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Improving sanitation and hygiene: effects on childhood growth in rural Zambia

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IMPROVING SANITATION AND HYGIENE: EFFECTS ON CHILDHOOD GROWTH IN RURAL ZAMBIA

by

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IMPROVING SANITATION AND HYGIENE: EFFECTS ON CHILDHOOD GROWTH IN RURAL ZAMBIA

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ABSTRACT

The relationships between water, sanitation, and hygiene (WASH) interventions and malnutrition markers such as stunting, wasting, and underweight have been poorly characterized until recently. There is a need to identify interventions that may play a role in these relationships to improve nutritional status of children under 5 years old. In 2013, Zambia was not on track to meet MDG 7c, to halve the proportion of the population without sustainable access to safe drinking water and basic sanitation. To address this goal, the Zambian government implemented the Zambia Sanitation and Hygiene Program (ZSHP). The goal of the program was to reduce WASH-related diseases in rural areas by promoting community wide sanitation using community-led total sanitation (CLTS), legal enforcement, and hygiene promotion. An important component of the ZSHP is CLTS, which has been implemented in a majority of districts. The overall study aims to explore the effectiveness of a CLTS intervention on coverage and quality of household sanitation facilities, defecation behavior, and child health in a rural setting in Zambia. A secondary outcome that was measured in the analysis of the overall study was the effect of CLTS on stunting, wasting, and underweight in children under the age of 5. These three outcomes are the focus of this thesis. It was hypothesized that these three outcomes would decrease in prevalence with an increase in sanitation coverage resulting from the CLTS program.

Cross-sectional anthropometric and household data for Zambian children under 5 and their households from baseline and end line surveys were analyzed to determine any association between multiple WASH indicators and nutritional status. The baseline survey was conducted in 2013 and the end line in 2016. Only households with at least one child under the age of 5 were surveyed at both baseline and end line. Primary caretakers were interviewed during home visits to assess sanitation resources, child-feeding practices, and the health status of their children under the age of 5. In addition, anthropometric data of children under the age of 5 was taken to assess their nutritional status of their children. The prevalence of underweight, stunting, and wasting at end line was 12.9%, 40.9%, and 7.4% respectively, all of which showed statistically significant decreases from baseline measurements ($p=\leq 0.001$, 0.03, and ≤ 0.001 respectively). Predictors of undernutrition were analyzed using logistic regression controlling for age and sex. Nutritional status of children under 5 years of age was found to be associated with several WASH indicators. Children who were taken to a clinic during an episode of diarrhea and children who lived in households with an improved water source had 46% and 26%, respectively, decreased odds of being stunted. Children who lived in households that were close (<4 min walk) to a water source had a 73% decrease in odds of being wasted. Finally, children who had diarrhea in the two weeks before the survey had 63% and 42% increased odds of being underweight or wasted respectively. Focus areas of the program have increased coverage of key indicators of sanitation and hygiene but a relatively high prevalence of sanitation- and hygiene-related diseases remain. These

rural areas have high rates of reported diarrhea, acute respiratory illness, and stunting among young children even though most have had exposure to the ZSHP activities. With increased focus, not only on better human sanitation, but also on household environment sanitation, the prevalence of disease and malnutrition will start to decrease and we will begin to see healthier communities in Zambia.

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LIST OF ABBREVIATIONS

ARI.....acute respiratory illness

BU ..... Boston University

CI.....confidence interval

CLTS..... community-led total sanitation

DHS.....Demographic and Health Survey

EED.....environmental enteric dysfunction

EHT..... Environmental Health Technician

HAZ .....height-for-age z-score

IRB..... Institutional Review Board

ISO ..... International Standards Organization

LE.....legal enforcement

MDG .....Millennium Development Goals

MUAC.....mid-upper arm circumference

ODF.....open defecation free

SE..... standard error

SEA ..... standard enumeration area

SDG..... Sustainable Development Goals

SHINE.....Sanitation Hygiene Infant Nutrition Efficacy

SQ-LNS..... small-quantity lipid-based nutrient supplements

UN..... United Nations

UNICEF ..... United Nations International Children's Emergency Fund

WASH.....water, sanitation, and hygiene

WAZ ..... weight-for-age z-score

WHA.....World Health Assembly

WHO.....World Health Organization

WHZ .....weight-for-height z-score

ZCAHRD ..... Zambia Center for Applied Health and Research Development

ZSHP.....Zambia Sanitation and Hygiene Program

INTRODUCTION

1.0 Background

1.1 Malnutrition, a global public health problem

Malnutrition and inadequate diet are some of the biggest risk factors for the global burden of disease.[1] Undernutrition, specifically, is a global problem that results in stunted, wasted, and underweight children. Childhood and maternal undernutrition are responsible for almost 30% of the estimated annual burden of disease in Africa.[2] Globally, stunting affected 23.2% of children in 2015 (Fig.1).[3,4] One in four children under age 5 had stunted growth in 2014—an estimated 158.6 million children.[5] Stunting is defined as the percentage of children, aged 0 to 59 months, whose height-for-age Z (HAZ) score is below minus two standard deviations (moderate and severe stunting) and minus three standard deviations (severe stunting) from the median of the WHO Child Growth Standards.[6] Stunting results from chronic undernutrition. This reflects the cumulative effects of chronic deficits in food availability and intake, poor childcare practices, and illness. For many children, stunted growth starts before birth as a result of poor maternal nutritional status and worsens gradually during the first 2 years of life.[7] The first 1000 days, from conception until the age of 2 years, are a critical window of opportunity, during which timely interventions can have a measurable and lasting impact on the prevention of child stunting.[8-13] Wasting is defined as the percentage of children, aged 0 to 59 months, whose weight-for-height Z (WHZ) is below minus two standard deviations (moderate and severe wasting) and minus three standard deviations (severe wasting) from the median of the WHO Child Growth Standards.[6] Wasting is generally the result of an acute lack of calories

and nutrients from famine or a severe and sudden illness but may also be the result of a chronic unfavorable condition. In 2015, 7.4% of children were wasted.[3,4] Lastly, underweight is defined as the percentage of children, aged 0 to 59 months, whose weight-for-age Z (WAZ) score is below minus two standard deviations (moderate and severe underweight) and minus three standard deviations (severe weight) from the median of the WHO Child Growth Standards.[6] Underweight serves as a composite measure that captures both stunting and wasting.[14] In 2013, 15% of children globally were underweight.[3,4] Evidence has shown that the mortality risk of children who are even mildly underweight is nearly double the risk of death of their well-nourished counterparts. This risk increases to five- to eightfold in moderately to severely underweight children.[15]

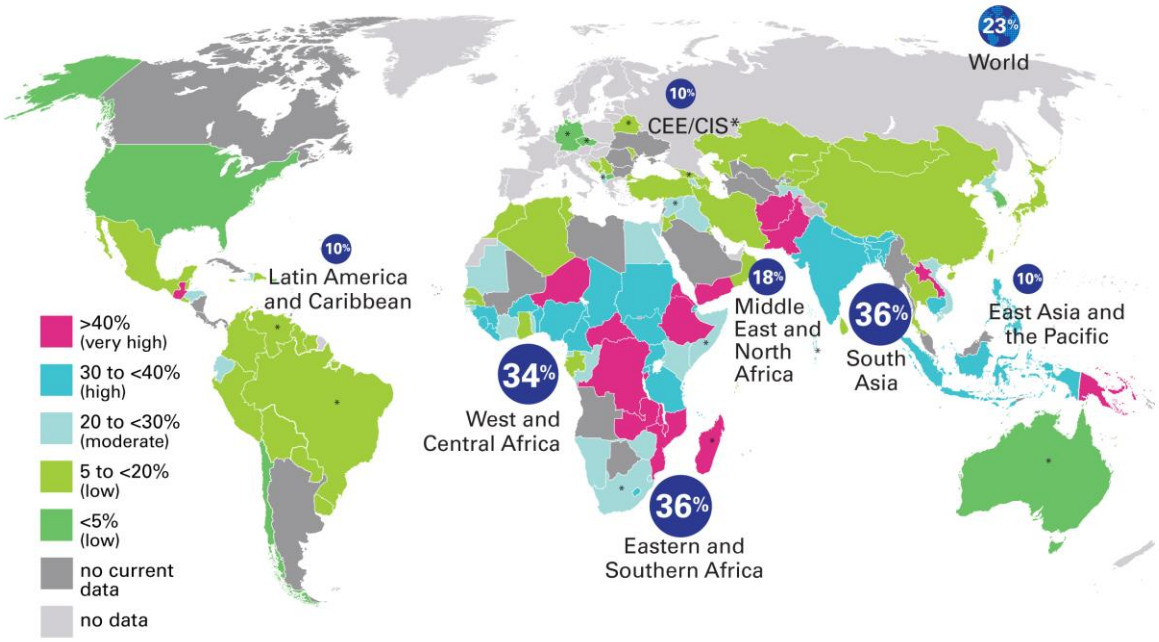

Figure 1: Percentage of children under 5 who are stunted, 2010–2016[16] Figure downloaded from UNICEF at https://data.unicef.org/topic/nutrition/malnutrition/ **(Source:** UNICEF, WHO, World Bank Joint Child Malnutrition dataset, September 2016 update)

In the past few years, nutrition has come to the forefront of many development agencies and their goals. In 2012 the World Health Assembly (WHA) recognized the need for global action to address the universal and destructive problem of the double-burden of malnutrition, the coexistence of undernutrition along with overweight and obesity, within individuals, households and populations, and across the life course. The WHA unanimously agreed to six global nutrition targets.[17] The first target is a 40% reduction in the number of children under 5 who are stunted and the sixth is to reduce childhood wasting to less than 5% and maintain this level.[17] The current projection of stunted children under age 5 in 2025 is 128 million.[18] The target is 100 million.[18] The number of stunted children under 5 is declining in every region worldwide except Africa and Oceania.[19] In order to

achieve the sixth nutrition target by 2025, the 2015 rate of 7.4% will need to see a 40% reduction.[18] Current development goals are expanding. Along with the Global Nutrition Target, the United Nations (UN) has developed the Sustainable Development Goals (SDG) to follow the Millennium Development Goals (MDG). Goal 2 of the SDGs is to end hunger, achieve food security and improved nutrition, and promote sustainable agriculture by 2030.[20] These are ambitious goals but current research and programs involving nutrition are at the forefront of many development agencies and organizations.

1.2 Effects of undernutrition

Undernutrition is both a cause and a consequence of poverty and is a major contributor to child mortality.[21] This positive feedback loop of undernutrition and poverty can negatively affect all aspects of an individual's health and development and impedes economic and social progress at the community and national levels (Fig. 2).[22] The effects of undernutrition start early. The first 1000 days are especially important for optimal physical, mental, and cognitive growth as well as health, and development.[23,24] Unfortunately, this period is often marked by macro- and micronutrient deficiencies that interfere with optimal growth. As Maureen Shaw from 1,000 Days states, "Children who get the right nutrition in their first 1,000 days are ten times more likely to overcome life-threatening childhood diseases, complete nearly five more grades in school, go on to earn 21% more in wages as adults and are more likely to have healthier families of their own."[25, 11]

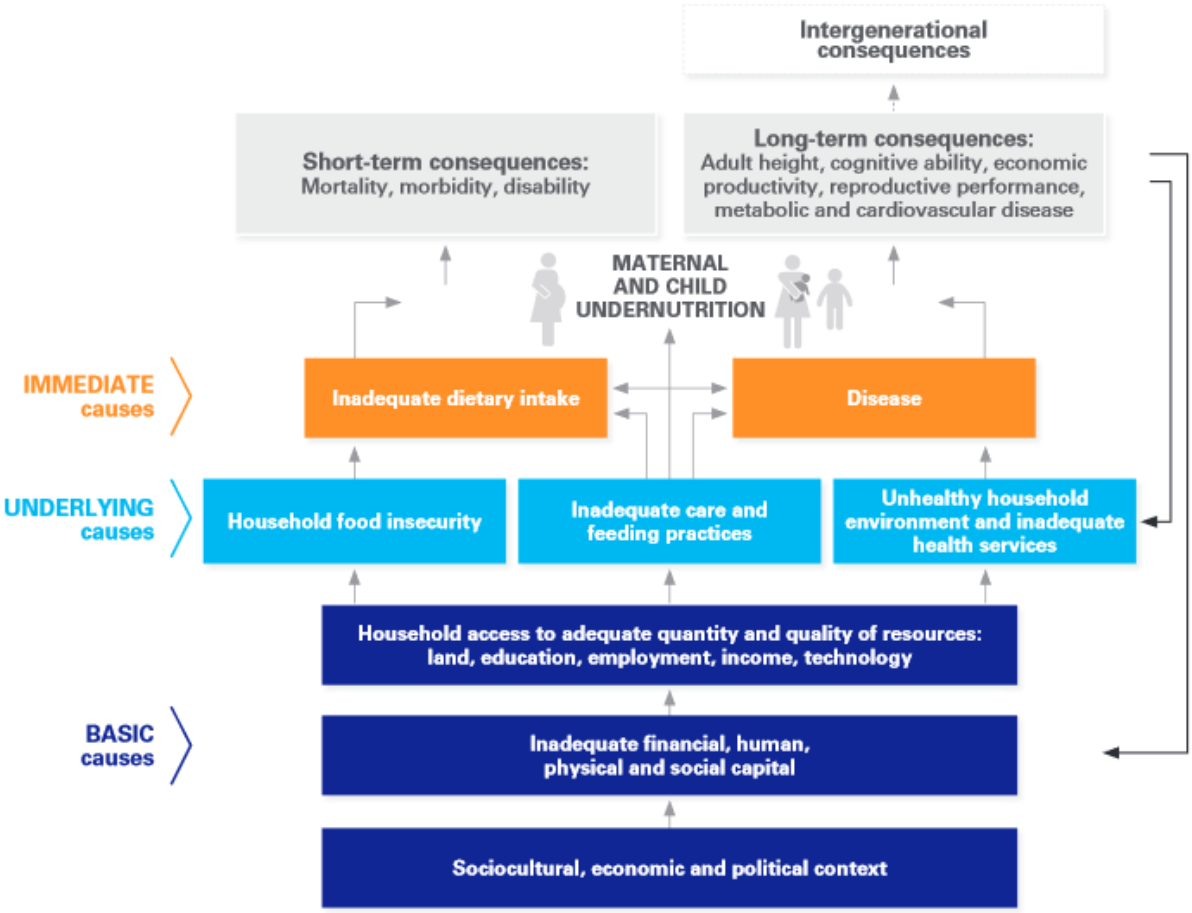

Figure 2: Conceptual framework of the determinants of child undernutrition.[22] The black arrows show that the consequences of undernutrition can feed back to the underlying and basic causes of undernutrition, perpetuating the cycle of undernutrition, poverty, and inequities. Figure downloaded from UNICEF at https://www.unicef.org/gambia/Improving_Child_Nutrition_-_the_achievable_imperative_for_global_progress.pdf (Source: Adapted from UNICEF, 1990)

1.3 Nutrition only interventions cannot solve this global problem

Previous solutions to this concerning problem of global undernutrition have been strictly nutrition-based interventions. For decades, there have been many supplemental feeding programs, micronutrient supplement interventions, and education programs. These programs have made a small impact on stunting and wasting rates. Nutrition interventions,

even if implemented at 90% coverage, are estimated to reduce worldwide stunting by 20%.[26] These findings suggest that stunting is unlikely to be eliminated without addressing the underlying determinants of undernutrition alongside deficiencies in the quantity and quality of infant and child nutritional intake.

Undernutrition is directly caused by inadequate food availability, dietary intake, and/or disease (nutrition specific) but also is indirectly related to many factors, including contaminated drinking water and poor sanitation and hygiene (nutrition sensitive).[14] Effectively and sustainably improving nutrition outcomes requires a coordinated, multi-sectoral approach among the health, water, sanitation and hygiene (WASH) sectors and strong community engagement.

1.4 Water, Sanitation and Hygiene (WASH)

Along with nutrition-based programs, WASH programs and interventions have the potential to reduce undernutrition. With better WASH, children will not get sick as often. A 2012 retrospective analysis from 145 countries concluded that 842,000 diarrhea deaths are estimated to be caused by a cluster of risk factors: inadequate drinking water, inadequate sanitation, and inadequate hand hygiene. This amounts to 1.5% of the total disease burden and 58% of diarrheal diseases.[27] In children under 5 years old, 361,000 deaths could be prevented, representing 5.5% of deaths in that age group.[26] Poor WASH leads to infection and disease, resulting in undernutrition. In the body's weakened state, it becomes more prone to infection and disease, creating a vicious cycle of poor health and

development. The dual burden of poor WASH and undernutrition is common in areas with high rates of poverty, such as Sub-Saharan Africa and South Asia. Together, these account for the highest burden of child undernutrition and poor WASH globally.[28]

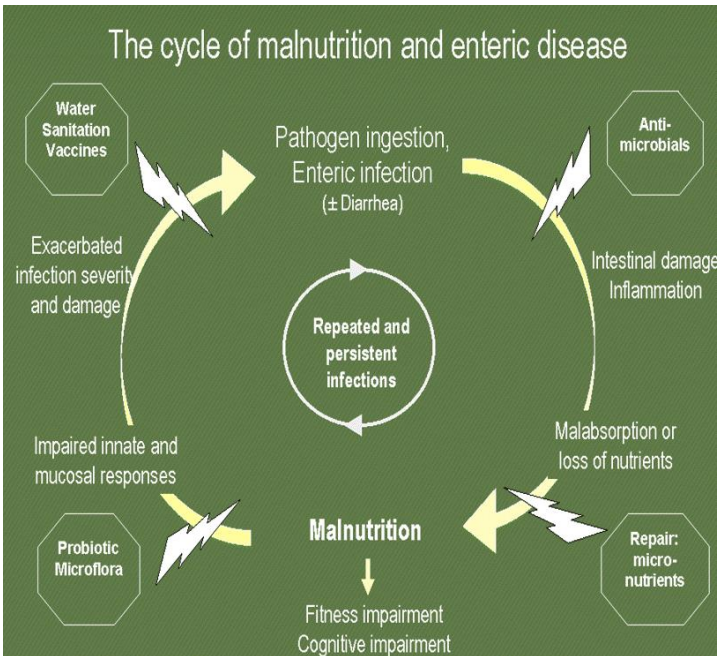

Figure 3: The vicious malnutrition and disease cycle[29]
Downloaded from MAL-ED at https://mal-ed.fnih.org/

Better WASH practices would break the vicious cycle of malnutrition (Fig. 3).[29]

WASH interventions can interrupt the transmission of fecal pathogens from the surrounding external environment to humans through several pathways, as highlighted in the F-diagram (Fig. 4). When feces are removed from this environment, proper sanitation and hygiene can act as primary barriers to disease. This approach prevents fecal pathogens from entering water sources and from contaminating fly populations and cross contamination with food sources.

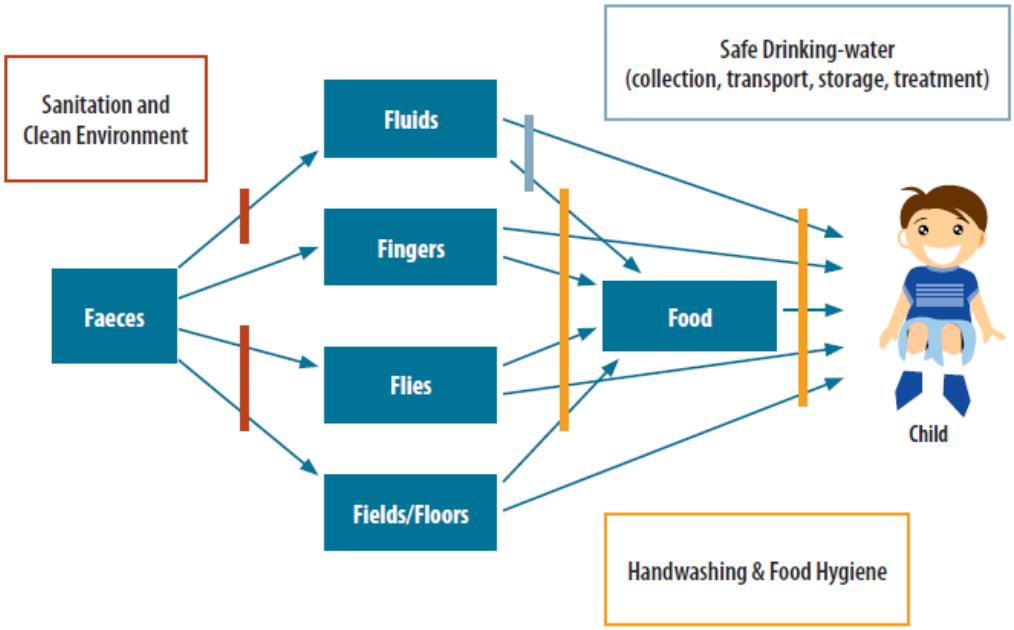

Figure 4: F-Diagram
(Figure taken from World Health Organization, 2015)[30]

One such intervention that has been implemented in several countries is community-led total sanitation (CLTS). This program uses participatory methods to eliminate the practice of open defecation in rural communities and promote building of toilets. At the district level, selected villagers, are trained to facilitate a process in communities known as triggering. Triggering is a process aimed at using small hands-on exercises to cause the communities to realize that 'they eat their own shit' because of a lack of hygiene and sanitation in their community.[31] This may lead to a greater appreciation of the potential health impact of inadequate sanitation and hygiene. The triggering is designed to encourage

villages to decide to form a sanitation committee, to build their own latrines, and improve their hygiene. The implementing organization does not give hardware or financial subsidies to assist households in constructing latrines.[32] The champion with support from the Chief, councilors, and environmental health technicians (EHTs) will follow up on triggered villages until the village attains open defecation free (ODF) status. Following the claims of ODF by champions or the village headman, the district authorities verify the village's status. Communities that successfully eliminate open defecation and achieve universal latrine coverage are rewarded with ODF certification, typically presented by government officials during a ceremony to post a sign declaring the community's status. It is important to achieve ODF status for a community not only for the status of being ODF but also for the health of the entire community. It is only moderately beneficial to a single household's health if they do not practice open defecation because they are still affected by the open defecation of their neighbors. However, when an entire community is ODF, the health of that single household increases by much more.

This program has been shown in Mali to successfully reduce stunting and wasting in children under 5.[33] This cluster-randomized trial included households in rural villages (clusters) from one district of Mali. Every household in the study had to have at least one child younger than 10 years of age. Villages were randomly assigned to receive the CLTS program or no program. The primary health outcome was diarrhea. Secondary outcomes included height-for-age, weight-for-age, stunting, and underweight. All outcomes were measured 1.5 years after intervention delivery among children younger than 5 years. Little

improvement was observed in diarrhea prevalence but greater accessibility of toilets and improvements in child growth were seen. In CLTS villages, 35% of children under 5 were stunted compared with 41% in control villages, and the difference in mean HAZ was 0.18 (95% CI 0.03 to 0.32).[33] Additionally, in CLTS villages, 22% of children under 5 were underweight compared with 26% in control villages, and the difference in mean WAZ was 0·09 (95% CI –0·04 to 0·22) between groups.[33] In CLTS villages, children under 2 years of age at enrollment showed greater improvements in height and weight than older children.[33]

Unimproved sanitation, poor hand-washing, poor water quality, and living in a non-ODF village can cause fecal contamination in a household. Cummings et al. describe well how nutrition and WASH are interconnected.[34] The authors use the four pillars of food and nutrition security and link them to WASH:

1. Food 'availability' is linked through water as a resource for agricultural production.
2. Food 'access' is linked to WASH through household income that may be diverted from food by the cost of obtaining or treating water and ensuring adequate sanitation.
3. Food 'stability' is connected through the difficulty of treating related infectious disease or associated inability to work.
4. Food 'utilization' is intertwined through the effect of WASH-related enteric infections on the body's ability to utilize the available nutrients.[34]

The fourth and last pillar is the most important in children under 5. There are multiple ways for children to not be able to use the nutrients they receive. A few examples are continuous bouts of diarrhea, worms, and environmental enteric dysfunction (EED).[35-42]

1.5 WASH and nutrition challenges in Zambia

Zambian children under age 5 face multiple obstacles with respect to their survival and development. In 2013, Zambia was not on track to meet MDG 1, to halve the proportion of people who suffer from hunger, and MDG 7c, to halve the proportion of the population without sustainable access to safe drinking water and basic sanitation.[43] An estimated 8.4 million people lack access to improved sanitation, of which around 2.1 million practice open defecation in Zambia.[44] To address MDG 7c, the Zambian government implemented a program called the Zambia Sanitation and Hygiene Program (ZSHP). The goal of the program was to reduce WASH-related diseases in rural areas by promoting community wide sanitation using CLTS, legal enforcement (LE), and hygiene promotion.[45] The government, along with UNICEF, piloted CLTS in the Macha area, Choma district in Southern Province with great success (Fig. 5).[44]

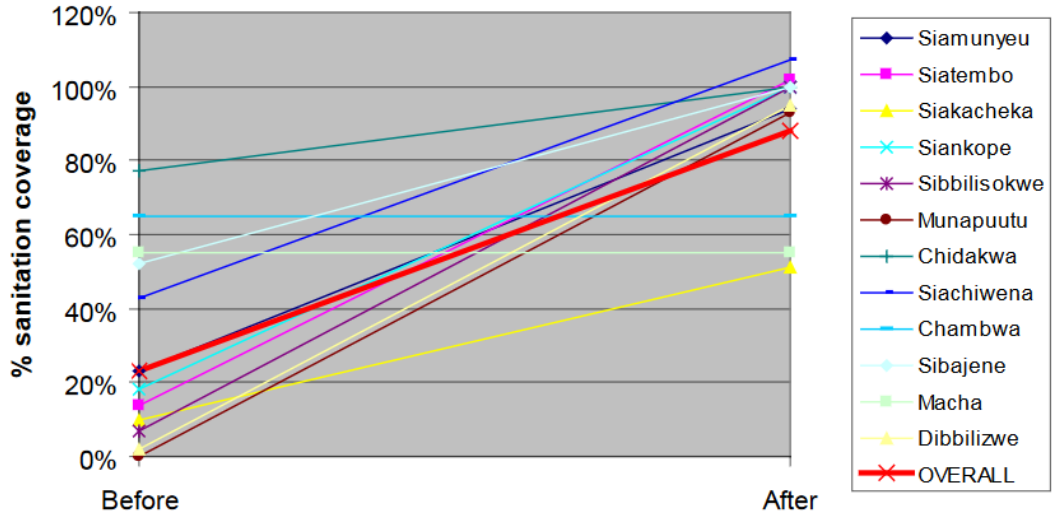

Figure 5: % Sanitation coverage before and after CLTS implementation in 12 areas of the Chiefdom of Macha in Southern Province and overall (Figure taken from UNICEF, 2009)[44]

Notable adaptations in the Zambia program included co-leadership by traditional and civil leaders and the inclusion of non-traditional stakeholders such as the media and the judiciary.[46] According to the Zambia 2013/2014 Demographic and Health Survey (DHS), 40% of children under 5 are stunted, 6% are wasted, and 15% are underweight. Zambia's stunting rate has been increasing over the years.[46] The percentage of stunting peaks at about two years and then slowly declines in older ages (Fig. 6).[46] Diarrhea is one of the leading contributors to the high under 5 mortality rate and children aged 6-23 months are most susceptible to diarrhea (28 %).[46]

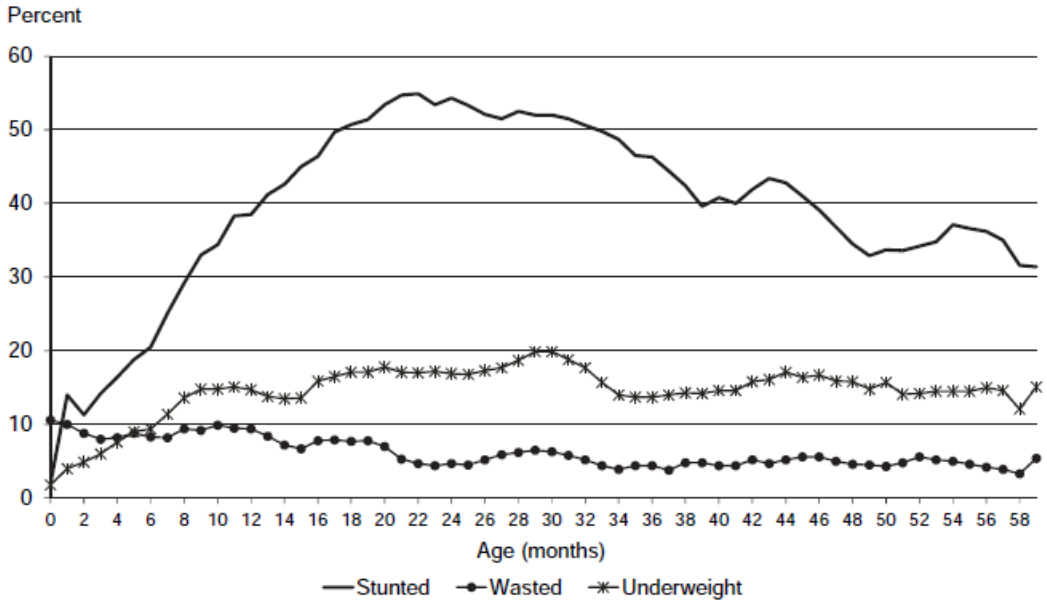

Figure 6: Nutritional status of children by age (Figure taken from ZDHS 2013-14)[46]

2.0 Objective

The aim of the overall analysis of the ZSHP was to explore the effectiveness of a CLTS intervention on coverage and quality of household sanitation facilities, defecation behavior, and child health in rural Zambia. The ultimate goal of the ZSHP was to contribute to

achievement of the SDG 6 targets. The overall aim of the impact evaluation was to determine the effect of CLTS on the prevalence of diarrheal disease in children under 5, proportion of households that use an improved facility, proportion of households that have a handwashing facility with a washing agent, and proportion of households that live in an ODF-certified village. A secondary outcome that was measured in the analysis of ZSHP was the effect of CLTS on the proportion of stunting, wasting, and underweight in children under 5. It was hypothesized that these three outcomes would decrease with an increase in sanitation coverage resulting from the CLTS program. These three anthropometric outcomes are assessed in this thesis.

METHODS

1.0 Research

This was a cross-sectional survey design that used a household population-level survey. A baseline survey was performed in 2013 along with an end line survey in 2016. The study was conducted from selected standard enumeration areas (SEAs) from rural districts in eight of the ten provinces of Zambia where the CLTS project was implemented.

1.1 Study population

Caregivers with children under five years old (0-59 months) in the study area were interviewed for the household survey. The sample was designed to provide "nationally" representative estimates of WASH indicators for rural Zambia. The primary sampling unit was the SEA. A list of rural SEAs from districts in the eight provinces where the project is being implemented was requested from the Central Statistical Office. In the first stage, 50 SEAs were selected and stratified by province and district to ensure complete geographical coverage. In each of the 50 SEAs, an average of 25 households were selected by equal probability systematic sampling.

The program had phased implementation beginning early in 2012. The baseline evaluation was conducted from June to August 2013, and the end line evaluation from June to August 2016. End line household surveys were conducted to measure the impact of ZSHP and CLTS after three years of implementation. Because of the phased implementation, it was not possible to select all study areas that had not had some level of exposure to program activities for the baseline evaluation.

1.2 Recruitment and informed consent

When interviewers entered, unannounced to selected households, they briefly introduced themselves and the purpose of the visit and asked for mothers/caregivers with children aged 0-59 months. In a situation where the household had more than one mother/caregiver with a child of this age, the older mother/caregiver was interviewed as she was more likely to be the partner of the head of household or head of household herself and would thus be in a better position to respond to all the questions. The interviewers obtained informed consent in the participants' local language. They explained the purpose and rationale of the study, and informed the participants that they would not be paid for participating, they were not obliged to participate, and they could refuse to answer any question. They were assured of confidentiality regarding any information they provided. They were asked to sign, mark, or thumbprint the consent form, and offered the opportunity to receive a copy of the consent form. Once written informed consent was provided, a participant was interviewed.

1.3 Data collection

The caregivers were interviewed in their homes by trained interviewers. Information collected included knowledge of good hygiene practices, household water treatment practices, understanding of the link between diarrhea and poor hygiene and sanitation, access to and use of improved sanitation, hand washing practices, source and storage of drinking water and any barriers encountered in accessing these services. They were also asked about recent illnesses of their children, particularly diarrhea and acute respiratory illness (ARI), and actions taken during the illness including type and source of treatment. Socio-demographic characteristics of respondents and family were also collected. The

interviewers asked about expenditure on the construction and maintenance of latrines and hand washing materials. Dates when the latrines were constructed were also collected. We also asked about the source of information on sanitation and hygiene; and in areas where CLTS had started, any contact with the program and participation in the activities as well as when the program started in their village. Additionally, toilet facilities for the household, water storage containers, and sites for washing hands were inspected. Weight, height, and mid upper arm circumference (MUAC) of children under five years of age in the household were measured.

1.4 Data quality issues and feedback from the field

The field team for both the baseline and end line study was recruited from a pool of experienced field staff that the Zambia Center for Applied Health and Research Development (ZCAHRD) has used over the years to conduct similar field activities. The end line field team had almost all of the same members as the baseline with the exception of 3 members. They received a five day training at baseline and end line to ensure that they had the appropriate training and skills necessary to the overall conduct of the study, safety of research subjects, and quality of the resulting data. They were trained on how to use the study instruments and re-trained on anthropometric measurements. They were taken through the forms question by question, explaining each thoroughly and detailing the information required. The training also covered the protection of human participants, confidentiality and the process of obtaining informed consent.

The interviews were conducted in the interviewee's own language. Although the interviewers spoke many of the relevant languages, in a few cases, local interpreters were engaged to assist with administering the survey forms.

Several levels of supervision of data collection and checking of study forms were used to ensure the quality of data. Three teams were involved in the data collection. Each team was made up of three data collectors and a supervisor. Each team was allocated a vehicle and worked together in the same area to ensure that the supervisor had daily contact with data collectors. The supervisor collected and checked forms to ensure that they were completed properly and there were no blank cells. The supervisors also made both scheduled and unscheduled visits to data collectors during interviews. A study coordinator travelled to visit each team and collected and checked surveys. The study coordinator also was in the field to troubleshoot any questions or problems. Challenges encountered were mostly logistical. The respondents were excited about the study and payment for participation was not an issue, since during the consent process, it was explicitly stated that they would not be paid for their participation.

1.5 Ethical approval

Ethical approval was obtained from the Boston University Institutional Review Board (BU IRB) and a local Zambian ethical review committee (ERES Converge IRB). All consent forms were developed in accordance with the BU and ERES Converge IRB ethics committee guidelines. Consent forms were translated into the major local languages spoken in the study districts (Bemba, Nyanja and Tonga).

2.0 Data management and statistical analyses

The data collection tools were designed in TeleForms. The Teleforms enabled hand-written text to be translated to computer readable files by scanning the files and optical character recognition. The data were entered into a Microsoft Access database. As Teleforms included a data verification system, there was no need for multiple data entry. The paper forms were scanned and imported as faxed forms into the computer and all fields were verified through the TeleForms system. Analysis was done using R software.[47] Proportions of key indicators were calculated with 95% confidence intervals (CI). P-values were used along with 95% CIs to compare baseline outcomes to end line outcomes. Statistical significance was defined as a p-value of 0.05. A proportional odds model, or ordered logistic regression, was used to estimate the adjusted odds ratio (OR) among children younger than 5 years between the three categories, no undernourishment, moderately undernourished, and undernourished in each of the outcomes, stunting, wasting, and underweight for diarrhea, reported type of facility, observed facility, handwashing, CLTS initiation, open defecation, appropriate disposal of child feces, water source, time to water source, and clinic visit for diarrhea. Child age in months and child's sex were adjusted for in all of the models. The OR compares the odds of being either moderately undernourished (stunted, wasted, or underweight) or undernourished to not being undernourished and also the odds of being either not undernourished or moderately undernourished to being undernourished. Moderate stunting was defined as HAZ $\leq$ -1 and $\geq$ -2, stunting was defined as a HAZ $\leq$ -2, and severe stunting was defined as HAZ $\leq$

-3 among children under 5 years. Moderate wasting, wasting, and severe wasting were defined as WHZ ≤ -1 and ≥ -2, WHZ ≤ -2, and WHZ ≤ -3 respectively. Lastly, moderate underweight, underweight, and severe underweight were defined as WAZ ≤ -1 and ≥ -2, WAZ ≤ -2, and WAZ ≤ -3 respectively.

RESULTS

1.0 Survey results

A total of 1204 caregivers of children 0-59 months were interviewed in the baseline survey and 1170 caregivers of children 0-59 months at end line. There was a 100% response rate with no households refusing to complete the survey. In both the baseline and end line surveys, participants were recruited from 47 of the 50 SEAs. Three SEAs were not visited because they were inaccessible, due to security or geographical challenges such as unpassable rivers. No attempt was made to replace the inaccessible SEAs.

1.1 Household characteristics

The mean household size at baseline was 5.8 family members, ranging from 2 to 16 with a median of 5. The mean household size at end line was 6.1 family members, ranging from 2 to 23 with a median of 6. Almost half of the households at both baseline and end line had 4 to 6 people (47.3% and 47.8% respectively) (Table 1). The average number of children under 5 per household at both baseline and end line was 1.4, ranging from 1 to 5 with a median of 1.

Table 1: Household characteristics

Household size	Baseline survey	End line survey	p-value
< 4 persons	17.8% (214/1,204)	14.1% (165/1,168)	0.018*
4-6 persons	47.3% (569/1,204)	48.8% (570/1,168)	0.48
> 6 persons	35.0% (421/1,204)	37.1% (433/1,168)	0.31

*indicates statistical significance

The mean age of children under 5 at baseline and end line was 26.7 and 27.4 months respectively (Table 2). Their median age was 26 months and 51.2% were females in both

baseline and end line. Most of the children were in the age group of 24-59 months (55.4% and 56.5%) while 26.4% and 22.8% were 0-11 months old and 18.2% and 20.6% were 12-23 months (Table 2).

Table 2: Characteristics of children under 5

Characteristic	Baseline Survey	End line Survey	p-value
Number of U5[#] children	1641	1671	
Mean age of caretaker (SE^)	26.7 (0.4)	27.4 (0.4)	
Age group	N=1,443	N=1,664	
0-11 months	381 (26.4%)	379 (22.8%)	0.02*
12-23 months	263 (18.2%)	345 (20.7%)	0.09
24-59 months	799 (55.4%)	940 (56.4%)	0.55
Sex	N=1,641	N=1,671	
Female	841 (51.2%)	856 (51.2%)	1
Male	800 (48.8%)	815 (48.8%)	1

^Standard error, *indicates statistical significance, #under age 5

The percentage of respondents that indicated that they knew CLTS was yet to be initiated decreased from baseline to end line, from 43.7% to 8.2%. A little over a third, 38.1%, at end line indicated that they did not know whether the program had been initiated in their village, compared with 34.9% at baseline. While only 4% of respondents indicated that it had been initiated more than 12 months ago at baseline, 44.6% at end line indicated initiation over 12 months ago (Table 3).

Table 3: Household reports of their awareness of the timing of the initiation of CLTS (n=1203 (baseline) n=1168 (end line))

Timing of initiation	Percent baseline	Percent end line
Not yet	43.7%	8.2%
Within last 3 months	9%	2.6%
Within 4-6 months	3%	1.3%
Within 6 – 12 months	4.5%	5.2%
More than 12 months	4%	44.6%
Do not know	34.9%	38.1%

The primary impact indicator of the ZSHP, two-week diarrhea prevalence among children under 5, was 20.4% (95% CI: 18.2% - 22.5%) and 19.1% (95% CI: 17.2% - 21.0%) at baseline and end line respectively (Table 4). The prevalence of diarrhea was greatest among 0-11 month old children at baseline and among 12-23 month old children at end line (32.6%; 95% CI: 27.6% - 37.5%) (Table 4). Diarrhea prevalence significantly increased from baseline to end line in the 12-23 month age group (p=0.001) and significantly decreased from baseline to end line in the 24-59 month age group (p=0.004). Prevalence of diarrhea was greatest among females at baseline, 21.1% (95% CI: 18.0% - 24.1%), and males at end line 19.3% (95% CI: 16.6% - 22.1%) (Table 4). As the prevalence in females decreased, the prevalence in males remained about the same. Neither changed significantly (p=0.32 and p=0.94). In addition, there were no significant differences among males and females at baseline or end line (p=0.51 and 0.82 respectively).

Table 4: Diarrhea prevalence in children under 5

Characteristic	Baseline Survey	95% CI	End line Survey	95% CI	p-value
Number of U5 Children	1340		1664	3004	
Overall prevalence	20.4% (273/1,340)	(18.3%, 22.6%)	19.1% (318/1,664)	(17.3%, 21.1%)	0.41
Age group					
0-11 months	22.5% (84/373)	(18.6%, 27.0%)	23.0% (87/379)	(19.0%, 27.4%)	0.96
12-23 months	20.2% (51/252)	(15.7%, 25.6%)	32.6% (112/344)	(27.8%, 37.7%)	0.001***
24-59 months	18.3% (100/547)	(15.3%, 21.7%)	12.6% (118/934)	(10.7%, 14.9%)	0.004**
Sex					
Females	21.1% (145/688)	(18.2%, 24.3%)	18.9% (161/852)	(16.4%, 21.7%)	0.32
Males	19.6% (128/652)	(16.8%, 22.9%)	19.3% (157/812)	(16.8%, 22.2%)	0.94

1.2 Stunting

The prevalence of stunting ($-2 \geq HAZ \geq -3$) among children under 5 at baseline was 13.7% (95% CI: 11.3% - 16.5%) and at end line was 22.7% (95% CI: 20.7% - 24.9%) (Table 5). This was a highly statistical significant increase. The prevalence was highest in children aged 24-59 months at baseline, 15.4% (11.9% - 19.8%), and in children aged 12-23 months at end line, 25.4% (95% CI: 20.9% - 30.4%) (Table 5). Prevalence was lowest in children aged 0-11 months at both baseline and end line, 8.9% (5.5% - 14.2%) and 14.1% (95% CI: 10.5%- 18.7%) respectively (Table 5). Stunting significantly increased from baseline to end line in the 12-24 month and 24-59 month age groups (p=0.01 and 0.001 respectively). The 0-11 month age group stunting prevalence also increased from baseline to end line but not significantly. Stunting prevalence in both males and females increased significantly from baseline to end line (p=<0.001 and 0.003 respectively).

Table 5: Stunting prevalence (-2 ≥ HAZ ≥ -3) in children under 5

Characteristic	Baseline Survey	95% CI	End line Survey	95% CI	p-value
Number of U5 children	670		1507		
Overall prevalence	13.7% (92/670)	(11.3%, 16.5%)	22.7% (342/1,507)	(20.7%, 24.9%)	<0.001***
Age group					
0-11 months	8.9% (15/168)	(5.5%, 14.2%)	14.1% (39/277)	(10.5%, 18.7%)	0.14
12-23 months	15.1% (27/179)	(10.6%, 21.1%)	25.4% (82/323)	(20.9%, 30.4%)	0.01**
24-59 months	15.5% (50/323)	(11.9%, 19.8%)	24.4% (221/907)	(21.7%, 27.3%)	0.001***
Sex					
Females	14.0% (49/350)	(10.8%, 18.0%)	21.7% (168/774)	(18.9%, 24.7%)	0.003**
Males	13.4% (43/320)	(10.1%, 17.6%)	23.7% (174/733)	(20.8%, 27.0%)	<0.001***

*indicates statistical significance. ***indicates highly significant.

In contrast to stunting, the prevalence of severe stunting among children under 5 was 32.4% and 18.2% at baseline and end line respectively (Table 6), a significant decrease ($p<0.001$). The prevalence was highest in children aged 24-59 months at baseline (43.7%) and 12-23 months at end line (24.5%) (Table 6). The age group with the lowest prevalence was children aged 0-11 months at both baseline and end line (13.7% and 15.9%) (Table 6). Severe stunting significantly decreased from baseline to end line in the 24-59 month age group ($p<0.001$) and for both males and females ($p<0.001$ for both). Severe stunting was higher among males at 34.4% and 21.4% (Table 6). Both males and females had a significant decrease in prevalence from baseline to end line ($p<0.001$ for both comparisons)**.**

Table 6: Severe stunting prevalence (HAZ ≤ -3) in children under 5

Characteristic	Baseline Survey	95% CI	End line Survey	95% CI	p-value
Number of U5 children	670		1507	2177	
Overall prevalence	32.4% (217/670)	(29.0%, 36.0%)	18.2% (275/1,507)	(16.4%, 20.3%)	<0.001***
Age group					
0-11 months	13.7% (23/168)	(9.3%, 19.7%)	15.9% (44/277)	(12.1%, 20.7%)	0.62
12-23 months	29.6% (53/179)	(23.4%, 36.7%)	24.5% (79/323)	(20.1%, 29.4%)	0.25
24-59 months	43.7% (141/323)	(38.4%, 49.1%)	16.8% (152/907)	(14.5%, 19.3%)	<0.001***
Sex					
Females	30.6% (107/350)	(26%, 35.6%)	15.2% (118/774)	(12.9%, 17.9%)	<0.001***
Males	34.4% (110/320)	(29.4%, 39.7%)	21.4% (157/733)	(18.6%, 24.5%)	<0.001***

*** Indicates very highly significant

There was no effect on stunting prevalence for children that lived in a village where CLTS had been initiated. Children were less likely to be stunted if their household had an improved source of drinking water (Table 7). There was not a significant difference in stunting prevalence children living in a household with an improved latrine opposed to children living in a household with an unimproved latrine or that did not have a facility (Table 7). Children that reported having diarrhea in the past two weeks did not have a difference in stunting compared to children that did not have diarrhea in the past two weeks (Table 7). However, of the children that had diarrhea, children that went to the clinic for their diarrhea were less likely to have stunting (Table 7). Interestingly, children that live in households that dispose of child feces appropriately had an increased odds of stunting.

Table 7: WASH outcomes stratified by stunting status

Indicator	No Stunting	Moderate Stunting	Stunting	OR^ (95%CI)
CLTS initiated	462 (34.7%)	316 (23.7%)	554 (41.6%)	1.30 (0.93, 1.84)
Reported Improved facility	418 (34.6%)	279 (23.1%)	511 (42.3%)	1.09 (0.96, 1.24)
Observed Improved facility	416 (35.1%)	270 (22.8%)	500 (42.2%)	1.04 (0.59, 1.84)
No open defecation	329 (35.0%)	215 (22.9%)	395 (42.1%)	1.06 (0.87, 1.28)
Appropriate disposal of child feces	428 (33.9%)	298 (23.6%)	537 (42.5%)	1.43 (1.10, 1.85)*
Improved water source	298 (37.8%)	197 (25.0%)	294 (37.3%)	0.74 (0.61, 0.89)*
Time to water source > 4 min	326 (34.0%)	236 (24.6%)	397 (41.4%)	0.89 (0.68, 1.15)
Handwashing with agent	313 (33.8%)	248 (26.8%)	365 (39.4%)	.94 (0.77, 1.15)
Diarrhea in the last two weeks	90 (31.1%)	74 (25.6%)	125 (43.3%)	1.18 (0.93, 1.49)
Clinic visit for diarrhea	67 (34.9%)	50 (26.0%)	75 (39.1%)	0.54 (0.33, 0.86)*

*indicates statistical significance

^ The OR compares the odds of being either moderately stunted or stunted to not being stunted and also the odds of being either not stunted or moderately stunted to being stunted.

1.3 Wasting

The prevalence of wasting was 14.1% (95% CI: 12.0% - 16.2%) at baseline and 7.4% (95% CI: 6.1% - 8.8%) at end line (Table 8). This difference was significant ($p<0.001$). The prevalence was lowest among the 12-23 months (12.2%) and highest among the 24-59 months (16.6%) at baseline (Table 8) but, unlike stunting, there was no significant difference between age groups ($p=0.28$). At end line, the prevalence of wasting was lowest among the 24-59 months (7.0%) and highest among the 0-11 months (8.5%). Once again,

the difference between the age groups was not significant (p=0.69). Comparing end line to baseline, only one age group (24-59 months) significantly decreased from 16.6% to 7.0% (p<0.001). The prevalence among males, at baseline, was 17.2% (95% CI: 14.0% - 20.4%), which was significantly higher than in females (p<0.004) (Table 8). However, at end line the prevalence among males was 6.7% (95% CI: 5.1% - 8.8%), which was lower than in females (8.0%, 95% CI: 6.3%, 10.1%) but was not significant (p=0.40) (Table 8). The prevalence in males decreased significantly from baseline (17.2%) to end line (6.7%) (p<0.001). The prevalence in females decreased but not significantly (p=0.06).

Table 8: Wasting prevalence (WHZ ≤ -2) in children under 5

Characteristic	Baseline Survey	95% CI	End line Survey	95% CI	p-value (95% CI)
Number of U5 children	1063		1507	2570	
Overall prevalence	14.1% (150/1,063)	(12.1%, 16.3%)	7.4% (111/1,507)	(6.1%, 8.8%)	<0.001***
Age group					
0-11 months	13.7% (43/315)	(10.3%, 17.9%)	8.5% (23/272)	(5.7%, 12.4%)	0.063
12-23 months	12.2% (26/213)	(8.5%, 17.3%)	7.7% (25/326)	(5.2%, 11.1%)	0.108
24-59 months	16.6% (66/397)	(13.3%, 20.6%)	7.0% (63/906)	(5.5%, 8.8%)	<0.001***
Sex					
Females	11.1% (60/540)	(8.7%, 14.0%)	8.0% (62/777)	(6.3%, 10.1%)	0.06
Males	17.2% (90/523)	(14.2%, 20.7%)	6.7% (49/730)	(5.1%, 8.8%)	<0.001***

***indicates highly significant

There was no effect on wasting prevalence for children who lived in a village where CLTS had been initiated. Children were much more likely to be wasted if their household was greater than 4 min away from a water source (Table 9). There was not a significant

difference in wasting prevalence among children living in a household with an improved latrine opposed to children living in a household with an unimproved latrine or that did not have a facility (Table 9). Children that reported having diarrhea in the past two weeks had a greater odds of being wasted compared to children that did not have diarrhea in the past two weeks (Table 9). However, of the children that had diarrhea, children that went to the clinic for their diarrhea were not any less likely to be wasted (Table 9). Children that live in households that reported washing their hands with soap had a trend towards a decreased odds of wasting.

Table 9: WASH outcomes stratified by nutrition status

Indicator	No Wasting	Moderate Wasting	Wasting	OR^ (95%CI)
CLTS initiated	1082 (81.3%)	149 (11.2%)	100 (7.5%)	1.15 (0.72, 1.94)
Reported improved facility	993 (82.3%)	129 (10.7%)	84 (7.0%)	0.91 (0.77, 1.08)
Observed improved facility	968 (81.8%)	127 (10.7%)	89 (7.5%)	0.91 (0.47, 2.29)
No open defecation	773 (82.3%)	97 (10.3%)	69 (7.3%)	0.93 (0.71, 1.21)
Appropriate disposal of child feces	1041 (82.4%)	134 (10.6%)	89 (7.0%)	0.81 (0.58, 1.16)
Improved water source	646 (82.0%)	90 (11.4%)	52 (6.6%)	0.96 (0.74, 1.24)
Time to water source > 4 min	785 (81.8%)	112 (11.7%)	63 (6.6%)	1.73 (1.16, 2.67)*
Handwashing with agent	773 (83.4%)	97 (10.5%)	57 (6.1%)	.79 (0.60, 1.04)
Diarrhea in the last two weeks	224 (77.8%)	36 (12.5%)	28 (9.7%)	1.42 (1.02, 1.95)*
Clinic visit for diarrhea	146 (76.4%)	25 (13.1%)	20 (10.5%)	1.43 (0.77, 2.76)

*indicates statistical significance

^ The OR compares the odds of being either moderately wasted or wasted to not being wasted and also the odds of being either not wasted or moderately wasted to being wasted.

1.4 Underweight

The prevalence of underweight was 37.3% (95% CI: 34.3% - 40.4%) at baseline and 12.9% (95% CI: 11.4% - 14.7%) at end line (Table 10). This difference was significant ($p<0.001$). The prevalence was lowest among the 0-11 month age group at both baseline (13.1%) and end line (9%). The highest prevalence was among the 24-59 months (52.4%) at baseline (Table 10) and among the 12-23 month age group at end line (15.3%). At end line, the prevalence of wasting was lowest among the 24-59 months (7.0%) and highest among the 0-11 months (8.5%). Comparing end line to baseline, both the 12-23 month and 24-59 month age groups significantly decreased in underweight prevalence from 32.5% to 15.3% ($p<0.001$) and 52.4% to 13.4% ($p<0.001$), respectively (Table 10). The prevalence in males decreased significantly from baseline (38.8%) to end line (6.7%) ($p<0.001$) (Table 10). The prevalence in females decreased significantly as well from baseline (35.9%) to end line (8.0%) ($p<0.001$) (Table 10).

Table 10: Underweight prevalence (WAZ ≤ -2) in children under 5

Characteristic	Baseline Survey	95% CI	End-line Survey	95% CI	p-value
Number of U5 children	955		1554		
Overall prevalence	37.3% (356/955)	(34.3%, 40.4%)	12.9% (201/1554)	(11.4%, 14.7%)	<0.001***
Age group					
0-11 months	13.1% (33/251)	(9.5%, 17.9%)	9% (29/324)	(6.3%, 12.6%)	0.14
12-23 months	32.5% (75/231)	(26.8%, 38.8%)	15.3% (59/385)	(12.1%, 19.3%)	<0.001***
24-59 months	52.4% (248/473)	(47.9%, 56.9%)	13.4% (113/845)	(11.2%, 15.8%)	<0.001***
Sex					
Females	35.9% (179/499)	(31.8%, 40.2%)	8.0% (62/777)	(8.8%, 13.1%)	<0.001***
Males	38.8% (177/456)	(34.5%, 43.4%)	6.7% (49/730)	(12.8%, 17.9%)	<0.001***

***indicates highly significant

There was no effect on underweight prevalence for children that lived in a village where CLTS had been initiated (Table 11). Although there was not a statistical association between reductions in underweight for children living in households with an improved source of drinking water, the data show a positive trend with a 95% CI of 0.68, 1.01 (Table 11). There was not a significant difference in underweight prevalence in children living in a household with an improved latrine opposed to children living in a household with an unimproved latrine or that did not have a facility (Table 11). This was noticed in both the reported and observed latrine outcomes with observed latrine having a wider variability than the reported latrine (95% CI: 0.68, 2.24 and 0.91, 1.20) (Table 11). Children that reported having diarrhea in the past two weeks had a large increase in odds (1.68 95% CI: 1.26, 2.10) of being underweight compared to children that did not have diarrhea in the

past two weeks (Table 11). However, for the children that had diarrhea, going to the clinic was not associated with the outcome of underweight (Table 11). Interestingly again, children that lived in households that dispose of child feces appropriately had an increased odds of underweight (Table 11).

Table 11: WASH outcomes stratified by underweight status

Indicator	No Underweight	Moderate Underweight	Underweight	OR^ (95%CI)
CLTS initiated	825 (60.0%)	373 (27.1%)	177 (12.9%)	1.00 (0.69, 1.45)
Reported improved facility	746 (59.9%)	329 (26.4%)	170 (13.7%)	1.04 (0.91, 1.20)
Observed improved facility	729 (59.7%)	324 (26.5%)	169 (13.8%)	1.21 (0.68, 2.24)
No open defecation	580 (59.9%)	260 (26.9%)	128 (13.2%)	1.05 (0.85, 1.29)
Appropriate disposal of child feces	769 (59.2%)	347 (26.7%)	183 (14.1%)	1.53 (1.16, 2.04)*
Improved water source	511 (62.5%)	204 (25.0%)	102 (12.5%)	0.83 (0.68, 1.01)
Time to water source > 4 min	593 (60.0%)	261 (26.4%)	134 (13.6%)	1.13 (0.86, 1.49)
Handwashing with agent	595 (61.7%)	249 (25.8%)	121 (12.5%)	.89 (0.72, 1.12)
Diarrhea in the last two weeks	159 (53.7%)	89 (30.1%)	48 (16.2%)	1.63 (1.26, 2.10)*
Clinic visit for diarrhea	109 (55.6%)	52 (26.5%)	35 (17.9%)	0.91 (0.57, 1.45)

*indicates statistical significance

^ The OR compares the odds of being either moderately underweight or underweight to not being underweight and also the odds of being either not underweight or moderately underweight to being underweight.

DISCUSSION

The findings of this impact evaluation demonstrate a significant reduction of severe stunting between baseline and end line, with severe stunting reduced by 14.2 percentage points. It is important to re-iterate that the baseline and end line data were collected during the same time of the year and there were no ongoing outbreaks in either time period. In addition, food availability should have been similar in both time periods. The significant decrease in severe stunting at end line was driven by decreases in stunting prevalence in children aged older than 2 years old. If these children were exposed to the CLTS program for the entire three years of the program, these findings would be consistent with the window of opportunity to prevent long-term stunting in those aged younger than 2 years, and suggest that preventing early exposure to fecal contamination could be crucial to achieve improvements in child health.[48] The children in the age group of 23-59 months were the only group that had a decrease in both wasting prevalence and severe stunting. This may be due to different baseline characteristics between the children measured at baseline and the children measured at end line. However, both baseline and end line children had similar household characteristics other than the WASH indicators. A more likely explanation, as noted above, for this observation is that the children in this age group, at end line, were exposed to the intervention for the whole three-year period. This result is similar to the trial done in Mali.[33] That trial evaluated the same children at end line as they did at baseline and found that the increase in child height was driven exclusively by improvements in children aged younger than 2 years old at enrolment. They noted that an even larger effect was seen with children younger than 1 year at enrolment.[33]

Although this impact evaluation was not a randomized trial like the trial in Mali, many comparable outcomes were observed. The first similarity was observing improvements in child growth despite the fact that the program was not associated with a significant reduction in diarrheal disease in children.[33] The absence of an effect on diarrhea in the Mali trial was consistent with their finding that drinking water quality was similar across both their control and intervention groups.[33] Although the study in Zambia did not evaluate water quality, survey questions were asked to the caregiver about the household's water source and whether or not it was an improved water source. From these data, it was observed that stunting was negatively correlated with having an improved water source in Zambia. This would seem to be contrary to the trial in Mali, however, once again, water quality was not tested in our study. Similar to the Mali results, evaluations of rural sanitation programs in India also reported no effect on diarrhea or water quality, although these programs also had limited success in changing defecation behaviors whereas the ZSHP and the Mali trial had success in behavior change.[33,49,50]

A second possible explanation for the improvement in child growth without a decrease in diarrheal disease may be due to the fact that increased latrine use may have reduced the exposure to fecal matter, which in turn reduced the prevalence of intestinal worm infections, which can contribute to malnutrition and stunted growth in children.[51] However, sanitation intervention studies in India reported no effect on worm infections.[49, 50] Whether or not there were lower rates of worm infections, lower levels of environmental fecal

contamination could potentially contribute to less EED among children. EED, a subclinical disorder characterized by poor nutrient absorption in the gut and associated with stunting in children[52] has been shown to be associated with a contaminated environment.[53] A study in rural Bangladesh showed that children from households with improved sanitation and a clean household were less likely to have biomarkers of EED.[53] A proof-of-concept trial in Zimbabwe, the Sanitation Hygiene Infant Nutrition Efficacy (SHINE) trial, is exploring the connection between EED and stunting. It has been designed as a 2 × 2 factorial trial to assess the independent and combined effects of protecting babies from fecal ingestion and optimizing nutritional adequacy of infant diet on length and hemoglobin at 18 months of age.[54] This in-depth randomized controlled trial should provide us with a better understanding of the pathways and causes of stunting.

Finally, in our study, overall stunting was surprisingly positively correlated with the appropriate disposal of child feces. Stunting did not appear to be associated with any other WASH indicator. This is in contrast to a recent study that showed children with access to an improved latrine but not an improved water source were at lower risk of stunting than those without access to an improved latrine.[55] When latrine type is corrected for in the current study, the odds ratio for water source showed a slight increase in odds of stunting when one does not have access to an improved water source.

Interestingly, while severe stunting decreased and drove the overall stunting results, stunting ($-2 \geq HAZ \geq -3$) showed a statistically significant increase. This may suggest that

there is some other factor at play. However, as stated above, all of the data was collected at the same time of year with no disease outbreaks during either collection period. Additionally, there was no difference in food availability between baseline and end line. This could be indicative of better feeding practices or possibly results of nutrition-specific interventions from other projects or organizations. Another reason that the prevalence of stunting increased while severe stunting decreased could be that a majority of children who were stunted at baseline remained stunted at end line, in addition to children from the severely stunted group improving their growth from baseline enough to no longer be severely stunted but remain stunted overall at end line.

Compared to the 2013/14 DHS, the overall stunting prevalence at baseline (46.1%) was a touch higher than the DHS in rural areas (42%).[56] The overall end line prevalence (40.9%) showed consistency with the national DHS average (40%).[56] In terms of severe stunting, the study's average (32.4%) was significantly higher than the DHS (17%).[56] However, the DHS does not stratify severe stunting into rural and urban, so this difference could be because of sampling differences. However, at end line the overall average was right on target (18.2%).

Next, our data revealed a decrease in wasting from 14.1% to 7.4% that was temporally associated with the ZSHP. This is a large decrease. Wasting was positively associated with diarrhea in this study. Children that had reported diarrhea in the past two weeks had a 50% increased odds of being wasted. It is important to pay attention to wasting since it is a

measure of current malnutrition and can be a predictor for stunting and long term chronic malnutrition.[57] Even though stunting was not associated with diarrhea directly, it may be correlated through wasting. The prevalence of diarrhea went down over the three years as did the prevalence of wasting and stunting. Although the overall decrease in diarrhea prevalence was not significant, there was a significant decrease in diarrhea prevalence in the 24-59 month age group, which is also the age group where statistically significant decreases were seen in all three nutritional status indicators. Our prevalence of wasting was much higher at baseline (14.1%) than what was reported in the 2013/14 ZDHS (6%).[56] The discrepancy between these two numbers may be due to differences in population sampling between our survey and the DHS, a difference in average age of the population, or timing of survey relative to household food availability as the DHS data was collected from August 2013 to April 2014. However, in the end line evaluation, the wasting prevalence (7.4%) is much closer to that of the 2013/14 ZDHS.

Lastly, the underweight prevalence decreased from 37.3% to 12.9% and was positively correlated to appropriate disposal of child feces and diarrhea. Since underweight is a composite indicator of stunting and wasting it could be expected that it would also correlate with diarrhea. In the randomized trial of CLTS in Mali, no differences in WAZ and reduction in the proportion of underweight children were observed between control and intervention villages.[33] There was however, a decrease in severely underweight children in the intervention villages compared to the control villages. There has not been a lot of research on the effects of WASH interventions on underweight and this could be an area

of further study. Compared to the 2013/14 ZDHS, the underweight prevalence at baseline was much higher (37.3%) than the national average. However, at end line the prevalence was slightly lower (12.9%) than the national average (15%).[56] The baseline sex difference mirrors the DHS, with males having a higher prevalence (38.8%) of being underweight than females (35.9%) in our study. However, at end line this was reversed with females having a higher prevalence (8.0%) than males (6.7%). The national averages for males (16%) and females (14%) in the DHS were in between the baseline and end line figures of this study.

This impact evaluation adds to a global meta-analysis of risk factors for childhood stunting. This analysis found that the leading risk for stunting worldwide was being term and small for gestational age.[58] Additional stunting risk factors were poor sanitation (7.2 million cases) and diarrhea (5.8 million cases).[58] In addition to WASH interventions, it is important to remember nutrition-specific interventions such as the mother groups in Zambia where a decreased odds in stunting was observed in intervention sites. The program implemented group meetings, where the mothers were taught a diverse curriculum with content on cognitive stimulation and play practices, child nutrition and cooking practices, and self-care for good mental health. The mothers also received biweekly house visits from a trained community health worker, who screened and referred children for infections and acute malnutrition, and provided parents with reminders to use routine child health services, including immunizations.[59] In addition to nutrition screening and education, nutrition supplementation interventions play a part in reducing malnutrition. A study in Burkina

Faso looked at the effect small-quantity lipid-based nutrient supplements (SQ-LNS) had on stunting and wasting in young children (9 months old). Provision of SQ-LNS along with simple feeding advice and treatment of confirmed cases of malaria and reported diarrhea resulted in significantly greater growth velocity and lower prevalence of stunting, wasting and anemia among children in the intervention group compared to children in the non-intervention group.[60] The growth effect was significantly greater among children whose initial length was below the 10th percentile of initial length of study participants, indicating that those with the greatest degree of initial growth restriction benefitted most. An important factor in all of these interventions is that they used multiple types of interventions and were community based. These studies along with this impact evaluation calls for a new focus on interventions to improve the environment in which mothers and families live, with specific attention to improving sanitation.

This study has several important limitations. We relied on respondent self-reporting to measure defecation behaviors, illness symptoms, and mortality; these outcomes are thus subject to reporting bias. This study mainly looked at household and caretaker behavior rather than child behavior. In future studies, it would be useful to also identify children's behaviors such as handwashing and environment of play to focus on key areas of possible infection. This was a cross-sectional study, even though two time measurements were taken, the end line households and children may not have been the same as baseline households and children. Some children may have been the same if their household was randomly chosen in both the baseline and the end line but the children in the baseline were

not specifically chosen in the end line. In future studies it would be helpful to assess the same children and households at baseline and end line as in the Mali study. We also were not able to get true baselines for all of the SEAs because the program had already begun in some areas prior to the baseline survey. This results in not having a true baseline to compare the end line. However, the end line was taken three years after the baseline, giving the government and UNICEF a great amount of time to fully implement the program in many areas. Finally, we did not measure child parasite infections or biomarkers of environmental enteropathy. Future research is warranted to understand if improved sanitation could improve child height through these pathways.

In conclusion, the results show that the focus areas of ZSHP have decreased all three nutritional status indicators, stunting, wasting, and underweight, while increasing coverage of key indicators of sanitation and hygiene. However, a still relatively high prevalence of sanitation- and hygiene-related diseases were prevalent. Even though stunting has significantly decreased, the prevalence among young children, even though most have had exposure to the ZSHP activities, was still relatively high at 40.9%. On the other hand, wasting has decreased by almost 50% to a nearly acceptable prevalence of 7.4%. Despite continued reports of high rates of diarrhea and ARI, great improvements have been observed in the nutritional status of children under 5. In essence, the challenge is ensuring that the right people receive the right interventions at the right time. This means ensuring that populations with a high burden of stunting are targeted before or when growth faltering occurs and with appropriate WASH interventions alongside more traditional nutrition-

specific interventions. Reaching those at risk may require interventions that go beyond the scope of the traditional package of WASH interventions to ensure that young children are protected from exposure to enteric pathogens. Reducing the burden of stunting requires continuing the current efforts to diagnose and treat maternal and child infections, especially diarrhea, along with a renewed focus on clinical and public health interventions that concentrate on improving nutrition and sanitation among mothers and families. With increased attention to the most at risk population, prevalence of disease and malnutrition will start to decrease and we will begin to see healthier communities.

APPENDIX

Appendix 1: Household survey form

ZSHP HOUSEHOLD SURVEY FORM

Study ID number __ __/__ __/__ __/__ __
(Province 2 digits; District 2 digits; SEA 2 digits; household number 2 digits)

Is this household living in an ODF certified village?

1. Yes
2. No
99. Do not know

Date (__ __/__ __/__ __) (dd/mo/yr)

1.0 HOUSEHOLD SOCIO-DEMOGRAPHIC DATA
1.1 How old are you?__-__(years) (99 IF UNKNOWN)

1.2. What is the highest level of education that you attained?
1. No education
2. Primary (grades 1-7)
3. Secondary (grades 8-12)
4. College
5. University

1.3. What ethnic group or tribe do you belong to?
1. Bemba
2. Tumbuka
3. Chewa
4. Ngoni
5. Kaonde
6. Lozi
7. Luvale
8. Lunda
9. Tonga
10. Other (specify)_____

1.4. What is your main occupation?
1. Housewife
2. Farmer
3. Business/self employed

4. Civil servant
5. Unemployed
6. Other (specify)_____

1.5. What is your marital status?

1. Single/not married
2. Married
3. Separated/divorced
4. Widowed

1.6. Who is the head of this household?

1. Respondent
2. Husband/partner
3. Female relative
4. Male relative

IF RESPONSE TO Q1.6 IS "RESPONDENT", SKIP TO Q1.11.

1.7 How old is the head of household?__ __(years) (99 IF UNKNOWN)

1.8. What is the highest level of education that the head of household attained?

1. No education
2. Primary (grades 1-7)
3. Secondary (grades 8-12)
4. College
5. University

99. Do not know

1.9. What ethnic group/tribe does the head of household belong to?

1. Bemba
2. Tumbuka
3. Chewa
4. Ngoni
5. Kaonde
6. Lozi
7. Luvale
8. Lunda
9. Tonga
10. Other (specify)_____

99. Do not know

1.10. What is the main occupation of the head of household?

1. Housewife
2. Farmer

3. Business/self employed
4. Civil servant
5. Unemployed
6. Other (specify)_____
99. Do not know

1.11. How many people live in this household? __ __

1.12. How many children under five years old live in this household? __ __

1.13. How many children aged 5-12 years live in this household?__ __

1.14. Who owns the house you live in?
1. Household
2. Rented
3. Relative - no rent is paid
4. Supplied by employer
5. Other (specify)_____

1.15. What type of floor does the house have?
1. Sand/earth
2. Dung
3. Cement
4. Bamboo/palm
5. Parquet or polished wood
6. Vinyl or asphalt
7. Ceramic tiles
8. Carpet
9. Other (specify)_____

1.16. What is the main type of material that the house walls are composed of?
1. No walls
2. Cane/palm/trunk
3. Mud
4. Bamboo pole with mud
5. Stone with mud
6. Plywood
7. Cardboard
8. Cement
9. Stone with lime/cement
10. Bricks
11. Cement blocks
12. Wood planks/shingles

13. Other (specify)_____

1.17. What material is the roof of the house made of?

1. No roof
2. Thatch/palm leaf
3. Rustic mat
4. Palm/bamboo
5. Metal/iron sheets
6. Wood
7. Calamine/cement fiber (asbestos)
8. Concrete
9. Ceramic/Harvey tiles
10. Roofing shingles
11. Mud tiles
12. Other (specify)_____

1.18. What is the main type of cooking fuel that you use in this house?

1. Electricity
2. Solar
3. Gas
4. Kerosene
5. Charcoal
6. Wood
7. Straw/shrubs/grass
8. No food cooked in household
9. Other (specify)_____

1.19. Does your household own any of these? (SHADE ALL THAT APPLY)

1. Radio
2. Cassette player
3. VCR/DVD player
4. Mobile telephone
5. Non-mobile telephone
6. Watch
7. Refrigerator
8. Television
9. Bed
10. Chair
11. Table
12. Cupboard
13. Sofa
14. Clock
15. Fan
16. Sewing machine

17. Plow
18. Tractor
19. Hammer mill
20. Grain grinder

1.20. Does your household own any of the types of transport? (SHADE ALL THAT APPLY)

1. Bicycle
2. Animal drawn cart
3. Motorcycle/scooter
4. Car/truck
5. Boat with a motor
6. Banana boat
7. Canoe

1.21. Does your household own or have any of the following? (SHADE ALL THAT APPLY)

1. Cattle

1.0 A If yes, number of cattle _ _ _

2. Agricultural land

2.0 A If yes, how many hectares of land? _ _ _

3. Bank/savings account (at least one household member has an account)

1.22 How much did your family spend on health (treatment and prevention of illness) in the last 3 months? _____ZMW

2.0 HAND WASHING PRACTICES AND KNOWLEDGE OF DISEASE CAUSATION

2.1 When do you consider important for washing hands?
FIRST ASK QUESTION AND ALLOW RESPONDENT TO PROVIDE RESPONSES WITHOUT PROMPTING AND ENTER RESPONSES IN COLUMN 2. SECOND, REVIEW EACH OPTION AND DOCUMENT RESPONSE

Category	Response without prompt (yes/no)	Response with prompt (yes/no)
Before preparing food		
Before eating		
Before feeding a child		
After defection or visiting a toilet		

After washing child's bottom or changing diapers		
After disposing of child feces		
Other (specify)		
Other (specify)		

2.2 Which of the following activities did you perform most recently today?

1. Prepared food
2. Fed a child
3. Defecation
4. Washed child's bottom or changed diapers
5. Disposed of child feces

IF RESPONSE WAS "1. PREPARED FOOD" OR "2. FED A CHILD", THEN ASK Q2.3a.

2.3a. Did you wash your hands before this activity?

1. Yes
2. No

IF RESPONSE WAS "3. Defecation", "4. Washed child's bottom or changed diapers, or "5. Disposed of child feces", THEN ASK Q2.3b.

2.3b. Did you wash your hands after this activity?

1. Yes
2. No

IF RESPONSE TO Q2.3a or Q2.3b IS "2. NO", THEN SKIP Q2.4.

2.4. Please describe how you washed your hands during this activity?

1. With water only?
2. With water and soap or detergent
3. With water and ash
4. Mud/sand
5. Other (specify)_____

2.5. Do you have a specific place where you usually wash your hands?

1. Yes
2. No

IF THE RESPONSE IS '2. NO', SKIP TO Q2.7.

2.6. Where do you usually wash your hands? (SHADE ALL THAT APPLY)

1. Inside or at a location near the toilet
2. Inside or near the kitchen or cooking place
3. Elsewhere in yard
4. Outside yard

2.7 How much do you usually spend per week on supplies (e.g. soap, detergent) to wash your hands?

_____ ZMW

2.8. What do you think is the harm or danger of not treating water to drink or not storing drinking water safely? (SHADE ALL THAT APPLY; DO NOT PROMPT)

1. Diarrhea
2. Cholera
3. Typhoid
4. Acute respiratory infection
5. Water will be contaminated
6. Sickness (unspecified)
7. Other (specify)_____

2.9. What do you think is the harm or danger of not washing hands with soap after defecation or disposing of child feces? (SHADE ALL THAT APPLY; DO NOT PROMPT)

1. Diarrhea
2. Cholera
3. Typhoid
4. Acute respiratory infection
5. Will contaminate water or food
6. Sickness (unspecified)
7. Other (specify)_____

2.10. What do you think is the harm/danger of not using a clean latrine for defecation? (SHADE ALL THAT APPLY; DO NOT PROMPT)

1. Diarrhea
2. Cholera
3. Typhoid
4. Acute respiratory infection
5. Will contaminate water or food
6. Sickness (unspecified)
7. Other (specify)_____

2.11. What do you think is the harm/danger of defecating in the open (bush, ground)? (SHADE ALL THAT APPLY; DO NOT PROMPT)

1. Diarrhea
2. Cholera
3. Typhoid
4. Acute respiratory infection
5. Will contaminate water or food
6. Sickness (unspecified)
7. Other (specify)_____

2.12. What do you think are important causes of diarrhea? (SHADE ALL THAT APPLY; DO NOT PROMPT)

1. Dirty water
2. Dirty food
3. Uncleanliness/bad hygiene
4. Dirty environment
5. Flies
6. Other 1 (specify)_____
7. Other 2 (specify)_____

2.13. What do you think are important causes of acute respiratory infections? (SHADE ALL THAT APPLY; DO NOT PROMPT)

1. Dirty water
2. Dirty food
3. Uncleanliness/bad hygiene
4. Dirty environment
5. Overcrowding
6. Cold
7. Indoor air pollution
8. Sick family members or friends
8. Other 1 (specify)_____
9. Other 2 (specify)_____

3.0 WATER SOURCES

3.1. What is the main source of drinking water for members of your household?

1. Piped water into dwelling
2. Piped water to yard/ plot
3. Public well or standpipe
4. Borehole/ tubewell[1]

[1] Water delivered through a pump powered by human, wind, electric, diesel or solar means

5. Protected dug well[2]
6. Protected spring[3]
7. Rainwater
8. Unprotected spring
9. Unprotected dug well
10. Cart with small tank/drum (water trucked into community and sold from water truck)
11. Tanker truck
12. Surface water (rivers, dams, lakes, ponds, streams, canals, irrigation channels)
13. Other (specify)_____

3.2. How long does it take to go to the source of drinking water and come back?
DO NOT ASK THIS QUESTION IF RESPONSE TO Q3.1 IS "PIPED WATER INTO DWELLING" OR "PIPED WATER TO YARD/PLOT".
No of minutes__ __ __ (999 IF DO NOT KNOW)

3.3. Who is responsible for fetching the water for the household? CHECK ALL THAT APPLY.
THIS QUESTION IS FOR THOSE WHO RESPONDED TO Q 3.2 ABOVE.

1. Adult woman
2. Adult man
3. Female child (under 15 years)
4. Male child (under 15 years)
5. Do not know

3.4. How many times a day does the household fetch water each day?
__ __ (number of times)

3.5. Do you treat your water in any way to make it safer to drink?

1. Yes
2. No

IF RESPONSE TO Q3.5 IS "NO", SKIP Q 3.6 TO 3.9, AND PROCEED TO SECTION 4.0.

[2] Protected from runoff water by a well lining or casing raised above ground level and a platform that directs spilled water away from the well. It is covered so that bird/animal droppings cannot fall into the well

[3] Protected from bird/animal droppings by "spring box" constructed of brick/concrete and built around the spring so that water flows directly out of the box into a pipe or cistern without being exposed to outside pollution.

3.6. What do you usually do to the water to make it safer to drink? CHECK ALL THAT APPLY.

1. Boil
2. Add bleach/chlorine
3. Use water filter (ceramic, sand, composite)
4. Solar disinfection
5. Strain it through a cloth
6. Let it stand to settle
7. Other (specify)_____

3.7 When was the last time you treated water to make it safe to drink?

1. Today
2. Within the last week
3. Within the last month
4. Within the last 2 months
5. Over 2 months ago

3.8 Which method did you use the last time you treated water to make it safe?

1. Boil
2. Add bleach/chlorine
3. Use water filter (ceramic, sand, composite)
4. Solar disinfection
5. Strain it through a cloth
6. Let it stand to settle
7. Other (specify)_____
88. Do not remember

3.9 How much do you spend per week to treat water to make it safer to drink?
_____ (ZMW)

4. 0 SANITATION

4.1 What kind of toilet facility do members of your household usually use?

1. Flush/pour flush to (piped sewer system, septic tank, pit latrine)
2. Ventilated improved pit latrine (VIP)
3. Pit latrine with slab/platform (made of mud, concrete, or wood)
4. Composting toilet
5. Pit latrine/ open pit without slab/platform to cover the pit and/or no walls and/or roof
6. No facilities; use bush or field
7. Other (specify)_____

IF THE RESPONSE TO Q4.1 IS "3. PIT LATRINE WITH SLAB/PLATFORM", ANSWER Q4.1.1.
IF THE RESPONSE TO Q4.1 IS "6. NO FACILITIES", SKIP "Q4.2 TO Q4.9" AND PROCEED TO Q4.10
IF ANY OTHER ANSWER PROCEED TO Q4.2

4.1.1 Does the pit latrine with slap/platform have the following items?
(SHADE ALL THAT APPLY AND SEE PICTURES IN EVALUATION FIELD GUIDE)

1. Roof
2. Privacy (walls, door, cloths, other sight protection)
3. Lid
4. Slab/platform is smooth and easy to clean
5. Slab/platform is raised

4.2. Do you share this facility with other households?

1. Yes
2. No

IF RESPONSE TO 4.2 IS "NO", THEN SKIP Q4.3.

4.3. How many households use this toilet facility?

__ __ (No. households)

4.4. Can any member of the public use this toilet?

1. Yes
2. No

4.5. Who provided the funding/resources/materials for the construction of this toilet? (SHADE ALL THAT APPLY)

1. Household
2. NGO not related to CLTS (Specify_____)
3. Family member
4. Government
5. Church/mission
6. Other, specify _____
9. Do not know

4.6. When was this toilet constructed?

1. Within the last 6 months
2. Within 6 months to one year
3. Within the last one to two years
4. More than 2 years ago

99. Do not know

4.7. How much did it cost to construct this toilet facility?_____ZMW (99999 IF DO NOT KNOW)

4.8. When was this toilet rehabilitated?
1. Within the last 6 months
2. Within 6 months to one year
3. Within the last one to two years
4. More than 2 years ago
88. Not applicable (Has not been rehabilitated)

4.9. How much did it cost to rehabilitate this toilet facility?_____ZMW (99999 IF DO NOT KNOW)

4.10. How much does it cost per month to maintain this toilet facility? _____ZMW (99999 IF DO NOT KNOW)

4.11. Has any of your latrines in this household ever collapsed?
1. Yes
2. No

4.12. Why did the latrine collapse?
1. Sandy soil
2. Water logged soil
3. Poor construction
4. Rain
5. Other, specify_____

4.13. The last time the youngest child (0-3 years) in this household passed stools, what was done to dispose of the feces?
1. Child used toilet/latrine
2. Put/rinsed into toilet or latrine
3. Buried
4. Put/rinsed into drain or ditch
5. Thrown into garbage
6. Left in the open
7. Other (specify) _____
88. Not applicable (all children aged >3 years)
99. Do not know

4.14. How often does any member of this household (apart from children under five years old) defecate outside on the ground?

1. Daily
2. At least once a week
3. Occasionally
88. Never
99. Do not know

4.15. Where do you dispose of your household waste (garbage)? CHECK ALL THAT APPLY.

1. Throw in the backyard
2. Throw in open spaces
3. Deposit in the dumping space
4. Collected by agency free of charge
5. Collected by agency but we pay for it
6. Burning
7. Burying

5.0 SOURCES OF INFORMATION ON WATER, SANITATION, AND HYGIENE

5.1. Where do you normally receive information on water, sanitation and hygiene? (SHADE ALL THAT APPLY)

1. Posters and handbills
2. Health education by community health workers
3. Health education by community health assistants (CHAs)
4. Health education by CLTS community champions
5. Health education by Sanitation Action Group (SAG)
6. Radio
7. Television
8. Newspapers
9. Drama groups
10. Chief
11. Headmen
12. Other (specify) _____

5.2. When was the last time you received a message on hand-washing with soap?

1. Within the last week
2. Within 1 month
3. Within 2 months
4. Within 6 months
5. More than 6 months ago

88. Never
99. Cannot remember

5.3. What was the source of this message?

1. Posters and handbills
2. Health education by community health workers
3. Health education by community health assistants (CHAs)
4. Health education by CLTS community champion
5. Health education by Sanitation Action Group (SAG)
6. Radio
7. Television
8. Newspapers
9. Drama groups
10. Chief
11. Headmen
12. Other (specify) _____

99. Cannot remember

5.4. When was the last time you received a message on use of safe water?

1. Within the last week
2. Within 1 month
3. Within 2 months
4. Within 6 months
5. More than 6 months ago

88. Never
99. Cannot remember

5.5. What was the source of this message?

1. Posters and handbills
2. Health education by community health workers
3. Health education by community health assistants (CHAs)
4. Health education by CLTS community champion
5. Health education by Sanitation Action Group (SAG)
6. Radio
7. Television
8. Newspapers
9. Drama groups
10. Chief
11. Headmen
12. Other (specify) _____

99. Cannot remember

5.6. When was the last time you received a message on sanitary latrine use and feces disposal?

1. Within the last week
2. Within 1 month
3. Within 2 months

4. Within 6 months
5. More than 6 months ago
88. Never
99. Cannot remember

5.7. What was the source of this message? (SHADE ALL THAT APPLY)
1. Posters and handbills
2. Health education by community health workers
3. Health education by community health assistants (CHAs)
4. Health education by CLTS community champion
5. Health education by Sanitation Action Group (SAG)
6. Radio
7. Television
8. Newspapers
9. Drama groups
10. Chief
11. Headmen
12. Other (specify) _____
99. Cannot remember

5.8. When was the CTLS project initiated in your village?
1. Not yet
2. within the last 3 months
3. within the last 4-6 months
4. Within 6 -12 months
5. More than 12 months ago
99. Do not know

5.9. Has any member/volunteer of this project visited your home to talk about/discuss sanitation and hygiene issues (i.e. sanitary feces disposal, safe water use and hand washing practices)?
1. Yes
2. No

5.10. When was the last time he/she visited?
1. Within the last week
2. Within 1 month
3. Within 2 months
4. Within 6 months
5. More than 6 months ago
88. Not applicable (No visit)
99. Cannot remember

5.11 Have you participated in a group event organized by the CLTS champion, SAG group or traditional leader, where you discussed about water, toilets, defecation in the bush, sanitation and hygiene?

1. Yes
2. No

5.12. When was the last time you participated in such an event?

1. Within the last week
2. Within 1 month
3. Within 2 months
4. Within 6 months
5. More than 6 months ago

88. Not applicable (No participation)
99. Cannot remember

6.0 DIARRHEA AND ARI PREVALENCE AND TREATMENT

6.1.a Characteristics of children under the age of 5 years, diarrhea and ARI prevalence, their immunization status and anthropometry.

	Child 1	**Child 2**	**Child 3**
Age (years)*			
Sex (M/F)			
Breastfeeding (Y/N)			
Diarrhea in the last two weeks**			
How many days did the diarrhea last			
Cough in the last two weeks (Y/N)***			
Runny nose in the last two weeks (Y/N)***			
Difficult or fast breathing in the last two weeks (Y/N)***			
Vitamin A supplementation in last 12 months (Y/N)			
Immunizations (review under 5 card)			

BCG			
OPV 0			
OPV 1			
OPV 2			
OPV 3			
DPT-hepB-Hib 1			
DPT-hepB-Hib 2			
DPT-hepB-Hib 3			
Measles			
Rotavirus			
Weight of child			
Height/length of child			
Mid upper arm circumference of child			

*For babies less than one month enter zero (0) months
**Diarrhea defined as ≥3 loose or watery bowel movements per 24 hours
***ARI defined as cough plus runny nose or cough with fast or difficulty breathing

6.1.b Was the under-five card seen?
1. Yes
2. No

6.2. Diarrhea treatment in children under the age of 5 years who have had an episode of diarrhea during the past two weeks.

	Child 1	**Child 2**	**Child 3**
Was child given any of these?			
Fluids from ORS sachet			
ORS fluid			
Homemade fluid			
Was child taken to heath facility during the diarrhea?			
How was child breastfed/fed during the diarrhea?	a) less b) same c) more	a) less b) same c) more	a) less b) same c) more
Was child given any of these during the diarrhea?			

Zinc			
Amoxicillin pill/syrup			
Cotrimoxazole (septrin)			
Antimotility pill/syrup			
Unknown pill/syrup			
Injection			
IV Fluids			
Home remedies/herbal			
Other (specify)			
Cost of treatment			

6.3. ARI treatment in children under the age of 5 years who have had an episode of ARI during the past two weeks

	Child 1	**Child 2**	**Child 3**
Was child taken to heath facility during the ARI?			
Was child given any of these during the ARI?			
Amoxicillin pill/syrup			
Cotrimoxazole (septrin)			
Cough mixture (syrup)			
Panadol/aspirin			
Other antibiotic			
Home remedies/herbal			
Other (specify)			
Cost of treatment			

6.4. Household roster of children 5 to 12 years of age and diarrhea and ARI prevalence

	Child 1	**Child 2**	**Child 3**
Age (years)			
Sex (M/F)			
Diarrhea in the last two weeks*			
How many days did the diarrhea last?			

Cough in the last two weeks**			
Runny nose in the last two weeks**			
Fast or difficult breathing in the last two weeks*			

*Diarrhea defined as ≥3 loose or watery bowel movements per 24 hours
**ARI defined as cough plus runny nose or cough with fast or difficulty breathing

6.5. Diarrhea treatment in children 5-12 years of age who have had an episode of diarrhea during the past two weeks

	Child 1	**Child 2**	**Child 3**
Was child given any of these?			
Fluids from ORS sachet			
ORS fluid			
Homemade fluid			
Was child taken to heath facility during the diarrhea?			
How was child fed during the diarrhea?	d) less e) same f) more	d) less e) same f) more	d) less e) same f) more
Was child given any of these during the diarrhea?			
Zinc			
Amoxicillin pill/syrup			
Cotrimoxazole (septrin)			
Antimotility pill/syrup			
Unknown pill/syrup			
Injection			
IV Fluids			
Home remedies/herbal			
Other (specify)			
Cost of treatment			

6.6. ARI treatment in children 5 – 12 years of age who have had an episode of ARI during the past two weeks

	Child 1	Child 2	Child 3
Was child taken to heath facility during the ARI?			
Was child given any of these during the ARI?			
Amoxicillin pill/syrup			
Cotrimoxazole (septrin)			
Cough mixture (syrup)			
Panadol/aspirin			
Other antibiotic			
Home remedies/herbal			
Other (specify)			
Cost of treatment			

7.0 OBSERVATION OF WATER STORAGE

7.1 How is water stored for drinking?

1. Bottles
2. Jerry cans
3. Earthen pots
4. Buckets
5. Jugs
6. Plastic container
7. Other (specify)_____

7.2 Is the container covered?

1. Completely covered
2. Partially covered
3. Uncovered

7.3 Does it have a narrow or wide mouth?

1. Narrow
2. Wide

7.4 Does it have a spigot?

1. Yes
2. No

7.5. Is it within the reach of children?

1. Yes
2. No

7.6. Is it within the reach of animals?

1. Yes
2. No

8.0 OBSERVATION OF TOILET FACILITY

8.1 Type of toilet facility?

11. Flush/pour flush to (piped sewer system, septic tank, pit latrine)
2. Ventilated improved pit latrine (VIP)
3. Pit latrine with raised floor (made of mud, concrete, or wood)
4. Composting toilet
5. Pit latrine/open pit without raised floor to cover the pit
8. No facilities; use bush or field
9. Other (specify)_____

IF THE RESPONSE TO Q8.1 IS "3. PIT LATRINE WITH SLAB / PLATFORM", ANSWER Q8.1.1

8.1.1 Does the pit latrine with slap / platform have the following items?
(SHADE ALL THAT APPLY AND SEE PICTURES IN EVALUATION FIELD GUIDE)

1. Roof
2. Privacy (walls, door, cloths, other sight protection)
3. Lid
4. Slab / platform is smooth and easy to clean
5. Slab / platform is raised

8.2. Is there evidence of recent use of the pathway to the latrine?

1. Yes
2. No
99. Not sure

8.3 Is there evidence of recent use of the latrine?

1. Yes
2. No
99. Not sure

8.4 Is the toilet area clean?

1. Yes
2. No

8.5 Is stool visible on the slab or floor?

1. Yes

2. No

8.6. Is there any fecal smell in the toilet area?
1. Yes
2. No

8.7. Are there flies or insects in the toilet area?
1. Yes, many flies or insects
2. Yes, a few flies or insects
2. No

8.8. Is water and soap for washing hands in or close by?
1. Yes
2. No

9.0 OBSERVATION OF HAND WASHING AREAS
Only complete this section if there is a hand washing area.

Location 1: _____

9.1 What type of Hand Washing Facility?
1. Tippy Tap
2. Water in a bucket with tab
3. Water in a bowl/bucket with mug
4. Water in a bowl/bucket without mug
5. Pressure bottle
6. Dip and drip
7. Running water (pipe stand, sink, etc.)
8. Other, specify_____

9.2 Is water available?
1. Yes
2. No

9.3. Is washing agent available?
1. Yes
2. No

9.4 What type of washing agent?
1. Soap
2. Detergent
3. Ash/mud
4 Liquid soap

5. Sand/ mud
6. Other (specify other _____)
88. Not applicable

9.5 Are there any traces of recent use?
(Such as water in the sink / wet floor; partially used soap; clear path to facility)
1. Yes
2. No

9.6 When was this hand washing facility constructed? (Ask if hand washing facility is tippy tap, pressure bottle, dip and drip, or running water)
1. within the last 6 months
2. within 6 months to one year
3. within the last one year to two years
4. More than 2 years ago
Do not know

9.7.How much did it cost to construct this hand washing facility?
_____ZMW

Location 2: _____
9.8 What type of Hand Washing Facility?
1. Tippy Tap
2. Water in a bucket with tab
3. Water in a bowl/bucket with mug
4. Water in a bowl/bucket without mug
5. Pressure bottle
6. Dip and Drip
7. Running water (pipe stand, sink, etc)
8. Other, specify_____

9.9 Is water available?
1. Yes
2. No

9.10. Is washing agent available?
1. Yes
2. No

9.11 What type of washing agent?
1. Soap
2. Detergent

3 Liquid soap
4. Ash
5. Sand/ mud
6. Other (specify other _____)
9. Not applicable

9.12 Are there traces of recent use? (Such as water in the sink / wet floor; partially used soap; clear path to facility)

1. Yes
2. No

9.13 When was this hand washing facility constructed? (Ask if hand washing facility is tippy tap, pressure bottle, dip and drip, or running water)

1. within the last 6 months
2. within 6 months to one year
3. within the last one year to two years
4. More than 2 years ago

Do not know

9.14 How much did it cost to construct this hand washing facility?

_____ZMW

LIST OF JOURNAL ABBREVIATIONS

Am J Clin Nutr	American Journal of Clinical Nutrition
Am J Med	American Journal of Medicine
Am J Trop Med Hyg	American Journal of Tropical Medicine and Hygiene
BMC	BioMed Central
BMJ	British Medical Journal
J Pathol	Journal of Pathology
PLoS	Public Library of Science
PMC	PubMed Central
Proc Nutr Soc	The Proceedings of the Nutrition Society

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