may be responsible for the persistent undernutrition, especially stunting. It also possible that undernutrition could have worsened the disease prevalence through compromising the immune system (Tomkins & Watson, 1989). The mechanisms through which infections can cause/increase malnutrition are through loss of appetite, malabsorption, decreased metabolism, poor feeding practices during illness, and direction of nutrients away from growth and towards the immune response (Tomkins & Watson, 1989; Stewart et al., 2013; Mahmud & Mbuya, 2016). The interaction of undernutrition and infection could also worsen the situation, leading to a poorer nutritional status.

6.4.2 Why was the increase in stunting higher in the experimental than control group?

Surprisingly, the results showed that more infants and children in the experimental group were stunted than those in the control group, while those in control group showed a higher prevalence of wasting at baseline, while more in the experimental group were wasted at follow up suggesting possible differences in the determinants, although both conditions were not significant between the two areas. While unexpected, the results indicate higher levels of disease but a better FCS in the control than the experimental group, with a substantial difference at follow-up. The FCS is a better predictor of quality of diet and food security status than the number of meals an infant/ child took every day (WFP, 2008). Since the infants and children in the control group had a good FCS, it could have provided the energy to make up for the growth lost (catch-up growth) during illness (Briend, Khara & Dolan, 2015). This suggests that the control group was potentially being affected by short-term nutrient deprivation, resulting from the seasonal diseases that children suffered, but were able to experience higher catch-up growth.

It can be speculated that the control group could have been experiencing a peak of seasonal diseases at end of rain season, which may have had a different impact on nutritional status than prolonged exposure to inadequate food, which is likely to be the case in the experimental group. Because the study was conducted at the time when the rainy season was almost ending, diseases related to poor WASH practices could have been at their highest peak. During moderately dry periods, diseases like diarrhoea peak due to the concentration or build-up of pathogens in the environment. Heavy rainfall dilutes pathogens, reducing transmission to humans (Bhavnani et al., 2014; Carlton et al., 2014). However, it may flush pathogens into unsafe water sources. Since the study areas were characterised by high levels of open defecation, poor quality toilet facilities, unsafe disposal of infant/child faeces, and poor quality water sources, the heavier rain could have contributed to higher disease conditions. If diseases were at a peak during the rainy season, this might entail fewer diseases during the dry season, allowing catch-up growth in infants and children (Richard et al., 2014), especially in the control group which experienced a high prevalence of disease. This could have been the reason why wasting was more common in the control group (Onis & Blössner, 1997). Nevertheless, interpreting the situation this way should be taken with caution since, although the groups differed in the levels of malnutrition, it was still high in both groups, and the difference was not significant.

Conducting a check during the dry season could have given a different disease and growth pattern, and would have verified the speculation regarding peaks of diseases. Such information is key in programme planning and implementation. Future research with short intervals of data collection for nutritional status and WASH factors would bridge the knowledge gap of the diseases, catch-up growth and infant/child growth in Zambia.

6.4.3 Why did malnutrition not decrease with the decrease in disease burden?

The findings show an overall reduction in disease pattern over the study period in both the experimental and control group, but did not show a corresponding reduction in malnutrition patterns, with the exception of wasting and underweight in the control group. Traditionally, emphasis on infections have been on overt diseases such as diarrhoea and respiratory infections as some of the major contributors to infant and child growth failure. However, there is a change in thinking about the subtle condition known as EE that may occur in infants and children for a very long time without the appearance of physical signs, compromising the functioning of the gut in its ability to absorb and utilise nutrients (Guerrant et al., 2016; Mbuya & Humphrey, 2016; Kosek et al., 2017). Even with improvements in environmental conditions, an infant or child or individual with EE takes a long time to recover, and this probably varies according to how long one has had the condition (Mbuya & Humphrey, 2016). Mbuya and Humphrey (2016) further suggested that EE may play a role in the reported high levels of stunting in utero, and it therefore requires further investigation. EE could explain about 55% of linear growth faltering in infants and children (Mbuya & Humphrey, 2016). This may explain the complexity of the causal factors of malnutrition. This may mean that even in the presence of proper diet, nutritional status improvements may not be adequately achieved due to poor functioning of the gut. Many studies have explained that EE is a result of poor environmental conditions, especially in developing countries. Therefore, it can be that continued or increased malnutrition at follow-up could largely be a spillover of negative factors from infancy deprivation, including disease, poor diet, food insecurity and adverse environment (Ajao et al., 2010). With evidence of poor environmental conditions in the two areas, reducing malnutrition may not be an achievable goal unless issues of EE research and intervention are considered.

The finding that undernutrition increases with decrease in diseases can also be explained by findings by others that reveal an increase in malnutrition with increasing age (Lima et al., 2000). Infants less than six months old, have less risk of developing undernutrition due to the protection around this age that appropriate feeding practices offers, especially exclusive breastfeeding, as elucidated in Chapter 5. It reduces the risk of consuming contaminated food (Howie et al., 1990; Popkin et al., 1990; Lima et al., 2000). However, when the ideal situation is not attained, growth faltering can occur much earlier than six months (Maleta et al., 2003; Mamidi et al., 2011; Christian et al., 2013).

Beyond six months, much change occurs in an infant/ child's life due to the addition of complementary foods that may be contaminated by poor environment (Motarjemi et al., 1993; Sheth & Dwivedi, 2006;). The contamination could be from water used to make liquids given to the babies or used to prepare foods, and limited availability of water. This could have affected the hygiene practices, especially regarding infant/child utensils and food preparation (Subcommittee on Nutrition and Diarrhoea et al., 1992). A similar situation was found in this study which exhibited poor utensil and food handling practices, in addition to poor WASH practices.

In addition to compromised standards with complementary feeds, infants/children start accessing objects and other areas for play, increasing their exposure to different pathogens (Marquis et al., 1990; Mbuya & Humphrey, 2016). An observational study conducted in Zimbabwe showed infants ingesting soil, stones and chicken faeces which were all contaminated with *E. coli* (Ngure et al., 2013) while Marquis et al., (1990), in Lima, Peru, reported the presence of *Campylobacter jejuni* in 50% of free-range chickens found inside of the home and in infant/child play places. In this study, a cohort of infants/children was followed, and by the end time of the study, the children were in the high exposure age period of above 12 months. This period is considered as being one of high exposure due to child exploration increasing the risk of disease, which is exacerbated by animal faeces being observed in households. This is likely a contributing factor to the increased levels of stunting and underweight.

Another possible explanation is that even with a decrease in disease prevalence, the accumulative poor growth due to previous diets may not have been normalised, due to continued poor feeding and care and WASH practices which still lead to the presence of disease, even if reduced. In this case, the children may not have been experiencing adequate catch-up growth to an optimal level within the reference growth curve.

The effects of stunting do not end with poor cognitive development and WASH-related diseases only, but also affect body metabolism, which increases the risk of obesity in childhood, adolescence and adulthood (Sawaya & Roberts, 2003; Krebs et al., 2007). The resultant obesity is also a risk factor for many non-communicable diseases such as type 2 diabetes, and cardiovascular diseases in successive stages of the life cycle (Shrimpton et al., 2001; Briana & Malamitsi-Puchner, 2009).

It is also possible that the quality of programme monitoring could have affected the outcome of the programme. It is suggested that the difference in the prevalence of stunting and wasting between the experimental and control groups at both baseline and follow-up may be due to inadequate monitoring of the programme. This would result in a lack of the information required to address barriers to change and to inform decision-making. Monitoring allows the tracking of changes and the identification of lessons learnt and gaps faced to inform adjustments to existing approaches (Reynolds & Sutherland, 2013).

In summary, this chapter was intended to measure the levels of malnutrition and evaluate the difference in infant/child growth in the experimental and control groups. The prevalence of malnutrition in the category of stunting was high (more than one-third of infants and children stunted) in both groups. Despite having received WASH services, the experimental group did not have better infant and child growth rates than the control group, which was expected to have a higher risk profile due to poorer WASH outcomes and a higher disease burden. In addition, more infants/children became stunted as they were growing older, despite the reduction in disease prevalence.

6.5 References

Abizari, A.-R., Azupogo, F., Nagasu, M., Creemers, N., Brouwer, I.D. & Ahunu, B. 2017. Seasonality affects dietary diversity of school-age children in northern Ghana. *PLoS ONE*. 12(8):e0183206. DOI: 10.1371/journal.pone.0183206.

Ajao, K., Ojofeitimi, E., Adebayo, A., Fatusi, A. & Afolabi, O. 2010. Influence of family size, household food security status, and child care practices on the nutritional status of under-five. *African Journal of Reproductive Health*. 14(December):123–132. DOI: 10.2307/41329750.

Arsenault, J.E., Nikiema, L., Allemand, P., Ayassou, K.A., Lanou, H., Moursi, M., De Moura, F.F. & Martin-Prevel, Y. 2014. Seasonal differences in food and nutrient intakes among young children and their mothers in rural Burkina Faso. *Journal of Nutritional Science*. 3:e55. DOI: 10.1017/jns.2014.53.

Bhavnani, D., Goldstick, J.E., Cevallos, W., Trueba, G. & Eisenberg, J.N.S. 2014. Impact of Rainfall on Diarrheal Disease Risk Associated with Unimproved Water and Sanitation. *American Journal of Tropical and Hygiene*. 90(4):705–711. DOI: 10.4269/ajtmh.13-0371.

Briana, D.D. & Malamitsi-Puchner, A. 2009. Intrauterine growth restriction and adult disease : the role of adipocytokines. *European Journal of Endocrinology*. 160:337–347. DOI: 10.1530/EJE-08-0621.

Briend, A. 1990. Is diarrhoea a major cause of malnutrition among the under-fives in developing countries? A review of available evidence. *European Journal of Clinical Nutrition*. 44:611–628.

Briend, A., Khara, T. & Dolan, C. 2015. Wasting and stunting-similarities and differences: policy and programmatic implications. *Food and Nutrition Bulletin*. 36(1 Suppl):S15-23. Available: http://www.ncbi.nlm.nih.gov/pubmed/25902610.

Carlton, E.J., Eisenberg, J.N.S., Goldstick, J., Cevallos, W., Trostle, J. & Levy, K. 2014. Heavy rainfall events and diarrhea incidence: The role of social and environmental factors. *American Journal of Epidemiology*. 179(3):344–352. DOI: 10.1093/aje/kwt279.

Checkley, W., Buckley, G., Gilman, R.H., Assis, A.M.O., Guerrant, R.L., Valentiner-branth, P., Lanata, C.F., Black, R.E., et al. 2008. Multi-country analysis of the effects of diarrhoea on childhood stunting. *International Journal of Epidemiology*. 37(June):816–830. DOI: 10.1093/ije/dyn099.

Christian, P., Lee, S.E., Angel, M.D., Adair, L.S., Arifeen, S.E., Ashorn, P., Barros, F.C., Fall, C.H.D., et al. 2013. Risk of childhood undernutrition related to small-for-gestational age and preterm birth in low- and middle-income countries. *International Journal of Consumer Studies*. 42(August):1340–1355. DOI: 10.1093/ije/dyt109.

Cogill, B. 2003. *Anthropometric indicators measurement guide*. Washington D.C.

Condon-Paoloni, D., Cravioto, J., Johnston, F.E., Licardie, E.R.D.E. & Scholl, T. 1977. Morbidity and growth of infants and young children in a Rural Mexican Village. *American Journal of Public Health*. 67(7):651–656.

Crane, R.J., Jones, K.D.J. & Berkley, J.A. 2015. Environmental enteric dysfunction: An overview. *Food and Nutrition Bulletin*. 36(1):76–87.

CSO, MAL & IAPRI. 2012. *2012- Rural Agricultural Livelihood Surveys (RALS)*. Lusaka, Zambia.

CSO, MOH, TDRC, UNZA & MACRO International. 2014. *Zambia Demographic and Health Survey 2013-14*. Lusaka, Zambia.

De Onis, M. & Blössner, M. 1997. *Database on child growth and malnutrition*. Geneva.

Donowitz, J.R., Haque, R., Kirkpatrick, B.D., Alam, M., Lu, M., Kabir, M. & Kakon, H. 2016. Small intestine bacterial overgrowth and environmental enteropathy in Bangladeshi children. *mBio*. 7(1):1–7. DOI: 10.1128/mBio.02102-15.Editor.

Field, A. 2009. *Discovering Statistics using spss*. 3rd ed. London, UK: SAGE.

Guerrant, R.L., Deboer, M.D., Moore, S.R., Scharf, R.J. & Aldo, A.M. 2014. The impoverished gut - a triple burden of diarrhoea, stunting and chronic disease. *Nature Reviews Gastroenterology & Hepatology*. 10(4):220–229. DOI: 10.1038/nrgastro.2012.239.

Guerrant, R.L., Leite, A.M., Pinkerton, R., Medeiros, P.H.Q.S., Cavalcante, P.A., Deboer, M., Kosek, M., Duggan, C., et al. 2016. Biomarkers of environmental enteropathy, inflammation, stunting, and impaired growth in children in Northeast Brazil. *PLoS ONE*. 11(9):1–20. DOI: 10.1371/journal.pone.0158772.

Howie, P.W., Forsyth, S.J., Ogston, S.A., Clark, A. & du Florey, C. V. 1990. Protective effect of breast feeding against infection. *British Medical Journal*. 300(January):11–16.

Kosek, M., Haque, R., Lima, A., Babji, S., Shrestha, S., Qureshi, S., Amidou, S., Guerrant, R.L., et al. 2013. Fecal Markers of Intestinal Inflammation and Permeability Associated with the Subsequent Acquisition of Linear Growth Deficits in Infants. *American Journal of Tropical Medicine and Hygiene*. 88(2):390–396. DOI: 10.4269/ajtmh.2012.12-0549.

Kosek, M.N., Ahmed, T., Bhutta, Z., Caulfield, L., Guerrant, R., Houpt, E., Kang, G., Kosek, M., et al. 2017. Causal pathways from enteropathogens to environmental enteropathy: eindings from the MAL-ED Birth Cohort Study. *EBioMedicine*. 18:109–117. DOI: 10.1016/j.ebiom.2017.02.024.

Krebs, N.F., Himes, J.H., Jacobson, D., Nicklas, T.A. & Guilday, P. 2007. Assessment of child and adolescent overweight. *Peadiatrics*. 120(Suppl. 4):S193–S228. DOI: 10.1542/peds.2007-2329D.

Lima, A.A.M., Moore, S.R., Barboza, M.S., Soares, A.M., Schleupner, M.A., Newman, R.D., Sears, C.L., Nataro, J.P., et al. 2000. Persistent diarrhea signals a critical period of increased diarrhea burdens and nutritional shortfalls: A prospective cohort study among children in Northeastern Brazil. *Journal of Infectious Diseases*. (181):1643–1651.

Mahmud, I. & Mbuya, N. 2016. *Water, sanitation, hygiene, and nutrition in Bangladesh: can building toilets affect children's growth?* Washington DC: World Bank Group. Available: http://dx.doi.org/10.1596/978-1-4648-0698-8.

Maleta, K., Virtanen, S., Espo, M., Kulmala, T. & Ashorn, P. 2003. Timing of growth faltering in rural Malawi. *Archies of Disease in Childhood*. 88(7):574–578. DOI: 10.1136/adc.88.7.574.

Mamidi, R.S., Shidhaye, P., Radhakrishna, K. V, Babu, J.J. & Reddy, P.S. 2011. Pattern of growth faltering and recovery in under five children in India using WHO Growth Standards - A Study on first and third national family health survey. *Indian Pediatrics*. 48:855–60. Available: http://www.ncbi.nlm.nih.gov/pubmed/21555805.

Marquis, G.S., Ventura, G., Gilman, R.H., Porras, E., Miranda, E., Carbajal, L. & Pentafiel, M. 1990. Fecal contamination of shanty town toddlers in households with non-corralled poultry, Lima, Peru. *American Journal of Public Health*. 80(2):2–5.

Mbuya, M.N.N. & Humphrey, J.H. 2016. Preventing environmental enteric dysfunction through improved water, sanitation and hygiene: an opportunity for stunting reduction in developing countries. *Maternal & Child Nutrition*. 12 Suppl 1:106–20. DOI: 10.1111/mcn.12220.

McGrady, J. 2014. *Statistical Reasoning for Public Health: Estimation, Inference and Interpretation [Coursera Video]*. Available: https://www.coursera.org/learn/statistical-reasoning-1

Motarjemi, Y., Kaferstein, F., Moy, G. & Quevedo, F. 1993. Reviews/analyses contaminated weaning food : a major risk factor for diarrhoea and associated malnutrition. *Bulletin of the World Health Organization*. 71(1):79–92.

NFNC. 2011. *National Food and Nutrition Strategic Plan for Zambia 2011-2015; with a multisector strategic direction on the first 1000 most critical days to prevent child stunting*. Lusaka, Zambia.

NFNC. 2012. *The First 1000 Most critical Days Three Year Programme- 2013 to 2015: Based on Strategic Direction One: Prevention of Stunting in Children less than two years of age in the National Food and Nutrition Strategic Plan (NFNSP) 2011-2015*. Lusaka, Zambia.

Ngure, F.M., Humphrey, J.H., Mbuya, M.N.N., Majo, F., Mutasa, K., Govha, M., Mazarura, E., Chasekwa, B., et al. 2013. Formative research on hygiene behaviors and geophagy among infants and young children and implications of exposure to fecal bacteria. *American Journal of Tropical and Hygiene*. 89(4):709–716. DOI: 10.4269/ajtmh.12-0568.

Nguyen, H.T., Eriksson, B., Petzold, M., Bondjers, G. & Tran, T.K. 2013. Factors associated with physical growth of children during the first two years of life in rural and urban areas of Vietnam. *BioMed Central Peadiatrics*. 13(149):1–10. DOI: 10.1186/1471-2431-13-149.

Olofin, I., McDonald, C.M., Ezzati, M., Flaxman, S., Black, R.E., Fawzi, W.W., Caulfield, L.E., Danaei, G., et al. 2013. Associations of suboptimal growth with all-cause and cause-specific mortality in children under five years: A pooled analysis of ten prospective studies. *PLoS ONE*. 8(5):1–10. DOI: 10.1371/journal.pone.0064636.

Popkin, B.M., Adair, L., Akin, J.S., Black, R., Briscoe, J. & Flieger, W. 1990. Breast-feeding and diarrheal. *Peadiatrics*. 86(6):874–882.

Reynolds, H.W. & Sutherland, E.G. 2013. A systematic approach to the planning, implementation, monitoring, and evaluation of integrated health services. *BioMed Central health services research*. 13(168):1–11. DOI: 10.1186/1472-6963-13-168.

Richard, S.A., McCormick, B.J.J., Miller, M.A., Caulfield, L.E. & Checkley, W. 2014. Modeling environmental influences on child growth in the MAL-ED cohort study: opportunities and challenges. *Clinical Infectious Diseases*. 59(suppl 4):S255–S260. DOI: 10.1093/cid/ciu436.

Satter M.E. 1986. The feeding relationship. *The American Dietetic Association*. 86:352–356.

Sawaya, A.L. & Roberts, S. 2003. Stunting and future risk of obesity : principal physiological mechanisms Baixa estatura nutricional e risco de obesidade futura : principais mecanismos fisiológicos. *Cad. Saúde Pública, Rio de Janeiro*. 19(suppl. 1):21–28.

Sheth, M. & Dwivedi, R. 2006. Complementary Foods Associated Diarrhea. *Indian Journal of Pediatrics*. 73(1):61–64.

Shrimpton, R., Victora, C.G., de Onis, M., Lima, C., Blo, M. & Graeme, C. 2001. Worldwide Timing of Growth Faltering: Implications for. *Pediatrics*. 107(5):1–7.

Stewart, C.P., Iannotti, L., Dewey, K.G., Michaelsen, K.F. & Onyango, A.W. 2013. Contextualising complementary feeding in a broader framework for stunting prevention. *Maternal & Child Nutrition*. 9 Suppl 2:27–45. DOI: 10.1111/mcn.12088.

Subcommittee on Nutrition and Diarrhoea, Diseases, Subcommittee on Diet Physical Activity And, Pregnancy Outcome Committee on International, NutritionPrograms, N. & Food and Nutrition Board. 1992. *Nutrition issues in developing countries: Part I: Diarrheal diseases, Part II: Diet and activity during pregnancy and lactation*. Washington D.C.

Tomkins, A. & Watson, F. 1989. *Malnutrition and Infection − A review − Nutrition policy discussion paper No. 5*. (5). Geneva, Swizerland.

Victora, C.G., de Onis, M., Hallal, P.C., Blössner, M. & Shrimpton, R. 2010. Worldwide timing of growth faltering: revisiting implications for interventions. *Pediatrics*. 125(3):e473–e480. DOI: 10.1542/peds.2009-1519.

WHO. 2016. *Children: reducing mortality*. Available: http://www.who.int/mediacentre/factsheets/fs178/en/ [2017, July 31].

WHO. 2017. *Global health observatory (GHO) data: Under-five mortality*. Available: http://www.who.int/gho/child_health/mortality/mortality_under_five_text/en/ [2017, July 28].

World Bank Group. 2017. *Mortality rate, under-5 (per 1,000 live births)*. Available: http://data.worldbank.org/indicator/SH.DYN.MORT [2017, July 28].

World Food Programme. 2008. *Food consumption analysis - calculation and use of the food consumption score in food security analysis*. Rome. Available: http://home.wfp.org/stellent/groups/public/documents/manual_guide_proced/wfp197216.pdf.

CHAPTER 7: SANITARY CONDITIONS AND NUTRITIONAL STATUS

7.1 Introduction

This chapter aims to evaluate the association between quality of water, sanitation and hygiene practices, and the nutritional status of children in the two areas studied in order to address the objective below. This chapter also attempts to respond to the overall title of the thesis in determining the effect of WASH services and practices on child growth and the incidence of disease. Using the ANCOVA, the chapter will discuss whether the differences in the control and experimental groups regarding HAZ still manifest after controlling for WASH factors. Further analysis using logistic regression will also attempt to make an association between stunting and diseases only, as well as between stunting and other factors. Finally, an overall interpretation of the results will be made in the discussion.

Objective:

> *To assess the association between quality of water, sanitation and hygiene practices between the two areas studied with the nutrition status of infants and children.*

7.2 Materials and Methods

The ANCOVA test was applied to test whether the experimental group had better nutritional status than the control group, based on stunting. That is, whether the difference in the two areas was largely accounted for by the WASH services received in the experimental and control groups. The main question was, "did the difference between the control and experimental groups regarding HAZ (stunting) still manifest itself in the data once water, sanitation and hygiene practices were controlled for?" The fixed factor was the area of residence, whether the infants or children lived in the experimental or control group areas.

Firstly, a test was conducted to find out if the variances between the experimental and control groups were the same using the ordinary ANCOVA (homogeneity variance test). The Leven test for interaction of homogeneity term showed that the two groups were the same ($p = 0.331$, F.951). Thus, the assumption of equality of variances was not violated.

Secondly, since no one variable was the best true indicator of either sanitation or hygiene from the several variables collected, the data were reduced into composites using the dimension reduction technique-Principle Component Analysis (details in Chapter 4). The data were reduced into one general factor component for each (sanitation and hygiene factors) using scores which represented a better indicator of sanitation and hygiene of the mother and infant/child. This provided a shared variance of sanitation and hygiene variables. The sanitation composite consisted of the type of toilet for the household and how they disposed of the infant/child faeces the last time the infant/child passed stools. Hygiene consisted of the mother's, infant's and child's hygiene component as described above. Before running the model, the variable for age was computed to get the differences in age of children between the baseline and follow-up.

The tests of Between-Subjects Effects was conducted to discover if any of the independent variables had a significant effect, if there was an interaction between these variables, and if they were significant. The area of residence which determined if one was in the experimental or control group was put into the model. It indicated that change in stunting tended to differ between the experimental and control groups (F=0.255, p=0.61) in a non-significant way, and accounted for less than 0.1% (0.001) of the variability.

The mean differences in growth of infants and children showed which area had more infants/children either gaining or losing weight. The ANCOVA test was applied to test whether the differences in growth of children between control ($\bar{x}$ = -0.56, SD 1.60) and experimental ($\bar{x}$ =-0.46, SD 1.27) groups were due to age difference, water source, sanitation quality, or hygiene practices. The Leven test for interaction of homogeneity of regression term was conducted and showed a non-differential relationship between the two study groups (F (1.195) =0.998, p=0.32). It was therefore assumed that the variance between two groups was the same i.e. homogeneity. The test between subject effects was not statistically significant (p=0.638) and Eta squared of 0.001, confirming that only about 0.1% of the variability in infant/child growth could be accounted for by the study area.

The relationship was significant for age difference (F (1,189) =36.566, p<.01) across all models, while HAZ at baseline (F (1,189) =6.62, p=0.01) of the study was only significant in model 1, indicating that the adjusted means of the two variables were not equal.

To measure mother/caregiver's nutritional status, waist, height and weight measurements were taken. The waist was measured using a tape measure to the nearest 0.1cm with minimal clothing. The tape measure was placed around the middle, just above the hipbones ensuring that it was horizontal around the waist. Without compressing the skin, the waist was measured just after breathing out.

Height was measured using the height board to the nearest 0.1cm. The women were asked to stand with their back against the height board. Arms were let to hang freely by the side of their bodies, legs placed together, head facing straight ahead and bringing the headpiece down on the upper most point of the head, the measurements were taken.

Weight was measured using an electronic scale to the nearest 0.1g. Women were asked to stand on the scale when the display showed zero reading. Heavy clothing, objects or jewellery were removed. Whilst on the scale, they were asked to stand still on the centre of the scale. With arms hanging loosely at their sided and looking straight ahead, the measurements were taken. The scales were checked with a known weight to ensure accuracy.

7.3 Results

7.3.1 The ANCOVA test with stunting

Table 7-1 shows the ANCOVA to test whether a) the experimental group had a better nutritional status than the control group using the HAZ at follow-up as an outcome; and b) whether the differences in the nutritional status may be because the experimental group had a better WASH intervention. It is clear from Table 7-1 that the covariate (area of residence) did not have an influence on HAZ of children at follow-up (p=0.56, 95%CI: -0.31, 0.57) but the HAZ at baseline influenced the outcome at follow-up (p<0.01, 95%CI 0.28, 0.55), accounting for about 36.5% of the variation in infant/child growth when all three WASH variables were included in the model. In this case, infants/children who had a better HAZ score at the beginning of the study were more likely to have a better HAZ score at follow-up. In models 1-3 where age, the area of residence and HAZ at baseline were entered in models with each of the three WASH variables, the variance accounted for by HAZ was lower than in the overall model, although the difference with the sanitation model was not much. Comparing the first three models shows that when sanitation is poor, growth in HAZ is more affected than when water sources are unsafe and hygiene practices are poor.

Table 7-1: Analysis of covariance for stunting by area of study (control and experimental groups)

Variable	F	p value	Measure of association
Model 1: Infant/child sex, difference in age and water source			
Water Source: follow up	0.73	0.39	0.00
Water Source: baseline	2.69	0.10	0.01
Age difference	17.09	**0.00**	**0.08**
Sex of infant/child	0.55	0.46	0.00
HAZ: baseline	47.64	**0.00**	**0.20**
Area of residency	1.65	0.20	0.01
Model 2: Infant/child sex, age difference and hygiene			
Hygiene factor: follow up	0.02	0.90	0.00
Hygiene factor: baseline	0.01	0.92	0.00
Age difference	10.38	**0.00**	**0.06**
Sex of infant/child	0.20	0.66	0.00
HAZ: baseline	42.16	**0.00**	**0.21**
Area of residency	1.05	0.31	0.01
Model 3: Infant/child sex, difference in age and sanitation			
Sanitation factor: follow up	1.40	0.24	0.02
Sanitation factor: baseline	0.63	0.43	0.01
Age difference	1.13	0.29	0.02
Sex of infant/child	0.92	0.34	0.01
HAZ: baseline	36.94	**0.00**	**0.35**
Area of residency	0.34	0.56	0.01
Model 4: Infant/child sex, difference in age, water source, hygiene and sanitation			
Hygiene factor: follow up	0.18	0.67	0.00
Hygiene factor: baseline	0.25	0.62	0.01
Sanitation factor: follow-up	0.62	0.43	0.01
Sanitation factor: baseline	0.19	0.67	0.00
Water source: follow up	0.39	0.54	0.01
Water source: baseline	0.03	0.87	0.00
Age difference	0.57	0.45	0.01
Sex of infant/child	0.54	0.46	0.01
HAZ: baseline	30.49	**0.00**	**0.37**
Area	0.07	0.80	0.00

7.3.2 Association of stunting with diseases

A multiple logistic regression analysis (Table 7-2) showed no association of diseases with stunting at either baseline or follow-up.

Table 7-2: Association of diseases the infants and children suffered- with HAZ at baseline and follow-up

Disease			Baseline	Follow-up
		No. (%)	**OR (95%CI)**	**OR (95%CI)**
Diarrhoea	Yes	69 (45.4)	0.85 (00.42 1.73) p 0.648	0.69 (0.32 1.47) p 0.33
	No	83 (54.6)		
Hotness	Yes	111 (72.5)	0.75 (0.34 1.66) p 0.479	0.98 (0.40 2.43) p 0.97
	No	42 (27.5)		
Coughing	Yes	118 (77.1)	0.99 (0.42 2.34) p 0.985	1.09 (0.42 2.80) p 0.86
	No	35 (22.9)		
Sore eyes	Yes	54 (35.3)	0.86 (0.41 1.83) p 0.698	0.64 (0.28 1.44) p 0.28
	No	99 (64.7)		
N-153||			**Baseline**; Cox & Snell R Square = .007: Nagelkerke R Square = 0.010; Hosmer and Lemeshow Test = .561	**Follow up**; Cox & Snell R Square - .020, Nagelkerke R Square- .027, Hosmer and Lemeshow Test-.958

7.3.3 Factors associated with stunting (besides WASH factors)

Multiple logistic regression analysis (Table 7-3) revealed that age group (OR 0.26, 95% CI 0.11, 0.61), feeding the infant/ child slowly (OR 0.28, 95% CI 0.11, 0.72), and deworming (0.50, 95% CI 0.26, 0.95) were associated with stunting. Children who were older than 12 months and were dewormed were less likely to suffer from stunting, especially in the control group. Feeding the infant/child slowly with patience also reduced the risk of stunting among infants/children. In the control group, infants and children living in households where the head of household had another occupation rather than farming were less likely to suffer from stunting (OR 0.20, 95% CI 0.04, 0.90).

Table 7-3: Determinants of stunting (HAZ) among infants and children 6-23 months in the study areas at baseline

Predictor	Prevalence Total (%)	Pooled OR (95% CI)	Control OR (95% CI)	Experimental OR (95% CI)
Sex of infant/ child				
Female	158 (53.7)	1	1	1
Male	136 (46.3)	0.76 (0.42, 1.35)	1.03 (0.40,2.66)	0.58 (0.24, 1.36)
Age of infant/child				
6-12 months	121 (41.0)	1	1	1
>12 months	174 (59.0)	**0.26 (0.11,0.61)***	**0.29 (0.08,0.95)***	**0.23 (0.06,0.88)***
No. of main meals				
≤2 meals	39 (13.9)	1	1	1
>2meals	241 (86.1)	1.09 (0.39,3.00)	1.19 (0.29,4.86)	0.69 (0.10,4.92)
Infant's/child's diseases				
Has disease	257 (87.4)	1	1	1
No disease	37 (12.6)	0.64 (0.26, 1.51)	1.78 (0.37,8.57)	0.37 (0.12,1.12)
Sex of household head				
Female	42 (14.3)	1	1	
Male	252 (85.7)	0.10 (0.39, 2.07)	0.88 (0.24,3.23)	0.58 (0.16,2.15)
Household size				
Above 5	95 (32.2)	1	1	1
Up to 5 members	200 (67.8)	1.14 (0.57, 2.25)	0.71 (0.23,2.16)	1.69 (0.64,4.44)
Mother's age				
15-30 years	186 (63.7)	1	1	1
>31 years	106 (36.3)	0.78 (0.42, 1.44)	0.66 (0.25,1.75)	0.97 (0.39,2.40)
Water				
Not safe	86 (29.3)	1	1	1
Safe	208 (70.7)	0.96 (0.50, 1.87)	0.92 (0.35,2.48)	0.64 (0.16,2.50)
Feeding infant/child slowly				
No	254 (89.8)	1	1	1
Yes	29 (10.2)	**0.28 (0.11,0.72)***	0.2 (0.08,1.02)	0.16 (0.02,1.32)
Deworming				
No	143 (49.3)	**1**	**1**	1
Yes	147 (50.7)	**0.50 (0.26,0.95)***	**0.24 (0.09,0.64)***	0.96 (0.36,2.56)
Vaccinations				
No	91 (30.8)	**1**	**1**	1
Yes	204 (69.2)	0.98 (0.44, 2.18)	0.63 (0.19,2.07)	1.32 (0.37,4.76)
Infant/child's food consistency				
Thin	56 (20.2)	**1**	**1**	
Thick	221 (79.8)	0.88 (0.34, 2.27)	0.78 (0.19,3.11)	1.16 (0.25,5.43)
Occupation HH				
Farmer	235 (86.4)	1	**1**	1
Other	37 (13.6)	0.63 (0.28, 1.46)	**0.20 (0.04,0.90)***	1.37 (0.44,4.22)

N = 295, **Overall:** Hosmer and Lemeshow Test, .979; Cox & Snell R^2 .161; Nagelkerke R^2.221; chi-square 42.195, P< 0.000 **||** **Hamangaba**-Hosmer and Lemeshow Test.991**;** Cox & Snell R^2, 282; Nagelkerke R^2.391; chi-square 42.150, P .000 **||** **HH= Household head; Njolamwanza**- Hosmer and Lemeshow Test**,** .228; Cox & Snell R^2, .134; Nagelkerke R^2.183; chi-square 16.590, P .219||
Hh = household head, *Significant at p=0.05

7.4 Discussion

The results show that the availability of WASH services was not a major determinant factor in the reported outcome of stunting (HAZ). The analysis illustrates that a) the WASH services received in the experimental did not significantly account for the differences in infant and child growth between the experimental and control groups; b) despite the experimental group having better indicators of WASH factors, the growth of infants and children did not differ from the control group (Chapter 6); c) with a reduction in disease burden as children grew older (Chapter 5) there was no corresponding decrease in stunting in both areas; and d) although the prevalence of some diseases was significantly different, they were still high in both areas. Further, results showed that having a better nutritional status at baseline was associated with better growth at follow-up and this was not influenced by area of residence.

The findings above show that the growth was not likely to be influenced much by either having received the WASH services or not. Other causes of stunting should be investigated, although it is likely that a combination of WASH and other factors work better to produce adequate nutritional status. However, the reasoning should be taken with caution, as WASH factors are distal factors that may not affect nutritional indices directly, as so many pathways are involved in causing undernutrition. Furthermore the WASH serviced area was not 100% optimally serviced as was originally thought. In addition, the sample size of the study could have been too small to pick up the effect of distal factors, meaning that a larger data set could have picked up the associations.

7.4.1 Why were the WASH factors not a major determinant of stunting?

The finding that WASH factors were not a major determinant of stunting was not surprising considering that the country has been implementing several programmes to control malnutrition, including WASH interventions, but not much change has been observed for decades. Malnutrition has been above 40% since 1992. The WASH factors may not have been a major factor in the difference in growth of infants/children between the control and experimental groups because the study could have missed some key pathways to undernutrition. For instance, the disease prevalence in the study areas reduced considerably as infants/children became older, but the infants/ children could also have been affected by other conditions such as EE which results from exposure to poor sanitation and hygiene, and unsafe water (Petri, Naylor & Haque, 2014; Mbuya & Humphrey, 2016), as explained in the previous chapters. Existence of EE is possible in both areas because deeper exploration of data showed that not all households in the experimental had adequate WASH services and practices. Since EE can occur for a long time without being noticed, it hinders nutrient absorption and may lead to oral vaccination failure, (Gilmartin & Petri, 2015). It is possible that it may have obscured the visibility of WASH factors as a determinant of stunting. EE may be responsible for the poor outcomes of interventions targeted at reducing malnutrition due to the above mentioned characteristics of EE (Petri, Naylor & Haque, 2014; Gilmartin & Petri, 2015). Fuller et al.,(2016) explained that it is not only helminths and diarrhoea conditions which reduce nutrient absorption and promote an immune response that increases energy expenditure to slow growth, but also long-term exposure to pathogens causing EE. In Ecuador, Fuller et al., (2016) found that infants and children with optimal sanitation were still stunted, concluding that some other pathways are critical in infant and child growth. Similarly, in this study, other pathways not studied, such as EE, could be playing a significant role in stunting levels apart from diseases related to WASH factors. EE could also be responsible for the non-significant difference in the nutrition indices between the control and experimental groups regarding stunting, despite significant differences in some WASH factors and diseases.

Reasoning further, since both areas had not attained full coverage of WASH programmes probably they have not yet experienced the herd protection from the households with safely managed sanitation facilities in the case of the experimental group (Fuller et al., 2016). It is also important to note that WASH factors are predisposing factors which do not work directly, but are mediated by other factors such as disease (including diarrhoea, coughing and malaria) to cause undernutrition by compromising the immune system. For instance, Checkley et al., (2008) explained that an infant or child who experienced more days of diarrhoea before 24 months of age had an increased risk of stunting at 24 months.

In the present study, both health facility records and reports of diseases suffered in the two weeks before the study showed high levels of disease prevalence. Diseases occurred within one year of the study to a maximum of five episodes per infant or child using health facility records, with the possibility of underestimation due to non-health seeking behaviour by some mothers/caregivers. The finding may demonstrate that the environment at baseline did not change much over the study period to improve nutritional status, but rather worsened with cumulative diseases and poor diets, which reinforce each other.

Similarly, the type and quality of foods that infants and children consumed did not change over the study period. For instance, responsive feeding practices, which are stimulation behaviours known to increase infant/child food intake contributing to a reduction in infant and child undernutrition (Harbron & Najaar, 2013; Satter, 1986), did not improve over time. The complementary feeding practices as judged by FCS, number of meals consumed per day, and seven days food intake did not improve. Appropriate complementary feeding practices can reduce about 30% of stunting (Mbuya & Humphrey, 2016) which, when combined with the reduction of disease, could yield much higher benefits. Disease and diet quality tend to reinforce each other either positively or negatively. However, in most developing countries including Zambia, such benefits may be suppressed due to the presence of EE, a hidden condition that may affect the growth of infants and children more than the overt diseases.

7.4.2 Why did stunting at baseline account for more variance in infant and child growth than at follow-up?

It was interesting to find that stunting at baseline was associated with stunting at follow-up. Since the HAZ at both baseline and follow-up were a result of the infant/child's environment (which may not have changed much), the association may not reflect a causal relationship but rather a continuation of a poor environment and poor child care practices during the follow-up period. Evidence shows that stunting is a chronic disease that develops slowly. The slow onset of stunting may be attributable to exposure to long-term chronic conditions, such as poor diet and care of infants and children, poor nutrition of women, and poor sanitation in households which do not allow adequate growth. Fedorov and Sahn (in Handa & Peterman, 2009:7) define catch-up growth as the "relationship between height in the previous period and height in the current". If there is no significant association found, then the damage incurred in the past does not transmit to the future. However, in this study, a significant relationship was found. It indicates therefore that the poor nutritional status of the infants and children persisted over a year. This may in part be due to some of the factors studied e.g. diseases but may also have been due to factors-which were not studied, such as EE. Some scholars have reasoned that the occurrence of EE in infants and young children most likely worsen the poor growth which could have existed in utero and early childhood, resulting in stunting (Owino et al., 2016). In this case, there is need to study the role of EE in pregnancy outcomes. The results may also explain the tendency for stunting to increase from birth to about 24 months of age, after which it stabilises. As discussed in Chapter 2, EE leads to poor access to and utilisation of nutrients by the body, leading to deficiencies even with adequate diets (Owino et al., 2016; Watanabe & Petri, 2016).

Adverse environmental conditions exist partly due to the effects of poor long-term policies, or inadequate enforcement of policies, that could have a positive effect on reducing infant and child stunting (Aguayo & Menon, 2016). It is expected that if policies are addressed, the chance of reducing stunting to reasonable levels could increase. However, to change the adverse conditions requires the change or reinforcing of policies that support a) infant/child survival leading to improvements in diets, child care practices, water and sanitation, disease prevalence, and access to health services; and b) economic development. Nonetheless, this may not be the case since, according to Joel (2016), economic growth may not lead to public development expenditure, considerable reductions in poverty, and/or increase in equity, which are pathways through which economic growth is expected to assist in reducing stunting in developing countries.

For several decades, the country has been implementing strategies to reduce undernutrition. For instance, since about 1993 the country has been implementing the Infant and Young Child Feeding programme aimed at increasing the rate of appropriate feeding practices. About 24 years later, the country has attained 73% reported exclusive breastfeeding at two months and 45.2% at five months. Infants and children 6-23 months with adequate dietary diversity (food from 4 or more recommended food groups) are still few (19%), while those receiving a minimum number of meals are decreasing (56% in 2009 to 46% in 2013) (CSO et al., 2014). Before blaming other factors for high stunting, infant and child feeding practices should be investigated, due to the low and slow adoption of practices which may increase stunting. These findings describe a continuation of poor conditions in infant and children's lives.

The finding that HAZ at baseline determined the HAZ at follow-up could also be explained by the evidence which has shown that poor growth (especially stunting) starts from birth, and continues to about 2-3 years of age (Shrimpton et al., 2001; Maleta et al., 2003). Other researchers report in utero stunting (de Onis & Branca, 2016; Christian et al., 2013), supporting the presence of adverse environmental factors throughout the lifecycle.

Another factor to consider when regarding perpetual stunting is poverty. Poverty continues to strike societies, limiting their ability to bring about the expected behaviour change, and therefore has an indirect impact on infant and child feeding and care. About 54.4% of the population in Zambia is considered poor, with higher levels in rural (76.6%) than in urban areas (23.4%) (CSO, 2016). The poverty levels could have limited the improvements in some factors, as most of the conditions of our interest are known to occur in areas of high poverty. When poverty is high, people may not afford decent essentials for their families such as good environmental conditions, adequate access to health, and good nutrition. For instance, helminths have been categorised as "diseases of poverty", as they are most common in areas of high poverty (Costa et al., 1987; Brooker et al., 2006; Hotez, 2007; Hotez et al., 2008; Hotez, 2008; Harhay, Horton & Ollliaro, 2010). Similarly, poor WASH practices and high rates of diarrhoea have been reported to occur in the poor 2013; Watanabe & Petri, 2016; Owino et al., 2016).

It is also important to note that some of the factors reported above (improvements in infant/child feeding and care practices, and environmental conditions) have taken several decades to reach the reported levels. While progress is slow, these factors are the anchor for the much needed nutritional change if implemented in a multisectoral approach with convergence at community levels (IFPRI, 2011). Since change in most of these indicators is likely to take several generations, so is the likely change in the stunting rate. The current required global average annual rate of change to reach the WHO 2025 target of reducing stunting by 40% is 3.9% (Onis et al., 2013), *but the actual global* average annual rate of reduction is 2.1% (IARC, 2015), which may even be lower for Zambia. Keeping this in mind, it is not surprising that HAZ at baseline accounted for the large variance in growth at follow-up.

7.4.3 Why was age prominently associated with undernutrition?

Age was found to be a factor in prevalence of undernutrition not only with the ANCOVA analysis but also with the logistic regression. The findings show that younger infants and children had a lower prevalence of undernutrition for all three categories, but showed a higher prevalence of diseases related to WASH factors. However, further analysis with logistic regression shows that older children were less likely to suffer from stunting. Data further show that a quarter of children persisted with stunting a year later, while another quarter became stunted during this time, indicating that many children were reaching the second year of life without recovering from stunting.

Several studies have shown that age is an indicator of when environmental-related diseases are likely to peak, giving an opportunity to intervene for the maximum benefits. The common trend is that diseases start rising rapidly shortly after birth and continue increasing up to about 24 months (Onis & Blössner, 1997). Checkley et al., (2008), in a multi-country analysis of the effects of diarrhoea on infant and childhood stunting, demonstrated that only 10% of infants and children who were stunted before 24 months of age recovered from stunting by 24 months. This evidence supports the finding in this study that 25% of children became stunted in the one year of follow-up. This shows the relationship that exists between age, disease and undernutrition, particularly stunting. The impression is that a high burden of disease and persistent stunting in early childhood is overwhelming.

Prolonged exposure to diseases is a risk factor associated with stunting. It is possible that the impact of disease in early infancy could be responsible for much of the stunting that occurred later in young childhood in the study population. De Onis & Blössner (1997) reported that stunting starts rising at about three months and slows down at around three years of age, after which mean heights run parallel to the reference standard. Humphrey (2009) further elaborated that 25% of all stunting in children around 24 months old may be attributable to having five or more episodes of diarrhoea in the first two years of life.

Another aspect of research has examined early childhood diseases with poor gestational maternal nutrition, resulting in a birth outcome that is prone to environmental-related diseases. Stunting starts from gestation, especially in the first trimester, arising from the poor nutrition of the mother (ACC/SCN, 2000b; Dewey & Khadija, 2010; de Onis & Branca, 2016). Studies in Malawi (Maleta et al., 2003) and India (Mamidi et al., 2011) reported the presence of height (length) faltering at birth, which continued through to about three years of age. Prendergast and Humphrey (2014) and Christian et al., (2013) reported that about 20% of stunting occurs in the womb. This assertion, together with the findings from Malawi and India reported above, supports the findings in the present study which show that much of the growth patterns obtained a year later in the study at follow-up was dependent on HAZ obtained earlier at baseline. Stunting may not be addressed even after birth due to continued poor environment resulting from poor feeding practices, infant/child care practices, inadequate WASH factors, and other factors (Onis & Branca, 2016). Improvements in the feeding and care practices mentioned above can result in an increase in growth as high as four times the mean velocity-for-age (Handa & Peterman, 2009). Therefore, infants/children stunted before 2-3 years of age may be considered as being in a state of failing to grow, which is recoverable with quick action. However, in those above that age who have failed to grow to the required level, the stunting may be irreversible (De Onis & Blössner, 1997; Prendergast & Humphrey, 2014). Nevertheless, some scholars do not support the view that the damage occurring beyond two years is irreversible per se. Rather, they support the view that while there is need to prevent poor growth in early life when most stunting occurs, there is also a need to continue promoting child growth beyond the first two years of life, due to evidence supporting the potential for children to catch-up in growth, learning and cognition even after two years (Chedekel, 2014).

7.4.4 Infant/child growth and disease

Just as for WASH factors reported earlier, no disease was found to be directly linked to stunting. However, some studies have linked stunting to fever (Wamani et al., 2006), diarrhoea (Condon-paoloni et al., 1977; Humphrey, 2009), worm infections (Wamani et al., 2006; Moore et al., 2001), EE (Kosek et al., 2013; Spears, 2013) and other diseases. With the assertion by some scholars (eg. Briend, 1990) that diseases like diarrhoea may not be the main cause of malnutrition, other factors need to be sought.

This study did not find an association between infant and child nutritional status and the availability of WASH services. While there does not seem to be much association between stunting and WASH factors, the present study illustrated an indirect relationship through an intermediate factor - deworming. Deworming was found to be associated with reduced stunting. The relationship stems from the fact that deworming is a treatment for STHs which are associated with a poor unhealthy environment. The most important pathways include poor sanitation, water, personal and household hygiene. Therefore, deworming - and not WASH factors - have been associated with reduced stunting, probably due to it being a closer predisposing factor (in this case, STHs) to stunting than the WASH factors themselves. Treating helminths - a response factor to STHs which are closer to the outcome - provides an immediate solution for removal of the source of poor health in the host, allowing for quick recovery until another infestation occurs. WASH factors, being predisposing factors, work through the immediate causal factors (mediator) of inadequate diet and disease to cause stunting, and therefore may not be the most visible factors associated with stunting.

Moreover, at baseline, most of the infants and children were still young and susceptible to disease, meaning deworming could have been a proxy indicator of worm infestations in the study areas. Worm infestation is a possibility due to the high level of open defecation, use of unsafe water sources, poor disposal of infant/child faeces, the presence of animal faeces, and dirty play areas reported in the study. It is also not surprising that this effect was only in the control group which reported high proportions of poor WASH factors and having treated some STHs.

The finding, that infants and children from household heads with other occupations rather than being a farmer are likely to be less stunted in the control group only, is expected. Chapter 4 showed that income levels are low in these communities, reducing their purchasing power. It could be that families with other sources of income can access more quality diets than those relying on farming only. This calls for concern because only 13.6% of households relied on other occupations for income or food security, while the rest of the households were farmers. In addition, Chapter 4 also showed that the two areas did not differ in the wealth of the households regarding productive assets, quality of the houses they lived in, and ownership of non-productive assets. Farming was their main source of livelihood. It is expected that food production would support household food consumption and that diversification may occur with diversified food production. Though this may be true to some extent, it is important to understand why malnutrition is so high when 75.9% and 89.5% of households own large and small livestock respectively. Also, almost all had land for subsistence (95.3%) and cash crops (71.4%). The question remains whether the animals are utilised to provide meat and milk as a source of protein and micronutrients, or are crops mainly accessed for consumption.

The paradox of having high levels of malnutrition in the midst of plenty of animals and land for farming needs to be well understood in the two areas to develop meaningful interventions. Although data was not available, it was evident from observations that maize and other crop production and consumption was quite high. The concern of non-consumption of animal sources of food lies in the fact that animals are energy-dense, an excellent source of high-quality and readily digested protein, and have a high content of bioavailable micronutrients (Neumann, Harris & Rogers, 2002). However, owning animals does not always translate into addressing malnutrition. In Kenya, it was reported that the number of small livestock owned was positively associated with infants and children being underweight, while ownership of large ruminants increased the number of underweight infants and children, while stunting was not affected by either the number or type of livestock owned by the household (HarvestChoice, 2014).

It is also possible that the high disease prevalence in the two areas could have cancelled out any benefits arising from consumption of animal source foods (Neumann, Harris & Rogers, 2002). As explained in other chapters, infections and parasites divert the nutrients needed for growth, causing some deficit. Illness such as diarrhoea causes poor appetite and loss of nutrients, limiting the amount of foods consumed, while STHs such as Ascaris also cause loss of blood and malabsorption.

Several studies have reported education, especially of the mother, to be a major determinant of stunting or undernutrition (Kavosi et al., 2014; Chhoun, 2016; Habyarimana, Zewotir & Ramroop, 2016). In this study, education showed a small effect on stunting, probably due to a small sample of the mothers who had never been to school.

In summary, the findings showed that the differences in linear growth observed in the two groups (although not significant) may not simply be due to the fact that the experimental group received WASH interventions or services (ANCOVA). Rather, linear growth outcome was affected by other factors, in this case HAZ at baseline, and age differences between baseline and the follow-up period. Further findings showed that deworming, feeding the infant/ child slowly, child age group, and occupation (in the control group) were associated with linear growth, supporting the notion that undernutrition is a multifaceted problem. The reasons why WASH factors did not account for the differences is not clear, but it can be speculated that it could be poor programme design, implementation and monitoring, or the existence of other conditions which have not been considered in the study, such as EE. Contamination of the WASH change process from other areas which could have received the services may also have occurred.

7.5 References

ACC/SCN. 2000. *Low Birthweight: Report of a Meeting in Dhaka, Bangladesh on 14-17 June 1999. Eds. Pojda J and Kelley L. Nutrition Policy Paper #18.* Geneva, Switzerland. Available: http://www.marchofdimes.com/professionals/medicalresources_lowbirthweight.html.

Aguayo, V.M. & Menon, P. 2016. Stop stunting : improving child feeding , women ' s nutrition and household sanitation in South Asia. *Maternal and Child Nutrition*. 12(Suppl.1):3–11. DOI: 10.1111/mcn.12283.

Briend, A. 1990. Is diarrhoea a major cause of malnutrition among the under-fives in developing countries? A review of available evidence. *European Journal of Clinical Nutrition*. 44:611–628.

Brooker, S., Clements, A.C.A., Hotez, P.J., Hay, S.I., Tatem, A.J., Bundy, D.A.P. & Snow, R.W. 2006. The co-distribution of Plasmodium falciparum and hookworm among African schoolchildren. *Malaria Journal*. 5(99):1–8. DOI: 10.1186/1475-2875-5-99.

Checkley, W., Buckley, G., Gilman, R.H., Assis, A.M.O., Guerrant, R.L., Valentiner-branth, P., Lanata, C.F., Black, R.E., et al. 2008. Multi-country analysis of the effects of diarrhoea on childhood stunting. *International Journal of Epidemiology*. 37(June):816–830. DOI: 10.1093/ije/dyn099.

Chedekel, L. 2014. *Consequences of malnutrition may be reversible later in childhood*. Available: https://www.bu.edu/today/2014/consequences-of-malnutrition-may-be-reversible-later-in-childhood/#share-tools [2017, April 17].

Chhoun, P. 2016. Social Determinants of Maternal and Child Undernutrition in Cambodia: A Systematic Review. *International Journal of Food and Nutritional Science*. 3(2):331–337. Available: http://www.ommegaonline.org/article-details/Social-Determinants-of-Maternal-and-Child-Undernutrition-in-Cambodia--A-Systematic-Review/881.

Christian, P., Lee, S.E., Angel, M.D., Adair, L.S., Arifeen, S.E., Ashorn, P., Barros, F.C., Fall, C.H.D., et al. 2013. Risk of childhood undernutrition related to small-for-gestational age and preterm birth in low- and middle-income countries. *International Journal of Consumer Studies*. 42(August):1340–1355. DOI: 10.1093/ije/dyt109.

Condon-paoloni, D., Cravioto, J., Johnston, F.E., Licardie, E.R.D.E. & Scholl, T. 1977. Morbidity and growth of infants and young children in a Rural Mexican Village. *American Journal of Public Health*. 67(7):651–656.

Costa, L.E.M.F.F., Magalhaes, M.H.A., Rocha, R.S. & Antunes, C.M.F. 1987. Water-contact patterns and socioeconomic variables in the epidemiology of schistosomiasis mansoni in an endemic area in Brazil. *Bulletin of the World Health Organization*. 65(1):57–66.

CSO. 2016. *2015 Living Conditions Monitoring Survey (LCMS) Report*. Lusaka, Zambia.

CSO, MOH, TDRC, UNZA & MACRO International. 2014. *Zambia Demographic and Health Survey 2013-14*. Lusaka, Zambia.

Dewey, K.G. & Khadija, B. 2010. *Why stunting matters*. Washington D.C.

Fuller, J.A., Villamor, E., Cevallos, W., Trostle, J. & Eisenberg, J.N.S. 2016. I get height with a little help from my friends: herd protection from sanitation on child growth in rural Ecuador. *International Journal of Epidemiology*. 45(2):460–469. DOI: 10.1093/ije/dyv368.

Gilmartin, A.A. & Petri, W.A.J. 2015. Exploring the role of environmental enteropathy in malnutrition, infant development and oral vaccine response. *Philosophical Transactions of the Royal Society B: Biological Sciences*. 370. DOI: http://dx.doi.org/10.1098/rstb.2014.0143.

Habyarimana, F., Zewotir, T. & Ramroop, S. 2016. Key Determinants of Malnutrition of Children under Five Years in Rwanda: Simultaneous Measurement of Three Anthropometric Indices. *African Population Studies*. 54(3):138–149. Available: http://krepublishers.com/02-Journals/JHE/JHE-54-0-000-16-Web/JHE-54-3-000-16-Abst-PDF/JHE-54-3-138-16-3000-Habyarimana-F/JHE-54-3-138-16-3000-Habyarimana-F-Tx[1].pmd.pdf.

Handa, S. & Peterman, A. 2009. Is there catch-up growth? Evidence from three continents. *JEL Classification*. 1(September):1–39.

Harbron Janetta and Najaar B. 2013. Paediatric food-based dietary guidelines for South Africa: responsive feeding: establishing healthy eating behaviour early on in life. *South African Journal of Clinical Nutrition*. 26(3):141–149.

Harhay, M., Horton, J. & Ollliaro, P.L. 2010. Epidemiology and control of human gastrointestinal parasites in children. *Expert Review of Anti-infective Therapy*. 8(2):219–234. DOI: 10.1586/eri.09.119.Epidemiology.

HarvestChoice. 2014. Available: https://harvestchoice.org/labs/chicken-or-cow-effects-livestock-ownership-animal-source-foods-consumption-and-childhood-nutrit [2017, September 01].

Hotez, P.J. 2007. Neglected diseases and poverty in "'the other America'": the greatest health disparity in the United States? 1(3):1–3. DOI: 10.1371/journal.pntd.0000149.

Hotez, P.J. 2008. Holidays in the sun and the Caribbean's forgotten burden of neglected tropical diseases. *PLoS Neglected Tropical Diseases*. 2(5):1–2. DOI: 10.1371/journal.pntd.0000239.

Hotez, P.J., Bottazzi, M.E., Franco-paredes, C., Ault, S.K. & Periago, M.R. 2008. The neglected tropical diseases of Latin America and the Caribbean: a review of disease burden and distribution and a roadmap for control and elimination. *PLoS Neglected Tropical Diseases*. 2(9):1–11. DOI: 10.1371/journal.pntd.0000300.

Humphrey, J.H. 2009. Child undernutrition, tropical enteropathy, toilets, and handwashing. *Lancet*. 374(9694):1032–1035. DOI: 10.1016/S0140-6736(09)60950-8.

IARC. 2015. *Mycotoxin Control in Low- and Middle- Income Countries: chapter2 child stunting in developing countries*. Geneva, Switzerland: WHO.

IFPRI. 2011. *Working multisectorally in nutrition: principles, practices, and case studies*. J. Garrett & N. Marcela, Eds. Washington, D.C: International Food Policy Research Institute.

Joe William, Rajaram Ramaprasad, and Subramanian S. V. (2016) Understanding the null-to-small association between increased macroeconomic growth and reducing child undernutrition in India: role of development expenditures and poverty alleviation *Maternal & Child Nutrition (2016), 12 (Suppl. 1), pp. 196–209*

Kavosi, E., Hassanzadeh Rostami, Z., Nasihatkon, A., Moghadami, M. & Heidari, M. 2014. Prevalence and Determinants of Under-Nutrition Among Children Under Six: A Cross-Sectional Survey in Fars Province, Iran. *International Journal of Health Policy and Management*. 3(2):71–76. DOI: 10.15171/ijhpm.2014.63.

Kosek, M., Haque, R., Lima, A., Babji, S., Shrestha, S., Qureshi, S., Amidou, S., Guerrant, R.L., et al. 2013. Fecal Markers of Intestinal Inflammation and Permeability Associated with the Subsequent Acquisition of Linear Growth Deficits in Infants. *American Journal of Tropical Medicine and Hygiene*. 88(2):390–396. DOI: 10.4269/ajtmh.2012.12-0549.

Maleta, K., Virtanen, S., Espo, M., Kulmala, T. & Ashorn, P. 2003. Timing of growth faltering in rural Malawi. *Archies of Disease in Childhood*. 88(7):574–578. DOI: 10.1136/adc.88.7.574.

Mamidi, R.S., Shidhaye, P., Radhakrishna, K. V, Babu, J.J. & Reddy, P.S. 2011. Pattern of growth faltering and recovery in under five children in India using WHO Growth Standards - A Study on first and third national family health survey. *Indian Pediatrics*. 48:855–60. Available: http://www.ncbi.nlm.nih.gov/pubmed/21555805.

Mbuya, M.N.N. & Humphrey, J.H. 2016. Preventing environmental enteric dysfunction through improved water, sanitation and hygiene: an opportunity for stunting reduction in developing countries. *Maternal & Child Nutrition*. 12 Suppl 1:106–20. DOI: 10.1111/mcn.12220.

Moore, S.R., Lima, A.A.M., Conaway, M.R., Schorling, J.B., Soares, A.M. & Guerrant, R.L. 2001. Early childhood diarrhoea and helminthiases associate with long-term linear growth faltering. *International Journal of Epidemiology*. 30(6):1457–1464. DOI: 10.1093/ije/30.6.1457.

Neumann, C., Harris, D.M. & Rogers, L.M. 2002. Contribution of animal source foods in improving diet quality and function in children in the developing world. *Nutrition Research*. 22:193–220.

Onis, M. De & Blössner, M. 1997. *Database on child growth and malnutrition*. Geneva.

Onis, M. de & Branca, F. 2016. Childhood stunting: A global perspective. *Maternal and Child Nutrition*. 12(Suppl.1):12–26. DOI: 10.1111/mcn.12231.

Onis, M., Dewey, K.G., Borghi, E., Onyango, A.W., Blössner, M., Daelmans, B., Piwoz, E. & Branca, F. 2013. The World Health Organization's global target for reducing childhood stunting by 2025: rationale and proposed actions. *Maternal & Child Nutrition*. 9(S2):6–26. DOI: 10.1111/mcn.12075.

Owino, V., Ahmed, T., Freemark, M. & Kelly, P. 2016. Environmental Enteric Dysfunction and growth gailure: Stunting in global child health. *Pediatrics*. 138(6):1–10. DOI: 10.1542/peds.2016-0641.

Petri, W.A.P.J., Naylor, C. & Haque, R. 2014. Environmental enteropathy and malnutrition : do we know enough to intervene ? *BioMed Central Medicine*. 12:1–5.

Prendergast, A.J. & Humphrey, J.H. 2014. The stunting syndrome in developing countries. *Paediatrics and International Child Health*. 34(4):250–265. DOI: 10.1179/2046905514Y.0000000158.

Satter M.E. 1986. The feeding relationship. *The American Dietetic Association*. 86:352–356.

Shrimpton, R., Victora, C.G., Onis, M. De, Lima, C., Blo, M. & Graeme, C. 2001. Worldwide Timing of Growth Faltering: Implications for. *Pediatrics*. 107(5):1–7.

Spears, D. 2013. *The nutritional value of toilets: How much international variation in child height can sanitation explain?a*. Delhi, India.

Wamani, H., Nordrehaug, A.S., Peterson, S., Tumwine, J.K. & Tylleska, T. 2006. Predictors of poor anthropometric status among children under two years of age in rural Uganda. *Public Health Nutrition*. 9(3):320–326. DOI: 10.1079/PHN2005854.

Watanabe, K. & Petri, W.A. 2016. Environmental Enteropathy : elusive but significant subclinical abnormalities in developing countries. *EBioMedicine*. 10:25–32. DOI: 10.1016/j.ebiom.2016.07.030.

CHAPTER 8: CONCLUSIONS, RECOMMENDATIONS AND LIMITATIONS

8.1 Conclusions

Overall, the findings show that WASH services and practices were not the only major determinants of undernutrition in infants and young children, but rather that the nutritional status of infants and children at the baseline study were. However, results still indirectly point to WASH factors as critical factors through some proximate determinants such as disease and parasite infestations. The findings in this study suggest that interventions to address the proximate determinates (infant/child feeding, care, WASH, and access to health) are key in preventing or controlling stunting in the study areas. Addressing the proximate determinants is the basis for preventable disease control. However, more research may be required to understand the existence and contribution of other factors to address the situation. Furthermore, the findings show differences in the levels of WASH practices. Although the experimental group showed better WASH practices in most of the key factors, including a source of drinking water, toilet availability and type, there were still high levels of poor practices in both communities. Such practices include exposure to faecal matter through unsafe sanitation facilities, poor disposal of infant/child faeces, and open defecation, which enhance exposure to pathogens. Pathogens tend to contaminate the food, water, cooking and infant/child play areas, or can be directly absorbed through dirty fingers, and other dirty surfaces and objects.

The adverse conditions reported above were to some extent responsible for the high prevalence and frequency of WASH-related diseases in both the control and experimental groups, which were higher than the national prevalence. The prevalence was higher among younger than older children. None of the WASH factors showed a direct relationship with the four common diseases among infants and children in the two areas, but did show an indirect relationship with other factors which included deworming and household size, regular cleaning of toilet, and mother's hygiene.

In addition to disease and poor WASH services and practices, the prevalence of stunting was high (one third of infants and children) in both groups. The findings showed no differential stunting levels between the experimental and control groups, questioning the role of WASH services in infant/child health and nutrition, particularly after demonstrating a higher risk profile due to poorer WASH outcomes and higher disease prevalence in the control group. Also, more children became stunted as they were growing older, despite the reduction in disease prevalence.

The ANCOVA was used to test whether the experimental group had better nutrition status, and whether the differences were because the experimental group received WASH services. The conclusion was that the differential linear growth observed in the two groups, though not significant, may not simply be due to the fact that the experimental group received WASH interventions or services. Rather, the linear growth outcome was heavily affected by other factors, in this case HAZ at baseline, and age difference between baseline and follow-up. The logistic regression analysis further showed that deworming, feeding the infant/child slowly, infant/child age group, and occupation of head of household (control only) were associated with linear growth, supporting the notion that undernutrition is a multifaceted problem. The reason why WASH factors did not account for much of the difference is not clear. However, the Proximate Determinant Conceptual Framework shows that WASH facctors are an intermediary variables between the underlying/distal variable (age) and the outcome variable (stunting), therefore, age operates though WASH factors to bring about stunting. This implies that it has an underlying influence on stunting. It can also be speculated that it could be poor programme design, implementation and monitoring; low level of education of the mothers; or the existence of other conditions which have not been considered in the study, such as EE. It is also possible that WASH information could have filtered into the control group from other areas which have received the services.

The implications for not adequately addressing poor WASH practices would ultimately have a continued impact on infant/child survival. This is not only regarding high levels of morbidity and undernutrition in the two areas, as highlighted in the earlier chapters, but also future gain due to reduced cognitive development, poor school performance, and stunting affecting the reproductive outcomes.

8.2 Recommendations

The research was undertaken to address the gap in information regarding the relationship between water, sanitation and hygiene, and the growth and health of infants and children in a specific area of Zambia. The idea was to evaluate an area that had good WASH facilities and one which did not. The research was meant to generate information that would inform decision-making regarding the implementation of programmes related to WASH interventions and nutrition to improve infant and child survival. The recommendations made in this section use findings from the data collected in the two areas, and the literature review. The intended users are stakeholders working in the areas of food and nutrition, WASH, agriculture, social welfare or protection, in programming, policy-making and research.

8.2.1 Improving environmental conditions

Considering the indication of high levels of contact with faeces in households in both areas as a result of limited and unsafe sanitation facilities, poor disposal of infant/child faeces, visible animal faeces in the yard, poor garbage disposal, dirty yards, and small livestock kept in the house, there is a need to find ways of breaking the barriers to dealing with limited or unsafe sanitation practices. Currently, Zambia is promoting sectors involved in nutrition programming to implement high impact nutrition programmes in the same area and targeting the same households (convergence). Convergence ensures that all targeted households should receive a package of interventions promoting crop and dietary diversity, WASH services and practices particularly nutrition education, and other infant/child feeding and care interventions such as the Infant and Young Child Feeding programme, and micronutrient supplementation. Implementing interventions to control stunting without addressing the barriers to safe sanitation, such as open defecation, unsafe disposal of infant/child faeces, and poor sanitation facilities, means that Zambia may not achieve its intended goal of reducing undernutrition and mortality among under-five children.

8.2.2 Expanding the objectives and components of the WASH programme in Monze

This study could not easily verify the role of WASH factors in infant and child growth as seen from the results which indicated non-differential stunting between the control and experimental group. The possible explanation could be because of some hidden outcome from the poor WASH factors which were not included as part of the study or as part of the programme such as EE. The WASH programme in Monze needs to consider incorporating a deliberate action to understand the situation of EE in their programme areas to confirm whether the lack of difference in infant and child stunting in the study areas could be associated with EE, the current silent factor in infant/child health, especially in developing countries like Zambia.

However, seeing overwhelming evidence from the literature of the relationship between growth and EE, and between EE and poverty, it is important to consider understanding of EE to guide programming and proper use of resources. Continued implementation without taking such factors into consideration may not make efficient use of resources. The benefits to infant and child growth may be minimal.

8.2.3 Intensifying awareness of WASH services to change behaviour

To bring about the expected change in infant and child growth, the country needs to continue with the message of the need to have a clean environment. However, this may be challenging because currently about 44% and 65% of the population have access to safe sanitation and water, respectively, a requirement to prevent pathogen entry into the body.

The country therefore needs to intensify awareness of WASH services to change behaviour, with consistent monitoring to identify key reasons for non-adherence to good practices. A supply of major WASH elements such as boreholes should be advocated in poor communities, especially rural areas.

8.2.4 Improving national programming

The major form of undernutrition in Zambia is linear growth deficit (stunting), which is known to rob infants, children and adults of their full potential to contribute to national development. Considering how critical linear measurements are in determining infant and child growth, there is a need to hasten the inclusion of height measurements in the GMP sessions. This would provide on-the-spot nutrition monitoring and promotion that would help households address stunting before children are two years of age, when there would still be an opportunity to reverse it. Height measurements would further provide up-to-date trends of stunting in the country, which is key for nutrition programming, and identifying areas that need emergency attention, complementing the current data that provides stunting rates at the provincial level only.

Attention should be paid to improving nutrition during pre-pregnancy, pregnancy and lactation to ensure healthy birth outcomes and early childhood growth. Right from birth, adequate and appropriate feeding and care practices including improving complementary feeding practices should be emphasised to ensure good nutrition in the early years of life. To address the above issue requires tackling the main underlying problem, which is poverty.

Addressing poverty is likely to improve other distal factors such as education, income levels, gender inequalities, and predisposing factors such as WASH, food security, and care practices.

Poverty reduction programmes that improve the economic situation of the households and the provision of adequate social and health services are urgently needed. This is especially the case in rural areas, which have a bigger share of poverty. As evidence shows, if most interventions are effectively and efficiently targeted during the first 1000 days, when most benefits are seen, the country is likely to see a reduction in disease and thus a reduction in undernutrition over the years.

WASH interventions should be accompanied by the initiatives for improving livestock management practices to reduce infants/children's exposure to animals and animal faeces. Agriculture and the nutrition sector need to work together to ensure adequate and non-conflicting messages regarding livestock rearing.

Since messaging on WASH factors has been focused more on adult excreta and less on animal and infant/child faeces disposal, health promotion should consider emphasising the message of the impact of animal faeces on human health and of the disposal of infant/child faeces.

8.2.5 Addressing the information gap

This study shows that there was no difference in the way infants and children were growing among the WASH-serviced and non-serviced communities including questioning the quality of WASH services that were provided in the serviced area (experimental group). It may also indicate a lack of focus on key variables closely associated with growth, such as EE. Based on the global evidence of the impact of EE on infant and child growth, the country needs to seek to understand the extent of EE.

There is also need for a study to understand why reducing stunting is so slow in Zambia meaning that it will take a long time to achieve the required target of reduction in malnutrition. Considering that not many differences were seen in infant and child growth between the experimental and control groups, the areas could be experiencing similar challenges to the rest of the country.

8.3 Limitations of the study

Several limitations of the study need to be mentioned. Since some of the information was reported by the respondents, there is the possibility of over-reporting positive actions to impress the interviewer. These outcomes are thus subjected to reporting bias. However, most of the information was collected using both self-reporting by respondents, and observation by the interviewer of things like the sanitation, water and hygiene situation.

Only one follow-up was conducted a year later, at the same time of year as the baseline, and both periods were at the end of the rainy season. Conducting a midline follow-up around October when the country is dry would have provided a better picture of disease pattern, food consumption, and even nutritional status.

The study did not collect data on HIV status of children as a confounder of growth or illness. It is possible that there could have been a high HIV prevalence in one of the areas, which could have impacted on (leading to underestimation) infant and child growth, or could have explained the lack of significant difference in infant/child growth in the two areas.

Reporting on diseases partly depended on the infants/child's hospital treatment record, which did not capture illnesses not reported to the health facility. The non-capturing of illnesses not reported to the health facility could have led to underestimation of diseases children suffered during the study period. In addition, respiratory infections were noted as coughing, without distinguishing between lower tract respiratory tract infection and upper tract respiratory tract infections. In this study, it was also difficult to calculate disease incidence rate ratio because the study relied on hospital data which did not capture illnesses which were not reported at the health centre. This was due to lack of close follow-up between the two phases to capture all infants and children who developed diseases, and whether or not the caregiver sought treatment.

The sample obtained was lower than sample which on the face value suggests a significant non-participation bias. it is possible that this non participation bias could be present in the sample, however, it was also observed that the estimation for estimated sample was from the Zambia Demographic survey which is at country and provincial level which might be significantly different from the estimation for this population, however, because in this population we included in our sample all that consented and only _1- refused (Figure 0-1) representing decreasing (1%) non participation rate. Therefore, it was concluded that the influence due to non-participation is insignificant in our sample and the difference between estimated and realised sample is only due to wrongly estimated the proportion for underweight for this community.

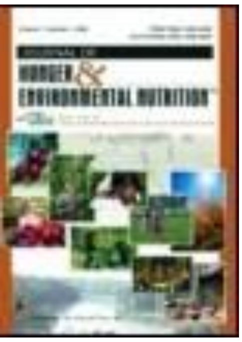
Contribution of this PhD

The thesis has contributed to the body of knowledge on the relationship between WASH factors and nutrition. It has clearly illustrated that although an association of WASH factors and nutrition exists, it is not a direct relationship as there are several pathways through which WASH factors have to function to cause malnutrition. The thesis has managed to further show that many factors are involved in leading to malnutrition including that by addressing WASH factors alone, the country may not be able to reach its target of addressing the reduction of malnutrition. In addition, the findings contribute to evidence regarding the effects of poor WASH services on the nutritional status of infants and children which is lacking in Zambia. It answers the call by policy makers to develop local research to understand the Zambian situation. It is hoped that the evidence will contribute to nutrition programming particularly in addressing WASH factors and nutrition.

Furthermore, the research demonstrated the important role of one of the rarely researched components of responsive feeding –"feeding the child slowly"- as one of the key components associated with malnutrition (appendix 1). With such evidence, the responsive feeding practices should be promoted in communities along with other interventions targeted at improving the lives of infants and children.

APPENDICES

1.0 Article: Feeding the child slowly



Taylor & Francis
Taylor & Francis Group

Journal of Hunger & Environmental Nutrition

ISSN: 1932-0248 (Print) 1932-0256 (Online) Journal homepage: http://www.tandfonline.com/loi/when20

"Feeding a child slowly:" a responsive feeding behavior component likely to reduce stunting: Population-based observations from rural Zambia

Raider H. Mugode, Thandi Puoane, Charles Michelo & Nelia P. Steyn

To cite this article: Raider H. Mugode, Thandi Puoane, Charles Michelo & Nelia P. Steyn (2017): "Feeding a child slowly:" a responsive feeding behavior component likely to reduce stunting: Population-based observations from rural Zambia, Journal of Hunger & Environmental Nutrition, DOI: 10.1080/19320248.2017.1403409

To link to this article: https://doi.org/10.1080/19320248.2017.1403409

Published online: 21 Dec 2017.

JOURNAL OF HUNGER & ENVIRONMENTAL NUTRITION
https://doi.org/10.1080/19320248.2017.1403409

Taylor & Francis
Taylor & Francis Group

"Feeding a child slowly:" a responsive feeding behavior component likely to reduce stunting: Population-based observations from rural Zambia

Raider H. Mugode[a], Thandi Puoane[b], Charles Michelo[c], and Nelia P. Steyn[d]

[a]National Food and Nutrition Commission, Lusaka, Zambia; [b]Department of Public Health, School of Medicine, University of the Western Cape, Cape Town, South Africa; [c]School of Medicine, University of Zambia, Lusaka, Zambia; [d]Department of Human Biology, Division Human Nutrition, University of Cape Town, Cape Town, South Africa

ABSTRACT
Zambia has a very high prevalence of stunting (40%). Child feeding behaviors such as "feeding the child slowly" are now receiving attention in addressing child undernutrition, particularly stunting. A study was undertaken in two rural areas of Zambia and mothers of 295 children 6–24 months old were questioned about their feeding behaviors including "feeding a child slowly." The study found reduced stunting among children older than one year who were fed slowly, had been dewormed, and consumed thicker (more energy-dense) foods. It is recommended that these feeding practices should be incorporated in health promotion interventions to reduce the burden of malnutrition.

KEYWORDS
Feeding slowly; feeding behaviors; stunting; children; undernutrition; malnutrition; food security

Introduction

Globally, 25% of the children are stunted, 15% underweight, and 8% wasted.[1] In sub-Saharan Africa, 40% were stunted and 21% were underweight in 2011.[2] In Zambia, in 2014, 40% children were stunted and 15% were underweight.[3] Malnutrition is an indirect cause of child mortality and is attributed to about 35% of child deaths globally.[4] Numerous consequences of undernutrition have been documented, including late school entry, poor educational attainment, early school dropout, high morbidity and mortality, economic losses due to decreased work ability,[5] poor reproductive outcomes in terms of fetal death, low birth weight, obstructed labor, and increased risk of chronic diseases in adulthood.[4,6]

Feeding behaviors have been recognized as being key to infant and child survival, in addition to focusing on food intake and disease control.[7] One such behavior is feeding the child slowly, a component of responsive feeding behavior. Responsive feeding entails an active way to motivate infants and children to eat by means of interactive behaviors between the mother/

CONTACT Nelia P. Steyn nelia.steyn@uct.ac.za Division Human Nutrition, University of Cape Town, P/Bag X3, Observatory, 7925, South Africa.

caregiver and the child.[8] These include assisting the infant or child to eat; feeding with love, slowly and with patience; experimenting with different foods; and minimizing distractions during meals.[9,10] Responsive feeding has long been recognized as a key element in determining child nutritional status. Responsive feeding encompasses the behavior of both the mother and the child being able to respond to each other during feeding.[11] While the role of the mother is to provide quality and appropriate activities in a positive and supportive environment, including speed of feeding,[12] the child should be allowed to feed slowly or at its own pace. Similarly, controlling feeding behaviors such as forcing the child to eat, unattended self-feeding, and dietary restrictions can lead to less food intake, placing the child at risk of malnutrition.[11–16]

Responsive feeding is among the child-care practices that are known to increase child food intake and reduce the risk of disease.[8,12] This is in addition to feeding-care practices (breastfeeding, appropriate complementary feeding) and preventive health-care practices (immunizations, supplementation, deworming, prompt health-seeking behavior, safe sanitation, and safe drinking water).[16,17] These behaviors are known to increase food intake, leading to a reduction in child undernutrition.[8,12] In addition, responsive feeding builds emotional bonding between the pair, which is necessary for healthy growth.[5,8] An abundance of evidence exists on the causes of undernutrition, including a high demand of nutrients for growth, poor food intake, poor feeding behaviors, and diseases.[18] Food intake is affected by the status of household food security, child-care and feeding practices, and diseases.[17] Among all these causes, child-care practices, especially interactive behaviors during feeding, have received little attention when designing nutrition interventions,[16] yet are an important element in improving dietary intake to reduce undernutrition.[3,9,10,16]

The purpose of the present study was to determine whether feeding the child slowly is associated with lower levels of stunting among young children. The data presented forms part of the first phase (cross-sectional baseline) of a cohort study aimed at evaluating the effect of poor water, poor sanitation, and poor hygiene practices on the nutritional status of children aged 6–24 months over a period of 12 months.

Methods

Population and setting

The study was conducted in the Monze district, which is about 200 km from the capital city of Lusaka in Zambia. The District Health Office identified study areas with a high prevalence of undernutrition, and purposively selected Hamangaba and Monze. In addition to a high prevalence of stunting in each of these communities, these locations were also selected based on their level of exposure to clean water and good sanitation. However, although the two areas are found approximately 114 km apart, in both areas people depend on agriculture and animal production for their livelihood, with the majority being small-scale farmers. The target group was households with children aged 6–24 months of age. Children with physical disabilities (e.g. disabled children) and children who were ill at the time of the study were excluded from the study.

Study design & sampling

This was a cross-sectional study. Study sites were selected purposely by the District Health Office targeting two areas: Njolamwanza, which was predominantly serviced with safe water and sanitary facilities, and Hamangaba, a poorly serviced area (control). This was a requirement of the main study, which aimed at examining the nutrition and health status of children in the two different areas that could be classified as exposure and control for the purpose of comparison. Census standard areas (CSAs) and standard enumerator areas (SEAs) were used to sample households using maps. Households in the study areas were listed to enable the random selection of households. A total of 295 households with children between 6 and 24 months were randomly selected; Njolamwanza (n:140) and Hamangaba (n:155). Only one child per household was selected randomly from children in the household between 6 and 24 months.

Data collection

Among the selected respondents, interviews and observations were conducted using a questionnaire and observation checklist, respectively, to collect information on socioeconomic and demographic factors, nutrition variables, anthropometric data, water, sanitation, and hygiene information. The data were collected by enumerators who were trained in anthropometric measurements and questionnaire administration. Anthropometric measurements were taken during data collection at household visits. Children's weights were measured using a Salter scale to the nearest 0.1 kg. The length (measurement in recumbent position) was measured to the nearest 0.1 cm using a length-measuring board as recommended for infants and young children 0–24 months or less than 85 cm.[19]

The variable "feeding slowly" (with patience in an interactive manner) was measured as a single variable and as one of the ways among the several elements of responsive feeding (trying different foods, asking someone else to feed the child, helps the child to eat, and does not force-feed the child) mothers/caregivers use to motivate their children to eat, especially when they feel that the child has not eaten enough. A multiple-response questionnaire required the enumerator to mark all the ways the mother/caregiver indicated they used to motivate their children to eat.

The variable "type of food given to the child" was defined by two categories of thickness of porridge. The texture of thick porridge allows it to stay easily on the spoon without running off when the spoon is tilted, while thin porridge is the opposite of thick. The porridge pours out of the spoon when tilted. It is often fed from a cup or poured from the hand.

A food consumption score (FCS) was calculated by adding the frequency of consumption of different food groups by the child during the seven days before the survey.[20] The FCS has been validated by the World Food Programme (WFP) for use in community household surveys as a proxy indicator of food security.[20] Mothers/caregivers were asked to recall how many days in a week the child was given certain foods from eight groups (e.g. starches, legumes, fruits, vegetables, dairy, meats, oil, and sugar), which was multiplied by its weight to create a score. The weighted score ranges from 0 to 112. Three categories (as defined by WFP) of poor (0–21), borderline (21.5–35), and acceptable (>35) food intake were used to determine the levels of food intake.

The World Health Organization (WHO) and United Nations Child Fund (UNICEF)[21]provided the guide for quality of water as safe or unsafe water grouped as "improved" and "unimproved" water sources. An "improved water source" includes a piped water supply into the dwelling, piped water to a yard/plot, a public tap/standpipe, a tube well/borehole, a protected dug well, a protected spring, and rainwater. An "unimproved water source" includes an unprotected well, an unprotected spring, a cart with a small tank/drum, a water tanker-truck, and surface water.

Data analysis

The Emergency Nutrition Assessment (ENA) for Standardized Monitoring and Assessment of Relief and Transitions (SMART) programme[22] was used to calculate the z scores used to determine the nutritional status of children using three anthropometric indices: weight-for-height, height-for-age, and weight-for-age. These were compared with the WHO growth standards using the ENA package. Malnutrition was determined as the proportion of children below −2 and −3 standard deviations (SDs) (z-scores) of all of the three indices, while overweight was the proportion of children with a weight-forheight above +2 z-scores.[6,19,23] IBM SPSS version 20 (Armonk, NY: IBM Corp.) was used for the other analyses. Prior to analysis, data were entered using the Epi data package.[24] Thereafter, the first analyses were descriptive analyses of socio-demographic variables and other key variables, namely socioeconomic, demographic, water, sanitation and hygiene, and nutritional status. Logistic regressions were used to derive the association between these variables and the outcome variable, stunting. Prevalence was standardizedfor-age using the national census (2010) in order to control for changes in the age structure. Cross-tabulations were conducted with stunting as the outcome variable to test for bivariate relationships.

Significant variables and other important variables that were not significant were placed in a multivariate logistic regression model to determine the associations of predictors in relation to the outcome variables. The distribution of age as a continuous variable conformed to normality as assessed by probability plots. Interactions were studied using the likelihood ratio test, and when identified, the terms were computed to allow estimation of the statistical effect of one of the variables separately for each level of the effectmodifying variable. Model diagnostics were performed using the maximum likelihood estimation (MLE) and the Hosmer–Lemeshow goodness-of-fit. The variables in the model were feeding slowly, being adjusted for age of child and mother, sex of child and household head, number of meals per day, thickness of food given to the child (whether pouring or dropping (thick) consistency), diseases suffered two weeks before the survey, vaccinations, deworming, water quality, hygiene status of mother and child, household size, and occupation of the household. Child age and type of food given were further adjusted between stunting and feeding slowly as likely cofounders.

Ethics

The protocol was approved by the ethics committee of the University of the Western Cape and Biomedical Ethics Committee of the University of Zambia, Ridgeway Campus (Assurance No. FW A00000338 IRB00001131 of IORG0000774). Permission was also granted by the Ministry of Health and the District Medical Office in Monze. Informed signed consent was obtained from the mothers/caregivers of the participating households. The research presented no known risks associated with participating in the study, and neither were there any direct benefits to the participants.

Results

Participation and distribution

The sample included 295 participants and the mean age of children was 14.4 (SD 5.9) months, of which 54% were females and 46% were males (Table 1). The median age was 14.7 (IQR 8.8, 19.6) months. The households were mainly headed by males who were middle-aged, and the majority had only attained a primary education. Unlike household heads, most mothers/caregivers were in the early childbearing age period, having mostly attained a

Table 1. Socio-demographic data for households with infants 6–24 months in the study areas.

	Overall	Hamangaba N = 155	Njolamwanza N = 140	
Variable	N (%)	N (%)	N (%)	P value
Age of household head 15–30 years	96 (33.0)	51 (33.1)	45 (32.8)	0.97
31–45 years	126 (43.3)	66 (42.9)	60 (43.8)	
Over 45 years	69 (23.7)	37 (24.0)	32 (23.4)	
Sex of household head Female	42 (14.3)	24 (15.5)	18 (12.9)	0.63
Male	252 (85.7)	131 (84.5)	121 (87.1)	
Marital status of household head				0.13
Not married	40 (13.7)	17 (11.1)	23 (16.5)	
Married	252 (86.3)	136 (88.9)	116 (83.5)	
Education level of household head				0.05
None	9 (3.1)	2 (1.3)	7 (5.1)	
Primary	158 (54.1)	92 (59.7)	66 (47.8)	
Secondary	112 (38.4)	53 (34.4)	59 (42.8)	
Above secondary	13 (4.5)	7 (4.5)	6 (4.3)	
Age of mother 15–30 years	186 (63.7)	96 (63.2)	90 (64.3)	0.26
31–45 years	93 (31.8)	51 (33.6)	42 (30.0)	
Over 45 years	13 (4.5)	5 (3.3)	8 (5.7)	
Education of mother/caregiver None	6 (2.5)	1 (0.8)	5 (4.4)	0.05
Primary	139 (58.4)	81 (64.8)	58 (51.3)	
Secondary	89 (37.4)	42 (33.6)	47 (41.6)	
Above secondary	4 (1.7)	1 (0.8)	3 (2.7)	
Occupation household head				0.09
Farmer	235 (86.4)	126 (89.4)	109 (83.2)	
Teacher	8 (2.9)	3 (2.1)	5 (3.8)	
Businessman	15 (5.5)	9 (6.4)	6 (4.6)	
House/farmer worker	7 (2.6)	1 (0.7)	6 (4.6)	
Driver/conductor	3 (1.1)	1 (0.7)	2 (1.5)	
Other occupations	4 (1.5)	1 (0.7)	3 (2.3)	
Household size ≤ 5	200 (67.8)	101 (65.2)	99 (70.7)	0.40
>5	95 (32.2)	54 (34.8)	41 (29.3)	
Total income of household				
<100	83 (28.4)	45 (29.2)	38 (27.5)	0.77
101–1000	169 (57.9)	89 (57.8)	80 (58.0)	
>1000	40 (13.7)	20 (13.0)	20 (14.5)	
Sex of children Female	158 (53.7)	88 (56.8)	70 (50.4)	0.08
Male	136 (46.3)	67 (43.2)	69 (49.6)	
Age of child below 12 months	126 (42.7)	77 (49.0)	50 (35.7)	0.01*
between 12 & 18 months	90 (23.7)	36 (22.6)	35 (25.0)	
above 18 months	99 (33.6)	44 (28.4)	55 (39.3)	
Water quality unimproved (unsafe)	86 (29.3)	67 (44.4)	19 (13.3)	<0.001***
Improved (safe)	208 (70.7)	84 (55.6)	124 (86.7)	

*p < 0.05, ***p < 0.001

primary education. Farming was the main livelihood activity in the study areas.

Child malnutrition

The two areas were generally comparable, except for age distribution, education status of the mother/caregiver (p = 0.045), and water quality by which the two areas differed significantly. Overall, the prevalence of stunting was

Table 2. Prevalence of malnutrition among children 6–24 months in the study areas.

		Severe(<-3 z-score)	Moderate (≥ −3 and <-2 z-score)	Normal (≥ −2 z score)	
	N	N (%)	N (%)	N (%)	p -value
Wasting					
Total	288	7 (2.4)	12 (4.2)	249 (86.5)	0.342
Hamangaba	153	6 (4.1)	6 (4.1)	126 (85.1)	
Njolamwanza	135	1 (0.7)	6 (4.3)	123 (87.9)	
Stunting					
Total	292	33 (11.3)	65 (22.3)	194 (66.4)	0.561
Hamangaba	150	12 (8.0)	36 (24.0)	102 (68.0)	
Njolamwanza	142	21 (14.8)	29 (20.4)	92 (64.8)	
Underweight					
Total	290	3 (1.0)	32 (10.7)	256 (88.3)	0.682
Hamangaba	148	2 (1.4)	17 (11.5)	129 (87.2)	
Njolamwanza	142	1 (0.7)	14 (9.9)	127 (89.4)	

33.6% (95%CI 28.18%, 39.02%) and did not differ significantly between the two areas: 32% versus 35.2% for Hamangaba and Njolamwanza, respectively (p = 0.17) (Table 2). In contrast, the proportion of underweight was much lower than stunting: 12.9% in Hamangaba and 10.6% in Njolamwanza . The overall proportion of wasting was 6.6%, being 8.2% in Hamangaba and 5% in Njolamwanza. There were no statistical differences between the two areas regarding stunting, underweight, and wasting.

Responsive feeding practices and general feeding practices

Responsive feeding practices observed during the study are shown in Table 3. Overall, it is interesting to note that only 10.2% of mothers/caregivers fed their children slowly and only 35.1% helped their children to eat. Less than 30% tried another food and less than 10% asked another person to feed the child. On the positive side, a low percent (6.7%) forced their children to eat. Table 4 provides data on general feeding practices. In the youngest age group, more than 87% of the caregivers reported giving children less than

Table 3. Responsive feeding practices among children 6–24 months in the study areas.

Responsive feeding practices	Overall Number (%)	Hamangaba Number (%)	Njolamwanza Number (%)
Helps child to eat Yes	99 (35.1)	48 (33.1)	51 (37.2)
No	183 (64.9)	97 (66.9)	86 (62.8)
Does not force-feed child Yes	264 (93.3)	9 (6.2)	10 (7.3)
No	19 (6.7)	137 (93.8)	127 (92.7)
Tries another food Yes	74 (26.1)	39 (26.7)	35 (25.5)
No	209 (73.9)	107 (73.3)	102 (74.5)
Feeds slowly (patiently) Yes	29 (10.2)	21 (14.4)	8 (5.8)
No	254 (89.8)	125 (85.6)	129 (94.2)
Asks another person to feed the child Yes	17 (6.0)	5 (3.4)	12 (8.8)
No	266 (94.0)	141 (96.6)	125 (91.2)

Table 4. Child feeding practices by age among children 6–24 months living in Monze District.

Variable	Overall No. (%)	≤12 months No. (%)	>12 months No. (%)	p
No. of main meals/day				
<3 meals/day	39 (13.9)	34 (87.2)	5 (12.8)	0.000
≥3 meals/day [a]	241 (86.1)	72 (29.9)	169 (70.1)	
No. of snacks/day				
<2 snacks	250 (89.6)	100 (40.0)	150 (60.0)	0.017
≥2 snacks[b]	29 (10.4)	5 (17.2)	24 (82.8)	
Reduced child meal sizes [c]				
Yes	62 (22.7)	21 (33.9)	41 (66.1)	0.656
No	211 (77.3)	78 (37.0)	133 (63.0)	
Not eat the ad lib [d]				
Yes	18 (6.7	7 (38.9)	11 (61.1)	0.779
No	250 (93.3	89 (35.6)	161 (64.4)	
Food consumption score [e]				
≤35 point score	41 (14.4)	29 (70.7)	12 (29.3)	.000
>35 point score	243 (85.6)	81 (33.3)	162 (66.7)	

[a] Ideally the child should have three meals a day [b] Ideally the child should have at least two snacks a day [c] Meals are reduced in size when the home is food insecure [d] Feeding times are reduced and child does not eat whenever hungry [e] A score of at least 35 is acceptable. Less indicates food insecurity

three meals a day, while this decreased to 12.8% in the older group. It is interesting to note that in the older group, 82.8% of caregivers reported giving children two or more snacks (between meals) a day. Caregivers reported reducing meal sizes in one-third of the young children and twothirds of the older children. Seven percent of caregivers reported that children were not allowed to eat all day (ad lib) due to a lack of food in the home at times. In terms of having an FCS greater than 35, which is regarded as being acceptable, 66.7% of the older group met this criteria. However, only 33% of the younger children had an FCS greater than 35.

Factors associated with stunting

Overall, multivariate analysis showed that feeding the child slowly, together with age group and deworming, were predictors of stunting (Table 5). In children where the practice of feeding the child slowly was reported, stunting was less prevalent than in children where this was not practiced [AOR (adjusted odds ratio) 0.28; 95% CI: 0.11, 0.72]. This was the most prominent when the food ingested was thick [OR 0.46; 95% CI: 0.23, 0.92]. In addition, data from both study areas showed that stunting was less likely in children older than one year than in the younger age group [AOR 0.26; 95%CI: 0.11, 0.61] as well as in children who had been dewormed [AOR 0.50; 95% CI: 0.26, 0.95], which was the case in Hamangaba [AOR 0.24; 95% CI: 0.09, 0.64] but not in Njolamwanza. Feeding the child slowly in children older than one year showed a much stronger reduced likelihood of stunting than younger children not fed slowly [AOR 0.32;

Table 5. Association of "feeding slowly" with stunting (height for age < −2SD) among infants 6–24 months in the study areas.

Predictor	Prevalence Total (%)	Univariate: Pooled OR (95% CI)	Multivariate: Hamangaba OR (95% CI)	Multivariate: Njolamwanza OR (95% CI)	Multivariate: Pooled OR (95% CI)
Feeding child slowly Yes	29 (10.2)	0.45 (0.21–0.98) p 0.045*	0.23 (0.08,1.02) p 0.054	0.16 (0.02,1.32) p 0.089	0.28 (0.11, 0.72) p = 0.008**
Sex of child Male	136 (46.3)	0.82 (0.50,1.34) p 0.427	1.03 (0.40,2.66) p 0.955	0.58 (0.24, 1.36) p 0.208	0.76 (0.42, 1.35) p 0.347
Age of child >12 months	174 (59.0)	0.22 (0.13,0.39) p 0.000***	0.29 (0.08,0.95) p .040*	0.23 (0.06,0.88) p 0.032*	0.26 (0.11,0.61) p 0.002**
No. of main meals >2meals	241 (86.1)	0.43 (0.19,0.98) p 0.045*	1.19 (0.29,4.86) p 0.805	0.69(0.10,4.92) P 0.712	1.09 (0.39,3.00) p 0.875
Child's diseases None	37 (12.6)	0.49 (0.24,0.97) p 0.042*	1.78 (0.37,8.57) p 0.473	0.37(0.12,1.12) p 0.077	0.64 (0.26, 1.51) p 0.310
Sex of household head Male	252 (85.7)	1.16 (0.58,2.31) p 0.671	0.88 (0.24,3.23) p 0.848	0.580 (0.16,2.15) p 0.414	0.10 (0.39, 2.07) p 0.802
Household size 5≤members	200 (67.8)	1.23 (0.72,2.09) 0.443	0.71 (0.23,2.16) 0.545	1.69 (0.64,4.44) p 0.291	1.14 (0.57, 2.25) p 0.716
Age of the mother >31 years	106 (36.3)	0.64 (0.38,1.05) P 0.076	0.66 (0.25,1.75) p 0.402	0.97(0.39,2.40) p 0.941	0.78 (0.42, 1.44) p 0.426
Water Safe	208 (70.7)	0.82 (0.48,1.41) p 0.474	0.92 (0.35,2.48) p 0.876	0.64(0.16,2.50) p 0.519	0.96 (0.50, 1.87) p 0.906
History of deworming Yes	147 (50.7)	0.35 (0.21, 0.59) p .000***	0.24 (0.09,0.64) p .004**	0.96(0.36,2.56) p 0.939	0.50 (0.26, 0.95) p 0.035*
Vaccinations Yes	204 (69.2)	0.32 (0.17,0.58) p 0.000***	0.63 (0.19,2.07) p 0.447	1.32(0.37,4.76) p 0.670	0.98 (0.44, 2.18) p 0.962
Type of food given Thick food	221 (79.8)	0.46 (0.23, 0.92) p 0.027*	0.78 (0.19,3.11) p 0.725	1.16 (0.25,5.43) p 0.852	0.88 (0.34, 2.27) p 0.788
Occupation household head Other occupations[a]	37 (13.6)	0.54(0.27, 1.10) p 0.090	0.20 (0.04,0.90) p .036*	1.37(0.44,4.22) p 0.585	0.63 (0.28, 1.46) p 0.283
			Hosmer and Lemeshow test = 0.282 Cox & Snell R^2 = 0.391 Nagelkerke R^2 chi-square = 42.150, p = 0 .000	Hosmer and Lemeshow test = 0.132 Cox & Snell R^2 = 0.180 Nagelkerke R^2 chisquare = 16.590, p = 0.219;	Hosmer and Lemeshow test = 0.159 Cox & Snell R^2 = 0.218 Nagelkerke R^2 chi-square = 42.195, p < 0.000

Note: the category value is the opposite of the category listed *p < 0.05; **p < 0.01; ***p < 0.001. [a] the opposite is farmer; N = 295.

95% CI: 0.14, 0.75, p = 0.008]) (Table 6). When type of food given, deworming, and water quality were added to the model, it did not change the effect of feeding slowly. This means that even though children above one year are less likely to be stunted, when feeding slowly becomes part of the child's feeding practice, stunting is likely to be reduced by 68% in model 1 and by 71% in model 2.

Discussion

Overall, there is a high prevalence of stunting in this population. Stunting is affected by various factors that include, among others, biological ones (age

Table 6. Association of "feeding slowly" with stunting (height for age < −2SD) among infants 6–24 months in Hamangaba and Njolamwanza areas.

Predictor	Prevalence	Adjusted OR (95% CI) Model I	Adjusted OR (95% CI) Model II	Hamangaba	Njolamwanza
Feeding slowly					
No	254 (89.8)	1	1	1	1
Yes	29 (10.2)	0.32 (0.14,0.75) p 0.008**	0.29 (0.12,0.70)	0.35 (0.11,1.09) p = 0.07	0.14 (0.02,0.90) p = 0.04*
Child's age					
6–12 months	121 (41.0)	1	1	1	1
>12 months	174 (59.0)	0.21 (0.11,0.38) p 0.000***	0.26 (0.13,0.52)	0.30 (0.12,0.76) p 0.01*	0.22 (0.07,0.65) p 0.006**
Type of food given					
Less thick	56 (20.2)		1	1	1
Thick food	221(79.8)		1.04 (0.45,2.40)	0.89 (0.29,2.75) p 0.84	1.68 (0.44,6.37) p 0.45
Deworming No			1	1	
Yes			0.51 (0.28,0.92)	0.27 (0.11,0.63) p 0.002**	0.94 (0.40,2.21) p 0.89
Water quality Unsafe			1		
Safe			0.93 (0.51,1.72)	0.87 (0.38,2.00) p 0.75	0.89 (0.28,2.86) p 0.84
			Total Hosmer & Lemeshow test = 0.729 Cox & Snell R^2 = 0.134 Nagelkerke R^2 = 0.184	Hamangaba Hosmer & Lemeshow test = 0.963 Cox & Snell R^2 0.198 Nagelkerke R^2 = 0.275	Njolamwanza Hosmer & Lemeshow test = 0.296 Cox & Snell R^2 0.101 Nagelkerke R^2= 0.138

*p < 0.05; ** p < 0.01; ***p < 0.001.

group of the child), environmental (worms), and child-care behaviors (child feeding practices). The finding that age is associated with stunting has also been reported elsewhere.[25,26] Unlike most studies,[27,28] the present study shows that as children grow older, the risk of stunting is reduced, especially above the age of one year. There are several factors that could have changed with age that can be attributed to this scenario. These may include reduction of disease episodes as children grew older or they may have received an improved diet. [29–31]

The association of "worm infestations" with stunting is expected due to poor water and sanitation services and high levels of infection (data not shown) in Hamangaba. High morbidity in children (as in this study) negatively affects child growth.[32–34] This adds to existing evidence on the important role deworming plays in a poor environment in improving child survival. Soil-transmitted helminths (STHs) tend to flourish in poor environments such as those with poor sanitation and hygiene, and water that is not safe.[35] Therefore, deworming offers an opportunity to treat the supposedly unreported STHs in the study areas. A review by Hotez et al.[36]indicated that in Guatemala and along the north Pacific coast of South America, helminths were associated with underweight and stunting, respectively. Furthermore, the finding that dewormed children were less likely to be stunted support the evidence that STHs, just like other infections, tend to be associated with micronutrient deficiencies such as chronic anemia, leading to a compromised immune system.[37–39] The end result may be a double state of increased infestations and infection among the affected children.

Feeding the child slowly was strongly and negatively associated with stunting. We believe that this is reasonable because child feeding behaviors of this kind affect food intake and child growth since the infant will eat more when fed by the mother in a responsive manner.[8,12,16] Furthermore, it provides an opportunity for the mother and baby pair to interact during feeding, which may lead to building of the bond between them (ibid). Feeding slowly (exercising patience) while feeding may reduce the likelihood of using forceful means of feeding and unattended self-feeding, which have been reported to contribute to less food intake.[11–14] Similar findings to this study have been reported by other researchers. Ha et al.[14] found that when responsive feeding behaviors such as non-pressuring or forcing and positive verbalization to the child are part of the eating episodes, food acceptance by the children was improved. In Ghana, Nti and Lartey[40] reported that the children of caregivers who were the most responsive during feeding demonstrated a healthier appetite and interest in food. Although feeding slowly was observed to be an important factor, it was practiced by few mothers (10.2%) in this study. Several researchers have reported that few caregivers practice these key feeding behaviours.[3,14] It is therefore clear that even if age is associated with stunting, it is possible to further improve its effect when other child-care practices such as feeding the child slowly and deworming are part of the way of feeding and caring for the child. Similarly, clean water, good sanitation, and hygiene play an important role in preventing diseases.

The association among feeding slowly, deworming, and age of the child with stunting may be an indication that supporting interventions that promote good child feeding and caring behaviors can reduce stunting. This may be true for interventions, especially those addressing complementary feeding and environmental health. Targeting caregivers by providing them with information on such behaviors and supporting them through community networks would increase their knowledge base and the desire to take action.

The finding that stunting was not different in the two sites given the large difference in water and sanitation facilities was unexpected given the effect that disease has on nutrition. However, it is also an indication that there are other factors that we did not study, which could have explained the reason for this situation. A bigger study would probably assist in addressing such challenges.

We are aware that in surveys like this, there may be many inherent biases. Since most of the responses were reported by caregivers, overreporting was possible, and would have led to the overreporting of some variables. Regarding the variable “feeding the child slowly,” a negative social desirability effect may have occurred. Mothers/caregivers may have opted not to report on the latter, thinking it to be an undesirable behavior. This may have been a possible explanation why those that reported feeding slowly were few. Furthermore, the researchers had no control over the services that were being provided in the two study areas by the various service providers such as the Department of Health and nongovernmental organizations. This could also have resulted in bias.

The study had limitations. Being a cross-sectional study, the study design has limited power to detect associations and therefore results should be used with caution. Such a study could not allow sufficient time to observe improvements in the outcome of interest. Future studies involving methods that can allow making better inferences could be considered. Furthermore, the study focused more on response from caregivers instead of long observational periods, which are more reliable to observe the actual practice/behavior.

Conclusion

We have observed that feeding a child slowly, a component of responsive feeding, the use of thicker (more energy-dense) food, age of the child, and the practice of deworming were all negatively associated with stunting. These findings illustrating an association between feeding children slowly and stunting emphasize that feeding practices in general are important elements to consider in the fight against the burden of malnutrition. It was also found that stunting was the lowest among children older than one year who consumed thicker foods, further indicating that stunting is also associated with the quality of diet. Generally, these findings suggest that feeding practices coupled with types of food and infection control should be considered in behavioral interventions for reducing the stunting burden in this population. In addition, deworming, which is already supported by health authorities in Zambia, should continue to be promoted in addition to adequate sanitation, safe water, and good hygiene. Increasing the awareness of caregivers about these findings is extremely important so that continued individual and community participation is passed on to new generations, thereby promoting good community practices such as feeding slowly and acceptable food preparation. It is recommended that whenever possible, health and nutrition promotion community-based strategies on primary health care should include information on responsive feeding.

Acknowledgments

We also acknowledge the various contributions made by the following people for this work: the members of the UNZA-SoM SACORE Steering Committee (Dr Margret Maimbolwa, Dr Paul Kelly, Dr Hellen Ayles, & Dr Charles Michelo). We also acknowledge the Monze DHMT for allowing the study and the support rendered during the study.

Disclosure statement

The author(s) declare that they have no competing interests.

Funding

We acknowledge the support provided by the Research Support Centre at the University of Zambia, School of Medicine (UNZA-SoM), through the Southern African Consortium for Research Excellence (SACORE), which is part of the African Institutions Initiative Grant of the Wellcome Trust.

Notes on contributors

RM and NPS conceptualized the study, RM was actively involved in implementation of the study. RM and CM performed the data analyses. RM, NPS, and CM were involved in the writeup of the study.

References

1. United Nations Child Fund, World Health Organization. Joint UNICEF -WHO -The World Bank Child Malnutrition Database : Estimates for 2012 and Launch of Interactive Data Dashboards. New York: United Nations ChildFund; Geneva: WHO; 2013:2–4.
2. United Nations Child Fund, Improving Child Nutrition. The Achievable Imperative for Global Progress [Internet]. New York, USA: UNICEF; 2013:1–132. http://scholar.google.

com/scholar?hl=en&btnG=Search&q=intitle:IMPROVING+CHILD+NUTRITION+The+achievable+imperative+for+global+progress#0.

3. Central Statistical Office, Ministry of Health, TDRC, UNZA, MACRO International.Zambia Demographic and Health Survey 2013–14. Lusaka, Zambia: Ministry of Health; 2014.
4. Black RE, Allen LH, Bhutta ZA, et al. Maternal and child undernutrition 1: maternaland child undernutrition : global and regional exposures and health consequences. Lancet. 2008;371:5–22. doi:10.1016/S0140-6736(07)61690-0.
5. Black MM, Aboud FE. Responsive feeding is embedded in a theoretical framework ofresponsive parenting. J Nutr. 2011;141:490–494. doi:10.3945/jn.110.129973.
6. Dewey KG BK. Why Stunting Matters. Washington, D.C: Alive and Thrive, FHI 360, Washington, DC; 2010:1–7.
7. Engle P, Pelto G. Responsive feeding: implications for policy and program implementation. J Nutr. 2011;141:508–511. http://jn.nutrition.org/content/141/3/508.short.
8. Harbron J, Najaar B. Paediatric food-based dietary guidelines for South Africa: responsive feeding: establishing healthy eating behaviour early on in life. S Afr J Clin Nutr. 2013;26(3):141–149.
9. Pan American Health Organization. Guiding Principles for Complementary Feeding of the Breastfeed Child. Washington, D.C: PAHO; 2003.
10. ACC/SCN. Lutter C. Meeting the Challenges to Improve Complementary Feeding. Scn News. 2003; USAID. https://www.popline.org/node/233102. Accessed December 12, 2017.
11. Aboud FE, Moore AC, Akhter S. Effectiveness of a community-based responsivefeeding programme in rural Bangladesh : a cluster randomized field trial. Matern Child Nutr. 2008;4(2008):275–286. doi:10.1111/j.1740-8709.2008.00146.x.
12. Satter ME. The feeding relationship. Am J Diet Assoc. 1986;86:352–356.
13. Brown A, Lee MD Early influences on child satiety-responsiveness: the role of weaningstyle. Pediatr Obes 2013 Dec 17; 1–10. http://www.ncbi.nlm.nih.gov/pubmed/24347496. Accessed December 18, 2014.
14. Ha PB, Bentley ME, Pachón H, et al. Caregiver styles of feeding and child acceptance offood in rural Viet Nam. Food Nutr Bull. 2002;23(4):92–98. doi:10.1177/15648265020 234S213.
15. Stewart CP, Iannotti L, Dewey KG, et al. Contextualising complementary feeding in abroader framework for stunting prevention. Matern Child Nutr [Internet]. 2013 Sep;9 (Suppl 2):27–45. http://www.ncbi.nlm.nih.gov/pubmed/24074316. Accessed December 10, 2014.
16. Amugsi DA, Mittelmark MB, Lartey A, et al. Influence of childcare practices onnutritional status of Ghanaian children : a regression analysis of the Ghana Demographic and Health Surveys. BMJ Open. 2014;4:1–10. doi:10.1136/bmjopen2014-005340.
17. UNICEF. The State of the World's Children. New York, USA: Oxford University Press; 1998.
18. Imdad A, Yakoob MY, Bhutta Z. Impact of maternal education about complementaryfeeding and provision of complementary foods on child growth in developing countries. BMC Public Health. 2011 Jan;11(Suppl 3):1–14. http://www.pubmedcentral.nih. gov/articlerender.fcgi?artid=3231899&tool=pmcentrez&rendertype=abstract. Accessed December 10, 2014.
19. De Onis M, Blössner M. Database on Child Growth and Malnutrition. Geneva:WHO; 1997.
20. Wiesman D, Bassett L, Benson T, et al. Validation of the World Food Programme's food consumption score and alternative indicators of household food security. Int Food Policy Res Inst. https://books.google.co.za/books?hl=en&id=e9tPwZdWR8IC&oi=fnd&pg=PR9&dq=World+food+program+food+consumption+score&ots=Ao3PPFrzW&sig=ExYmdSu62E95_KEkRX4fd8zhqvM#v=onepage&q=World%20food%20pro gram%20food%20consumption%20score&f=false. Accessed May 15, 2017.
21. WHO and UNICEF. Core Questions on Drinking-Water and Sanitation for Household Surveys. Geneva, Swizerland: WHO; 2006.
22. SMART Methodology. ENA for SMART - Software for Emergency Nutrition Assessment. http://www.nutrisurvey.de/ena_beta/ena-epiinfo/index.htm. Accessed December 12, 2017.
23. CDC and WFP. A Manual: Measuring and Interpreting Malnutrition and Mortality. Rome: FAO; 2005.
24. IBM. IBM SPSS Statistics. http://www-01.ibm.com/support/docview.wss?uid= swg1PM54938. Accessed December 12, 2017. Published 2012.
25. Central Statistical Office (CSO), Ministry of Health (MOH), Tropical Diseases ResearchCentre (TDRC), University of Zambia, Macro International Inc. Zambia Demographic and Health Survey 2007. Lusaka, Zambia.

https://www.dhsprogram.com/Where-WeWork/Country-Main.cfm?ctry_id=47&c=Zambia&Country=Zambia&cn=&r=1. Accessed December 12, 2017. Published 2009.

26. Van de Poel E., Hosseinpoor A.R., Speybroeck N., Van Ourti T., Vega J. Malnutritionand the disproportional burden on the poor : the case of Ghana. Int J Equity Heal. 2007;6(21):1–12.
27. Ramli, Agho K.E., Inder, K.J., Bowe, S.J., Jacobs, J., Dibley, M.J. Prevalence and riskfactors for stunting and severe stunting among under-fives in North Maluku province of Indonesia. BMC Pediatr. 2009;9(64):1–10. doi:10.1186/1471-2431-9-64.
28. Kikafunda JK, Walker AF, Collett D, et al. Risk factors for early childhood malnutritionin Uganda. Pediatrics. 1998;102(4):1–10. doi:10.1542/peds.102.4.e45.
29. Richard SA, Black RE, Gilman RH, et al. Catch-up growth occurs after diarrhea in earlychildhood. J Nutr. 2014;144(6):965–971. http://www.ncbi.nlm.nih.gov/pubmed/24699805.
30. Garza C. Commentary: please sir, I want some more (and something else). Int J Epidemiol. 2015:1–3. http://www.ije.oxfordjournals.org/cgi/doi/10.1093/ije/dyv299.
31. Paudel R, Pradhan B, Wagle RR, et al. Risk factors for stunting among children: acommunity based case control study in Nepal. Kathmandu Univ Med J. 2011;10 (39):18–24. http://www.ncbi.nlm.nih.gov/pubmed/23434956.
32. ACC/SCN. Third Report on the World Nutrition Situation. Geneva: WHO; 1997.
33. Schmidt MK, Muslimatun S, West CE, et al. Nutritional status and linear growth ofindonesian infants in west java are determined more by prenatal environment than by postnatal factors. J Nutr. 2002;132:2202–2207.
34. Frongillo EA. Symposium : causes and etiology of stunting. J Nutr. 1999;129:529–530.
35. Harhay MO, Horton J, Ollliaro PL. Epidemiology and control of human gastrointestinalparasites in children. Expert Rev Anti Infect Ther. 2010;8(2):219–234. doi:10.1586/eri.09.119.
36. Hotez PJ, Bottazzi ME, Franco-Paredes C, et al. The neglected tropical diseases of LatinAmerica and the Caribbean : a review of disease burden and distribution and a roadmap for control and elimination. PLoS Negl Trop Dis. 2008;2(9):1–11. doi:10.1371/journal.pntd.0000300.
37. Ezeamama AE, Friedmana JF, Acosta LP, et al. Helminth infection and cognitiveimpairment among filipino children. Am J Trop Med Hyg. 2005;72(5):540–548.
38. UNICEF, United Nations University, World Health Organisation. Iron Deficiency Anaemia: Assessment, Prevention, and Control; A Guide for Programme Managers. Rome: WHO. 2001: 1–132.
39. Richard SA, Mccormick BJJ, Miller MA, et al. Modeling environmental influences onchild growth in the MAL-ED cohort study : opportunities and challenges. Clin Infect Dis. 2014;59(Suppl 4):255–260. doi:10.1093/cid/ciu436.
40. Nti CA, Lartey A. Effect of caregiver feeding behaviours on child nutritional status inrural Ghana. Int J Consum Stud. 2007;31(October):303–309. doi:10.1111/j.14706431.2006.00553.x.

2.0 Listing Sheet

A Study to Evaluate the Effect of Poor Water and Poor Sanitation on Growth in Infants and Young Children aged 6-24 months in Zambia

Place ________________ CSA [______] SEA [________] Village______________-
Household no.[_____]

Personal identity	**Name of household head and other members of the household**	**Relationship to household** Spouse......................1 Child..........................2 in-law........................3 grandchild.................4 parent........................5 Sister/brother...........6	**Sex** Male........1 Female....2	**Age in years for adults and in months for children underfive (0-59 months).** **Please indicate after each figure whether years or months**
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
12				
13				
14				
15				
16				
17				
18				
19				
20				

3.0 Study tools-Household questionnaire

Household Questionnaire

A Study to Evaluate the Effect of Poor Water and Poor Sanitation on Growth in Infants and Young Children aged 6-24 months in Zambia

1. The interview will take approximately 40 minutes and involve several members of your household. Are you willing to participate?	Yes.................................1 No....................................2
2. For this household the questionnaire has been	Completed ....1 Refused ....2 Partially completed.......... ....3 People absent for extended period ....4 Dwelling empty ....5 Others: ___________________.........................6
3. CSA	
4. SEA	
5. Household ID:	[_____][____][____]
6. Date of Survey Visit	
7. Village name	
8. Household GPS receiver no.	[_____][____]
9. Household Web point/Waypoint number:	[_____][____][____]
10. Household Latitude no. (in decimal degrees):	[_____][____].[____][____][_____][____][____]
11. Household Longitude no. (in decimal degrees):	[_____][____].[____][____][_____][____][____]
12. Household Altitude (Elevation) (Meters)):	[____][____][_____][____][____]
13. Parity of the mother/caregiver:	[_____][____]
14. Who is the head of the household?	
15. Who is being interviewed	
16. What is the relationship to the sampled child	
17 Interview name.................................	No. [__________]

GIS Information for the source of water

Source of water (Compare details with question 2b.15a)	
18. GPS receiver no.	[_____][____]
19. Web point/Waypoint number:	[_____][____][____]
20. Latitude no. (in decimal degrees):	[_____][____].[____][____][_____][____][____]
21. Longitude no. (in decimal degrees):	[_____][____].[____][____][_____][____][____]
22. Altitude (Elevation) (Meters):	[____][____][_____][____][____]

Consent

Participant's name………………………..

Participant's signature……………………………………….. Thumb print…………………………………

Date………………………

SECTION 1 SOCIO-DEMOGRAPHIC FACTORS AND HOUSING

Socio-demographic factors

1a.1. How many adult people (starting from 5 years) live in this household at least 4 days a week? ***(List in the household rooster all adult people (starting from 5 years) living in the household starting with the household head, spouse to the youngest child*)**

Household Roster

Name Please give me the names of the people who usually live in your household	**Date of birth**	**Relationship** What is the relationship to the household head Spouse......................1 Child..........................2 in-law........................3 grandchild.................4 parent........................5 Sister/brother............6 Niece/Nephew..........7	**Age in years**	**Sex** Male........1 Female....2	**What is the marital status of (name)** Single, Living together Married Divorced	**Highest level of education** None.........................1 Primary ....2 Secondary................3 Tertially 4	**Occupation**
101							
102							
103							
104							
105							
106							
107							
108							
109							
110							
111							
112							
113							
114							
115							
116							
117							
118							

1a.2. For children under 5 years

Child no./name	**Date of birth** *(Ask for underfive card to verify age)*	**Age** in months for children underfive (0-59 months)	**Sex** Male……1 Female..2	**Relationship** What is the relationship to the household head Spouse…………………1 Child……………………2 in-law……………………3 grandchild……………4 parent…………………5 Sister/brother…………6 Niece/Nephew………7	Is the child's mother **alive** Yes……………1 No……………2	Does the mother live in this household Yes……………1 No……………2	Has the household head been very sick in the last 3 months (*to an extent of not able to do some work*) Yes……………………1 No………………………2	LOST PARENT(S) BECAUSE OF:* HIV/AIDS ………1 Other causes…..2 No………………3 (***check***)
201.								
202.								
203.								
204.								
205.								
206.								

1a.3. The caregivers of children under 2 years of age

List the people who are caretakers of children under 0-23 months of age.(***List primary caregivers. Do not list visitors***.]

Name	Sex Male……………………1 Female………………2	Age (in years)	Relationship of primary caretaker to this child Mother ……………………………1 Grandmother ……………………2 Sister ……………………………3 Aunt ………………………………4 Father ……………………………5 Brother……………………………6 Grandfather) ……………………7 Other family (specify)……………8
1.			
2.			
3.			
4.			
5.			

Details of the reference child

Child ID (From the child roster)		
1a.4. When was the child born (**verify with under-five card and march with household roster**)	[____/____/_____] DD/MM/YYYY	
1a.5. Indicate the age in months of the child	[_____][_____]	
1a.6. What is the sex of the child	Male.................................1 Female..............................2	
1a.7. Where was (**name of child**) born?	Hospital...................................1 Health centre/Clinic ....2 Home ....3 Other Specify _____________ ...4	

B. Housing Characteristics

1b.8. How many rooms/huts does the dwelling have?	[___________]	**Skip instruction**
1b.9. Do you own your dwelling, including the land?	Yes..................................1 No ....2 Don't know............................3	►**1b.11**
1b.10. If not, how likely is it that you could be evicted from this dwelling:	Very likely........................1 Somewhat likely................2 Not at all likely.................3 Don't know.......................4	

What type of housing does the household-have? *(Tick if any of the following is available)*

1b.11. What is the flour made of?	**Response code**
***Natural floor* (**Earth/sand, Dung) 1	
Rudimentary floor (Wood planks/Palm/bamboo/leeds) 2	
***Finished floor* (**Concrete cement, Parquet/polished wood, Vinyl (Pc) or asphalt strips, Ceramic/terrazzo tiles, 3	
Other (specify)________________________________ 4	
1b.12. What is the roof made of (*record observation*)	
Natural roofing (No roof, palm 1	
Rudimentary roofing (thatch/rustic mat, wood 2	
Finished roofing (metal/iron sheets, asbestos, ceramic tiles/ Harvey tiles, cement 3	
***Other (Specify)* ______________________ 4**	
1b.13 Main material of the exterior walls	
Natural walls (no walls, cane/palm/trunks, mud tin or mud and sticks 1	
Rudimentary walls (unburnt bricks, bamboo/pole with mud, stone with mud, plywood, cardboard, reused wood 2	

Finished walls (cement, stone with lime/cement, burnt bricks, cement blocks, wood planks, ...3	
Other (specify) 4	

c. Household Wealth Index

1c.14. *Check from the household rooster how many adults are working and fill in the following table regarding their monthly earnings*.

Adult no.	Amount earned

Household equipment

1c.15. Does your household own the following items ***(if in working order only)?*** **(*Read all items and mark those mentioned*)**.

Item	Response code
Electricity/Solar panels	
A radio	
A television	
A mobile telephone	
A bed	
A chair	
A table	
A cupboard	
A sofa	
A clock	
A fan	
A sewing machine	
A cassette player	
A plough	
A grain grinder	
A VCR/DVD	
A tractor	
A vehicle (Car/truck)	
A hammer mill	
A bicycle	
An ox cart	
A motorcycle	
A refrigerator	
A cooker (Kerosene, gas cooker)	
Large livestock specify ______________________	
Small livestock specify ________________________	
Land for subsistence farming	
Land for cash crop (cotton, tobacco, paprika, vegetables, etc)	

SECTION 2: Water, sanitation, and hygiene

A. Sanitation

Question	Response codes	Skip instruct.
2a.1. Where is the toilet facility located?	Inside/attached to dwelling....................1 Outside in the yard.................................2 Elsewhere...3 Don't have...4	►2a.3 ►2a.11
2a.2. How far is the toilet facility from your living quarters? (*If feasible, observe*)	Less than 10 meters.............................1 10 to 50 meters......................................2 Over 50 meters......................................3 Don't know...4	
2a.3. What kind of toilet facility do members of your household usually use?	Flush/pour flush ....1 Ventilated improved pit latrine (VIP) .....2 Pit latrine with slab...............................3 Pit latrine without slab/open pit ....4 No facilities or bush or field..................5 Other (specify)____________________...6	
2a.4. How many households share this toilet facility?	Number.....................1 [__________] Not shared ....2 Don't know................3	 ►2a.8
2a.5. If shared, can any member of the public use this toilet	Shared between a few hhs only?...........1 Anybody in the n/bourhood can use ......2 Don't know...3	
2a.6. How much do you pay to use the toilet facility?	K ___________ ....1 Nothing...2 Don't know...3	 ►2a.8
2a.7. Do children have to pay?	Yes..1 No ....2 Don't know...3	
2a.8. Is the facility cleaned regularly?	Yes..1 No ....2 Don't know...3	
2a.9. When was the facility cleaned last?	Today ....1 Yesterday..2 Less than one week ago ....3 Several weeks ago ....4 Never ....5 Other (specify) _____________...............6 Don't remember 7	
2a.10 Do children under 5 use this toilet facility?	Yes..1 No ....2 Don't know...3	
2a.11. The last time [name of child] passed stools, what was done to dispose of the stools?	Child used toilet/latrine........................1 Put/rinsed into toilet or latrine.............2 Put/rinsed into drain or ditch................3	

	Thrown into garbage............................4 Buried ....5 Left in the open...................................6 Other (specify)......................................7 Don't Know 8	
2a.12. May I see the toilet facility after talking to you?	Yes...1 No ....2 N/A...3	
(Please use the observation checklist sheet to conduct observations which has been provided to you as a separate booklet. Note that the observations will be conducted at the end of interview)		
2a.13. Where do you usually wash your hands after using the toilet?	In or near toilet facility............................1 In or near kitchen....................................2 Elsewhere on premises ....3 Outside premises ....4 No specific place....................................5 Don't wash hands..................................6	
2a.14. Can you show me everything you use to wash your hands after talking to you?	Yes...1 No 2	
(Please use the observation checklist sheet provided to you to conduct observations at the end of interview)		

Type of water supply for the household

2b.15. What is the main source of drinking water for members of this household? ***(check one)***	Piped water...1 Standpipe ....2 Tubewell/borehole ....3 Protected dug well..................................4 Unprotected dug well..............................5 Protected spring......................................6 Unprotected spring..................................7 Surface water (*river/stream/pond/lake/dam*)...................8 Other (specify) ________________...........9	
What is the name of the source of water *(Give full description of the source. If source has several names please write them down in order of being the most common name)*		
2b.16. What is the secondary source *(**check source from question 2b.15**)*	[_______]	
2b.17 Do you treat your water in any way to make it safer to drink?	Yes...1 No 2	►**2b.20**

	Don't know...3	►2b.20
2b.18. If yes, what do you do most of the time to the water to make it safer to drink? (***Probe for one answer only representing what they do most of the times***)	Boil...1 Add bleach/chlorine.................................2 Strain it through a cloth...........................3 Use a water filter (ceramic, sand, composite, etc.) ....4 Solar disinfection ....5 Let it stand and settle (*abatama*) ....6 Other (specify)__________________........7 Don't Know 8	
2b.19. When did you treat your drinking water the last time using this method?	Today ....1 Yesterday...2 Over one day ago/less than one week.....3 One week ago or more/less than a month ago...4 One month ago or more ....5 Don't remember 6	
2b.20. Where do you get the water you give the child to drink?	Main source...1 Keep in special container for baby..........2 Others ____________________........3	
2b.21 What do you do to it to make the water safe before the child drinks?	Explain	
2b.22. How long does it take you to go to your main water source, get water, and come back?	Minutes [____________]...........................1 On premises..2 Don't know...3	►2b.24
2b.23. If water is not on premises, who usually collects water? (***Check all that apply***) (***Probe: Is this person under age 15 years? What sex? Circle the code that best describes this person***)	Adult woman ....1 Adult man ....2 Female child (under 15 years) ....3 Male child (under 15 years) ....4 Don't Know ....5 Other (specify)_________________..........6	
2b.24. What is the main source of water used by your household for other purposes, such as cooking and hand washing?	Piped water..1 Standpipe ....2 Tubewell/borehole ....3 Protected dug well..................................4 Unprotected dug well...............................5 Protected spring.....................................6 Surface water (*river/stream/pond/lake/dam*)...................8 Unprotected spring.................................7 Other (specify) _________________...........9	
2b.25. Do you pay for water?	Yes..1 No 2	►2c
2b.26. If yes, when do you pay?	Every load..1 Every day 2	

	Every week...3 Every month ....4 By volume/water meter ....5 Other (specify) _______________..........6 Don't know 7	
2b.27. If you pay by volume/water meter, what is the unit? PER CUBIC METER/CUBIC	Container/mbudiza.................................1 Per litre/gallon...2 Other (specify) _______________..........3 Don't know..4	
2b.28. How much do you pay per load or volume unit?	[K _________]	

Water Quantity Used by Household where Water Source is not in the Dwelling

2c.29. In what type of container is the water carried from your main source? (***Ask only if water is not in the house***)

Type of container		Is it with a lid	
1.Mbudiza/container (plastic or metal)	Yes.................1 No 2	Yes.......................................1 No 2	
2. Bucket	Yes.................1 No 2	Yes...1 No 2	
3. Drum	Yes.................1 No 2	Yes...1 No 2	
4. Jerry can	Yes................1 No 2	Yes...1 No 2	
5. Other (specify)_________________ _	Yes................1 No 2	Yes...1 No 2	
6. Don't know	Yes................1 No 2	Yes...1 No 2	
2c.30. What is the approximate volume in litres of: [*Note: If these are containers of standard size and consistently used by all households, this does not have to be asked during the survey, but can be calculated at time of data entry]*		Container/mbidiza, Chingumbuli, (plastic/metal) -___________ litres Bucket _________________ litres Drum/barrel _____________ litres Jerry can _______________ litres Others _________________ litres Don't know__________________	
2c.31. How many of these containers are carried at a time?		Container/mbidiza, Chingumbuli, (plastic/metal) _______ Bucket _____________________ Drum/barrel _________________ Jerry can ___________________ Others _____________________ Don't know__________________	

2c.32. How many loads do you fetch per day?	Container/mbidiza (plastic/metal) ________ Bucket _________________ Drum/barrel _____________ Jerry can _______________ Others _________________ Don't know___________________	
2c.33. In the last 2 weeks has the water from this source been unavailable for at least 1 whole day?	Yes..1 No ....2 Don't know..................................3	►sec D
2c.34. When there was no water from your main water source, what did you do to get water for drinking?	Wait until water becomes available .... 1 Get water from a different source ....2 Other(specify) ___________.......3 Don't know..................................4	

d. Water Storage and Handling

2d.35. Do you store water for drinking in the household?	Yes...1 No ....2 Don't know...3	►**sec e**
2d.36. Who takes water from these containers? ***(check all that apply)***	Adults..1 School age children ....2 Children underfive...3 Don't know...4	
2d.37. How do you remove water from the drinking water container?	Pouring..1 Dipping...2 Both pouring and dipping...................................3 Container has a spigot or tap..............................4 Other (specify) ____________________...........5 Don't know...6	►**2d.40**
2d.38. What do you use to remove water?	Same receptacle/cup used to drink from............1 Receptacle reserved for retrieving water...........2 Other (specify) _________________________..3	
2d.39. When were they cleaned last?	Today or yesterday ....1 Less than one week ago ....2 Several weeks ago ....3 Never ....4 Other (specify) ________________________....5 Don't remember...6	
2d.40. May I see the containers, please after talking to you?	Yes...1 No 2	
(Please use the observation checklist sheet to conduct observations which has been provided to you as a separate booklet. Note that the observations will be conducted at the end of interview)		

e. Channels of Communication

2e.41. What is your main source of information about personal and household hygiene (***bulondo***)?

1. Health worker/Health facility
2. Television
3. Church
4. School
5. Radio
6. Others ______

______

2e.42. What is your main source of information about child health (***seba***) in general?

______

______

______

2e.43. Have you been visited by or spoken with a community service worker (promoter) during the past month about water, sanitation, or hygiene?

1. Yes 2. No 3. Don't know **(►2e 45)**

2e.44. If yes, which messages did you hear?

______

______

2e.45. Have you heard any messages about water, sanitation and hygiene during the past month on the radio or TV?

______

______

2e.46. If yes, which messages on radio/TV did you hear?

______

______

f. Food Preparation, Storage, and Handling Practice

2f.47. The last time you prepared food, what steps did you go through before, during and after food preparation? (***Do not read the answers, encourage by asking if there is anything else until s/he says there is nothing else and check all mentioned***)	Wash hands before preparation................1 Wash food thoroughly ....2 Wash utensils and containers before preparation..3 Cook food thoroughly ....4 Other (specify) ________________............5 Don't know...6	

2f.48. Is there any food left from the last time you cooked for the family?	Yes..1 No 2	
2f.49. Is there any food left from the last time you cooked for {**name of baby**}?	Yes..1 No 2	
2f.50. If yes, how long ago did you prepare the food for the…; (***check a and b***)		
a. family	Less than an hour ago ....1 Several hours ago ....2 Yesterday..3 Several days ago....................................4 Don't know..5	
b. child? (*sampled child***)**	Less than an hour ago ....1 Several hours ago ....2 Yesterday..3 Several days ago....................................4 Don't know..5	
2f.51. Can you show me where you keep this food after talking to you?	Yes..1 No 2	
(Please use the observation checklist sheet provided to you to conduct observations at the end of interview)		
2f.52. Who takes food from the containers? (***Check all that apply***)	Adults..1 School age children.................................2 Children under 5......................................3	
2f.53. How do you usually remove food from the containers? (**Check one answer only**)	Utensils dedicated for removal.(e.g scoop spoon/chimpapuzyo)...1 Same utensils used for eating (e.***g spoon, folk***)...2 Fingers..3 Pouring from the container.........................4 Other (specify) ______________................5 Don't know..6	

2f.54. Can you tell me how you keep food safe to eat for the ….?
(***Do not read the answers, encourage by asking if there is anything else until s/he says there is nothing else and check all mentioned***)

a. family	**b. child?** (*sampled child*)
Wash hands before preparation...........................1	Wash hands before preparation.......................1
Wash hands before eating...................................2	Wash hands before eating................................2
Wash utensils & containers before preparation....3	Wash utensils & containers before preparation .3
Wash food thoroughly 4	Wash food thoroughly 4
Cook food thoroughly 5	Cook food thoroughly 5
Consume all food at once 6	Consume all food at once 6
Avoid keeping leftovers 7	Avoid keeping leftovers 7
Reheat leftovers well before eating....................8	Reheat leftovers well before eating..................8
Cover food containers..9	Cover food containers..9
Prevent flies from touching the food 10	Prevent flies from touching the food 10
Keep food in cold place or refrigerator...............11	Keep food in cold place or refrigerator............11
Keep food behind doors or screen 12	Keep food behind doors or screen 12
Use clean utensils for retrieving food.................13	Use clean utensils for retrieving food..............13
Other (specify)_________________...................14	Other (specify)_________________................14
Don't know...15	Don't know..15

2f.55. Who is the main food preparer (person doing it the most) in this household for the?

a. family	**b. child?** (*sampled child*)
The worker...1	The worker..1
Other adult female.....................................2	Other adult female....................................2
Grandmother...3	Grandmother..3
School age girl..4	School age girl...4
Male household member 5	Male household member 5
Other (specify) ________________............6	Other (specify) ______________________...6
Don't know...7	Don't know...7

g. Garbage and WASTE (GREY) WATER DISPOSAL

2h.56. How do you mainly dispose of water that has been used for washing dishes, doing laundry, and bathing? (***One answer only-probe for the main method used***)	Piped drain (In soak-away/cesspit/ septic system)..1 Street surface or empty space Outside Premises ....2 Into premises' yard ....3 Directly to garden ....4 Poured or carried into toilet facility ....5 Other (specify) _______________.............6	
2h.57. What is the main way you dispose of your garbage? (***One answer only-probe for the main method used)***	Collected from home by company/ government..1 In waste pit in yard...................................2 In waste pit nearby in community….........3 No pit/open area ....4 Fed to animals..6 Other(specify)____________________......7 Don't know..8	

Section 3: Child health (Makani a nseba)

3a.1. Has **the child** suffered from any of the following diseases or conditions in the last 2 weeks?

Disease	**Response code** Yes.....1 No .....2 Don't know.....3	**Skip inst.**
1. Diarrhoea (kusomoona)		
2. Coughing (kukola)		
3. Malaria *(confirmed at healthy facility)*(tutumaazi)		
4. Eye infections		
5. Respiratory infections (pneumonia) (Kuhundilila)		
6. Fever (Mubili kupya)		
7. Skin disease (Bulwazi bwachikanda e.g. bweele)		
8. Other, specify		

(If no to all of the above go to 3a.6)

3a.2. (If *yes to any of the above diseases, ask the following*) Did you seek medical advice or treatment when the child was sick in the past 2 weeks?	Yes.....1 No .....2 Child was not sick the past 2 weeks 3	►**3a.4**
3a.3. (*If not)*, why did you not seek treatment from the health service(*Do not read the answers, encourage by asking if there is anything else until s/he says there is nothing else and check all mentioned*)	No money .....1 Too far.....2 Child not seriously ill.....3 Nobody to go to/clinic closed.....4 Place usually has no drugs.....5 Staff are not friendly .....6 Other(specify)_________ ....7 Don't know.....8	
3a.4. (*If yes)*, how long after the illness started did you to take the sick child to the health facilities	Within a day.....1 More than day.....2	**3a.6**
3a.5. If more than a day, why did you wait that long before taking the child to the health facilities?		
3a.6. Did (**NAME of child**) receive vitamin A within the last 6 months?	Yes.....1 No .....2 Don't know.....3	

3a.7. In the last seven days, did (NAME) take iron pills or iron syrup (like this/any of these)?	Yes..1 No ....2 Don't know..3	
3a.8. Has (NAME) taken any drug for intestinal worms ***(Mayoka)*** (deworming) in the past 6 months?	Yes..1 No ....2 Don't know..3	
3a.9. Has the child received all the vaccinations for children below nine months (*check the status on the child's clinic card*).	Yes..1 No ....2 No, child below 9 months ....3 Don't know..3	
3a.10. Did [NAME OF CHILD] sleep under a bed net ***(musikito)*** last night?	Yes..1 No ....2 Don't know..3	**►sec 4**
3a.11 What type of net is it?	LONG-LASTING treatment (does not Require re-treatment)..........................1 Treated (dipped in a solution)..............2 Regular net (not treated) ....3 NO net ....4 Don't know..5	
3a.12. If treated, when was it impregnated the last time?	Is a new net ....1 Less than 6 month ago...........................2 Over 6 months ago................................3 No net..4 Never ....5 Don't know...6	

Section 4: Child Nutrition (Busani bwabana)

a. Breastfeeding practices (Kunyohya bana)

4a.1. Did the mother ever breastfeed (NAME)? **(*don't know only applies if the interviewee is not the mother*)**	Yes..1 No ....2 Don't know...3	**►4a.12**
4a.2. Was (**name of child**) given anything to drink/eat before putting him to the breast soon after birth? *(don't know only applies if the interviewee is not the mother)*	Yes..1 No ....2 Don't know...3	**►4a.4**
4a.3. if yes, what was (**NAME of child**) given to drink before putting him to the breast soon after birth? (*Continue asking if there is anything else until the respondent has nothing to say.* ***Do not read the list. record all mentioned by circling letter for each one mentioned****)*	Milk (other than breast milk) ....1 Plain water ....2 Sugar or glucose water...........................3 Gripe water ....4 Sugar-salt-water solution ....5 Fruit juice ....6 Infant formula ....7 Tea / infusions ....8 Honey 9	

	Other (specify) 10	
4a.4. Is the mother still breastfeeding (**name of child**)?	Yes...1 No ....2 Don't know...3	►**4a.6**
4a.5. If not currently breastfeeding, at what age was **(name of child)** when-you (or the mother) stopped breastfeeding him/her?	Specify months ______..........................1 Do not know 2	
4a.6. Did (**name of child**) drink anything from a bottle with a nipple yesterday or last night?	Yes...1 No ....2 Don't know...3	
4a.7. How soon after birth did you (or mother) put **(Name of child)** to the breast for the first time?	Less than an hour after birth...................1 1-3 hours after birth...............................2 More than three hours after birth............3 Not applicable..4	
4a.8. At what age did you (or the mother) give <u>(**name of child**)</u> liquids other than breast milk for the first time?	Less than 1 month..................................1 1 month..2 2 months..3 3 months..4 4 months..5 5 months..6 6 months..7 After 6 months ....8 still exclusive breastfeeding....................9 Don't know (not the mother)..................10	
4a.9. What was the first liquid other than breast milk that you gave <u>(**name of child**)</u>	Water..1 Coffee/tea...2 Formula..3 Soups/broths/gravy.................................4 Other Specify______________................5 Not applicable..6 Don't know/remember.............................7	
4a.10. At what age did you (or the mother) give (**name of child**) his/her first solid or semisolid food? ***(Note that soups and broths are liquids and cannot be considered semisolids or solid; soup with broken apart vegetables is considered a semisolid food)***	Less than 1 month..................................1 1 month..2 2 months..3 3 months..4 4 months..5 5 months..6 6 months..7 After 6 months ....8 still exclusive breastfeeding....................9 Don't know (not the mother)..................10	
4a.11. What was the first solid or semisolid food that was given to (**name of child**)?	Maize porridge.......................................1 Cassava porridge....................................2 Vegetable...3 Beans 4	

	Meat...5 (chicken/beef/pork/game/lamb) Fish..6 Egg...7 Milk product...8 Fruit..9 Other Specify __________........................10 Not applicable...11	
4a.12. At this age, what type of food do you give (**name of child)**	More liquid...1 More thicker...2 Still breastfeeding only...........................3	
b. Motivating the child to continue eating		
4b.13. If **(name of child)** stops eating and you think that he/she is still hungry, what do you do so that he/she continues eating? (Probe and **check all that apply**)	Motivates or helps child (**Speaks, sings, plays with the child**).................................1 Forces the child ....2 Tries another food.....................................3 Feeds slowly..4 Ask another person to feed the child.........5 Does nothing...6 Other Specify________________................7	
4b.14. If **(name of child)** is not able to feed him/herself, who feeds the child food If above 1 year, who assists the child to eat the food.	Mother...1 Sister ....2 Grandmother ....3 Father ....4 Others, Specify____________________......5	
4b.15. If **(name of child)** refuses to eat many foods, what do you do to let the child have food?	Experiment with different food combinations ....1 Try different tastes, textures ....2 Tries to encouragement ....3 Other Specify______________................4	

c. **Dietary diversity score**

(List all the foods and drinks eaten by this child yesterday starting from when he/she woke up until he/she went to sleep last night)

I. INDIVIDUAL CHILD DIETARY DIVERSITY			
No	**Questions and Filters**	**Coding**	
	Now I would like to ask you about (other) liquids or foods that (**Name of child**) may have had yesterday from the time s/he woke up in the morning upto the time they sleep in the night. I am interested in whether your child had the item even if it was combined with other foods. **Did (Name of Child) drink / eat:** **[_____]** Tick if the child is breastfeeding only	**4c.16.** In the past 24 hours did (**name of child**) eat the following? Child 1	**4c.17.** How many days in the past 1 week did (**name of child**) eat the following?

		1 = Yes 2= No	(*indicate the number of days*)
A	Milk such as tinned, powdered, or fresh milk?	[___]	[___]
B	Tea or coffee?	[___]	[___]
C	Any other liquids ***(chibwantu, nselele)***	[___]	[___]
D	Nshima, bread, rice, noodles, or other foods made from grains?	[___]	[___]
E	Pumpkin (*chitende*), carrots, squash, or sweet potatoes that are yellow or orange inside?	[___]	[___]
F	White potatoes **(Magwili)**, white yams **(lusala, chipama)**, manioc, cassava **(Mwaja)**, or any other foods made from roots	[___]	[___]
G	Any dark green leafy vegetables? ***(muchile/lungu, kalembula, chimowa, Kayuniyuni, rape, chomoliwa)***	[___]	[___]
	Other vegetables (cabbage, cauliflower,)	[___]	[___]
H	Ripe mangoes, pawpaws. muloolo or (***any other locally available vitamin a-rich fruits***)?	[___]	[___]
I	Any other fruits **(ngai/mbubu, muchingachinga, mbula, vwulimuninga)**	[___]	[___]
J	Liver, kidney, heart or other organ meats?	[___]	[___]
K	Any meat, such as beef, pork, lamb, goat, chicken, or duck?	[___]	[___]
L	Eggs ***(maji)***	[___]	[___]
M	Fresh or dried fish or shellfish? –Kapenta/bream	[___]	[___]
N	Any foods made from beans, cowpeas ***(nyabo), bambara nuts (mbwila), peas, lentils, or nuts (nyemu, butele)?***	[___]	[___]
O	Cheese, yogurt, sour (mabisi) or other milk products?	[___]	[___]
P	Any oil, fats, or butter, or foods made with any of these?	[___]	[___]
Q	Any sugary foods such as chocolates, sweets, candies, pastries, cakes, or biscuits?	[___]	[___]
R	Caterpillars/grasshopper (nseele/***inswa, matingatiila, nsozi)***	[___]	[___]

d. EATING PATTERN OF THE CHILD		
Questions	**Response Options**	
4d.18. How many times does (**name of child**) normally eat main meals?	[___] Meals / day	
4d.19. How many times does (**name of child**) normally eat snacks?	[___] Snacks / day	
4d.20. How many times did (**name of child**) eat main meals yesterday?	[___] Meals / day	
4d.21. How many times did (**name of child**) eat snacks yesterday?	[___] Snacks / day	

4d.22. In the past one week, did (**name of child**) ever eat less than s/he should have eaten for a day?	Yes................................1 No ....2 Don't know...................3	►**sec 5**
4d.23. If s/he ate less, what was the main problem?	1. Illness 2. Loss of appetite 3. Lack of food in the household	

Section 5: Food security

5a.1. In the last 12 months, since (current month) of last year, did you ever cut the size of (**name of child**'s) meals because there wasn't enough money for food?	Yes..1 No ....2 Don't know................................3	
5a.2. In the last 12 months, did (**name of child**) ever skip meals because there wasn't enough money for food?	Yes..1 No ....2 Don't know...............................3	 ►**5a.4** ►**5a.4**
5a.3. [IF YES ABOVE ASK] How often did this happen?	Almost every month…………………1 Some months but not every month……………………………….2 Only 1 or 2 months…………………3 Don't Know………………………….4	
5a.4. In the last 12 months, was (**name of child**) ever hungry but you just couldn't afford more food?	Yes..1 No ....2 Don't know...............................3	
5a.5. In the last 12 months, did (**name of child**) ever not eat for a whole day because there wasn't enough money for food?	Yes..1 No ....2 Don't know...............................3	

6. Child Anthropometric variables

Name Child	**6a.1** ID	**6a.2** Date of birth (dd/mm/yy)	**6a.3** Age (months)	**6a.4** Sex 1 = Male 2 = Female	**6a.5** Weight (kg 0.1) To the nearest	**6a.6** Length (cms 0.1)	**6a.7** MUAC	**6a.8** Oedema Yes/No
					_/_/._	_/_/_/._	_/_/._	

7. Maternal Factors

Take the following measurements from:

7a.1 The mother/caregiver: ID		**7a.2 The father: ID**	
Age	[________] years	Age	[________] years
Height	[________] cm	Height	[________] cm
Weight	[________] kg	Weight	[________] kg
Waist	[________] cm	Waist	[________] cm

Before leaving this household, verify the entire questionnaire and indicate the outcome of the interview on the fisrt page. Then thank those who participated in the interview:

Thank you for your participation and good bye!
Do not forget to visit water and food storage points, sanitary facilities and garbage disposal sites accessed by this household as part of the household questionnaire (a separate instrument) before moving on to the next household.

4.0 Observation Checklist

A Study to Evaluate the Effect of Poor Water and Poor Sanitation on Growth in Infants and Young Children aged 6-24 months in Zambia

1. ID:	[_____][____][____]
2. Date of Survey Visit	
3. Village	
4. Name of household head	
5. Time of the day when observation is conducted	

Observe the following at the household:

A. Floor

A.1. Floor is made of:

1. Mud 2. Cement 3.Dung 4.Other…………

A.2. Cleanliness of the floor,

1. Clean 2. Not clean

B. Water Storage

B.1. What type of containers are these? (Observe and check all that apply)
Narrow mouthed: opening is 3 cm or less (interviewers use template)

1. Narrow mouthed 2. Wide mouthed 3. Of both types

B.2. Are the containers covered? *(Observe and check)*

1. All are 2. Some are 3. None are

B.3. Where are the water containers placed *(Observe)?*

1. On the floor 2. Elevated above the floor

B.4. Are the water containers cleaned? *(Observe and check)*

1. Yes 2. No

C. Child cleanliness

C.1. Are the child's hands clean?

1. Clean 2. Not clean

C.2.Are the child's nails clean?

1. Clean 2. Not clean

C.3.Is the child's skin clean?

1. Clean 2. Not clean

C.4.Is the child's face clean?
1. Clean 2. Not clean

C.5.Are the child's clothes clean?
1. Clean 2. Not clean

D. Mother's cleanliness – (dress, skin, face)

D.1. Are the mother's hands clean?
1. Clean 2. Not clean

D.2. Are the mother's nails clean?
1. Clean 2. Not clean

D.3. Is the mother's skin clean?
1. Clean 2. Not clean

D.4. Is the mother's face clean?
1. Clean 2. Not clean

D.5. Are the mother's clothes clean?
1. Clean 2. Not clean

E. Cooking and feeding utensils

E.1. Where are family feeding utensils kept
1. On a stand 2. On the floor

E.2. Are family feeding utensils left clean
1. Clean 2. Not clean

E.3. Where are children's feeding utensils kept
1. On a stand 2. On the floor

E.4. Are feeding utensils left clean
1. Clean 2. Not clean

F. Food Preparation, Storage, and Handling Practice

F.1. Can you show me where you keep this food?
1. Yes 2. No

F.2. *Observe: are the containers covered?*
1. All are 2. None are 3. Some are

F.3. *Observe: where the food containers are placed?*

1. On the floor 2. Elevated above the floor

F.4. *Observe: what is the access to the food containers?*

1. Kept in refrigerator
2. Kept behind solid doors
3. Kept behind screened doors
4. Containers are in the open
5. Other? ....

G. Sanitation facilities:

G1.Toilet facility observation:

G1.1. *Return to question 2a.3 (section 2) and verify that the type of latrine indicated there is correct*

1. Yes, is correct 2. No, correction made 3. Did not verify 4. No toilet

G1.2. *Observe access to the facility; are there obstacles in the path, are there signs of regular use?* ***(Check all that apply)***

1. Dense vegetation
2. Waste or debris in its path
3. Major crevices or potholes
4. Mud
5. Entrance is obstructed
6. Path is clear
7. Path well-worn as sign of regular use
8. Other observation ____

____

9 No toilet facility

G1.3. *Observe the superstructure of walls, roof and door (**Check all that apply**)*

1. Has walls
2. Has a roof
3. Has door(s)
4. Superstructure damaged
5. No superstructure
6. Other____

G1.4. *If door(s) are present, can they be closed?*

1. Yes, are locked
2. No
3. Impossible to determine

G1.5. *If any type of pit latrine, are the holes covered?*

1. Yes 2. No 3. Not a pit latrine

G1.6. *Does it have any of the following child-friendly features? (may be separate or in the same compartment as an adult facility. observe and check all that apply.)*

1. Pit latrine with smaller hole
2. Lower seat
3. Potty available
4. None of the above
5. Cannot identify
6. Not a pit latrine
7. Other____

G1.7*. Is there faecal matter present inside the facility on floor or walls (human or animal)?*

1. Yes   2. No   3. Cannot assess

G1.8*. Is there faecal matter clearly visible in the pit at less than 30 centimetres depth? [As a sign that the pit is full]*

1. Yes   2. No   3. Cannot assess

G2. Hand washing Place

G2.1. *Is there a place for hand washing in the toilet facility or within 10 meters?*

1. Yes   2. No   3. No toilet

G2.2*. Observation only: is there water? Interviewer: turn on tap and/or check container and note if water is present*

1. Yes, found in hand washing place
2. Brought by caretaker within 1 min
3. No

G2.3 *Observation only: is there soap or detergent or ash?*

1. Found in hand washing place
2. Brought by caretaker within 1 min
3. No

G2.4*. Observation only: if there is soap, detergent, or ash, mark all that are present?*

1. Soap   2. Detergent   3. Ash

G2.5 *Observation only: is there a hand-washing device such as a tap, basin, bucket, sink, or tippy tap?*

1. Yes, found in hand washing place
2. Brought by caretaker within 1 min
3. No

G2.6*. Observation only: does the washing device allow unassisted washing and rinsing of both hands, for example, a tap, basin, bucket, sink, or tippy tap?*

1. Yes   2. No

G2.7 *Observation only: what method is used to dispense water?*

1. Tap or spigot
2. Tippy tap or similar device
3. Pipe without tap
4. Pour water into a basin or bucket
5. Pour water from container onto hands (Assisted by another person)
6. Pour water from container onto hands (Without assistance)
7. Other (specify) ___________________________________
8. Don't know

G2.8. *Observation only: is there a towel or cloth to dry hands?*

1. Yes, found in hand washing place
2. Brought by caretaker within 1 min
3. No

G2.9. *Observation only: does the towel or cloth appear to be clean?*

1. Yes 2. No 3. No cloth

G3 Hand washing Practice

Can you show me how you wash:

[Ask the caretaker to demonstrate/show how the child under 24 months washes his or her hands.] (Interviewer: observe the hand washing and answer the following questions)

a. your hands?	b. Baby's hands
1. Yes 2. No	1. Yes 2. No
1.Does the person use water? 1. Yes 2. No	*Does the child use water?* 1. Yes 2. No
2.Does the person use soap? 1. Yes 2. No	*Does the child use soap?* 1. Yes 2. No
3.Are both hands washed? 1. Yes 2. No	*Are both hands washed?* 1. Yes 2. No
4.Does (s)he rub hands together three times or more? 1. Yes 2. No	*Does s/he rub hands together three times or more?* 1. Yes 2. No
5.How does the person dry his or her hands? 1. With towel or cloth 2. In the air 3. Garment 4. Other (specify) _______________	*How does the child dry his or her hands?* 1. With towel or cloth 2. In the air 3. Garment 4. Other (specify) __________________

6.Does the towel or cloth the person uses appear to be clean? 1. Yes 2. No 3. N/A	*Does the towel or cloth the child uses appear to be clean?* 1. Yes 2. No 3 .N/A

G4. Household environment

G4.1 *Ask to see the room where cooking takes place: observe evidence of indoor smoke*

1. Smoke-filled room
2. Blackened ceiling or walls
3. Open fire place
4. No exhaust
5. Other (specify)_____________________________________
6. Don't know

G4.2. Are livestock (poultry, goats, pigs, etc.) kept inside living quarters at night?

1. Yes 2. No ►**G4.5**

G4.*3* *If yes, observe presence of livestock in living quarters during visit*

1. Livestock found in living quarters 2. Non found

G4.*4.* *Are faeces (human or animal) visible in the house or in the yard?*

1. Yes 2. No

G4.*5.* *Is there garbage lying in the open in the house or in the yard?*

1. Yes 2. No

G4.*6.* *Observe only: is the garbage covered*?

1. Yes
2. Uncovered ?, but no garbage
3. Uncovered? , but with garbage

G4.*7*.*Is there sewage in the yard?*

1. Yes 2. No

G4.*8*.*Is there garbage outside the premises or in the streets within 10 meters of dwelling?*

1. Yes 2. No

G4.*9*.*Is there sewage or are there open sewers outside the premises or in the streets within 10 meters of the dwelling?*

1. Yes 2. No

G4.*10*.*Is there considerable smoke around premises coming from the outside?*

1. Yes 2. No

G4.*11*.*Does the smoke come from burning garbage in the area?*

1. Yes 2. No 3. Don't know

G4.12. Is the house swept especially where the child most often plays

1. Yes 2. No 3. Don't know

G4.13. Is there stagnant water in the yard

1. Yes 2. No 3. Don't know

5.0 Age calendars for children and adults

a) Age in months calendar for children under five years of age (May 2014)

Month	Age	Month	Age	Month	Age	Month	Age
May 2015	0						
April 2015	1	Dec 2013	17	Aug 2012	33	Apr 2011	49
Mar 2015	2	Nov 2013	18	Jul 2012	34	Mar 2011	50
Feb 2015	3	Oct 2013	19	Jun 2012	35	Feb 2011	51
Jan 2015	4	Sept 2013	20	**May 2012**	**36**	Jan 2011	52
Dec 2014	5	Aug 2013	21	Apr 2012	37	Dec 2010	53
Nov 2014	**6**	Jul 2013	22	Mar 2012	38	Nov 2010	54
Oct 2014	7	Jun 2013	23	Feb 2012	39	Oct 2010	55
Sept 2014	8	**May 2013**	**24**	Jan 2012	40	Sept 2010	56
Aug 2014	9	Apr 2013	25	Dec 2011	41	Aug 2010	57
Jul 2014	10	Mar 2013	26	Nov 2011	42	Jul 2010	58
Jun 2014	11	Feb 2013	27	Oct 2011	43	Jun 2010	59
May 2014	12	Jan 2013	28	Sept 2011	44	May 2010	60
Apr 2014	13	Dec 2012	29	Aug 2011	45		
Mar 2014	14	Nov 2012	30	Jul 2011	46		
Feb 2014	15	Oct 2012	31	Jun 2011	47		
Jan 2014	16	Sept 2012	32	May 2011	48		

b) Age Calendar for Adults

Year	Age	Year	Age	Year	Age	Year	Age
2009	6	1989	26	1969	46	1949	66
2008	7	1988	27	1968	47	1948	67
2007	8	1987	28	1967	48	1947	68
2006	9	1986	29	1966	49	1946	69
2005	10	1985	30	1965	50	1945	70
2004	11	1984	31	1964	51	1944	71
2003	12	1983	32	1963	52	1943	72
2002	13	1982	33	1962	53	1942	73
2001	14	1981	34	1961	54	1941	74
2000	**15**	**1980**	**35**	**1960**	**55**	**1940**	**75**
1999	16	1979	36	1959	56	1939	76
1998	17	1978	37	1958	57	1938	78
1997	18	1977	38	1957	58	1937	79
1996	19	1976	39	1956	59	1936	80
1995	20	1975	40	1955	60	1935	81
1994	21	1974	41	1954	61	1934	82
1993	22	1973	42	1953	62	1933	83
1992	23	1972	43	1952	63	1932	84
1991	24	1971	44	1951	64	1931	85
1990	**25**	**1970**	**45**	**1950**	**65**	**1930**	**86**

6.0 Ethical approval

6.1 University of Western Cape Approval

UNIVERSITY of the WESTERN CAPE

OFFICE OF THE DEAN
DEPARTMENT OF RESEARCH DEVELOPMENT

14 December 2011

To Whom It May Concern

I hereby certify that the Senate Research Committee of the University of the Western Cape has approved the methodology and ethics of the following research project by: Mrs RH Mugode (School of Public Health)

Research Project:	Evaluation of the effect of poor water and poor sanitation on growth in infants and young children aged 6-24 months in Zambia
Registration no:	11/10/34

Ms Patricia Josias
Research Ethics Committee Officer
University of the Western Cape

Private Bag X17, Bellville 7535, South Africa
Tel: +27 21 959-2948/9
Fax: +27 21 959 3170
Website: www.uwc.ac.za

6.2 Biomedical Research Ethics Committee Approval

THE UNIVERSITY OF ZAMBIA

BIOMEDICAL RESEARCH ETHICS COMMITTEE

Telephone: 260-1-256067
Telegrams: UNZA, LUSAKA
Telex: UNZALU ZA 44370
Fax: + 260-1-250753
E-mail: unzarec@unza.zm

Ridgeway Campus
P.O. Box 50110
Lusaka, Zambia

Assurance No. FWA00000338
IRB00001131 of IORG0000774

10th August, 2012.

Your Ref: 003-03-12.

Ms. Raider Habulembe,
PO Box 32669,
Lusaka.

Dear Ms Habulembe,

RE: RE-SUBMITTED RESEARCH PROPOSAL: **"EVALUATION OF THE EFFECT OF POOR WATER, SANITATION AND POOR HYGIENE PRACTICES ON GROWTH AND INFECTIOUS DISEASES INCIDENCE IN INFANTS AND YOUNG CHILDREN AGED 6-23 MONTHS IN MONZE RURAL, ZAMBIA OVER A PERIOD OF 12 MONTHS"**

The above mentioned research proposal was re-submitted to the Biomedical Research Ethics Committee with recommended changes on 7th August, 2012. The proposal is approved.

CONDITIONS:

- This approval is based strictly on your submitted proposal. Should there be need for you to modify or change the study design or methodology, you will need to seek clearance from the Research Ethics Committee.
- If you have need for further clarification please consult this office. Please note that it is mandatory that you submit a detailed progress report of your study to this Committee every six months and a final copy of your report at the end of the study.
- Any serious adverse events must be reported at once to this Committee.
- Please note that when your approval expires you may need to request for renewal. The request should be accompanied by a Progress Report (Progress Report Forms can be obtained from the Secretariat).
- **Ensure that a final copy of the results is submitted to this Committee.**

Yours sincerely,

Dr. J.C Munthali
CHAIRPERSON

Date of approval: 10 August, 2012 **Date of expiry:** 09 August, 2013

6.3 Ministry of Health Approval

All Correspondence should be addressed to the Permanent Secretary
Telephone: +260 211 253040/5
Fax: +260 211 253344

REPUBLIC OF ZAMBIA

MINISTRY OF HEALTH

In reply please quote:

No. ____________

MH/101/17/6

NDEKE HOUSE
P. O. BOX 30205
LUSAKA

17th September, 2012

Ms. Raider Habulembe
P.O. Box 32669
LUSAKA

Dear Ms. Habulembe,

Re: Request for Authority to Conduct Research

The Ministry of Health is in receipt of your request for authority to conduct a study on **"Evaluation of the effect of poor water, sanitation and poor hygiene practices on the growth and infectious disease incidence in infants and young children aged 6-23 months in Monze rural, Zambia over a period of 12 months".** I wish to inform you that following submission of your research proposal to my Ministry, our review of the same and in view of the ethical clearance, my Ministry has granted you authority to carry out the study on condition that:

1. The relevant Provincial and District Directors of Health where the study is being conducted are fully appraised;
2. Progress updates are provided to MoH quarterly from the date of commencement of the study;
3. The final study report is cleared by the MoH before any publication or dissemination within or outside the country;
4. After clearance for publication or dissemination by the MoH, the final study report is shared with all the relevant Provincial and District Directors of Health where the study was being conducted, and all key respondents.

I consider your research topic to be of policy relevance.

Yours sincerely,

[illegible]
Dr. P. Mwaba
Permanent Secretary
MINISTRY OF HEALTH

7.0 Participant Information Sheet

UNIVERSITY OF THE WESTERN CAPE
Private Bag X 17, Bellville 7535, South Africa

Tel: +27 21-959, Fax: 27 21-959

E-mail: tpuoane@uwc.ac.za

INFORMATION SHEET

Project Title: A Study to Evaluate the Effect of Poor Water and Poor Sanitation on Growth in Infants and Young Children aged 6-23 months in Zambia

What is this study about?
This is a research project being conducted by Raider Habulembe Mugode at the University of the Western Cape. We are inviting you to participate in this research project because you have a child who is aged between 6 to 23 months in your household. The purpose of this research project is to collect data that will help us researchers and program officers to understand how issues of water, sanitation and hygiene affect the growth of children in this community. This will therefore help address issues of water, sanitation and hygiene and the growth of children in such a way that will lead to effective programming. In addition, outcomes of this study can also help other communities that have not participated in this program in terms of programming. it is also a requirement at my University in order for me to obtain a degree in Public health nutrition. The interview will take about 45 minutes.

What will I be asked to do if I agree to participate?
You will be asked to answer questions regarding the type of water and sanitary facilities you use in this household in particular for [**name of child**] and the hygiene practices you observe in the household. In addition, you will also be asked questions on how you feed [**name of child**], diseases that the child may have suffered in the previous 2 weeks and finally, the weight and heights of [**name of child**] and the mother will be taken. The interview will take about 40 minutes and about 10 minutes to observe some areas of your household such as the toilet, kitchen and where children play

Would my participation in this study be kept confidential?
We will do our best to keep your personal information confidential. To help protect your confidentiality, the information that will be collected from you and your household will be kept confidential and will not be given to any partner or project for further analysis. The questionnaire will be given a pseudo name and a number that will be used to enter as identity in the computer instead of real names. The computer will be protected with a password to avoid unpermitted accessing of the file. If we write a report or article about this research project, your identity will be protected to the maximum extent possible.

What are the risks of this research?
There are no known risks associated with participating in this research project.

What are the benefits of this research?

This research is not designed to help you personally, but the results may help the investigator learn more about how diseases resulting from poor water, sanitation and hygiene affect the health of children. We hope that, in the future, other people might benefit from this study through improved understanding of how safe water and sanitation cay help to improve the health of their children.

Do I have to be in this research and may I stop participating at any time?

Your participation in this research is completely voluntary. You may choose not to take part at all. If you decide to participate in this research, you may stop participating at any time. If you decide not to participate in this study or if you stop participating at any time, you will not be penalized or lose any benefits to which you otherwise qualify.

Is any assistance available if I am negatively affected by participating in this study?

If your household will found to be affected negatively in this study, the team will wither offer counselling on matters in which they have expert or refer you to the health facility for further assistance

What if I have questions?

This research is being conducted by *Raider Habulembe Mugode, School of Public Health* at the University of the Western Cape. If you have any questions about the research study itself, please contact Raider Habulembe Mugode at National Food and Nutrition Commission, P O Box 32669, Lusaka, Tel:0955763630, email: rhmgode@yahoo.com

Should you have any questions regarding this study and your rights as a research participant or if you wish to report any problems you have experienced related to the study, please contact:

Head of Department: Uta Lehmann
Dean of the Faculty of Community and Health Sciences:
University of the Western Cape
Private Bag X17
Bellville 7535
South Africa

Or

The Chairman
The University of Zambia Biomedical Research Ethics Committee
Box 50110
Lusaka, Zambia
Tel: 260 1 256067
Email: unzarec@zamtel.zm

This research has been approved by the University of the Western Cape's Senate Research Committee and The University of Zambia Biomedical Research Ethics Committee.

8.0 Permission Forms

8.1 Consent Form-Household Head or Spouse

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa

Tel: +27 21-959, Fax: 27 21-959

E-mail: tpuoane@uwc.ac.za

A Study to Evaluate the Effect of Poor Water and Poor Sanitation on Growth in Infants and Young Children aged 6-24 months in Zambia

The study has been described to me in language that I understand and I freely and voluntarily agree to participate. My questions about the study have been answered. I understand that my identity will not be disclosed and that I may withdraw from the study without giving a reason at any time and this will not negatively affect me in any way.

Participant's name……………………….
Participant's signature……………………………. Thumb print……………………………….
Witness……………………………….
Date……………………..

Should you have any questions regarding this study or wish to report any problems you have experienced related to the study, please contact the study coordinator:

Head of Department: Uta Lehmann
Dean of the Faculty of Community and Health Sciences:
University of the Western Cape
Private Bag X17
Bellville 7535
South Africa

Or

Professor Thandi Puoane
University of the Western Cape
Private Bag X17, Belville 7535
Telephone: (021)959-
Cell: 0827075881
Fax: (021)959- 2809
Email: tpuoane@uwc.ac.za

Or

The Chairman
The University of Zambia Biomedical Research Ethics Committee
Box 50110
Lusaka, Zambia
Tel: 260 1 256067
Email: unzarec@zamtel.zm

8.2 Assent Form – Children Under five Years

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa

Tel: +27 21-959, Fax: 27 21-959

E-mail: tpuoane@uwc.ac.za

A Study to Evaluate the Effect of Poor Water and Poor Sanitation on Growth in Infants and Young Children aged 6-24 months in Zambia

ASSENT FORM FOR CHILDREN AGED 6-24 MONTHS

The study has been described to me in language that I understand and I freely and voluntarily agree to allow my child to be part of this study. My questions about the study have been answered. I understand that my child's identity will not be disclosed and that I may withdraw the participation of my child from the study without giving a reason at any time and this will not negatively affect me and my child in any way.

Statement of Assent:

____

Name of Child

______________________ ______________________ ________________________

Name of Mother **Signature/Thumb print Date**

______________________ ______________________ ________________________

Name of Witness **Signature/Thumb print Date**

______________________ ______________________ ________________________

Name of Investigator **Signature/Thumb print Date**