College of Natural and Computational Sciences

Center for Food Science and Nutrition

Association of Water, Sanitation and Hygiene with Diarrhea and Stunting of Young children in urban slums of Addis Ababa, Ethiopia.

By: Marekegn Habtamu

This Thesis Submitted to the School of Graduate Studies of Addis Ababa University in Partial Fulfilment of the Requirements for Degree of Master of Science in *Community Nutrition*.

February, 2021

Addis Ababa, Ethiopia

Addis Ababa University
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This Thesis Submitted to the School of Graduate Studies of Addis Ababa University in Partial Fulfilment of the Requirements for Degree of Master of Science in *Community Nutrition.*

Advisor: - Dr. Kaleab Baye (PhD, Associate Prof)

Prepared By: - Marekegn Habtamu

February, 2021

Addis Ababa University

School of Graduate Studies

Center for Food Science and Nutrition

DECLARATION

I, the under signed declare that this is original work and has never been presented in this or any other university and that all source materials used for this thesis have been properly acknowledged.

Name: Marekegn Habtamu Tsadiku

Signature:

Place: Addis Ababa University, Addis Ababa, Ethiopia

Date of Submission: February 26, 2021

The thesis has been submitted for examination under approval of university advisor.

Name of Advisor: Dr. Kaleab (PhD, Associate Prof.)

Signature:

Date:

Addis Ababa University

School of Graduate Studies

Center for Food Science and Nutrition

Final Thesis Approval Form

As participants of the board of examiners of the final MSc thesis. Open defense, we declare that we have read and evaluated the thesis prepared by Marekegn Habtamu under the title allowed **"Association of Water, Sanitation and Hygiene with Diarrhea and Stunting of young children urban slums of Addis Ababa, Ethiopia"** and recommend for the degree of Master of Science in Community Nutrition.

Signed by the examining committee:

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Dr. Zeweter Abebe		
Name of Internal Examiner	**Signature**	**Date**
Mrs. Messeret Azene		
Name of Chair Person	**Signature**	**Date**

Contents

List of Figures

List of Tables

Abbreviations

EDHS	Ethiopian Demographic and Health Survey
EMDHS	Ethiopian Mini Demographic and Health Survey
HAZ	Height for Age
JMP	Joint Monitoring Program
SD	Standard Deviation
SDG	Sustainable Development Goal
SPSS	Statistical Package for Social Science
NGO	Non-Governmental Organization
UN-HABITAT	United Nations Human Settlements Program
UNICEF	United Nations Children's Fund
USAID	United States Agency for Development
WASH	Water, Sanitation and Hygiene
WHO	World Health Organization

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Abstract

Background*: Children who are living in slum areas exposed to poor environmental conditions (Poor water, sanitation and Hygiene), this will lead children to exposed for recurrent clinical and sub-clinical infections and chronic undernutrition. This study intended to identify the link between Water, Sanitation and Hygiene conditions and stunting in Addis Ababa Slum areas.*

Method: *A community based cross-sectional study was conducted on 711 children aged from 6-23 months from January 15 to February 30,2020. A multistage cluster sampling method was employed to select study participants. A structured questionnaire, observational checklist and anthropometric measurements were taken to collect data. Data were entered in to epi-data version 3.5.1 and height-for-age was transformed in to Z-Score with ENA-SMAR software. Data were then exported in to SPSS version 24 for descriptive and binary logistic regression analysis. The significance of association was declared < 0.05 with 95% confidence interval.*

Result: *The study found the prevalence of diarrhea 23.3% (95%CI 20.3-26.6 and stunting 15.9% (95% CI 13.4-18.8). Households with pit latrine without slab (AOR 1.54; 95%CI 1.04-2.28) and households who don't treat water at point of use (AOR 1.51 95%CI 1.04-2.19) were significantly associated with diarrhea. Age of a child 12-23 months (AOR 3.63; 95%CI 2.23-5.93), sex of child (AOR 1.72; 95%CI 1.13-2.64) and maternal education (AOR 1.93; 95%CI 1.14-3.26) were associated with childhood stunting.*

Conclusion: *This study confers diarrhea was determined by pit latrine without slab and utilization of untreated water at the point of use. Child age, sex and maternal educational levels are positive predictors of stunting.*

Key Words: Addis Ababa, Stunting, Diarrhea, WASH and Slum

1. Introduction

1.1. Background

Malnutrition is a general terminology, which encompasses undernutrition, micronutrient related malnutrition, over weight and obesity and diet-related non-communicable diseases (Bain et al., 2013). Malnutrition is a global problem with its various forms. It affects most of the world's population at some point in their life cycle, from infancy to old age. No country is untouched. It affects all geographies, all age groups, rich and poor people, and all sexes. Thus, It is a truly universal problem (Fanzo et al., 2018). Nevertheless, undernutrition is not uniformly disseminated across the world, three-fourth of the global malnourished children were located in sub-Saharan Africa and South Asian countries (Demilew & Abie, 2017). Therefore, malnutrition is a public health concern for developing countries, particularly in Southern Asian and Sub-Saharan Africa (Bain et al., 2013; Müller & Krawinkel, 2005; Van de Poel, Hosseinpoor, Speybroeck, Van Ourti, & Vega, 2008).

People who are particularly vulnerable to malnutrition includes young children, adolescent girls, pregnant and lactating women, older people, people who are ill or immuno-compromised, indigenous people and people in poverty.(Fanzo et al., 2018; UCHENDU, 2013).

Malnutrition has a short- and long-term consequences. About 20% of childhood mortality in low-income countries is associated with stunting or underweight. Inadequate nutrition during the first 2 years of life causes irreparable damage through impeding physical and cognitive growth. Stunted children complete fewer years of schooling and as adults have reduced work capacity, earn less income and have poorer health.(Fenn, Bulti, Nduna, Duffield, & Watson, 2012; Wolde, Berhan, & Chala, 2015)

According to 2015, United Nations International Children Fund's (UNICEF), approach to Scaling up nutrition and other studies, there is no a single cause for undernutrition. Rather it has multifactorial determinates identified by UNICEF's conceptual framework for child undernutrition. It categorizes as immediate cause (inadequate dietary intake and poor health status), underlying cause (household food insecurity, poor quality of caring practice, and unhealthy living environments), basic causes (economic, political, environmental, social and cultural factors). (Bain et al., 2013; Boah, Azupogo, Amporfro, & Abada, 2019; Fanzo et al., 2018; Fenske, Burns, Hothorn, & Rehfuess, 2013; Smith & Haddad, 2014; UNICEF, 2015). Over the last decades

much attention had been paid to recognize appropriate nutrition specific interventions/programs to tackle these multifactorial determinants of undernutrition. yet, the progress indicates that, there is no a single interventions that can effectively prevent early childhood undernutrition (Fenn et al., 2012; Smith & Haddad, 2014). According to Nutrition and Growth year book of 2019 explanation, to end chronic form of undernutrition or stunting, nutrition specific interventions are not sufficient to bring results as projected. Hence, it recommends to take nutrition sensitive interventions in to consideration (Koletzko B, 2019).

According to World Health Organization (WHO) 2017, integrated management of childhood illness report points out that a single intervention or program were not effective to reduce child mortality as expected. Subsequently, WHOs child health and development department in collaboration with UNICEF developed a strategy for integrated management of childhood illnesses. In order to reduce death, illness frequency and disability and improving child growth and development.(WHO, 2017).

The relationship between growth and health in childhood is very simple gage: healthy children grow well; sick children do not. Because of its remarkable sensitivity to environmental insults, growth is recognized as the best global indicator of child well-being (Langford, Lunn, & Brick, 2011).

The two major causes of growth faltering in childhood are malnutrition (undernutrition) and infection, which interact synergistically to create a vicious cycle of growth faltering (Langford et al., 2011). Various studies reveal that more than 50% of childhood deaths are attributable to diarrhea, acute respiratory illness, malaria and measles (Rice, Sacco, Hyder, & Black, 2000).

Although undernutrition particularly stunting is prevalent in developing countries (Rice et al., 2000). A study done by UNICEF, WHO and World Bank, 2018 highlighted that highest burden of stunting in under five children to be in developing nations: 32.1% Middle Africa accounts, 35.6% East Africa accounts and 33.3% South Asia (W. UNICEF, World Bank Group, 2018).

In most developing nations, poor environmental conditions recurrently lead’s children to exposed for pathogenic microbials. As the result prevalence of subclinical infections is likely to be high. While by definition such infections are less severe than those resulting in diarrhea, the potential chronic nature of subclinical infections suggested as an important factor for childhood growth faltering (Nataro & Guerrant, 2017; Rice et al., 2000). Environmental Enteropathy is one of

subclinical infections. It occurs among residents of an environment with poor sanitation and hygiene facilities, commonly in developing countries. Long lasting contact with fecal pathogens is imagined to cause inflammation and structural alteration in small intestine which ultimately induce functional change, consequently intestinal permeability, impaired immune functions of the gut, malabsorption and growth faltering.(Betebo, Ejajo, Alemseged, & Massa, 2017; Korpe & Petri Jr, 2012)

Poor environmental condition refers to poor access to clean water, sanitation, and hygiene (WASH). As studies indicate, poor condition of WASH is associated with 6.6% of the global burden of disease and disability, and 2.4 million deaths annually due to diarrhea and subsequent malnutrition. A study done by Ngure and friends shows that around 50% of maternal and childhood underweight is due to poor WASH (Ngure et al., 2014).

According to 2019, Ethiopian Mini Demographic and Health Survey (EMDHS) report 37% under five children in Ethiopia are shorter for their age (below -2 SD) among which 12% are severely stunted (below -3 SD). This study also indicates that, the prevalence of stunting increases steadily with age, from 22% among children 6-8 months up to 44% of children 48-59 months. Therefore, this indicates a need to pay much attention for nutrition sensitive intervention. (EMDHS, 2019).

To resolve pervasive undernutrition problems particularly stunting, government and developmental partners promoting multisectoral approaches. However, the association between water, sanitation, and Hygiene with stunting is less clear and there was also scarce evidence that has been carried out to investigate the WASH and nutrition in Ethiopia urban slums. Therefore, this study aimed to produce evidence that can fill the intended gap.

1.2. Statement of a problem.

Epidemiological inquiries informed that stunting occurs due to a multitude of reasons, of these environmental conditions related insult takes the largest share in low- and middle-income countries. a comparative risk assessment analysis conducted over 100 developing countries enlighten that environmental risk factor (i.e., poor drinking water quality and sanitary conditions) are the second leading risk factor for childhood stunting globally, in particular, South Asia and Sub-Sharan countries.(Danaei et al., 2016; Ngure et al., 2014)

In order to alleviate environment insults of stunting, several empirical evidences have been produced identify the association between WASH condition and growth faltering. However, findings of these studies are inconsistent.

A follow-up study done in rural Bangladesh, between children from households living in different status of environmental cleanliness (water quality, sanitary, and handwashing infrastructure) proved that children from clean households had a 0.54 higher standard deviation of height-for-age than from contaminated households.(Lin et al., 2013)

An operation research carried in Ethiopia by 2012, to draw effective strategy to reduce childhood stunting in food secured areas, the finding indicated that WASH intervention group show a significant increase in mean height-for-age Z-score (+0.33, P=0.02), with 12.1% decrease in the prevalence of stunting compared with other intervention groups. Additionally, Cochrane group review identified that WASH intervention has slight significant effect on height- for-age Z-score (MD 0.08; 95%CI 0.00 to 0.16).(Dangour et al., 2013; Fenn et al., 2012).

As opposed to findings of different observational studies regarding WASH and child linear growth, various benefit and efficacy trials had been conducted in rural settings of Bangladesh, Kenya and Zimbabwe and a longitudinal study in Nepal slums. Thus, the findings of these trials and longitudinal studies attested that WASH interventions have no effect on childhood linear growth. These inconsistent findings urged us to carried out the study.(Humphrey et al., 2019; Langford et al., 2011; Luby et al., 2018; Pickering et al., 2019).

The second claim of this study is lack of evidences in Ethiopia that have been conducted in relation to WASH and child growth in urban slum settings. Therefore, this study is intended to fill the gap.

1.3. Significance of the study

- The implication of this study is to designate the role of nutrition sensitive WASH intervention to reduce the burden of chronic undernutrition.
- This study also supports to understand the association between urban slum households WASH conditions and stunting.
- This study is helps for policy makers to formulate context relevant strategy to mitigate chronic nutrition in urban slum settings.
- This study will be a foundation for developmental partners and NGOs to design context relevant projects or programs, in order to alleviate stunting.
- This study will reveal spatial distribution of stunting and diarrhea in the study areas.
- This study will be a baseline study for other scholars to undertake further longitudinal or experimental studies for better understanding of causal association of dependent and independent variables.

1.4. Research Questions

- What seems water, sanitation and hygiene conditions of Addis Ababa slum areas?
- Does poor WASH condition have the association with childhood diarrhea and stunting?
- Which component of WASH is strong determinate of childhood diarrhea and stunting?

1.5. Objectives

1.5.1. General Objective

❖ The main aim of this study to identifying the association between water, sanitation and hygiene and other associated factors with childhood diarrhea and stunting in Addis Ababa slum areas.

1.5.2. Specific Objectives

❖ To evaluate water, sanitation and hygiene conditions of some selected residents in Addis Ababa slum areas.
❖ To determine the magnitude of diarrhea in Addis Ababa Slum areas.
❖ To determine the prevalence of stunting in Addis Ababa slums.
❖ To identify possible risk factors associated with diarrhea and stunting.

2. Review of Related Literature

2.1. Definition of Terminologies

This section of the literature review provides a background on stunting, its cause, consequence, epidemiology and WASH, definition and consequences of its inadequacy.

2.1.1. Stunting

Stunting (poor linear growth) is an indicator for chronic form of undernutrition during the most critical periods of growth and development in early life. (Agedew & Chane, 2015). According to WHO's child growth standard, stunting is defined as percentage of children aged from 0 to 59 months whose height-for-age (HAZ) is below minus two standard deviations (-2SD), in which (-3 to -2SD) is characterized as moderately stunting and (-3SD) and below classified as a sever stunting.(Solomon D, 2019) .

2.1.2. Water Sanitation and Hygiene (WASH)

WASH is a combination of different terminologies, that typically refers to activities aiming to improve access to, use of safe drinking water and sanitation as well as promotion of good hygiene practice (WHO/UNICEF/USAID, 2015)

Water component of WASH incorporates both the quality and quantity aspects. Water quality stands for implementing activities to protect from microbiological and chemical contaminates of drinking water(Organization, Supply, & Programme, 2015; WHO/UNICEF/USAID, 2015). Water quantity stands for provision of facilities and services that increase the amount of water available for drinking, cooking and maintaining good hygiene practice (Organization et al., 2015; WHO/UNICEF/USAID, 2015).

Sanitation is a broad terminology; it refers to implementation of different techniques and ways for safe and sustainable management of human excreta, including collection, storage, treatment, and disposal of feces and urine (Abdissa & Walelegn, 2016). It is also the provision and utilization of facilities and services that safely dispose human urine and feces, thereby preventing contamination of the environment (WHO/UNICEF/USAID, 2015).

Hygiene component of WASH refers to practice of hand washing with soap during critical periods (i.e. after defecation and disposal of child feces, prior to preparing and handling of food and before eating) (WHO/UNICEF/USAID, 2015)

2.1.3. Slum Household

According to UN-Habitat definition , Slum household is a group of individuals living under the same roof in an urban area who lack one or more of the following; durable housing of a permanent nature that protects against extreme climate condition, sufficient living space not more than three people sharing the same room, easy access to safe water in sufficient amounts at an affordable price, access to adequate sanitation in the form of private or public toilet shared by reasonable number of people and security of tenure that prevents forced evictions (UN-HABITAT, 2007).

2.2. Determinants of stunting

According to WHO, 2013 conceptual framework, stunting occurs due to multifactorial causes. And causes for stunting can be grouped as household and family factors, inadequate complementary feeding, breast feeding and infections. (Stewart, Iannotti, Dewey, Michaelsen, & Onyango, 2013)

2.2.1. Household and family factors

These factors show that stunting could occur due to maternal and/or household factors.

Maternal Factors

The UNICEF's conceptual framework and other pocket studies designates that nutritional and non-nutritional maternal factors could be a cause for stunting (Aguayo & Menon, 2016; Stewart et al., 2013). As to various studies indication maternal undernutrition is one of a determining factor for childhood growth faltering (Black et al., 2013). Intrauterine growth retardation due to maternal undernutrition contributes for 20% childhood stunting (Black et al., 2013).

A cohort study done in Bangladesh and a review conducted by Williams and friends indicates that maternal short stature is thought to be a risk factor for poor childhood growth. (Investigators, 2017; Williams & Suchdev, 2017). Similarly, a review of five birth cohort done by health-oriented research in transition societies group and cross-sectional study conducted in India identified that a 1cm maternal mean height increase was associated with 7.8%, 8.0%, 8.2% increases in the height-

for-age at 2 years, mid childhood and adulthood and decreased risk of childhood stunting respectively(Addo et al., 2013; Subramanian, Ackerson, Smith, & John, 2009).

Evidence from South Asia reveals that the crucial role of non-nutritional maternal factors like early age of marriage and conception, maternal education level, domestic violence, inadequate decision-making power and poor control over resources, strenuous agriculture activities are contributing factors for child undernutrition (Vir, 2016). Similarly, in Andhra Pradesh, India a cross-sectional study indicates that higher maternal autonomy expressed by access to money and freedom of choice to go to the market is significantly less likely to face growth faltering of children (Shroff et al., 2009).

The other maternal related factor is short birth spacing. Which doesn't permit woman's body to recuperate and replenish essential nutrients which leads to poor nutritional status and child hood stunting (Naik & Smith, 2015)

Home environment

As per the indication of WHO's conceptual framework, stunting could be caused by home environment related factors. Among these factors, poor child care practice is one of the determinates for stunting. A study conducted at Ghana explains that a 1 unit increase in child care practice score was associated with a 0.17 unit increase in height-for-age (Amugsi, Mittelmark, Lartey, Matanda, & Urke, 2014). Similar study has been done in Kenya in comparation of child care activities at different age category. The result showed that percentage of child care activities of children from 13-24 months of age below 50% as compared to 1-12 months. Hence the prevalence of stunting was high on children of 13-24 months (Kamau-Thuita, Omwega, & Muita, 2002).

Other study which was done to identify the relationship between breast and complementary feeding practice with infant morbidity and growth, the study determined that early introduction of complementary feeding was significantly associated with the risk of infection and later introduction of it can improve child growth (Kalanda, Verhoeff, & Brabin, 2006). A systematic review and meta-analysis conducted in Ethiopia also identified the first determinant of stunting in Ethiopia owing to non-adherence towards optimal feeding recommended by WHO and was found to be the most reported predictor of stunting in Ethiopia (Abate & Belachew, 2019)

Studies from different corners of the globe proved that food insecurity was one of home environment related determinants of growth faltering. Similar investigations likewise had been carried out in Ethiopia and they reveal parallel findings (Betebo et al., 2017; Chaparro, 2012; Shamah-Levy et al., 2017; Singh, Singh, & Ram, 2014).

As several studies conducted in different corners of the world shows, stunting could occur due to home environment factors other than aforementioned aspects like low socioeconomic status of the household and level of parental education particularly maternal/ caregivers' illiteracy was prominently associated with childhood stunting (Akombi et al., 2017; Kismul, Acharya, Mapatano, & Hatløy, 2018; Nshimyiryo et al., 2019; Tariku, Biks, Derso, Wassie, & Abebe, 2017; Wirth et al., 2017)

2.2.2. Dietary related factors

Dietary related factor for stunting is most commonly referring to poor quality of foods/ inadequate dietary diversity. A community based cross-sectional study conducted in western province of china demonstrates that exposure to inadequate minimum dietary diversity has increased risk of stunting (Wang et al., 2017). Similar study carried out in eastern Java, Indonesia confirmed that high dietary diversity score was associated with lower chances of childhood stunting (Mahmudiono, Sumarmi, & Rosenkranz, 2017). A national survey done in Bangladesh identified that children with high dietary diversity were linked with a 15, 26 and 31% reduced odds of being stunted among children aged 6–11, 12–23 and 24–59 months, respectively (Jee H Rah et al., 2010).

A similar national household survey of children aged 12 to 59 months conducted in Cambodia revealed that consumption of animal sourced foods were associated with reduced risk of stunting (Darapheak, Takano, Kizuki, Nakamura, & Seino, 2013). Other empirical evidence from rural Burkina Faso attests that high dietary diversity was associated with high HAZ among all study participants (Sié et al., 2018).

A cross-sectional and case control studies done in Ethiopia disclosed that dietary diversity scores ≥ 4 was an independent predictor of less likely occurrence of stunting (Berhe, Seid, Gebremariam, Berhe, & Etsay, 2019a; Yirgu Fekadu, Haile, & Stoecker, 2015).

2.2.3. Poor Water, Sanitation and Hygiene (WASH)

Copious pocket studies and a literature review conducted at different corners of the globe indicate that poor access to safe and clean water, sanitation facility and hygiene practice results undernutrition and stunting in children through numerous ways (Gizaw & Worku, 2019; Jee Hyun Rah et al., 2015).

A longitudinal study conducted in Peruvian peri-urban communities indicated that, poor water source and sanitation facility explains 40% growth deficit, which is far greater than growth deficit explained by diarrhea 16% (Checkley et al., 2004).

The most pertinent associations of poor WASH practice with undernutrition via repeated exposure of diarrhea. This is because diarrhea is considered as a means for malnutrition as well a consequence of it. Diarrhea reduces nutrient absorption and reduces dietary intake. on the other hand, malnutrition affects the immune system of a child leading to repeated episodes of diarrheal infection (J. Brown, Cairncross, & Ensink, 2013; van Cooten, Bilal, Gebremedhin, Spigt, & nutrition, 2019).

The other route of poor WASH practice and undernutrition is via frequent exposure to fecal pathogens in areas with poor sanitation and low public health services which in turn causes environmental enteric dysfunction (EED) (J. Brown et al., 2013; Owino et al., 2016).

2.2.4. Infection as a factor for Stunting.

Infection and nutrition have bimodal association. i.e., malnutrition impedes proper functioning of immune system and leads to frequent exposure to infection. As well clinical or subclinical infections will result malnutrition through various dimensions (K. H. J. T. J. o. n. Brown, 2003; Dewey, Mayers, & nutrition, 2011).

Clinical infection refers to signs and symptoms are overt. Among this diarrheal disease is the prominent one. Diarrheal disease could occur due to various causative agents, in which it includes pathogenic bacteria and other infective organisms. In most cases exposure to these pathogens occurs through ingestion of contaminated food, water, soil and utensils. Therefore, it robes fluids and essential nutrients like zinc from children. If these fluids and nutrients are not replaced, it will result in dehydration, malnutrition and subsequent growth faltering. Additionally, some studies indicate that infection leads to poor appetite and energy and nutrients obtained will be used for

immune system function rather than growth (Arnold et al., 2013; K. H. J. T. J. o. n. Brown, 2003; Dewey, Mayers, et al., 2011).

An infection is defined as subclinical when there are no apparent signs and symptoms but there is physiological evidence of intestinal abnormality (Dewey, Mayers, et al., 2011). Environmental enteropathy (EE) is one of the most hypothesized subclinical conditions associated with growth faltering. It has no superficial clinical symptoms however; it causes growth faltering through structural and functional change of small intestine consequently resulting in malabsorption of essential nutrients (Dewey, Mayers, et al., 2011).

2.3. Consequences of stunting

As to WHO's, 2013 conceptual framework of stunting and several pocket studies conducted in different parts of the globe indicate that growth faltering has short-term and long-term consequences.

2.3.1. Short-term consequences of stunting

A study done in different countries confirmed that early childhood stunting is a cause for under five mortality (Fawzi et al., 1997; McDonald et al., 2013; Olofin et al., 2013; Villamor, Misegades, Fataki, Mbise, & Fawzi, 2005).

2.3.2. Long-term consequences of stunting

Evidences from different corner of the sphere indicate that early childhood growth faltering will result in poor school achievement, reduced productivity and less earning (Dewey, Begum, & nutrition, 2011; Hoddinott, Alderman, et al., 2013; Hoddinott, Behrman, et al., 2013).

2.4. Epidemiology

This section provides an insight into global and local magnitude of undernutrition particularly stunting and the extent of WASH.

2.4.1. Prevalence of stunting

According to 2018, Global Nutritional Report the burden of stunting was declining from 32.6% of all under five children across the world in 2002 to 22.2% in 2017. Numerically this decline is from

198.4 million to 150.8 million. However, according to WHO prevalence threshold classification the magnitude of stunting is still higher in south Asia and sub-Saharan African countries.

Stunting among children in Africa decreased in percentage from 38.3% to 30.3% within the same period of time, yet owing to rapid population growth the actual number of stunted children increased. Geospatial data of UNICEF/WHO/World bank shows that trends in stunting vary significantly.

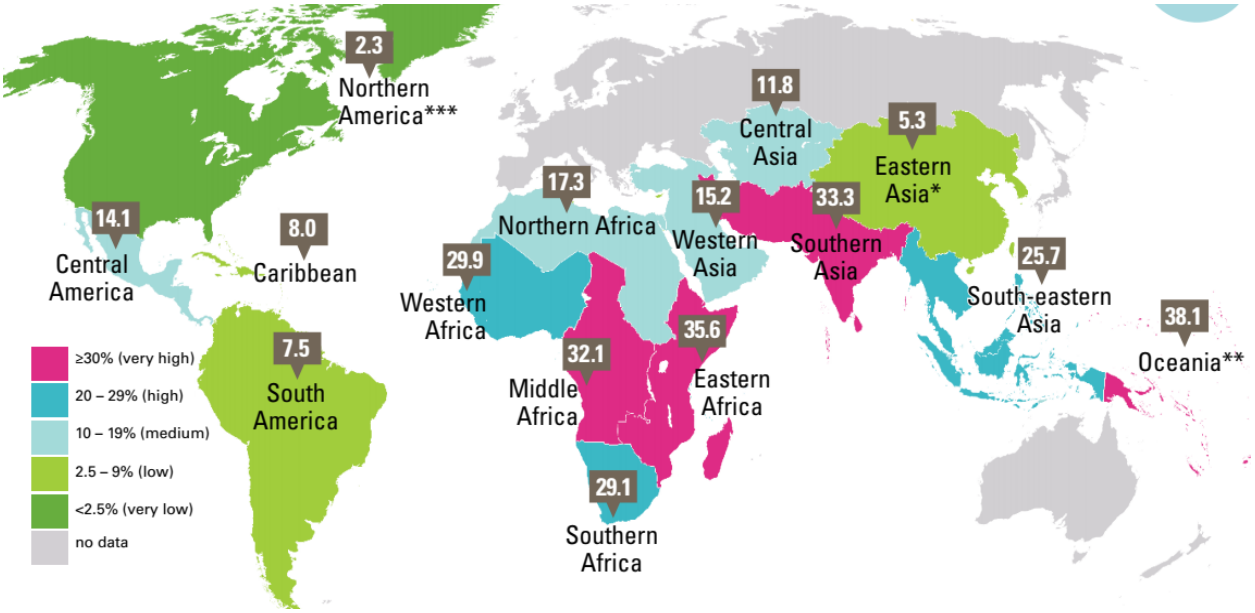


Figure 1 Prevalence of Stunting Across the Globe.

According to 2019, Ethiopian mini demographic and health survey, 37% of children under five were shorter for their age. And among those, 12 % of them were severely stunted (below -3 SD) This result indicated a 1% decline from 2016's EDHS. The survey report elucidated the prevalence of stunting generally increases exponentially with age, 22% among children of 6- 8 months to 44% of children in 48-59 months of age. Notably, the highest proportion 45% of stunting in children was observed at the age of 24-35 months, and it is also slightly higher among male than female children (40% versus 33%). In addition, stunting among children is greater in rural areas (41%) than in urban areas (26%). There are some regional variations in stunting as well. as high as of 49 % in Tigray where as 14% in Addis Ababa (EDHS, 2016; EMDHS, 2019)

2.4.2. WASH Coverage.

Drinking Water

According to WHO and UNICEF, joint monitoring program report utilization of safely managed water service increased from 61% in 2000 to 71% in 2017 i.e., seven out of ten people used safely managed drinking water service. Furthermore, it indicated coverage of safely managed service increased in all Sustainable Development Goal (SDG) regions. Based on available estimates, it rose from 25% to 35% in areas of least developed countries. About 1.8 billion people gained access to at least basic services. As this report indicates the population size who lack basic service decreased from 1.1 billion in 2002 to 785 million in 2017, similarly the number of people who collected water directly from surface decreased from 256 million in 2000 to 144 million (WHO, 2019)

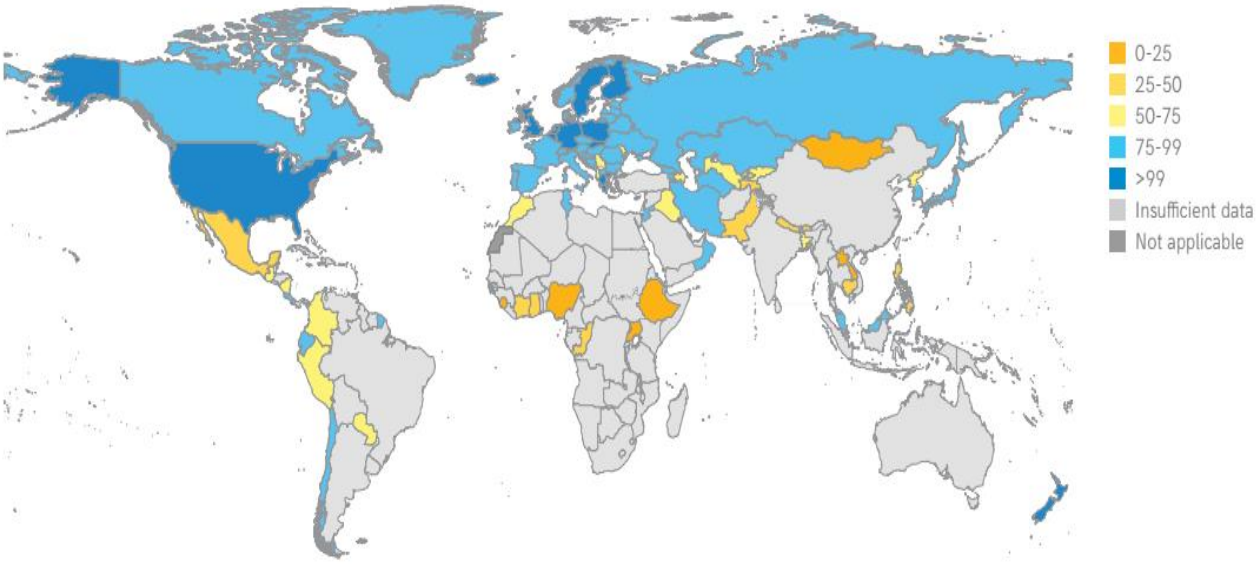


Figure 2 Magnitude of Safely Managed Drinking Water Across the World (WHO, 2019)

According EDHS, 2016 data, 97% of urban households have access to improved sources of drinking water, as compared with rural household.(EDHS, 2016)

Sanitation

WHO/UNICEF JMP report elucidates 54% of the global population (3.4 billion people) utilize safely managed sanitation service, i.e., four out of ten people use improved sanitation facility. An additional 2.2 billion used at least basic sanitation services while, 627 million people used limited

service, 701 million people used unimproved facilities and 673 million peoples practice open defecation. One third lived in least developed countries (WHO, 2019)

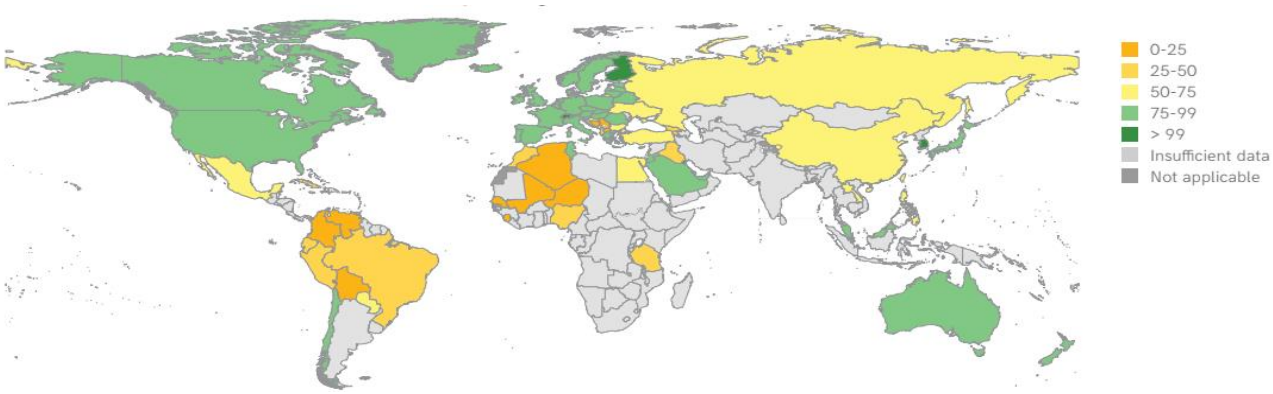


Figure 3 Estimates of Safely Managed Sanitation Across the World (WHO, 2019)

EDHS, 2016 revealed that 6% of Ethiopian households use improved toilet facilities (16% in urban area and 4% in rural areas). More than half (56%) of rural households utilize unimproved toilet facilities. More than one third (35%) of toilet facilities are shared in urban households, whereas only 2% of rural households used shared. In Ethiopia 39% or one in three households have no toilet facility (EDHS, 2016).

Hygiene

WHO/UNICEF's JMP report show that 60% of the global population had basic hand washing facilities with soap and water available at home. However, 3 billion people still lack basic hand washing facilities at home; 1.6 billion have limited facilities lacking soap or water, and 1.4 billion had no facility at all (WHO, 2019)

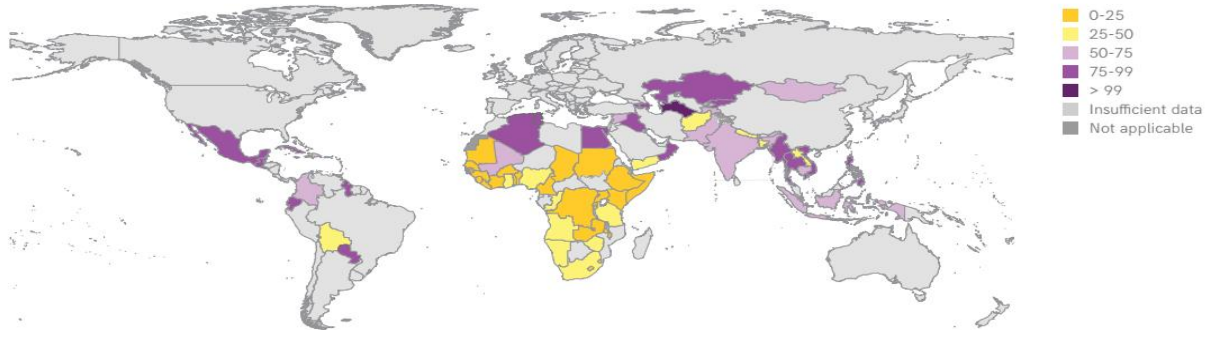


Figure 4 Estimates for Basic Hand Washing Facility Across the World (WHO, 2019)

EDHS, 2016 showed that 60% of the household had hand washing facility, (81% in urban areas and 55% in rural). Essential materials like soap and water were available in 28% of urban households and 7% of rural households and it also varies across regions(EDHS, 2016).

2.5. Conceptual Framework for Nutrition Sensitive WASH and Under Nutrition (Stunting).

There are a wide variety of complex factors and pathways which lead to undernutrition; often these paths are interconnected. Nutritional status is a result of a set of complex and interrelated factors creating synergy and depends on the environment in which people live and the process to which they are exposed at the household level. For the same reason maternal and child nutritional status cannot be analyzed only from a dietary point of view. Poor WASH induces child undernutrition through both biological and non-biological paths. While biological ways are being exposed to pathogenic microorganisms, that will induce infectious disease, non-biological track was time taken to fetch water. Which in turn reduces the time provide care for a child and economic activities (Chase & Ngure, 2016)

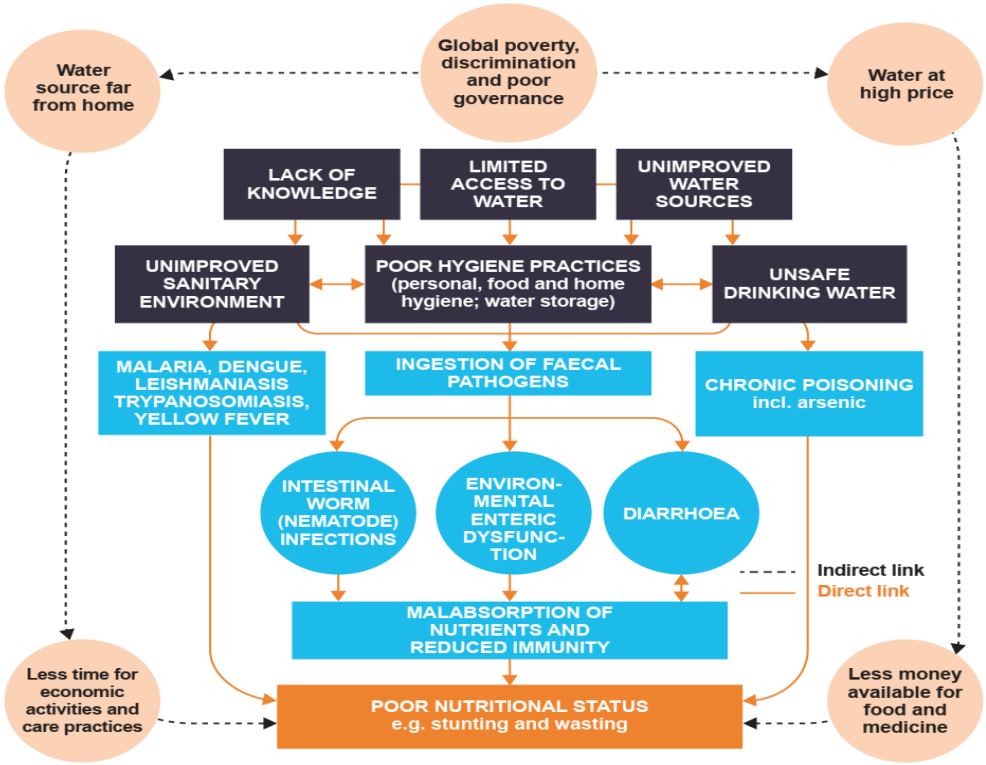


Figure 5 Conceptual Framework of poor WASH and Undernutrition (Dodos, Mattern, Lapegue, Altmann, & Aissa, 2017)

3. Materials and Method

3.1. Study Area

This study was conducted in Addis Ababa city administration. The city administration is selected purposively, because of a study conducted by world bank and global disaster reduction and recovery together indicates that 70-80% of the households are slums (GDRR, 2015).

Addis Ababa is one of the federal cities of Ethiopia. The city administration covers 527 square kilometer of the land in Ethiopia. The city administration subdivided in to 10 sub-cities and 99 woredas (districts). Addis Ababa lies at an elevation of 2,200 meters (7,200 ft) and located at 9°1′48″N 38°44′24″E. The city lies at the foot of Mount Entoto and forms part of the watershed for the Awash. From its lowest point, around Bole International Airport, at 2,326 meters (7,631 ft) above sea level in the southern periphery, Addis Ababa rises to over 3,000 meters (9,800 ft) in the Entoto Mountains to the north.

Addis Ababa is classified in to 10 administrative sub-cities, each of the sub-cities accompanies more than 75% slum households. In which they lack any one of the five indicators: - access to improved water, access to improved sanitation, sufficient living area durability of housing and access to secure tenure.(GDRR, 2015)

3.2. Study Design

Community based cross sectional study was employed to collect data regarding households WASH profile and nutritional status of children from 6-23 months. In Addis Ababa slum areas as of January 15 to February 30, 2020.

3.3. Data Collection Instruments

3.3.1. Structured questionnaire

The data was collected using interviewer administrated structured questionnaire to identify socio-demographic characteristics, economic status of the house hold. The questionnaire was originally prepared in English and translated to Amharic and retranslated to English to check consistency. The data was collected by trained data collectors, under the guidance and supervision of the investigator.

3.3.2. Observation check list

The observation checklist included inquiries regarding of the household environment availability of safe drinking water source, sanitary and hygiene facility in the household.

3.3.3. Anthropometric measurements

Anthropometric data, height, of the children in the study was measured by the trained data collectors and the investigator. the height of children was measured using wooden height boards with a precision of 0.1cm and a repeated measurement were taken to approve validity of measurements. Anthropometric indices: height for age and weight for age Was determined based WHO's growth chart standard reference.

3.4. Data Source and Study population

This study encompasses households who had children 6-23 months of age in the selected slum areas of Addis Ababa.

3.5. Inclusion and Exclusion Criteria

- This study included households who had children from 6-23 months of age.
- This study included caregivers who are willing to give consent to participate in this study.
- Households who had children with known previous history chronic disease were excluded from this study.

3.6. Sample size determination

Sample size was calculated using formula for estimation of single population proportion;

$$n = Z_{\alpha/2}^2 * P(1-P)/d^2$$

Where Z value is 1.96 at 95% confidence interval; P is estimated proportion of 50% and d margin of error of estimation was 5%. The calculated sample was 384 considering design effect of 2 and the final sample size was 768.

3.7. Sampling Technique

Multistage cluster sampling technique was employed to recruit study participants of Addis Ababa slum areas. First seven sub-cities (Addis Ketema, Akaki Kality, Gulele, Lideta, Kirkos, Kolfe keranio and Yeka) were selected randomly from Addis Ababa city administration sub-cities. Second districts were selected purposively, identifying areas which are not included in the city-wide slum upgrading plan (being implemented until 2025 by Addis Ababa city administration Housing Agency). The final participants were selected by employing systematic random sampling. The first household selected randomly and the second was selected based on the K^{th} value.

3.8. Data Analysis.

The data was analyzed by using ENA-SMART for anthropometric data, to determine Z-Score of HAZ for study participants and SPSS Version 24 was used to carried out descriptive statistics using frequency and precent to present findings of the study. Bivariate analysis was conducted to identify candidate variables for the final multivariate analysis. Variables with the p-value <0.2 in bivariate analysis were entered in the final multivariable logistic analysis. A p-value <0.05 was considered to declare the result as statistically significant.

3.9. Measurements

We administered a questionnaire to a mother or guardian of the children to collect a rage of factors that can be associated with diarrhea and stunting. The tool included items of WASH and other household related factors like household child care practice, household food security, dietary diversity, and child immunization.

Child care practices were tried to understood through questions related to child feeding practices such as exclusive breast feeding during the first six months, complimentary feeding practices. Household food security data were collected through employing Household Food Insecurity Assessment Scale (HFIAS). This tool is based on a set of nine questions and follow up of frequency of occurrence questions. Minimum dietary diversity was fulfilled if a child had received four or more food groups from seven WHO food groups in last 24 hours preceding the survey. The seven food groups were grains, roots and tubers; legumes and nuts; dairy products; flesh foods, eggs; Vitamin-A rich fruits and vegetables and other fruit and vegetables.

Child immunization status of children (Ever vaccinate yes/No) was checked by observing the immunization card, and if not, available mothers were asked to recall it. BCG vaccine was checked by observing scar on right or left arm.

Geographical location of the household and their elevation data were collected by using hand held Geographic positioning system (GPS) device.

3.10. Ethical Considerations.

The Ethical Clearance was secured from Addis Ababa University institutional review board of collage of natural and computational sciences. Prior to collection of data oral consent was obtained from children's parents/ caregivers of participant after reading and explaining objective of the study. Eventually the interview carried after obtaining parents/ caregiver's consent.

4. Results

4.1 sociodemographic characteristics

This study included 711 children aged 6-23 months. Among them 57.1% of study participants were in the age ranged of 13-23 months. Among the total participants 53.4% of them were males and 44.2% were the first child to their parents, 30.5% of theme were second child to their parents. Of the set of participant children 87.9% of them were cared by their mothers. Amid the included households, majority of them were male headed and merely 14.7% of them were female headed. From interviewed mothers 68.4% of them were housewives. Only 82.6% of the mothers were attended school, of them merely 21.7% of them high school completed. From the study samples 76.6% of the households had registered residency status in the woreda where they belong. Among the households 83.3% of them were not read a newspaper once a week. However, majority of the household had access to listen radio and to watch television.

Table 1: Sociodemographic Characteristics

Variables	Frequency (%)
Age of a child (month)	
6-12 month	305 (42.9%)
13-23 month	406 (57.1%)
Gender	
Female	331(46.6%)
Male	380 (53.4%)
Caregivers relationship to the child	
Mother	625 (87.9%)
Father	25 (3.5%)
Others	61 (8.5%)
Household Head	
Father	543 (76.4%)
Mother	105 (14.7%)
Other than father and mother	63 (8.9%)
Duration of living in Addis Ababa	
0-5 years	88 (12.4%)
6-10 years	94 (13.2%)
>=11 years	528 (74.2%)
Registered resident of the woreda	
Yes	552 (76.6%)
No	159 (22.4%)
Slum household	
Yes	509 (71.6%)
Marital status	
Married	575 (80.9%)
Occupation of the mother	
Housewife	487 (68.4%)
Employed	224 (31.6%)
Monthly income	
Less than 2000	351 (49.4%)
Greater than 2000	360 (50.6%)
School attendance of the mother	
Yes	587 (82.6%)
No	124 (17.4%)
Educational status of the mother	
Primary	363 (51.1%)
Secondary	154 (21.7%)
Vocational /technical	41 (5.8%)
Higher education	29 (4.1%)

4.2 Water, sanitation and hygiene (WASH) characteristics of the household

4.2.1 Household Water Source and Availability

Among the included households only 2.5% of theme were utilized water from unimproved source for drinking purpose. Similarly, 1.8% of the households utilized water from unimproved sources for other than drinking purpose. 92.5% of the households obtain drinking water irregularly, of these 50.9% of the households were not obtain water when needed.

Table 2: Households Water Source and Availability

Household water source for drinking purpose	**Frequency (%)**
Improved	691(97.5%)
Unimproved	18 (2.5%)
Household water source other than drinking purpose	
Improved	696 (98.2%)
Unimproved	13 (1.8%)
Does drinking water available intermittently?	
Yes	658 (92.5%)
Water availability when needed	
Available when needed	349 (49.1%)
Not available when needed	362 (50.9%)

- **Improved water source: -** a piped water source in to the home/yard/plot, public stand tap, tube well, borehole, protected well and protected spring, rainwater, and packed water.
- **Unimproved water source: -** unprotected well, unprotected spring, surface water sources like reiver, lake, dam, pond and stream.
- **Water is available when needed**: - when water is available at least 50% of the time (i.e., at least 12 hours per day and 4 days a week)

4.2.2 Household Water Handling Practice

From the total households 80.7% of them were utilized above 20 liters of water in a day. 88% of the household had information about the transmission of disease through contaminated water. However, 55.6% of the households were not employ any water treatment techniques. Among the households who apply treatment technique, 65.5% of them utilize chemicals for treatment purpose. 77.1% of the households' store drinking water, of them 74.9% of them were used jerrycan for as a storing container. 80.6% of the household place their water storing container on the floor inside the home. 95.4% of households cover the mouth of drinking water storing container, of these 32.2% of mouth size wide. Only 13% of the households were not use drinking water storing

container. Aside from the households who store drinking water 27.3% of theme clean the container once a day.

Table 3: Households Water Handling Practices.

Amount of water consumed per day in household	Frequency (%)
Below 20 lit	137 (19.3%)
Above 20 lit	574 (80.7%)
Households' perception about water safety	
Yes	377 (54.8%)
No	311 (45.2%)
Households water treatment	
No	391 (55.6%)
Households water treatment methods	
Boiling	110 (35.5%)
Chemicals	203 (65.5%)
Strain through cloth	1 (0.3%)
Bio sand/ composite	32 (10.3%)
Solar disinfection	2 (0.6%)
Let it stand and settle	2 (0.6%)
Other method	8 (2.6%)
Drinking water storage	
Yes	548 (77.1%)
No	163 (22.9%)
Storage container	
Clay pot	1 (0.2%)
Jerrycan	332 (74.9%)
Plastic bucket	104 (23.5%)
Iron bucket	6 (1.4%)
Drinking water storage container located	
On the floor inside the home	433 (80.6%)
Outside	92 (17.1%)
Inside the home above the floor (at least above 40 cm)	12 (2.2%)
Drinking water storage cover	
Yes	523 (95.4%)
No	25 (4.6%)
Containers mouth size	
Narrow	371 (67.7%)
Wide	176 (32.2%)
Use of drinking water storage container for other purpose	
Yes	477 (87%)
No	71 (13%)
Frequency of storage container cleaning	
Once a day	141 (27.3%)
Twice a day	32 (6.2%)
Once every two days	73 (14.1%)
Once every three days	125 (24.2%)
Weekly	146 (28.2%)

4.2.3 Household Sanitation

Among the participant households 2.3% of them were defecate openly and 37.6% of the households had unimproved toilet facility. 92.5% of the households share their toilet facility with other households. Only 1.2% of households had their toilet facility in their dwelling and 47.7% of them were located away from the dwelling and families' yard. According the observational check list report, around 56.1% of the households had open sewer. 53.7% of them has raw sewage in the compound/dwelling. Only 12.9% of them had feces around the hole or in the floor. Around 81.4% of the household's toilet facility had flies around it. Only 5.1% of the household had visible feces in their dwelling or compound. 7.5% of the households only had hand washing facility near by the toilet. Among the participant households,20.4% of them were only practice safe child waste disposal.

Table 4: Households Sanitation Characteristics

Variables	Frequency (%)
Toilet facility	
Improved	428 (60.2%)
Unimproved	267 (37.6%)
No facility (open defecation)	16 (2.3%)
Shared toilet facility	
Yes	658 (92.5%)
Toilet facility location	
Inside the family dwelling	8 (1.2%)
On the family yard/ plot	336 (51.1%)
Elsewhere	314 (47.7%)
Current functionality of toilet	
Yes	671 (95.4%)
Presence of open sewer	
Yes	399 (56.1%)
Prescence of raw sewage in the compound or dwelling	
Yes	382 (53.7%)
Presence of uncollected garbage	
Yes	392 (55.1%)
Presence of feces around the pit hole or in the floor	
Yes	92 (12.9%)
Presence of flies around toilet facility	
Yes	579 (81.4%)
Prescence of visible feces in the dwelling or compound	
Yes	36 (5.1%)
Presence of hand washing facility near the toilet	
Yes	53 (7.5%)
Presence of soap at the hand washing facility	
Yes	54 (7.6%)
Soap looks wet	
Yes	34 (64.2%)
child waste disposal	
Safe disposal	145 (20.4%)
Unsafe disposal	566 (79.6%)

- According to the definition WHO/UNICEF (2017) joint monitoring program (JMP), safe child waste disposal refers to defecation in to the latrine, disposal of child latrine in to latrine and child waste burial.

4.3 child care practice

More than 95% of the participant children were breast feed, among them 69.5% of them were introduced breast feeding with in the first one hour. 6% of them only had not feed colostrum. From the sampled children 16.9% of theme were introduced complimentary feeding before six months. On the time of data collection 82.5% of theme were breast feed partially. Majority of the child were usually feed by their mothers (86.9%). Porridge was the first complimentary food consumed by 45% children. On the time of data collection 74.3% was began to consume the family's food. 53.7% of the children were spent their time inside home and 42.5% of them had spent inside and outside of home. Only 23.3% of the children had loos or watery diarrhea by the past two weeks. Consequently, 47.5% of them had reduced their dietary intake compared to the previous amount.

Table 5: Household Child Care Practices

Characteristics	Frequency (%)
Child breast feeding	
Yes	685 (96.5%)
Time of breastfeeding	
Within 1 hour after birth	474 (69.5%)
After hours	104 (20.5%)
After days	49 (7.2%)
Not remembered	19 (2.8%)
Was colostrum ever feed?	
Yes	644 (94%)
Time of complimentary feeding started	
Before six months	120 (16.9%)
After six months	591 (83.1%)
Current status of breastfeeding	
Exclusive	49 (7.2%)
Partial breast feeding	565 (82.5%)
Not breastfeeding	71 (10.4%)
Who feeds usually	
Mother	575 (86.9%)
Father	18 (2.7%)
Siblings	10 (8.9%)
Other	59 (8.9%)
The first complimentary food served for a child	
Injera	24 (3.7%)
Bread	6 (0.9%)
Porridge	295 (45.1%)
Gruel	87 (13.3%)
Others	242 (37%)
Had a child begin family food	
Yes	528 (74.3%)
Where did a child spent by the las two weeks	
Inside the home	382 (53.7%)
Outside the home	25 (2.5%)
Inside and outside the house	302 (42.5%)
Other places	2 (0.3%)

Loos or watery stool/ Diarrhea by the past two weeks	
Yes	166 (23.3%)
Portion size of a child after diarrhea	
Much less	47 (47.5%)
Somewhat less	30 (30.3%)
About the same	14 (14.1%)
Stooped food	8 (8.1%)

4.4 Child Immunization

Among the study participant children 76.4% of them were ever vaccinated appropriate to their age based on the national EPI program. Amide the ever-vaccinated children 74.5% of them were vaccinated Rota virus vaccine.

Table 6: Child Immunization

Characteristics	Frequency (%)
Ever Vaccinated	
Yes	543 (76.4%)
No	168 (23.6%)
Rota virus vaccination	
Yes	530 (74.5%)
No	181 (25.5%)

Ever Vaccinated: A child who is immunized by one or more of vaccines appropriate to their age.

4.5 Household Food Security.

Among the participant households 57.5% of the households were food secured and 42.5% of theme were food in secured households.

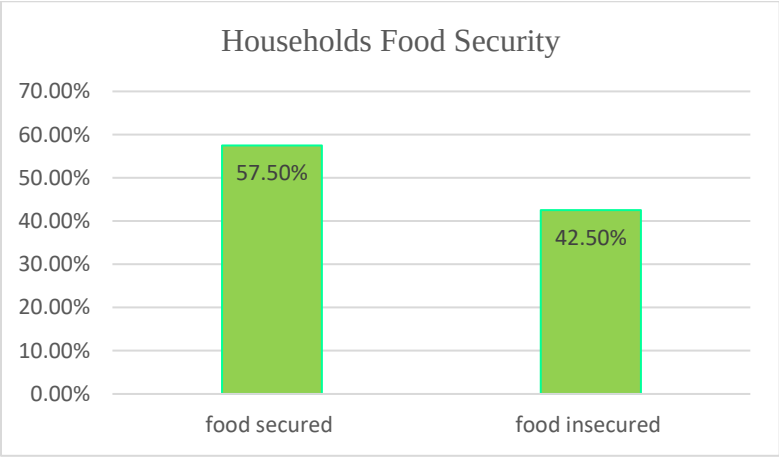


Figure 6: Household Food Security Magnitude

4.6 Dietary Diversity

Data for dietary diversity showed that more than half of children had low dietary diversity (1-2 food groups), 44.3% of children had medium dietary diversity scores (3-4 food groups) and the remaining children were consumed high dietary diversity (More than 4 food groups).

Table 7: Dietary Diversity Score of the Child

Characteristics	Frequency (%)
Low DDS	225 (50.4%)
Medium DDS	286 (44.3%)
High DDS	34 (5.3%)

As indicated in the figure below, 94.7% of study children were most frequently consumed cereals, grains and tubers. Subsequently, dairy products consumed by 52.4% of children. This figure also indicates that flesh and egg food groups were less frequently consumed food groups by children (7.4% and 12.2%) respectively.

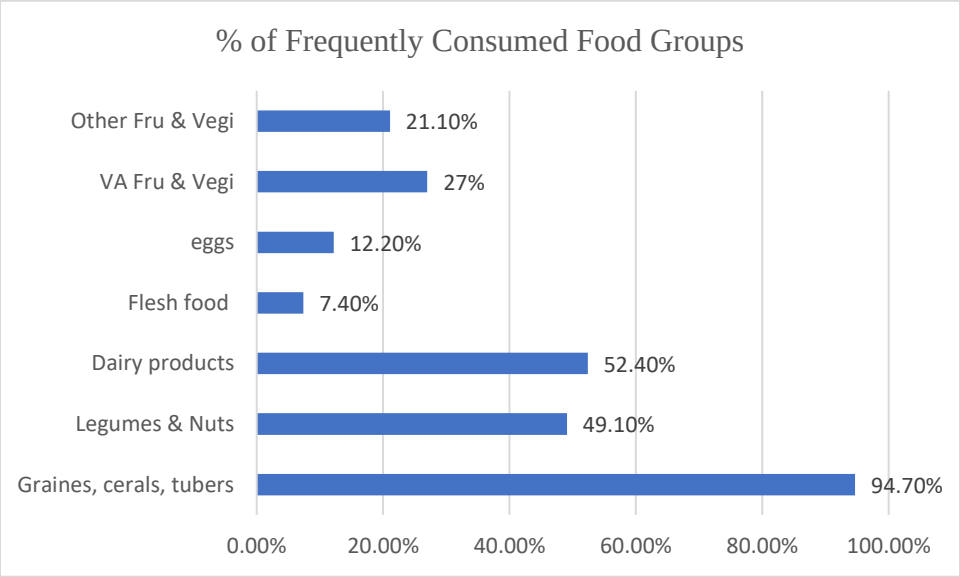


Figure 7: Most Frequently Consumed Food Groups

4.7 Nutritional Status

Anthropometric analysis revealed, prevalence of overall stunting, moderate stunting and sever stunting were 15.9% (95% CI 13.4-18.8), 10.1% (95% CI 8.1-12.6) and 5.8% (95% 4.3-7.7).

Table 8:- Nutritional Status of Children

Anthropometric indices	Category	Frequency (%)
Height for Age (stunting)	Over all stunting (<-2 HAZ Score)	113(15.9%)
	Moderate stunting (-3≤ HAZ Score -2)	72 (10.1%)
	Severe stunting (<-3 HAZ Score)	41 (5.8%)

HAZ: Height for age

Comparing age groups, the highest proportion of stunting was recorded in age group of 12-23 than 6-11 months.

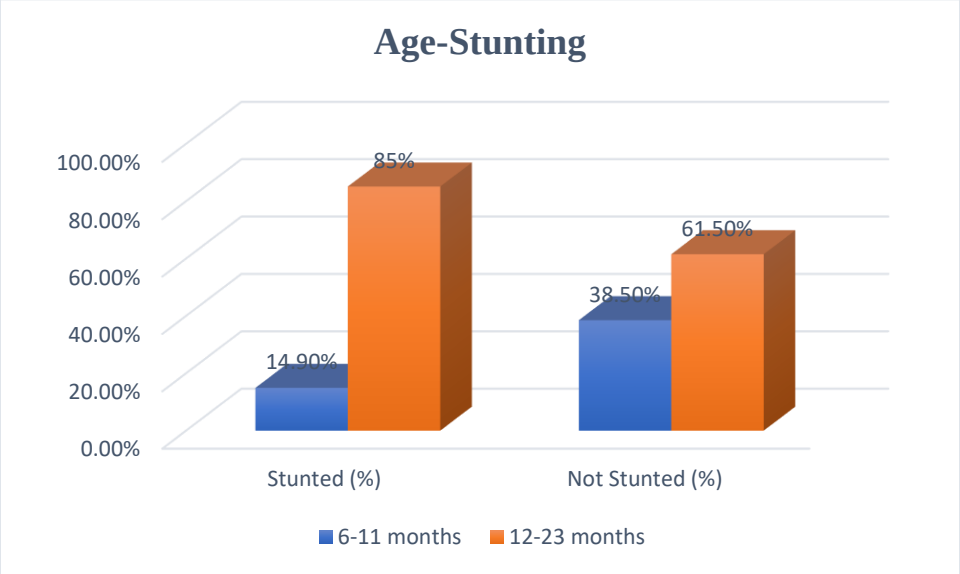
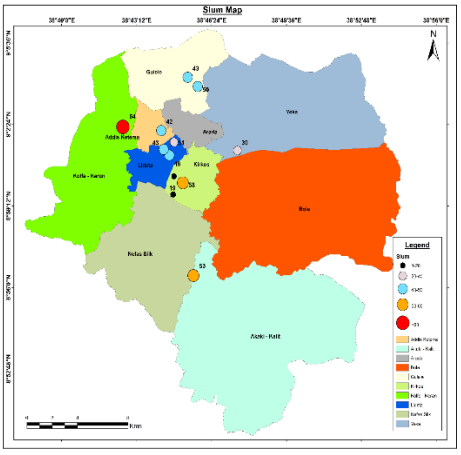


Figure 8: Proportion of Stunting with Age

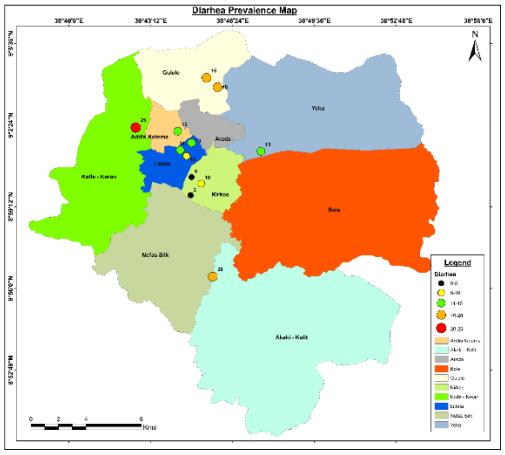
4.8 Spatial Distribution of Diarrhea, Stunting and Slum Household.

The map below indicates that geographical distribution of slum households, diarrhea and stunting cases clustered in the study area. It illustrates kolfe keranio sampling area encompasses the large number of slum households. In the same area the number of diarrheal and stunting cases are high as compared to the other areas.

Slum households cluster



Diarrheal Case cluster



Stunting Case Cluster

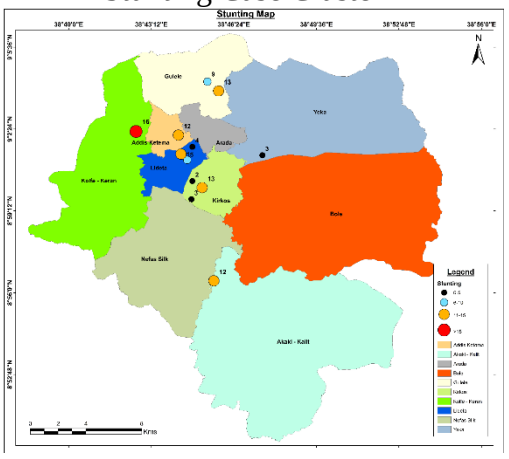


Figure 9: Spatial Distribution of Diarrhea, Stunting and Slum households

4.9 Factors Associated with Diarrhea and Stunting

4.9.1 Factors Associated with Diarrhea

The table below shows factors associated with diarrhea among children aged 0-23 months. Children from households who had pit latrine without slab were 1.5 times more likely to have diarrhea than children from households who don't use pit latrine without slab (AOR= 1.54; 95%CI 1.04-2.28). Children from households who don't treat water at the household level or at the point use were 1.5 times more likely to have diarrhea than children from households who treat water at the point of use (AOR= 1.51 95%CI 1.04-2.19).

Table 9: Factors Associated with Diarrhea

Variables	Categories	Diarrhea		COR (95% CI)	AOR (95% CI)
		Yes (%)	No (%)		
Maternal education level	Primary and below	125 (17.5%)	362 (50.9%)	0.65 (0.44-0.96)	1.38 (0.91-2.09)
	Secondary and above	41 (5.7%)	183 (25.9%)	1	1
Household monthly income	Less than 2000 birr	127 (17.8%)	361 (50.8%)	0.62 (0.44-0.89)	0.71 (0.45-1.09)
	Greater than 2000 birr	39 (5.5%)	184 (25.9%)	1	1
Treating water at household level	Yes	59 (8.4%)	253 (36%)	1	1
	No	105 (14.9%)	286 (40.7%)	1.57 (1.09-2.26)	**1.51 (1.04-2.19) ***
Pit latrine without slab	Yes	46 (6.5%)	198 (27.8%)	1.49 (1.02-2.18)	**1.54 (1.04-2.28) ***
	No	120 (16.9%)	347 (48.8%)	1	1

AOR: Adjusted Odds Ratio; COR: Crude Odds Ratio; CI: Confidence Interval; *Associations are significant at P<0.05

4.9.2 Factors Associated with Stunting

Variables entered in to binary logistic regression analysis shows that, 13-23 months of age children had a three-fold (AOR= 3.63; 95% CI= 2.23-5.93) likelihood of being stunting than children of 6-12 months of children. Children being Male were 1.72 times more likely to be stunted that females of the same age (AOR= 1.72; 95%CI= 1.13-2.64). Children from less educated mother were 1.9 times more likely to be stunted than children from mothers who attended high school and above.

Table 10: Factors Associated with Stunting

Variables	Categories	Stunting		COR (95% CI)	AOR (95% CI)
		Yes (%)	No (%)		
Gender	Female	41 (5.7%)	290 (40.7%)	1	1
	Male	73 (10.2%)	306 (43%)	3.52 (2.17-5.73)	**1.72 (1.13-2.64) ***
Age	6-12 months	23 (3.2%)	281 (39.5%)	1	1
	13-23 months	91 (12.8%)	315 (44.3%)	3.52 (2.17-5.73**)**	**3.63 (2.23-5.93) ***
Maternal level of education	Primary and below	92 (13%)	394 (55.5%)	2.14 (1.31-3.52)	**1.93 (1.14-3.26) ***
	Secondary and above	22 (3%)	202 (28.5%)	1	1
Monthly income	Below 2000 birr	90 (12.6%)	398 (56%)	0.54 (0.33-0.87)	0.67(0.40-1.12)
	Above 2000 birr	24 (3.4%)	198 (28%)	1	1
Food security	Food insecure	59 (8.3%)	243 (34.2%)	1.55 (1.04-2.33)	1.23 (0.82-1.99)
	Food secure	55 (7.75%)	353 (49.7%)	1	1
Amount of water used in a day per household	Less than 20 lit	30 (4.2%)	84 (11.8%)	1.65 (1.04-2.63)	1.44 (0.88-2.35)
	Above 20 lit	106 (14.9%)	490 (69%)	1	1
Slum household	Yes	90 (12.7%)	418 (58.9%)	1.56 (0.99-2.59)	1.43(0.84-2.41)
	No	24 (3.4%)	178 (25%)	1	1

AOR: Adjusted Odds Ratio; COR: Crude Odds Ratio; CI: Confidence Interval; *Association are significant at P<0.05

5. Discussion

The overall aim of this cross-sectional study was to examine the relationship of Addis Ababa slum areas' WASH infrastructure and practice with diarrhea and stunting of children within age range of 6-23months. The finding of this study indicates the prevalence of diarrhea to be 23.3%. The result is consistent with a systematic review and meta-analysis which revealed the prevalence of diarrhea in Addis Ababa is 24% (Alebel et al., 2018). However, this magnitude is relatively higher compared to 12% of diarrhea cases in under five children reported in Ethiopian Demographic Health Survey in 2016 (EDHS, 2016). This inconsistency in result might be due to age range of children. The Ethiopian demography and health survey report showed that the prevalence of diarrhea was 23-25% in age range of 6-23 months children.(EDHS, 2011, 2016; Mohammed & Tamiru, 2014). This age dependent increment of diarrheal prevalence might be due to the introduction of complimentary feeding and other liquids.

The study finding indicates that, children living in the household who had pit latrine without slab/ unimproved sanitation facility significantly contribute to childhood diarrhea. Similarly, studies conducted in rural Ethiopia and other African countries found consistent results(Moon, Choi, Oh, & Kim, 2019; Usman, Gerber, & von Braun, 2019; Yaya et al., 2018). Generally, these findings explain that presence of latrine in the household does not prevent children from having diarrhea unless it is constructed properly in a way to avoid excreta contact with human.

This study showed that, children from households not treating water at the point of use had significant association with childhood diarrhea. A randomized control trial conducted in Dire-Dawa Eastern Ethiopia revealed that incidence of diarrhea was reduced by 36% in the intervention group than the control group (Solomon, Robele, Kloos, & Mengistie, 2020). Similarly, this study finding was consistent with a result from comparative cross-sectional study conducted in Jimma zone, Ethiopia (Soboksa, Hailu, Gari, & Alemu, 2019). A systematic review conducted to assess impact of WASH intervention on childhood diarrhea had shown treating water at point of use decreases the risk of diarrhea by 40% (Darvesh et al., 2017). These discoveries explain that only obtaining drinking water from improved source does not always mean it is safe. It could be contaminated with microbials during carrying, storage and handling in the household.

The present study also aimed to assess the prevalence and impact of WASH and other associated factors for childhood stunting. This study revealed that, overall proportion of stunting was 15.9%. which is consistent with Ethiopian Demographic And Health Survey report in 2016 and 2019 mini demographic and health survey (EDHS, 2016; EMDHS, 2019).

This study also showed that the magnitude of stunting increases with the age of the child. Among the total stunted children, more than 80% occur during 12-23 months of age. This finding agrees with a cross-sectional study conducted in Afar, northeast Ethiopia. Other study conducted in North Waste Ethiopia shown analogous finding (Geberselassie, Abebe, Melsew, Mutuku, & Wassie, 2018; Gebre et al., 2019).This could partly be explained due to provision of inadequate complimentary feeding. Because of the chronic nature of stunting, it could also be due to nutritional status of the mother. The other possible justification would be exposure to recurrent infection from unhygienic preparation of complimentary foods.

Study's result showed that, Male children were 1.7 times more likely to be stunted compared to females of the same age. This finding is comparable with a study done Ayate town, northeast districts of Ethiopia (Gebre et al., 2019; Moges et al., 2020), a study conducted in Tanzania had also shown similar finding (Mbwana, Kinabo, Lambert, & Biesalski, 2017).

Finding of this study revealed that, children from less educated mothers had greater chance of being stunted as compared to children from mothers who attended high school and above. This study had consistent finding with studies conducted in Ethiopia and elsewhere. A cross-sectional study conducted in Bahirdar; northern Ethiopia showed children from mother who had completed higher education had lower odds of childhood stunting (Haile, Azage, Mola, & Rainey, 2016). Similarly, a study conducted in Mekelle city, Northern Ethiopia also confirmed that, children from mothers who lack formal education were 6.2 times more likely to be stunted than mothers who had formal education. (Berhe, Seid, Gebremariam, Berhe, & Etsay, 2019b), similar finding was also observed in Mozambique and Nepal(Dorsey et al., 2018; García Cruz et al., 2017) this could be in part due to poor health care service seeking behavior, being incognizant of nutritious diet to prepare complementary foods for the child, poverty and poor understanding of risky and protective factors for stunting.

6. Conclusion and Recommendation

This study was intended to assess impact of water, sanitation and Hygiene and other associated factors on diarrhea and stunting among children from 6-23 months. The prevalence of diarrhea and stunting was comparable with the national demographic and health survey findings. From these results, we can conclude that, major cases of diarrheal and stunting were found slum areas of Addis Ababa.

Among the WASH indicators, pit latrine without slab and poor water treatment at the point of use were strong predictors for childhood diarrhea. Nevertheless, none of WASH related indicators were a predictor for childhood stunting in the study area These finding helps to conclude WASH indicators must be context relevant. On our study area gender, age and maternal education was strong predictors of childhood stunting. Broadly speaking, poor WASH practice could be a factor for childhood diarrhea but not childhood stunting.

As per the finding we strongly recommend, governmental and nongovernment activities designed to improve child health or curb childhood diarrhea should take water, sanitation and hygiene related activities in to consideration.

According to our result, programs or projects as well government strategies designed to curb childhood stunting must be age and gender specific. In addition to this, it has to be capacity builder for mother or care takers.

Finally, we recommended that further investigation has to be done using context relevant WASH indicators through employing rigorous study designs that can attest causal relationship with outcome variables.

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Annex 1: Participants Information Sheet

Title of the Research: Water, Sanitation and hygiene (WASH) in Addis Ababa Slum and its association with stunting: a longitudinal Study

Name of Principal Investigator: Marekegn Habtamu Tsadiku

Name of Organization: Collage of Natural and Competitional Sciences, Center for Food Science and Nutrition, Community Nutrition Program, Addis Ababa University.

The aim of this study to identify the association between Water, Sanitation and Hygiene practices with Stunting of children aged from 6to 23 months of age.

Your cooperation and willingness to have your child and you to participate in this research study looking at the benefits of WASH on child growth. I assure you that all information that you give like your personal issues, your answer and ideas will be kept confidential and secured. You have full right to refuse from participating in this research (you can choose not to respond to some or all questions). If you are willing to participate, you will be interviewed about your WASH practice in the home, it will take 25-30 min. additionally we will measure the height of your child, It will help us to understand the nutritional status of your child and this measurement will not impose any harm to your child.

If you have any question about the survey and measurement you can ask me to clarify.

Are you willing to participate in the survey? Yes_____ NO_____

If the mothers/caregivers are willing to participate in the survey continue with the questions; if not you can leave them.

Annex 2: Introduction and Consent

Hello, my name is MAREKEGN HABTAMU TSADIKU I am working with Addis Ababa University. We are conducting a study on child growth and water, sanitation and hygiene. We are inviting you to have your child to participate in a study looking at the benefits of water, sanitation and hygiene access on child growth. Although you or your child may not directly benefit from the study, your participation will help us better understand the benefits of improved water, sanitation and hygiene on household and neighborhood level on child growth.

This study has multiple parts and we hope you agree to all of them. The first is a survey will ask questions about your household, people that live in the house, where you go to defecate, your habits around water use, how you feed your child and recent diarrhea that your child had in the last couple days. After the survey, we will measure your child's height and weight.

The survey may include some questions that may make you uncomfortable. You can choose to skip any question at any point during the study. You can take some time to think on whether you want your child to participate or not.

All information collected will also be stored in a secure tablet; only those who are a part of this study will have access to the information. It will be stored at securely at the Addis Ababa University.

If you have any questions, you can ask them at any point during the study visit. Your decision to have your child participate in this study is completely voluntary. If you choose to consent, you can change your mind at any point that you feel uncomfortable and do not want your child to participate any further. There will be no provided incentive for your child to participate in the study.

If you have any questions, you may ask them now or later, even after the study has started. If you have any questions later, you can contact Marekegn Habtamu (+251920194388 hmarekegn@gmail.com)

This proposal has been reviewed by the Addis Ababa University Institutional Review Board, who ensure that research studies are conducted ethically.

Before beginning the interview, I will also ask you to sign this consent form that we keep for our records to show that you have understood what I have told you and are willing to be in this study.

HAVE THE RESPONDENT SIGN CONSENT FORM AND PROVIDE CONTACT INFORMATION

Do you have any question?

May I begin the interview now?

Signature of the interviewer_____ Date_____

Time of interview _____ Hour _____ Min_____

Annex 3: Questionnaire

Date ___/_____/_____

ADDIS ABABA NUTRITION AND WASH SURVEY

HOUSEHOLD QUESTIONNAIRE

Identification

Place Name _____

Household Number _____

Household GPS Coordinates _____

Questionnaire Number _____

Interviewer Visit

	1	2	3	Final Visit	
Date				Day	
Time				Month	
Interviewers Name				Result	
Result*				Total No of visit	
Result Codes 1. Completed 2. No household member at home or No competent respondent at home during visit 3. Entire household absents for extended period 4. Postponed 5. Refused 6. Dwelling destroyed 7. Dwelling not found 8. Other _____ Specify				Total No of persons in the house	
				Total Eligible infants	

Supervisor Name _____

Supervisor Signature _____

D	Demographics	
D 1	How many infants aged between 6 and 23 months old live in this household?	_____ Infants
D 2	Are you the caregiver to any of these infants aged 6 - 23 months?	0 = No
	If the answer is "No" terminate interview and move to next house	1= Yes
D 3	How many male infants aged between 6 and 23 months old live in this household?	_____ Male
D 4	How many female infants aged between 6 and 23 months old live in this household?	_____ Female
If more than one infant is aged 6-23 months, randomly select one of the children, inquire the childs name and conduct the interview about that child. If there is only one infant aged 6-23 months, inquire the childs name and conduct the interview about that child.		
D 5	What is the age of [NAME] in completed months?	_____ Months
D 6	What is the sex of [NAME]?	1 = Female
		2 = Male
D 7	What is the birth order of [NAME]?	1 = First
		2 = Second
		3 = Third
		4 = Fourth
		99 = Other (SPECIFY)
D 8	What is your relationship to [NAME]?	0 = Mother
		1 = Father
		2 = Sibling
		3 = Aunt
		4 = Neighbor
		5 = Maid
		99 = Other (SPECIFY)
D 9	Who is the head of the household?	Father = 1
		Mother = 2
		99 = Other (SPECIFY)
D 10	What is your age in complete years?	_____ Years
D 11	How long have you continuously lived in Addis Ababa?	_____ Years _____ Months
		999 = Don't know
D 12	Are you or a registered resident of the *woreda?*	0 = No
		1 = Yes
D 13	What is your marital status?	1 = Married

		2 = Single
		3 = Widowed
		4 = Divorced
D 14	What is your occupation?	1 = Housewife
		2 = Daily laborer
		3 = Government employee
		4 = Merchant
		5 = Private
		6 = Unemployed
		99 = Other (SPECIFY)
D 15	Have you ever attended school?	0 = No
		1 = Yes
D 16	What is the highest level of education you attended: primary, secondary, vocational/technical or higher?	1 = Primary
		2 = Secondary
		3 = Vocational/technical
		4 = Higher
D 17	Do you read a newspaper at least once a week, less than once a week or not at all?	1 = At least once a week
		2 = Less than once a week
		3 = Not all
D 18	Do you listen to the radio at least once a week, less than once a week or not at all?	1 = At least once a week
		2 = Less than once a week
		3 = Not all
D 19	Do you watch television at least once a week, less than once a week or not at all?	1 = At least once a week
		2 = Less than once a week
		3 = Not all
D 20	Has a community health service provider previously provided information on child health to you?	0 = No
	If answer is 'No' skip to D 27	1 = Yes
D 21	Did they provide information on child stunting?	0 = No
		1 = Yes
D 22	How many people live in this household?	_____ People
D 23	How many of these are adults aged over 18?	_____ Adults

HA	Household Assets	
HA 1	What is the monthly income of this household?	_____ Birr
		999 = Don't know
HA 2	Does any member of this household have a bank account or microfinance savings account?	0 = No
		1 = Yes
		999 = Don't know
HA 3	Who owns this dwelling?	1 = Rented from government
		2 = Private rental
		3 = Owned
		4 = Not rented or owned
		999 = Don't know
HA 4	Does your household have:	0 = No 1 = Yes
	Electricity?	0 1
	A watch/clock?	0 1
	A radio?	0 1
	A television?	0 1
	A mobile phone?	0 1
	A non-mobile phone?	0 1
	A refrigerator?	0 1
	A table?	0 1
	A chair?	0 1
	A bed with cotton/sponge/spring mattress?	0 1
	An electric mitad?	0 1
	A kerosene lamp/pressure lamp?	0 1
HA 5	What type of fuel does this household mainly used for cooking?	1 = Electricity
		2 = LPG
		3 = Natural gas
		4 = Biogas
		5 = Kerosene
		6 = Charcoal
		7 = Wood
		8 = Straw/shrubs/grass
		9 = Agricultural crops
		10 = Animal dung
		11 = No food cooked in household
		99 = Other (SPECIFY)

HA 6	In this household, is cooking usually done in the house, in a separate building, or outdoors?	1 = In the house
		2 = In a separate building
		3 = Outdoors
		99 = Other (SPECIFY)
HA 7	Does this household have a separate room which is used as a kitchen?	0 = No
		1 = Yes
HA 8	MAIN MATERIAL OF THE FLOOR.	**Natural Floor**
	RECORD OBSERVATION	11 = Earth/sand
		12 = Dung
		Rudimentary Floor
		21 = Wood planks
		22 = Palm/bamboo
		Finished Floor
		31 = Wood
		32 = Vinyl or asphalt chips
		33 = Ceramic tiles
		34 = Cement
		35 = Carpet
		99 = Other (SPECIFY)
HA 9	MAIN MATERIAL OF THE ROOF	**Natural Roofing**
	RECORD OBSERVATION	11 = No roof
		12 = Thatch/leaf/mud
		Rudimentary Roofing
		21 = Rustic mat/plastic sheets
		22 = Reed/bamboo
		23 = Wood planks
		24 = Cardboard
		Finished Roofing
		31 = Corrugated iron/metal
		32 = Wood
		33 = Asbestos/cement fiber
		34 = Cement/concrete roof
		35 = Roofing shingles
		99 = Other (SPECIFY)
HA 10	MAIN MATERIAL OF THE EXTERIOR WALLS	**Natural Walls**
	RECORD OBSERVATION	11 = No walls
		12 = Cane/trunks/bamboo/reed
		13 = Dirt

		Rudimentary Walls
		21 = Bamboo/wood with mud
		22 = Stone with mud
		23 = Uncovered adobe
		24 = Plywood
		25 = Cardboard
		26 = Reused wood
		Finished Walls
		31 = Cement
		32 = Stone with lime/cement
		33 = Bricks
		34 = Cement blocks
		35 = Covered adobe
		36 = Wood planks/shingles
		99 = Other (SPECIFY)
HA 11	How many rooms in this household are used for sleeping?	_____ Rooms
HA 12	Does any member of this household own?	0 = No 1 = Yes
	A bicycle?	0 1
	A motorcycle or motor scooter?	0 1
	An animal-drawn cart?	0 1
	A car or truck?	0 1

WS	Water Sources	
WS 1	What is the main source of drinking water for members of your household?	**Piped water**
		11 = Piped into dwelling
		12 = Piped into yard/plot
		13 = Public tap/standpipe
		21 = Borehole
		Dug Well
		31 = Protected well
		32 = Unprotected well
		Water from Spring
		41 = Protected spring
		42 = Unprotected spring
		51 = Rainwater
		61 = Tanker truck
		71 = Cart with small tank
		Surface water
		81 = River/lake/pond/stream/dam
		91 = Bottled water
		99 = Other (SPECIFY)
WS 2	What is the main source of water for members of your household that is used for other purposes (other than drinking water) such as cooking and handwashing?	**Piped water**
		12 = Piped into yard/plot
		13 = Public tap/standpipe
		21 = Borehole
		Dug Well
		31 = Protected well
		32 = Unprotected well
		Water from Spring
		41 = Protected spring
		42 = Unprotected spring
		51 = Rainwater
		61 = Tanker truck
		71 = Cart with small tank
		Surface water
		81 = River/lake/pond/stream/dam
		91 = Bottled water
		99 = Other (SPECIFY)

WS 3	How far is the drinking water source if it is not in house or yard?	_____ meters
	Only ask if answer is to WS 1 is not 11 or 12	999 = Don't know
WS 4	Is drinking water available intermittently?	0 = No
	If answer is 'No' Skip to WS 6	1 = Yes
WS 5	How many hours per day has the water not been available?	_____ Hours
WS 6	In the past week how, many days was there no water available at all?	_____ Days
WS 7	D0 you purchase water when you are unable to get it from your usual source?	0 = No
		1 = Yes

WH	Water Handling	
WH 1	How much water does this household use in a day?	_____ Liters
		999 = Don't know
WH 2	Do you think the water is safe?	0 = No
		1 = Yes
		999 = Don't know
WH 3	Do you think that disease can be transmitted through contaminated water?	0 = No
		1 = Yes
		999 = Don't know
WH 4	Does this household do anything to water to make it safer to drink?	0 = No
	If answer is 'No' skip to WH 6	1 = Yes
		999 = Don't know
WH 5	If yes to WH 4, what did you use to treat the water that you are currently drinking?	A = Boil
		B = Add Bleach/Chlorine/Water Guard/Pur/Bishan Gari/Aqua Tabs
	Anything else?	C = Strain through a clothe
		D = Bio Sand/Composite/Ceramic Pot Filter
	RECORD ALL MENTIONED	E = Solar Disinfection
		F = Let it stand and settle
		X = Other (SPECIFY)
		Z = Don't know
WH 6	Do you store drinking water at home?	0 = No
	If Answer is 'No' skip to WH 21	1 = Yes
WH 7	What type of storage container does this household use for drinking water?	1 = Clay pot
		2 = Jerrycan
		3 = Plastic bucket
		4 = Iron bucket
		99 = Other (SPECIFY)
WH 8	What is the capacity of your household drinking water storage container?	_____ Liters
		999 = Don't know
WH 9	Where is the household drinking water storage container located?	1= On the floor inside the home
		2 = Outside

		3 = Inside the home above the floor (at least 40cm)
		9 = Other (SPECIFY)
WH 10	Is the household drinking water storage container always covered?	0 = No
		1 = Yes
		999 = Don't know
WH 11	Is the household drinking water storage container wide or narrow mouthed?	1 = Wide mouthed
		2 = Narrow mouthed
		999 = Don't know
WH 12	Is the drinking water storage container used for any other purpose?	0 = No
		1 = Yes
		999 = Don't know
WH 13	How often is the household drinking water storage container cleaned?	1 = Once a day
		2 = Twice a day
		3 = Once every 2 days
		4 = Once every 3 days
		5 = Weekly
		99 = Other (SPECIFY)
WH 14	How do you retrieve water from the drinking storage container?	1 = Pouring
	If answer is not 'Utensil/container' skip	2 = Dipping
	to WH 21	3 = Using a utensil/container
		99 = Other (SPECIFY)
		999 = Don't know
WH 15	Does the utensil/container used for water retrieval have a handle?	0 = No
		1 = Yes
		999 = Don't know
WH 16	Where do you put the water retrieval utensil/container?	1 = In a clean place
		2 = On the floor
		9 = Other (SPECIFY)
		999 = Don't know
WH 17	Do you wash your drinking water retrieval utensil/container before dipping?	0 = No
		1 = Yes
		999 = Don't know
WH 18	What do you use to clean your drinking water retrieval utensil/container?	1 = Water
		2 = Soap and water

		99 = Other (SPECIFY)
		999 = Don't know
WH 19	How frequently do you wash your drinking water retrieval utensil/container?	1 = After every use
		2 = Once a day
		3 = Not all
		99= Other (SPECIFY)
		999 = Don't know
WH 20	For how long is the household drinking water usually stored at home?	1 = Less than half a day
		2 = One day
		3 = Two days
		99 = Other (SPECIFY)
		999 = Don't know
WH 21	If this household does not have a piped water, what type of container is used to fetch water?	1 = Clay pot
		2 = Jerrycan
		3 = Plastic bucket
		4 = Iron bucket
		9 = Other (SPECIFY)
		999 = Don't know
WH 22	What is the capacity of your water collection container?	_____ Liters
		999 = Don't know
WH 23	Is the container used to fetch water covered when used to collect water?	0 = No
		1 = Yes
		999 = Don't know
WH 24	How of often the container that is used to fetch water cleaned?	1 = Once a day
		2 = Twice a day
		3 = Once every 2 days
		4 = Once every 3 days
		5 = Weekly
		99 = Other (SPECIFY)
		999 = Don't know
WH 25	Does this household use water from the same source for both drinking, bathing and washing clothes?	0 = No
		1 = Yes

HHS	Household Sanitation	
HHS 1	What kind of toilet facility do members of your household usually use when at home?	**Flush or pour flush toilet**
		11= Flushed to piped sewer system
	ASK TO OBSERVE THE TOILET FACILITY IF POSSIBLE	12= Flush to septic tank
	USE THE OBSERVATIONS TO COMPLETE QUESTIONS	13 = Flush to pit latrine
	HHS 26 - HHS 31	14 = Flush to somewhere else
		15 = Flush, don't know where
		Pit Latrine
		21 = Ventilated improve pit latrine (VIP)
		22 = Pit latrine with slab
		23 = Pit latrine without slab/open pit
		31 = Composting toilet
		41 = Bucket toilet
		51= Hanging toilet/hanging latrine
		61 = No facility/bush/field
		99 = Other (SPECIFY)
HHS 2	Do you share this facility with other households?	0 = No
	If answer is 'No' skip to HHS 4	1 = Yes
HHS 3	How many households use the shared latrine?	_____ Households
HHS 4	Where is this toilet facility located?	1 = Inside the family dwelling
	If answer is 'Inside the family dwelling' skip to HHS 6	2 = On the family yard/plot
		3 = Elsewhere
HHS 5	How far away from the household is the toilet facility?	Facility is _____ m away
		999 = Don't know
HHS 6	Is the toilet facility functioning now?	0 = No
		1 = Yes
HHS 7	How far away is your toilet facility with reference to the closest drinking water source?	Facility is _____ m away
		999 = Don't know
HHS 8	Do you wash your hands with soap after using the toilet facilty?	0 = No
		1 = Yes
		2 = Sometimes
HHS 9	Do you wash your hands without soap after visiting the toilet facility?	0 = No
		1 = Yes

		2 = Sometimes
HHS 10	Do you wash hands with soap before handling food?	0 = No
		1 = Yes
		2 = Sometimes
HHS 11	Do you wash your hands without soap before handling food?	0 = No
		1 = Yes
		2 = Sometimes
HHS 12	Do you wash your hands with soap before eating?	0 = No
		1 = Yes
		2 = Sometimes
HHS 13	Do you wash your hands without soap before eating?	0 = No
		1 = Yes
		2 = Sometimes
HHS 14	Do you wash your hands with soap after cleaning your yard or house?	0 = No
		1 = Yes
		2 = Sometimes
HHS 15	Do you wash your hands with soap after cleaning your yard or house?	0 = No
		1 = Yes
		2 = Sometimes
HHS 16	What kind of toilet facility do members of your household usually use when away from home?	**Flush or pour flush toilet**
	IF "FLUSH" or "POUR FLUSH" PROBE: Where does it flush to?	11= Flushed to piped sewer system
		12= Flush to septic tank
		13 = Flush to pit latrine
		14 = Flush to somewhere else
		15 = Flush, don't know where
		Pit Latrine
		21 = Ventilated improve pit latrine (VIP)
		22 = Pit latrine with slab
		23 = Pit latrine without slab/open pit
		31 = Composting toilet
		41 = Bucket toilet
		51= Hanging toilet/hanging latrine
		61 = No facility/bush/field
		99 = Other (SPECIFY)
HHS 17	Is there a separate area for bathing?	0 = No

	If answer is 'No' Skip to HHS 19	1 = Yes
HHS 18	How is the bathing water disposed?	1 = Flows to a connected sewer
		2 = Flows into an open sewer
		3 = In the latrine
		4 = Disposed off inside the compound
		5 = Disposed off outside the compound
HHS 19	How do you dispose of garbage?	1 = In a pit
		2 = Burning
		3 = Through in an open field
		4 = In a garbage container
		99 = Other (SPECIFY)
HHS 20	Is there a garbage receptacle for the household?	0 = No
		1 = Yes
HHS 21	Is their house-to-house collection of solid waste by Addis Ababa municipality?	0 = No
	If answer is 'No' skip to HHS 23	1 = Yes
HHS 22	What is frequency of waste collection by Addis Ababa municipality?	1 = Once a day
		2 = Once every two days
		3 = Once every three days
		99 = Other (SPECIFY)
HHS 23	PRESENCE OF OPEN SEWER OUTSIDE DWELLING?	0 = No
	RECORD OBSERVATION	1 = Yes
HHS 24	WAS THERE RAW SEWAGE IN THE COMPOUND/DWELLING DURING DATA COLLECTION?	0 = No
	RECORD OBSERVATION	1 = Yes
HHS 25	UNCOLLECTED GARBAGE PRESENT IN THE COMPOUND/DWELLING?	0 = No
	RECORD OBSERVATION	1 = Yes
HHS 26	ARE ANY FECES SEEN AROUND THE PITHOLE OR ON THE FLOOR?	0 = No
	RECORD OBSERVATION	1 = Yes
HHS 27	ARE THERE ANY FLIES AROUND THE TOILET FACILITY	0 = No
	RECORD OBSERVATION?	1 = Yes
HHS 28	ARE IN FECES VISIBLE EITHER IN THE DWELLING OR IN THE COMPOUND?	0 = No
	RECORD OBSERVATION	1 = Yes

HHS 29	DO YOU OBSERVE ANY HAND WASHING FACILITIES NEAR THE TOILET FACILITY?	0 = No
	RECORD OBSERVATION	1 = Yes
HHS 30	IS THERE SOAP AT THE HAND WASHING FACILITY?	0 = No
	RECORD OBSERVATION	1 = Yes
	IF ANSWER IS 'NO' SKIP TO HHS 8	
HHS 31	DOES THE SOAP AT THE HANDWASHING FACILITY LOOK WET?	0 = No
	RECORD OBSERVATION	1 = Yes

CC	Child Care	
CC 1	Was [NAME] ever breastfed?	0 = No
	If answer is 'No' skip to CC 6	1 = Yes
		999 = Don't know
CC 2	How many hours or days after birth was [NAME] breastfed for the first time?	1 = Within 1 hour
		2 = After__ hours
		3 = After __ days
		4 = I do not remember
		99 = Other (SPECIFY)
CC 3	Was colostrum ever fed to [NAME]?	0 = No
		1 = Yes
		999 = Don't know
CC 4	At what age did you or anyone else give [NAME] something apart from breast milk (including water, herbal infusions or any other kinds of foods)?	_____ Months
		999 = Don't know
CC 5	What is the current breast-feeding status of [MAME]?	1 = Exclusive breast feeding
	If answer is 'Exclusive breast feeding' skip to CC 9	2 = Partial breast feeding
		3 = Not breast feeding
CC 6	Who usually feeds [NAME]?	1 = Mother
		2 = Father
		3 = Siblings
		99 = Other (SPECIFY)
CC 7	What was the first food preparation given to [NAME]?	1 = Injera
		2 = Bread
		3 = Porridge
		4 = Gruel
		99 = Other (SPECIFY)
		999 = Don't know
CC 8	Has the [NAME] started to eat family food?	0 = No
		1 = Yes
CC 9	Where did the [NAME] spend days in the previous 2 weeks?	1 = Inside the home
		2 = Outside the home
		3 = Inside and outside the home
		99 = Other (SPECIFY)
CC 10	Has [NAME] had diarrhea in the last 2 weeks?	0 = No
		1 = yes
		999 = Don't know

CC 11	Has [NAME] had loose or watery stool in the last 2 weeks?	0 = No
		1 = yes
		999 = Don't know
CC 12	In the last 2 weeks, how many times has [NAME] had loose or watery stools?	_____Times
CC 13	When [NAME] had diarrhea, was [NAME] name given less than usual to eat, about the same amount, more than usual, or nothing to eat?	1 = Much less
		2 = Somewhat less
		3 = About the same
		4 = More
		5 = Stopped food
		6 = Never gave food
		999 = Don't know
CC 14	Did you seek advice or treatment for the diarrhea from any source?	0 = No
		1 = Yes

CI	Child Immunization			
CI 1	Do you have a card where [NAME] vaccinations are written down?	1 = Yes, seen		
	If YES: May I see it please?	2 = Yes, not seen		
	If '1' Skip to CI 3	3 = No card		
	If '2' Skip to CI 6			
	If '3' Skip to CI 6			
CI 2	Did you ever have a vaccination card for [NAME]?	0 = No		
		1 = Yes		
CI 3	**Copy date from the Card for each vaccine**			
	Write '44' in Day if card shows that a dose was given but no date is recorded			
		DAY	**MONTH**	**YEAR**
	BCG			
	Polio 0 (Polio given at birth)			
	Polio 1			
	Polio 2			
	Polio 3			
	DPT 1			
	DPT 2			
	DPT 3			
	DPT-HepB-Hb 1			
	DPT-HepB-Hb 2			
	DPT-HepB-Hb 3			
	Rota 1			
	Rota 2			
	Measles			
	Vitamin A (Most Recent)			
CI 4	BCG to Vitamin A all recorded?	0 = No		
	RECORD OBSERVATION	1 = Yes		
CI 5	Has [NAME] received any vaccinations that are not recorded on this card, including vaccinations given in a nation's immunization campaign?	0 = No		
		1 = Yes		
	RECORD 'YES' ONLY IF THE RESPONDENT MENTIONS AT LEAST ONE OF THE VACCINATIONS IN THE CI 3 THAT ARE NOT RECORDED AS HAVING BEEN GIVEN	999 = Don't know		
	WRITE 66 IN THE CORRESPONDING 'DAY' COLUMN			

CI 6	Did [NAME] have any vaccinations to prevent him/her from getting diseases, including vaccinations received in a national immunization campaign?	0 = No		
	RECORD 'YES' ONLY IF THE RESPONDENT MENTIONS AT LEAST ONE OF THE VACCINATIONS IN THE CI 3 THAT ARE NOT RECORDED AS HAVING BEEN GIVEN	1 = Yes		
	WRITE 77 IN THE CORRESPONDING 'DAY' COLUMN	999 = Don’t know		

CWD	Child Waste Disposal	
CWD 1	Does [NAME] use diapers?	0 = No
		1 = Yes
CWD 2	The last time [NAME] passed stools, what was done to dispose of the stools?	1 =Child Used Toilet/Latrine
		2= Put/rinsed into toilet or latrine
		3 = Put/rinsed into drain or ditch
		4 = Thrown into garbage
		5 = Buried
		6 = Left in the open
		99 = Other (SPECIFY)
		999 = Don't know
CWD 3	Is there a specific location where [NAME] is cleaned and changed?	0 = No
	If answer is 'No' skip to CWD 5	1 = Yes (LIST LOCATIONS)
		999 = Don't Know
CWD 4	Is the surface of the changing station cleaned after each time [NAME] is changed?	0 = No
		1 = Yes
		999 = Don't know
CWD 5	What is the relation of the person who most frequently cleans and changes [NAME]?	1 = Mother
		2 = Sister
		3 = Grandmother
		4 = Aunt
		5 = Brother
		6 = Father
		99 = Other (SPECIFY)
CWD 6	Do you wash your hands with soap after cleaning and changing [NAME]?	0 = No
		1 = Yes
		2 = Sometimes
CWD 7	Do you wash your hands without soap after cleaning and changing [NAME]?	0 = No
		1 = Yes
		2 = Sometimes
CWD 8	The last time your oldest child between 2 and 5 years old passed stools, what was done to dispose of the stools?	1 =Child Used Toilet/Latrine

	ONLY ASK IF THE INDEX CHILD ISN'T THE OLDEST CHILD IN THE HOUSE HOLD	2= Put/rinsed into toilet or latrine
		3 = Put/rinsed into drain or ditch
		4 = Thrown into garbage
		5 = Buried
		6 = Left in the open
		99 = Other (SPECIFY)
		999 = Don’t know

FS	Food Security	
FS 1	In the past 30 days did you worry that your household would not have enough food?	0 = No
		1 = Yes
	If answer is 'No' skip to FS 3	
FS 2	How often did this happen?	1 = Rarely (1-2 times)
		2 = Sometimes (3-10 times)
		3 = Often (more than 10 times)
FS 3	In the past 30 days were you or any household members not able to eat the kinds of foods you preferred because of a lack of resources?	0 = No
		1 = Yes
	If answer is 'No' skip to FS 5	
FS 4	How often did this happen?	1= Rarely (1-2 times)
		2 = Sometimes (3-10 times)
		3 = Often (more than 10 times)
FS 5	In the past 30 days did you or any household member eat just a few kinds of food day after day because of a lack of resources?	0 = No
		1 = Yes
	If answer is 'No' skip to FS 7	
FS 6	How often did this happen?	1 = Rarely (1-2 times)
		2 = Sometimes (3-10 times)
		3 = Often (more than 10 times)
FS 7	In the past 30 days did you or any household member eat food that you did not want to eat because of a lack of resources to obtain other types of food?	No = 0
		Yes = 1
	If answer is 'No' skip to FS 9	
FS 8	How often did this happen?	1 = Rarely (1-2 times)
		2 = Sometimes (3-10 times)
		3 = Often (more than 10 times)
FS 9	In the past 30 days did you or any household member eat a smaller meal than you felt you needed because there was not enough food?	No = 0
		Yes = 1
	If answer is 'No' skip to Next Section	
FS 10	How often did this happen?	1 = Rarely (1-2 times)
		2 = Sometimes (3-10 times)
		3 = Often (more than 10 times)

DD	Dietary Diversity			
	Now I would like you to tell me what [NAME] had to eat or drink after [NAME] woke up yesterday morning. Did [NAME] eat that food at home? What did [NAME] have next and at what time?" *[Proceed through the day, repeating these questions as necessary, and record each food or drink (including drinking water) consumed in column 3 of the 24-hour recall form. Remember to probe for any snacks and drinks consumed between meals]*			
	Time	**Place eaten**	**Food/drink**	**Description of ingredients**
	Interview Day of the Week		Mon Tue Wed Thu Fri Sat Sun	
DD 1	Was [NAME] sick during the last two days?			0 = No
	If answer is 'No' Skip to DD 4			1 = Yes
				999 = Don't know
DD 2	Did the sickness affect [NAME's] appetite?			0 = No
	If 'No' Skip to DD 4			1 = Yes
				999 = Don't know
DD 3	Did the sickness increase or decrease [NAME's] appetite?			0 = Increase
				1 = Decrease
DD 4	Was [NAME's] food intake yesterday unusual?			0 = No
				1 = Yes
				999 = Don't know
DD 5	Was yesterday a feast day?			0 = No
				1 = Yes
DD 6	Was yesterday a market day?			0 = No
				1 = Yes
DD7	Do you give [NAME] any of the following tablets?			0 = Iron
				1 = Vitamins
				2 = Other supplements (SPECIFY)
				3 = Anti-malarial

ANT	**Anthropometry**	
ANT 1	What is [NAME] birth date	_____ Day
		_____ Month
		_____ Year
ANT 2		0 = No
		1 = Yes
ANT 3	Weight	Weigh 1 _____ kg Weigh2 _____kg
		9 = Not present
		99 = Refused
		999 = Other
CHILD HEIGHT MEASUREMENTS SHOULD ONLY BE TAKEN WITH THE CHILD LYING DOWN ON ITS BACK		
ANT 4	Height	Height 1_____cm Height 2 _____
		9 = Not present
		99 = Refused
		999 = Other

Is there anything that did I did not ask and you think I should know?

If yes, please tell me know

Is there anything you would like to ask me about the topics we discussed today?

If yes, please tell me know

Thank you very much for your participation

Annex 4: Ethical Clearance

COLLEGE OF NATURAL & COMPUTATIONAL SCIENCES
Addis Ababa University
OFFICE OF THE DEAN
የዲን ጽ/ቤት

የተፈጥሮና ኮምፒቴሽናል ሣይንስ ኮሌጅ
አዲስ አበባ ዩኒቨርሲቲ

Ref. No. ቁጥር: CNSDO/300/12/2020
Date: ቀን: January 23, 2020

To Whom It May Concern

The College of Natural & Computational Sciences Institutional Review Board (**CNS-IRB**) Committee in its meeting held on 20/12/2019 Minute No. IRB/42/2019 has examined the project proposal entitled **"Water, Sanitation and Hygiene in Addis Ababa Slum and its Association with Stunting: A Longitudinal Study'' by Marakegn Habtamu,** from the Addis Ababa University.

The proposal is approved for implementation.

With regards,

Addisalem Adathun, PhD
Dean, College of Natural & Computational Sciences

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Annex 5: Plagiarism Summary

URKUND

Document Information

Analyzed document	Research Thesis for MSc (Final).pdf (D94891697)
Submitted	2/8/2021 7:22:00 AM
Submitted by	
Submitter email	kaleab.baye@aau.edu.et
Similarity	13%
Analysis address	kaleab.baye.aauni@analysis.urkund.com

Sources included in the report

SA	**University of Addis Ababa / Takele Final Draft.docx** Document Takele Final Draft.docx (D83986922) Submitted by: tariku.dejene@aau.edu.et Receiver: tariku.dejene.aauni@analysis.urkund.com	4
SA	**Misganaw Thesis 2016-2017.pdf** Document Misganaw Thesis 2016-2017.pdf (D30136716)	2
SA	**University of Addis Ababa / PhD- WaHe- SWM-Negasa Eshete - 7 Nov 2020.pdf** Document PhD- WaHe- SWM-Negasa Eshete - 7 Nov 2020.pdf (D84196497) Submitted by: azage.gyohannes@aau.edu.et Receiver: azage.gyohannes.aauni@analysis.urkund.com	16
W	URL: https://www.researchgate.net/publication/342292812_Unimproved_water_sanitation_and ... Fetched: 1/27/2021 11:54:35 PM	2
W	URL: https://bmcpediatr.biomedcentral.com/articles/10.1186/s12887-019-1595-3 Fetched: 11/7/2019 9:04:42 AM	2
W	URL: https://www.researchgate.net/publication/272402323_Household_Sanitation_and_Person ... Fetched: 1/10/2021 3:40:58 PM	1
SA	**0501.pdf** Document 0501.pdf (D43614747)	3
SA	**4523-MD Thesis- Arshiya Moin (GJ7866)-Community Medicine-AMU.docx** Document 4523-MD Thesis- Arshiya Moin (GJ7866)-Community Medicine-AMU.docx (D61767114)	2
W	URL: https://pubmed.ncbi.nlm.nih.gov/20842167/ Fetched: 2/8/2021 7:23:00 AM	2
W	URL: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-019-7325-9 Fetched: 11/8/2019 6:09:11 PM	2
W	URL: https://journals.plos.org/plosone/article%253Fid%253D10.1371/journal.pone.0217736 Fetched: 2/8/2021 7:23:00 AM	3
	URL: https://link.springer.com/article/10.1186/s13052-018-0457-1	

1/54