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Nafissa Johnson Date

Household Water, Sanitation and Hygiene (WASH) Conditions and Newborn Care Practices in the Amhara Region of Ethiopia: A Descriptive Study

By

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Masters of Public Health

Global Health

_____

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Committee Chair

Household Water, Sanitation and Hygiene (WASH) Conditions and Newborn Care Practices in the Amhara Region of Ethiopia: A Descriptive Study

By

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Bachelor of Science
Spelman College
2018

Thesis Committee Chair: Christine L. Moe, PhD

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Rollins School of Public Health of Emory University
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Abstract

Household Water, Sanitation and Hygiene (WASH) Conditions and Newborn Care Practices in the Amhara Region of Ethiopia: A Descriptive Study

By Nafissa Johnson

Background: Access to a safely managed water supply and improved sanitation facilities in households is essential to ensure health. Within sub-Saharan Africa, Ethiopia has the lowest coverage of improved water and sanitation services. Household WASH conditions are likely to impact newborn care practices and survival. There is a need to understand WASH conditions for newborns in urban and rural households and the impact on health outcomes. Understanding WASH conditions and behaviors could support the development of evidence-based WASH and newborn care interventions in Amhara, Ethiopia.

Methods: This study of a cohort of 586 newborns examined the results of a baseline survey, a household WASH survey conducted 7 days post-discharge, and lab-confirmed neonatal sepsis diagnosis. Descriptive statistics were conducted to summarize data. Univariate logistic regression was used to examine factors associated with any neonatal sepsis, early- and late-onset sepsis. Logistic regression was used to investigate factors associated with improved sanitation facility ownership and improved drinking water source access.

Results: 86.6% of respondents reported having access to a sanitation facility in their household. However, most respondents had access to an unimproved pit latrine (78.9%). Handwashing facilities were absent in 42.4% of households. 64.1% of urban households reported having access to a safely managed drinking water source, while 9.3% of rural households had access to a limited/basic drinking water source. Increased odds of any sepsis diagnosis (early- or late-onset sepsis) were associated with not washing hands before breastfeeding, household water storage method and cleaning frequency, and not washing the newborn. Covariates such as water storage cleaning frequency, water treatment frequency, age at first bath, bathing frequency, diaper type, material used to dry cord, and cord care counseling were associated with one or more sepsis outcome variables.

Conclusion: Our results indicated that respondents generally incorporated safe WASH and newborn care practices into their household routine. However, there is a need to strengthen good newborn care practices after leaving the health facility. Given the low access to improved toilet and hand hygiene facilities, it is essential to focus on improving household sanitation and hygiene infrastructure in Amhara communities.

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Chapter 1: Introduction

Access to a safely-managed water supply and improved sanitation facilities in households is essential to ensure health. UNICEF reports that 60-80% of communicable diseases in Ethiopia are attributable to inadequate sanitation facilities and limited access to a safely-managed drinking water supply (United Nations International Children's Education Fund, n.d). Common preventable communicable diseases that are associated with poor water, sanitation and hygiene (WASH) are diarrheal diseases, cholera, and typhoid fever. The World Health Organization reports that improving drinking water and sanitation service levels through regulation of piped water systems, sewage system connections, and wastewater treatment can reduce diseases associated with poor WASH (The World Health Organization, n.d).

The United Nations Sustainable Development Goal (SDG) 6 aims to reduce inequalities related to WASH services among member nations. Together, the targets for goal 6 are to ensure that all individuals have universal and equitable access to a safe and affordable drinking water supply and to ensure the availability of sustainable sanitation and hygiene services (World Health Organization and UNICEF, 2015). Within sub-Saharan Africa, Ethiopia has the lowest coverage of improved water and sanitation services (World Health Organization and UNICEF, 2015). During the United Nations Millennium Development Goal era (1990-2015), Ethiopia achieved the MDG target 7c in 2015 by increasing access to clean and safe drinking water supplies to its citizens. At the end of 2015, improved drinking water access increased to 57%, but access to improved sanitation only increased to 28% (WaterAid, n.d; World Health Organization, 2015a). Although Ethiopia has made strides in improving access to safe drinking water supplies, there are issues surrounding equitable access across urban and rural households. In the 2016 Ethiopia Demographic and Health Survey (EDHS), 97% of urban households had access to an

improved water source compared to 57% of rural households (Central Statistical Agency - CSA/Ethiopia & ICF, 2017). In addition to drinking water, improved toilet ownership in households was found to be low (6%), according to the 2016 EDHS. Among urban households, 16% of households had access to an improved toilet facility compared to 4% of rural households(Central Statistical Agency - CSA/Ethiopia & ICF, 2017).

In 2017, the U.S. Agency for International Development (USAID) reported that 63% of households had unimproved sanitation and hygiene in Ethiopia (United States Agency for International Development (USAID), 2020). In terms of handwashing, in 2017, only 23% of households have access to safely managed handwashing facility (United States Agency for International Development (USAID), 2020). Similar to the rural-urban disparity observed for safe water access, the 2016 EDHS found that access to essential cleaning agents, such as soap and water, was higher for urban households (28%) compared to rural households (7%) (Central Statistical Agency - CSA/Ethiopia & ICF, 2017). Regional data from the survey demonstrated that soap and water availability was the lowest in Amhara at 5% of households (4).

Household WASH conditions are likely to impact newborn care practices and survival. Bazzano, Oberhelman, Potts, Gordon, & Var state “environmental conditions and water, sanitation, and hygiene practices may contribute to the risk of infection in the first weeks of life” (Bazzano, Oberhelman, Potts, Gordon, & Var, 2015). According to Tolasssa et al., the neonatal mortality rate (NMR) is indicator of quality of newborn care. Ethiopia is one of the top five countries that contributes to neonatal mortality worldwide(Tolossa et al., 2020). The National Child Strategy for Newborn and Child Survival (2016-2020) helped to reduce child mortality, but rates are still high, and 18% of neonatal deaths are attributable to sepsis and tetanus(Tekelab et al., 2019; Tolossa et al., 2020). Settings in which neonatal infections may occur include health

care facilities and the households in which the newborn resides. UNICEF reports that within Ethiopia only 17% of people practice improved hygiene behaviors and live in a healthy environment(United Nations International Children's Education Fund, n.d). Reducing neonatal infections and mortality in Ethiopia relies in part on better understanding of current hygiene and sanitation practices in the households of newborns in order to promote effective approaches for improving WASH access, knowledge, attitudes, and practices related to newborn care.

Significance of Study

There are studies that have evaluated the association between household residence (urban and rural) and newborn care practices. In Southern Ethiopia, Chichiabellu et al. found that good essential newborn care practices were 2 times higher in urban areas compared to rural areas(Chichiabellu, Mekonnen, Astawesegn, Demissie, & Anjulo, 2018). However, within the Amhara region, where there is considerable newborn morbidity and mortality, there are no studies evaluating household WASH infrastructure and practices in the environment of newborns diagnosed with sepsis. Moreover, to date, there are limited studies investigating the impact of rural versus urban conditions on access to improved WASH infrastructure, WASH practices, and association with newborn health outcomes. There is a need to understand WASH conditions for newborns in urban and rural households and the impact on health outcomes. Understanding WASH conditions and behaviors could support the development of evidence-based WASH and newborn care interventions in Amhara. The purpose of this study is to: 1) characterize household WASH conditions and practices; 2) identify demographic and socio-economic determinants of safe and unsafe household WASH conditions and practices; and 3) examine if there are associations between household WASH conditions and practices and newborn care practices and health outcomes among a cohort of newborns who were recruited at birth at Felege Hiwot

Hospital in Bahir Dar City and Debre Tabor General Hospital in Debre Tabor in the Amhara Region of Ethiopia from August 2018 through June 2019. This study examines the results of a baseline survey at the time of recruitment that includes basic demographic and socioeconomic information, a household WASH survey conducted around 7 days post-discharge, and health outcome data based on lab analyses of blood samples from newborns suspected to have sepsis.

Chapter 2: Review of the Literature

Introduction

Sub-Saharan Africa has the lowest rates of access to sources of improved drinking water that can deliver safe and clean water by its construction, and sanitation globally (JMP, n.d; Roche, Bain, & Cumming, 2017). The urbanization of sub-Saharan African countries is defining the impact of adequate WASH provision and practices in households (Mackinnon, 2019). The promotion of safe drinking water sources, handwashing with soap at critical times, and access to safe sanitation facilities can help to reduce diseases related to poor sanitation and the transmission of enteric pathogens. In 2012, Pruss et al., estimated the number of deaths attributable to inadequate water, sanitation, and hygiene in low- and middle-income countries. In Ethiopia, for children under 5 the average number of deaths attributable to unsafe water was 17,019, unsafe sanitation was 9,367, and deaths related to unsafe hygiene was 11,186 in 2012 (Prüss-Ustün et al., 2014). In a 2020 case projection for sub-Saharan Africa countries, Ethiopia is estimated to have approximately 2 deaths per 1,000 annually that are attributable to poor WASH (Fuente, Allaire, Jeuland, & Whittington, 2020). According to Gizaw and Addisu, sustainable WASH practices have the potential to prevent at least 9.1% of the global disease burden and 6.3% of deaths, which can impact the household environment (Z. Gizaw & Addisu, 2020). In Ethiopia, 60 to 80% of communicable diseases are attributable to limited access to safe drinking water and inadequate hygiene and sanitation services(Soboksa, Gari, Hailu, & Alemu, 2020). According to the World Health Organization (WHO) and UNICEF, 28% of child deaths are attributable to poor sanitation and water(World Health Organization and UNICEF, 2015).

Increasing sanitation coverage and promotion of safe hand hygiene and water treatment are key to reduce WASH mortality among adults and children.

Current Status of WASH

Water and Sanitation Access in Sub-Saharan Africa

Sub-Saharan Africa has the lowest regional improved sanitation coverage. The goal of target 7.C of the Millennium Development Goal (MDG) was to halve the proportion of the population without access to a safe and sustainable drinking water source and basic sanitation. At the end of the Millennium Development Goal Plan, Sub-Saharan Africa did not reach the target. In 1990, 48% of the population in Sub-Saharan used an improved drinking water source, and by 2015, 68% of the population used an improved drinking water source(Economic & Affairs, 2016). In 1990, 24% of the population in Sub-Saharan African used in improved sanitation facility, and by the end of the MDG plan, 30% of the population used an improved sanitation facility.

After the MDG plan, the Sustainable Development Goals were created to improve the health and livelihoods of individuals all across the world and provide sustainable solutions. Targets 6.1 and 6.2 of the Sustainable Development Goals aimed to provide equitable access to safe and affordable drinking water and to adequate sanitation and hygiene for all by 2030 (World Health Organization and UNICEF, 2015). The SDG targets provided more stringent definitions of improved water and sanitation and addressed some of the limitations of the 2015 Millennium Development Goal Plan(1). The Joint Monitoring Programme (JMP) defines “improved drinking water sources” as those with the potential to deliver safe water, these sources include piped water, boreholes or tube wells, protected dug wells, and protected springs, rainwater, and packaged or delivered water(United Nations Children’s Fund and World Health Organization,

2020). Figure 1 depicts the JMP Drinking Water ladder, from safely managed sources (best) to untreated surface water (worst).

In comparison to other Sub-Saharan Africa countries, Ethiopia has the lowest improved water supply (42%) and sanitation coverage (28%) (Gebremichael et al., 2020). Gebremichael, Yismaw, Dejen, and Dires reported that Ethiopia has the poorest sanitation and drinking water infrastructure in Sub-Saharan Africa(Gebremichael, Yismaw, Dejen, & Dires, 2020), and there are stark differences between urban vs. rural population access to improved drinking water and basic sanitation services.

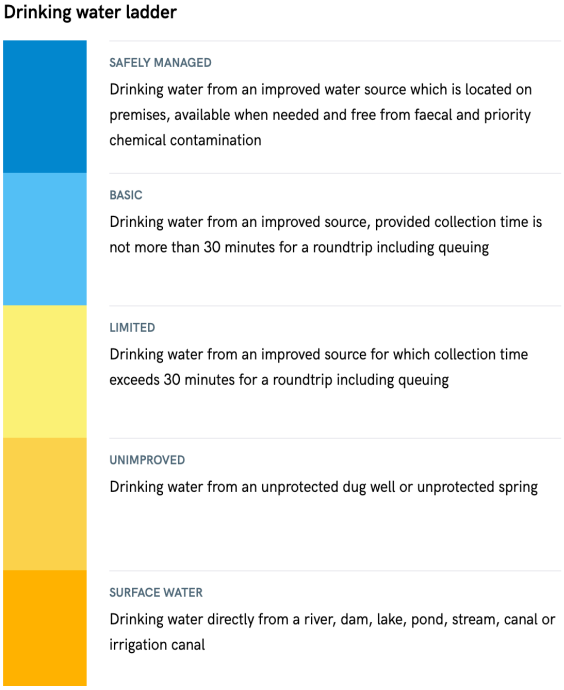


Figure 1
Note: JMP Drinking Water Ladder. Adapted from Joint Monitoring Programme for Water Supply and Sanitation. (2017). Drinking Water. Retrieved February 19, 2021, from https://washdata.org/monitoring/drinking-water

Drinking Water Infrastructure in Ethiopia

Coverage of improved water sources in the Amhara Region is 62%, which is the lowest in comparison to other regions in Ethiopia(Central Statistical Agency - CSA/Ethiopia, 2017). The three most common drinking water sources in urban households reported by the Ethiopian Demographic Health Survey (EDHS) in 2016, are water piped into the household's dwelling, yard or plot (63%), water piped into a public tap/ standpipe (13%); and water piped to a neighbor (12%)(Central Statistical Agency - CSA/Ethiopia & ICF, 2017). The majority of households in the Amhara Region, access drinking water through a tube well or borehole(Central Statistical Agency - CSA/Ethiopia, 2017). The percentage of households who access drinking water from a protected

spring or have piped water into a dwelling is 16.9% and 12.4%, respectively (Central Statistical Agency - CSA/Ethiopia, 2017). In 2016 EDHS reported that 97% of urban households have access to an improved source of drinking water in comparison to 57% of rural households (Central Statistical Agency - CSA/Ethiopia, 2017).

Water piped directly on premises is generally recognized to be a low-risk water source for urban households. However, despite its greater safety, there can still be risks. Piped water interruptions are a common occurrence in Ethiopia and may not be a reliable source for households to obtain water. Factors that contribute to piped water interruptions are well documented in the Addis Abba region and include surface water scarcity for water treatment plants during dry and short rainy seasons, and an old, poorly maintained, water distribution system(Adane, Mengistie, Medhin, Kloos, & Mulat, 2017). Due to the sporadic piped water services, households use water storage tanks to ensure water is available when needed.

Urban and Rural Household WASH Characteristics in Ethiopia

Drinking Water Sources, Storage, and Household Treatment

Within urban and rural households of Ethiopia, 3% and 43%, respectively, use an unimproved water source for drinking (Central Statistical Agency - CSA/Ethiopia & ICF, 2017). According to the JMP drinking water ladder (Figure 1), examples of unimproved drinking water sources include an unprotected dug well and unprotected spring (United Nations Children's Fund and World Health Organization, 2020).The purpose of water treatment is to reduce the risk of microbial contamination at either the source or during the domestic handling and storage process. Chalchisa, Megersa, and Beyene reported that water storage does impact water quality, and the quality of water can deteriorate after long storage due to introduction of contamination and to

regrowth of bacteria (Chalchisa, Megersa, & Beyene, 2017). In a study by Brick et al., water stored for 1-9 days showed a 67% increase in coliforms as storage time increased(Brick et al., 2004). According to WHO guidelines, safe drinking water should not have coliform bacteria detectable in 100 ml samples of water, and water turbidity values should be below 5 NTU (World Health Organization, 2017). The Drinking Water Quality Survey in Ethiopia showed that 53% of water samples collected from households in the Amhara region had turbidity levels above 5 NTU (Central Statistical Agency - CSA/Ethiopia, 2017). Reducing the time in which water sits in a storage container and using household water treatments methods can help to reduce microbial contamination, and infections and illness attributable to unsafe water quality.

The percentage of Ethiopian households reporting appropriate water treatment methods has fluctuated from 2005, 2011, and 2016 (3.0%, 8.2%, and 6.5%) (Geremew et al., 2018). Point-of-use water treatment methods in Ethiopia include filtration, boiling, straining water through a cloth, using bleach/chlorine, solar disinfection, and letting it stand and settle (Central Statistical Agency - CSA/Ethiopia & ICF, 2017; Geremew et al., 2018). In a study conducted by Geremew et al., researchers observed that socio-demographic and economic characteristics of households were associated with point-of-use water treatment methods in households(Geremew et al., 2018). Households that reported treating their drinking water in the Ethiopian Drinking Water Quality Survey, showed a decrease in *E. coli* detection (19%) in comparison to households who did not treat their water (9.7%) (Central Statistical Agency - CSA/Ethiopia, 2017). Geremew et al. found that the use of appropriate water treatment methods was associated with type of residence (urban vs. rural) and household head and educational status (Geremew et al., 2018). It is necessary to promote awareness of safe water handling practices in households in not only urban communities, but also within rural communities where water treatment is infrequent.

Sanitation Coverage

In sub-Saharan Africa, the number of individuals who practice open defecation increased from 204 million in 2000 to 220 million by 2015 (Leshargie et al., 2018). Latrine utilization is a major factor that can help to reduce the transmission of enteric diseases in developing countries, such as Ethiopia. A meta-analysis conducted by Leshargie et al. found that pooled prevalence of latrine utilization in the Amhara region of Ethiopia was 50.1% when reviewing published studies 1999-2017 (Leshargie et al., 2018). In Figure 2, the JMP defines various levels of sanitation and provide examples that range from safely-managed facilities (best) to open defecation (worst). The JMP defines an improved sanitation facility as one that is safely managed and separates human excreta from human contact(Joint Monitoring Program for Water Supply). Examples of improved sanitation facilities are: a flush or pour-flush toilet that is connected to a piped sewer system or septic tank, a ventilated pit latrine with slab, and a composting toilet.

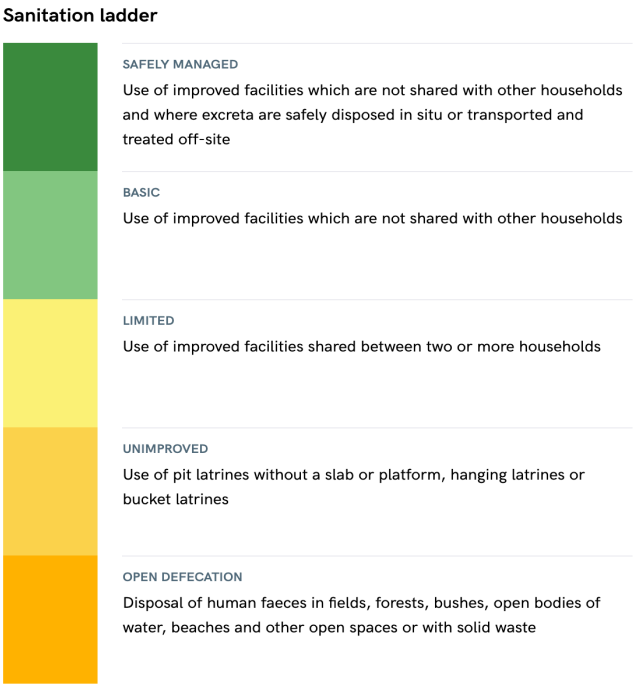


Figure 2.
Note. Adapted from JMP Sanitation Ladder Joint Monitoring Programme for Water Supply and Sanitation. (2017). Sanitation. Retrieved February 19, 2021, from https://washdata.org/monitoring/sanitation

An unimproved sanitation facility is a pit latrine without a slab or platform or a hanging/ bucket latrine. In 2016, EDHS reported that in urban areas of Ethiopia, 16% of households had access to an improved sanitation facility while 4% of rural households had such facility (Central Statistical Agency - CSA/Ethiopia & ICF, 2017). Most respondents living in urban households from EDHS reported to have access to a flush/pour flush into a septic tank (2.8%)(Central

Statistical Agency - CSA/Ethiopia & ICF, 2017). In contrast, respondents from rural households reported to have access to pit latrine with a slab (2.3%) (Central Statistical Agency - CSA/Ethiopia & ICF, 2017). In terms of shared facility 35% of urban and 2% of rural households share sanitation facilities (Central Statistical Agency - CSA/Ethiopia & ICF, 2017) Furthermore, 27.7% of respondents from urban households and 1.8% or respondents from rural households reported to share pit latrines with a slab. However, 56% of rural households use unimproved sanitation facilities, and one in three households in the country have no facility (Central Statistical Agency - CSA/Ethiopia & ICF, 2017).

Similar to the practice of safe water treatment methods, latrine utilization can be affected by multiple socioeconomic and demographic factors. When comparing urban and rural communities within Ethiopia, latrine utilization was higher for urban households (61.85%) than for rural households (49.25%) (Leshargie et al., 2018).The meta-analysis of latrine utilization conducted by Leshargie et al. in regions of Ethiopia (Afar, Amhara, Benishangul-Gumuz, Gambella, Harari, Oromia, and Southern Nations, Nationalities, and Peoples)showed that individuals in the household who have attained a higher educational status are more likely to use latrines and therefore affect health behaviors in the household(Leshargie et al., 2018). Although this study was able to identify factors and associations concerning pooled latrine utilization prevalence in Ethiopia, the findings of this cross-sectional study may not be representative of the determinants of latrine use for the entire country.

Advances and Challenges to Increasing Sanitation Coverage and Drinking Water Infrastructure in Households

According to the UN 2015 MDG report, Ethiopia was one of the countries in sub-Saharan Africa that did not meet the sanitation target goal (United Nations, 2015). According to Armah et al., during the MDG era the population in sub-Saharan Africa doubled, but access to improved

sanitation only increased by six percentage points (Armah et al., 2018). From 2010-2015, households with access to improved sanitation facilities declined to 53% from 74% in 2000-2005 (Armah et al., 2018). Armah et al., asserted that decline in improved sanitation facilities across Sub-Saharan countries can be attributable to the increasing population and the failure to increase access to improved sanitation facilities during this rise (Armah et al., 2018).

In 2017, the World Bank reported that 26.7% of the Ethiopian rural population, and 5% of the urban population still practice open defecation (The World Bank, 2017, n.d-b). The World Bank proposed that in order to eliminate the disparities in sanitation coverage in Ethiopia, it is critical to create sanitation service programs that can target the urban population and off-site sanitation infrastructures for rural communities. From 2012-2017, the MDG- Sanitation: Whole Sanitation Chain for Poor in Urban and Peri-Urban of Amhara program, was created to improve health and socio-economic status through the provision of sustainable sanitation services in Bahir Dar (Oscar Veses, 2016). One of the objectives of this sanitation program was to enhance the support for improved sanitation across all sectors, and to halve the population who did not have access to a sanitation facility. One of the major achievements of this program was the construction of ventilated pit latrines and EcoSan toilets in schools and the renovation of public and communal latrines (Oscar Veses, 2016). Even though this initiative was able to lead in the advancement of improving sanitation coverage within Bahir Dar, there were issues concerning the lack of awareness of good sanitation practices among the population and local authorities.

Ethiopia has made substantial progress in drinking water infrastructure. By 2015, Ethiopia achieved the MDG goal 7 target 7C. In the 2014 the JMP report, water supply was improved by 57% (97% in urban areas and 42% in rural areas) (World Health Organization, n.d). In the 2019 JMP Report: Progress on Household Drinking Water, Sanitation and Hygiene,

Ethiopia has increased the use of basic water services by over 20 percentage points(*Progress on household drinking water, sanitation and hygiene 2000-2017. Special focus on inequalities*, 2019). Although there have been great strides in the increase of basic water services, there is still a disparity in rural areas. Ethiopia has increased the use of basic water services by 23 percentage points but have been unable to reduce the inequalities between the richest and poorest quintile. The gap between the richest and poorest quintiles in rural areas of Ethiopia from 2000-2017, has steadily increased by 22 percentage points(*Progress on household drinking water, sanitation and hygiene 2000-2017. Special focus on inequalities*, 2019). This increasing trend showcases the need to create and ensure rural communities have access to water services. Although the provision of basic water services is adequate, the provision of improved drinking water infrastructures should be the goal for urban and rural households.

WaSH Knowledge, Attitudes, and Practices in Ethiopia

Bazzano et. al. reported that poor hygiene and sanitation practices and lack of access to a safe water source can increase the risk of infection in the first weeks of life(Bazzano et al., 2015). Globally, 35% of newborn deaths are attributable to sepsis, meningitis, and pneumonia, and some of these may be linked to poor WaSH access and practices at home and in healthcare facilities (Bazzano et al., 2015). According to Berhe et al., the lack of adequate knowledge, attitude, and practice associated with WaSH can fuel the transmission of pathogens in a household(Berhe et al., 2020). Adherence to safe WaSH practices is left to the household to uphold. Safe WaSH practices can be improved through educational awareness. Knowledge about health-related topics and risks can be motivators for adopting safe and sustainable health

behaviors. The promotion of safe WaSH practices can be incorporated into community-led WaSH interventions to help community members adopt healthy WaSH behaviors. According to UNICEF, community handwashing education can help to reduce overall cases of diarrhea by 31%, reduce diarrheal illnesses among individuals with a weakened immune system by 58%, and reduce respiratory illnesses by 28% (Mekonnen, 2014).

In a cross-sectional study conducted by Berhe et al. in the rural Tigray Region of Ethiopia, 93.9% of the participants knew the benefits of using a clean source of water to wash hands, and 94% understood that waterborne diseases can be prevented by consuming safe water(Berhe et al., 2020). One in four (25%) of the study participants believed that washing their hands with only water was enough to ensure that their hands were clean (Berhe et al., 2020).

According to 2016 EDHS data for households that were to have a place for handwashing, 27.8% of urban households in Ethiopia were observed to have soap and water in comparison to 7% rural households (Central Statistical Agency - CSA/Ethiopia & ICF, 2017). Soap, water, and other cleaning agents were not present in 43% of urban households and 68% of rural households (Central Statistical Agency - CSA/Ethiopia & ICF, 2017). The availability of soap and water was shown to be correlated with wealth in Ethiopia, in which households in the highest wealth quintile are 9 times more likely to have these cleaning agents than those in lowest wealth quintile(Central Statistical Agency - CSA/Ethiopia & ICF, 2017).

According to 2016 EDHS data, out of the l1 regions located in Ethiopia, the availability of soap and water was lowest (5%) in the Amhara Region in comparison to the Addis Abba Region (39%)(Central Statistical Agency - CSA/Ethiopia & ICF, 2017). A study conducted by Dagne et al. in the Debark Town in the Amhara Regin observed that knowledge, attitude, and water availability was associated with the practice of handwashing at critical time for mothers

(Dagne, Bogale, Borcha, Tesfaye, & Dagnew, 2019). Mothers who had knowledge on the importance of hand washing were more likely to self-report good hand washing practice in comparison to mothers who had limited knowledge (Dagne et al., 2019). However, a study conducted in a rural Nigerian community found that there was no significant association between handwashing practice and knowledge (Alphonsus O et al., 2017). Alphonsus et al. reported that commonly reported reasons for mothers not washing their hands in this community were mothers were too busy and the nonavailablity of soap and water (Alphonsus O et al., 2017). Hand washing practice and behaviors can be influenced by socioeconomic status, health services, standard of living, and educational status. Handwashing practices may not be solely based on knowledge of the practice.

Demographic and Socio-economic Characteristics in Ethiopia

Ethiopia is comprised of 11 regions, which includes Tigray, Affar, Amhara, Oromia, Somali, Benishangul-Gumuz, SNNPR, Gambela, Harari, Addis Ababa, and Dire Dawa (Azage, Motbainor, & Nigatu, 2020). The Amhara region is located in the Northwestern and North Central part of Ethiopia, and boarders the Ethiopian regions Tigray, Affar, and Benishangul-Gumuz (Ethiopia Regional State Government Amhara, n.d). According to the World Bank, the estimated population of Ethiopia in 2019 was 112,078,730 (The World Bank, 2019). In 2018, the crude death rate per 1, 000 people in Ethiopia was 7 (The World Bank, 2019). The fertility rate in 2018 was 4.3 births per woman, and the mortality rate for infants per 1,000 live births in 2019 was 37 (The World Bank, 2018 n.d-a).

Educational attainment, according to the 2016 EDHS, varies by wealth quintile. In the lowest wealth quintile,74% of women had no formal education in comparison to 19% of women

living in the highest wealth quintile (Central Statistical Agency - CSA/Ethiopia & ICF, 2017). In the Amhara region, 6% of women ages 15-49 and 8% of men ages 15-49 had completed a secondary education or higher (Central Statistical Agency - CSA/Ethiopia & ICF, 2017). Two out of three men were literate (69%) in comparison to four out of 10 women (42%) (Central Statistical Agency - CSA/Ethiopia & ICF, 2017) .

A common occupation for women living in the Amhara is agriculture. For women, 61.8% of respondents in the EDHS data were involved in agriculture, 16.7% of women were in sales and services, 7.8% of women were in skilled manual labor, 3.1% of women were in unskilled manual labor, and 5.0% of women held a professional, technical, or managerial job (Central Statistical Agency - CSA/Ethiopia & ICF, 2017). A common occupation for men living in the Amhara region was agriculture (76.8%)(Zemichael Gizaw et al., 2019). Other jobs held by men in the Amhara region include skilled manual labor (6.0%), unskilled manual labor (2.7%), sales and services (5.2%), and professional/technical/managerial (5.0%) (Central Statistical Agency - CSA/Ethiopia & ICF, 2017).

According to the World Bank, the average per capita income in Ethiopia is $850 USD(The World Bank, 2020). The proportion of the population living below the national poverty line in Ethiopia decreased from 30% in 2011 to 24% in 2016 (The World Bank, 2020).

Amhara Region of Ethiopia

The Amhara Region is located in the Northwestern and north central part of Ethiopia shown in Figure 3. In 2017, Ethiopia had a population of 21.1 million(United Nations International Children's Education Fund, 2018). Within Amhara, there are 10 administrative zones, 1 special zone, 105 woredas, and 78 urban centers(Government of Ethiopia, 2018). Bahir Dar is the capital of the Amhara Region and is one of the 10 administration zones. Bahir Dar is located 578 km North West of Addis Ababa and is the third largest city in Ethiopia (Bahir Dar University, 2014). According to the Central Statistical Agency in Ethiopia, the population of Bahir Dar was estimated to be 348,429 in 2017 (Gashu & Gebre-Egziabher, 2019).

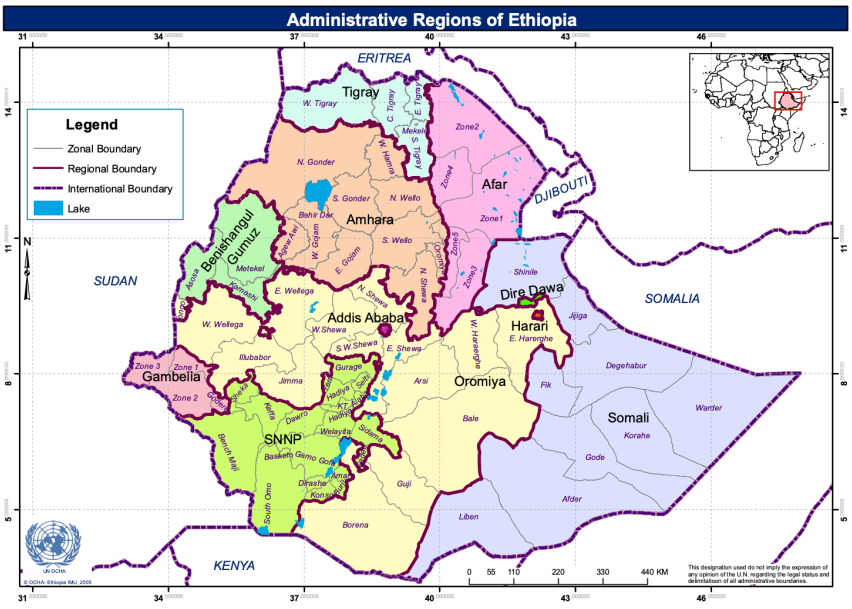


Figure 3.
Note. Administrative Regions of Ethiopia. United Nations Office for the Coordination of Humanitarian Affairs. (2005, October 31). Administrative Regions of Ethiopia. Retrieved February 19, 2021, from https://www.unocha.org/.

Debre Tabor Town is the capital of the South Gondar administrative zone found in the Amhara Region. Debre Tabor is located 667 km North West of the capital city Addis Ababa (Bahir Dar University, 2014). The current population is estimated to be 78,706 (Aragaw, Afework, & Getahun, 2020).

Newborn Care Practices for Urban and Rural Households in Ethiopia

Cord Care Practices

The World Health Organization reported that sub-Saharan Africa had the highest overall neonatal mortality rate in the world at 27 deaths per 1,000(World Health Organization, 2020).

Factors that contribute to neonatal deaths are pre-term births, intrapartum complications, and infections. The WHO recommends that newborns receive careful essential care, including hygienic umbilical cord care, skin care, and early exclusive breastfeeding (World Health Organization, 2020). Factors that can disrupt newborns from receiving good essential care are poverty, poor nutrition of the newborn, and insufficient access to water and sanitation (World Health Organization, n.d). Ethiopia is estimated to have 122,000 neonatal deaths per year. In the Amhara region, infant mortality is high at 76 per 1,000 live births, and neonatal mortality is estimated to be 54 per 1,000 live births (Callaghan-Koru et al., 2013). According to the 2016 EDHS, only 13% of newborns had a postnatal checkup. The difference between newborns who received postnatal care and those that did not was associated with household demographics. In urban areas, 37% of newborns received postnatal care in the first two days of life in comparison to 10% of newborns in rural areas (Central Statistical Agency - CSA/Ethiopia & ICF, 2017).

A study was conducted in four regions of Ethiopia to understand newborn care practices among women who gave birth within 1 to 7 months of the data collection in the Amhara, Oromia, Tigray, and Southern Nations, Nationalities and People Region (SNNPR) region. For mothers that had a home-based birth, 22 out of the 24 reported that a new razor blade was used to cut the umbilical cord (Amare, 2014). According to the 2016 EDHS, 9% of mothers applied a substance to the stump after the umbilical cord was cut (Central Statistical Agency - CSA/Ethiopia & ICF, 2017). Amare reported mothers in Amhara and Ormonia commonly applied butter to the cord after cutting, but handwashing was a rare practice for mothers applying a substance to the newborn (Amare, 2014). This study found that mothers of newborns received advice on cord care from various sources, including grandmothers, neighbors, health extension workers (HEWs), and Traditional Birth Attendants (TBAs) (Amare, 2014). Amare observed that

mothers who received advice from their grandmothers and mothers were advised to apply a substance to the cord in order prevent it from sticking to clothes. TBAs advised mothers to wash the cord regularly, wash the baby regularly and change clothes throughout the day (Amare, 2014). A health extension worker in Amhara advised mothers not to apply anything to the cord rather keep the area clean and dry (Amare, 2014). Most of the HEWs in the study population advised newborns not to apply anything and keep it dry in order to prevent infection (Amare, 2014). Similar practices were seen in among mothers who gave birth at the general hospital in Debre Tabor. Yisak and Ewunetei reported that 65% of mothers had correct knowledge concerning cord care, stating that the umbilical stump should remain uncovered and kept clean and dry(Yisak, 2020). In the case of applying substances to the umbilical cord stump, 6.5% of mothers reported that a substance should be applied (Yisak, 2020). Yisak and Ewunetei reported that 88.2% of mothers reported that if the umbilical cord is solid, water should be used to clean the area (Yisak, 2020). Identifying signs of infection and responding appropriately to potential cord infection is considered to be an essential practice for postnatal mothers. Amare reported that majority of the mothers, grandmothers and TBAs were not aware of risks of neonatal cord infection, and mothers who were shown pictures of cords were unable to identify when the cord appeared to be infected (Amare, 2014). In Debre Tabor, 18.8% of mothers had poor knowledge concerning cord care (Amare, 2014). Based on these studies findings, there are clear indications that mothers are receiving differing recommendations concerning cord care. The results of these show that there needs to be emphasis on HEWs and TBA trainings. Miseducation and poor health messaging can affect the care practices and behaviors of postnatal mothers.

Breastfeeding Practices

Breastfeeding is critical for providing infants with the necessary nutrients for optimal growth and development for the first six months of life (World Health Organization, 2019). The WHO reported that early initiation of breastfeeding can reduce the risk of infants acquiring infection in the first couple months of life and can reduce newborn mortality (World Health Organization, 2019). WHO and UNICEF recommend that newborns should be breastfed in the first hour after birth, exclusively breastfeed for the first six months, and afterwards complementary feeding with continuation of breastfeeding for up to two years or more(World Health Organization, 2019). The WHO defines exclusive breastfeeding as the practice where an infant only receives breastmilk (World Health Organization, 2019). During this period, the WHO recommends that infants should not be given other liquids, such as water, or solids (World Health Organization, 2019).

From the 2016 EDHS data, 73% of infants in Ethiopia were breastfed within the first hour of birth, and 92% of infants were fed within one day of their birth (Central Statistical Agency - CSA/Ethiopia & ICF, 2017). In comparison to the 2011 Ethiopian Demographic Survey, the percentage of newborns breastfed in the first hour increased by 22 percentage points (Central Statistical Agency - CSA/Ethiopia & ICF, 2017). The EDHS reported that 58% of children under 6 months of age were breastfed (Central Statistical Agency - CSA/Ethiopia & ICF, 2017).The practice of exclusive breastfeeding was shown to decrease in the Ethiopia as the children grew older. From 0-1 month, 74% were exclusively breastfed, and 34% from 4-5 months were exclusively breastfed (Central Statistical Agency - CSA/Ethiopia & ICF, 2017). Specifically, in the Amhara region the median duration that respondents reported to breastfeed the child was 4.1 months (Central Statistical Agency - CSA/Ethiopia & ICF, 2017).

A study conducted in the slums of Bahir Dar City assessed mothers' knowledge on infant and young children feeding (IYCF) recommendations and associated factors. When assessing IYCF recommendations, 135 out of the 471 (28.7%) of study participants had sufficient knowledge (Demilew, 2017). About the initiation of breastfeeding, 91.7% of mothers knew that a neonate should be breastfed within an hour of birth (Demilew, 2017). The importance of exclusive breastfeeding in the first six months was known by 84.3% of mothers, and 20.4% of mothers knew that breastfeeding should be continued for at least two years or beyond (Demilew, 2017). About the introduction of complementary foods, 87.9% of mothers knew the correct age for the introduction (Demilew, 2017). Demilew reported that there was a statistically significant association between educational status and the mother's knowledge about IYCF. Demilew reported that mothers who achieved an education beyond primary were 2.5 more times likely to have sufficient knowledge about IYCF practice than mothers who attained lower than secondary education (Demilew, 2017). Sixty percent of mothers received information on IYCF from health professional, 28.5% from mass media, and 11.5% from relatives (Demilew, 2017). Due to the quantitative focus of this study, the researchers did not utilize qualitative methods to probe further about the knowledge level of mothers concerning IYCF. In order to improve IYCF practices among households, Dilmew suggested educational programs that emphasize the importance of adequate IYCF and appropriate complementary foods as part of the provision of antenatal care for expectant mothers (Demilew, 2017).

Handwashing and Child Feces Disposal Practices

In order to improve child health outcomes, the UNICEF Baby WaSH program was designed to target pregnant women, parents, and children under 3 years of age (Federal Democratic Republic of Ethiopia Ministry of Health, 2017). Through this program, each factor

of WaSH services in relation to maternal, newborn, child health, and nutrition was prioritized. The Baby WaSH program includes a focus on handwashing and hand cleanliness (Federal Democratic Republic of Ethiopia Ministry of Health, 2017). In 2017, UNICEF conducted a knowledge, attitudes, and practices baseline survey to understand the factors that contributed to early childhood infection and found large differences between child caregivers in urban and rural communities. For the urban areas of Ethiopia, 57.6% of caretakers of children under three years of age reported washing their child on a daily basis in comparison to 22.7% of caretakers living in rural pastoral communities, and 34.3% of caretakers living in non-pastoral communities (Federal Democratic Republic of Ethiopia Ministry of Health, 2017). In urban areas, the percentage of mothers who reported to wash their hands before breastfeeding was 31.1%, compared to 0% in rural pastoralist, and 2.0% in rural non-pastoralist communities (Federal Democratic Republic of Ethiopia Ministry of Health, 2017). Women who reported sufficient knowledge on health risks concerning unsafe disposal of child feces in urban communities was 54.2%, 38.7% in rural pastoralist, and 50.4% in rural non-pastoralist communities (Federal Democratic Republic of Ethiopia Ministry of Health, 2017). Households reported to have safely disposed child feces by either burying or placing into the latrine the last time the child passed stool was 80.2% in urban communities, 23.4% in rural pastoralist, and 46.3% in rural non-pastoralist communities(Federal Democratic Republic of Ethiopia Ministry of Health, 2017).

There is little information and few studies concerning hygiene practices among mothers of newborns in the Amhara Region of Ethiopia. As part of a community cross-sectional study to understand factors associated with diarrhea in children under five in Bahir Dar City, researchers analyzed hygiene behavioral characteristics of caregivers. Dagnew et al. found that 88.6% of

respondents reported to have washed their hands with soap and water in comparison to 11.4% respondents who only used water (Dagnew et al., 2019). Handwashing at critical times was also assessed among respondents, 75.7% of respondents reported that they washed hands before food preparation, 89.8% reported washing hands after using the latrine, and 75.7% reported washing their hands after cleaning the child's bottom (Dagnew et al., 2019).

Community-Based Newborn Care Program in Ethiopia

In order to improve newborn survival in Ethiopia, the Community-Based Newborn Care (CBNC) Programme was created in 2013 by the Ethiopian Government. The CBNC was implemented in the Amhara region in 2018 as part of the program's agenda to scale up. The CBNC Program is comprised of 9 components in order to improve neonatal survival.

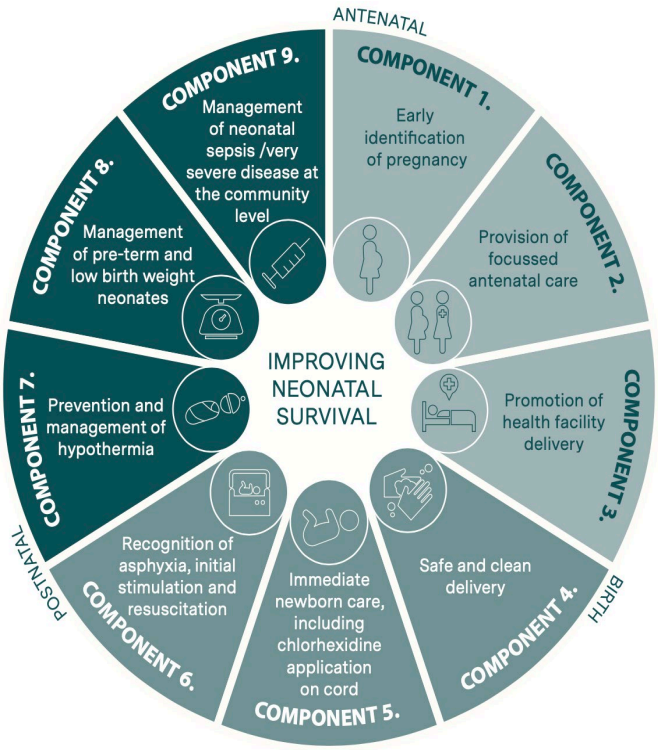


Figure 4.
Note. CBNC Programme Components. Adapted from Della Berhanu and Bilal Avan. Community-Based Newborn Care Programme in Ethiopia 2013 - 2017: Final Evaluation EXECUTIVE SUMMARY. London School of Hygiene & Tropical Medicine, 2019.

Some examples of postnatal components shown Figure 4 include immediate care for newborns and the application of chlorohexidine on the cord, management of pre-term and low birth weight neonates, and the management of neonatal sepsis and severe disease (Della Berhanu and Bilal Avan, 2019). This program provides services to women across Ethiopia through the use of HEWs to understand and identify factors associated with neonatal and infant mortality. In a summary of the CBNC's evaluation and progress by Berhanu and

Avan, there were significant changes in antiseptic usage in cord care in health care facility deliveries in the 2013 baseline survey (23%) to the 2017 follow-up survey (67%) (Della Berhanu and Bilal Avan, 2019). Berhanu and Avan also reported that more infants were receiving antibiotic treatment in 2017 than in 2013 for symptoms linked to severe disease (Della Berhanu and Bilal Avan, 2019).

In a process evaluation of the CBNC program, Gebremedhin et al. reported that healthcare providers in the Geze Gofa district of Ethiopia were not in compliance with the Community-Based Newborn Care Implementation guidelines (Gebremedhin, Daka, Alemayehu, Yitbarek, & Debie, 2019). This was in concordance with the Berhanu and Avan's finding about awareness and knowledge of severe danger signs relating to cord infections and management. According to the CBNC's evaluation summary, Berhanu and Avan, reported that HEWs had difficulty identifying and understanding messages depicted in the family health guide (Della Berhanu and Bilal Avan, 2019). Gebremedhin et al. reported that the proportion of newborns who received postnatal care from HEWs within 48 hours of birth in the last six month period was poor (34.5%) (Gebremedhin et al., 2019). One of the limitations concerning the process evaluation conducted by Gebremedhin et al. was discrepancies in the registration of services delivered when assessing HEWs' compliance with the program (Gebremedhin et al., 2019). Berhanu and Avan recommended strengthening HEWs' adherence to essential newborn care practices by providing additional training in family health and sick infant management to HEWs (Della Berhanu and Bilal Avan, 2019).

Sepsis among Neonates in Ethiopia and association with WaSH

Neonatal sepsis is a systemic infection affecting neonates during the first four weeks of life (Assemie et al., 2020). Assemie et al. reported neonatal sepsis to be the major cause of

neonatal mortality and morbidity due to the neonates' weak and immature immune system (Assemie et al., 2020). Belachew and Tewabe reported that magnitude of studies exploring factors associated with neonatal sepsis in Ethiopia is small (Belachew & Tewabe, 2020). In their systematic review and meta-analysis Belachew and Tewabe reported that random effect pooled prevalence of neonatal sepsis in Ethiopia was 49.9% (Belachew & Tewabe, 2020). According to Agnache et al. neonatal sepsis can be classified into two categories being either early-onset spies (sepsis acquired at birth up to 7 days of age) or late-onset sepsis (acquired 8 to 28 days of age) (Agnche, Yenus Yeshita, & Abdela Gonete, 2020). Kuti et al. reported that good hand hygiene practice in healthcare facilities and outside in communities is a cost effective practice that can reduce neonatal infections in low- and middle-income countries(Kuti et al., 2019). More information is needed to assess how household characteristics, such as the presence of handwashing and sanitation facilities, education and socioeconomic status of caregivers, and environmental factors, may impact the acquisition of neonatal infection in Ethiopia.

Chapter 3: Methods and Results

Overview of Methods

Mothers of low birth weight infants and normal birth weight infants born in two hospitals (Felege Hiwot and Debre Tabor) in the Amhara region of Ethiopia were recruited into a study of neonatal sepsis. Data from baseline (n=586), household WaSH (n=538) surveys, and clinical sepsis diagnoses of newborns were analyzed to understand socioeconomic characteristics, WaSH conditions, and newborn care practices of households with newborn infants in the Amhara Region of Ethiopia.

3.1 Study Area

The study was conducted in collaboration with the Amhara Public Health Institute (APHI), Felege Hiwot Referral Hospital, and the Debre Tabor General Hospital. These hospitals were selected due to the ongoing Kangaroo Mother Care (KMC) research program in the area, the high delivery rates, and their proximity to the Amhara Public Health Institute.

The Felege Hiwot Referral Hospital is one of the largest referral hospitals in the Amhara region. This hospital is located in the capital, Bahir Dar. This hospital is designed to receive severe referral cases across the region and provides care to 5-7 million people in the area. There are between 450 to 500 monthly deliveries, and the Neonatal Intensive Care Unit (NICU) cares for 7-25 babies per day. Within this hospital are 34 midwives, 2 OB/GYNs, and 10 NICU staff.

The Debre Tabor General Hospital is located in the South Gondar Zone of Amhara in Debre Tabor. This hospital provides care to over 2.5 million individuals. Approximately 260 newborn deliveries are conducted monthly. There are 23 midwives, 2 OB/GYNs, and 20 staff members in the NICU.

3.2 Study Sample Size and Recruitment Strategy

Initially, 800 infants were recruited per hospital over nine months. Infants were enrolled into the study from the Felege Hiwot Referral Hospital and the Debre Tabor General Hospital. In addition, upon enrollment, infants were grouped by risk category, either low birth weight or normal birth weight. Therefore, four cohorts were generated each birth weight category (low birth weight and normal) per each of the two hospitals. .Infants in the postnatal care unit (PNC) were defined as being in stable condition and were greater than or equal to 2,000 grams in weight. Infants recruited in the NICU were defined as high risk, in unstable condition, and weighing less than or equal to 2,000 grams. Low birth weight infants that were stable after birth were recruited from the KMC unit, and unstable infants were recruited from the NICU.

Random assignment was used to determine which infants were recruited across the two hospitals based on the estimated number of infants in each risk category per month. One study team member was responsible for the recruitment of infants in each hospital. A total of 267 infants were recruited from the Felege Hiwot Referral Hospital, and 327 infants were recruited from the Debre Tabor General Hospital.

3.3 Recruitment Inclusion and Exclusion Criteria

The following inclusion criteria were used for recruitment of infants into the study:

1. Born in either of the two study hospitals (Felege Hiwot and Debre Tabor)
2. Family resides within the defined study area
3. Vaginal delivery of infant

The following exclusion criteria were applied during the recruitment of infants across each hospital:

1. Born outside of the two study hospitals (Felege Hiwot and Debre Tabor)

2. Family resides outside the defined study area
3. Delivery of infant via Cesarean Section
4. Development of late onset sepsis at health facility (the occurrence of sepsis occurring after 72 hours or after more than three days)

3.3. Baseline Information Survey

A total of 267 mothers who delivered their child at the Debre Tabor General hospital, and 327 mothers who delivered their child at the Felege Hiwot Referral Hospital were interviewed. This baseline survey served to collect information concerning demographics, obstetric history, antenatal care, and the infant's weight. The baseline survey was conducted from September 2018 to June 2019.

3.4 Household WaSH Conditions Survey

After discharge (7 days), the study team visited mothers from the two hospitals at home to interview and observe the household WaSH conditions. From the Debre Tabor General Hospital, 250 mothers were interviewed, and 288 mothers were interviewed from the Felege Hiwot Referral Hospital. In the 22-question survey, respondents were asked questions about household water infrastructure, sanitation facilities, bathing, breastfeeding routines, and family handwashing behaviors. In order to understand the general environmental conditions of the household, structured observations were conducted by the survey team with the informed consent of the household members. The household WASH Conditions Survey was conducted from September 2018 to June 2019.

3.5 Clinical Microbiological Testing of Infants with Suspected Sepsis

Blood samples of newborns in the study that were suspected to have sepsis were taken. Blood samples were cultured, and bacterial isolates were tested for antimicrobial susceptibility

by manual testing or through use of Vitek 2 Microbial ID –Susceptibility testing system (Biomerieux).

3.6 Data Collection and Management

Mobile devices using the REDCap application collected data from the interviews and the household WaSH survey.

3.7 Ethical Considerations

The study protocol was approved the Emory Institutional Review Board and the Amhara Public Health Institute Ethics Review Committee for Approval.

3.8 Data Analysis

Data was cleaned and checked for discrepancies using Microsoft Excel. Data was exported to SAS version 9.4 for analysis. Descriptive statistical analyses were conducted in SAS to summarize data collected from each survey. Socioeconomic and demographic characteristics were summarized for all study households. Newborn care practices were summarized for all study households and also stratified by geographic location, and by type of drinking water access and type of sanitation access. Household WASH characteristics and practices were summarized for all study households and also stratified by household member, and by urban, peri-urban, and rural setting. Logistic regression analyses were used to examine demographic and socioeconomic predictors of access to: 1) improved toilet facilities, and 2) access to an improved drinking water source.

We conducted logistic regression to examine the association of the neonatal sepsis outcome variables and WASH infrastructure and practices, specifically access to: 1) improved toilet facilities, and 2) access to an improved drinking water source. Diagnosis of any neonatal sepsis, diagnosis of early-onset neonatal sepsis (occurrence of sepsis with the first 72 hours of

life or less than three days), and diagnosis of late-onset neonatal sepsis (the occurrence of sepsis occurring after 72 hours or after more than three days) were used separately for each model as the outcome of interest. Newborn care practice variables were used as exposure variables for each univariate model to assess if there was an association with sepsis diagnosis. Toilet type was dichotomized as being an improved or unimproved sanitation facility based on the JMP sanitation ladder (JMP, n.d). The exposure variable of primary drinking water source was dichotomized as either a safely-managed drinking water source or an unimproved source based on the JMP drinking water ladder(JMP, n.d). Independent covariates included in the model were: woreda, mother's educational status, household income, and mother's occupational status. Bahir Dar City was the reference group for comparison among woredas. The woredas Bahirdar Zuira and Mecha, and Farta and Libo KemKem were combined together for analysis based on the relative geography of each woreda. For the variable mother's educational status, no education was used the reference group. "Some education" was combined with "primary level education" due to the small number of respondents in these categories. Household income was divided into four categories: ≤20,000, 20,001-39,000, 39,001-59,000, and ≥59,001 with the reported household income of 20,001-39,000 used as the reference group. For mother's occupation, merchant and petty trader and professional and religious leader were combined together for analysis because observations were few in each category to accurately generate a model. The mother's occupational status of student was not used for analysis because there were too few observations.

Results

The main purpose of this study is to examine the relationships between household WASH conditions and practices and socio-economic and demographic factors of households with newborn infants who were recruited into a study of neonatal sepsis at Felege Hiwot Hospital in Bahir Dar City and Debre Tabor General Hospital in Debre Tabor, Ethiopia.

Table 1: Socioeconomic and Demographic Characteristics

Variable	n (%)
Woreda	**(n=586)**
Bahir Dar City	233 (39.7)
Bahirdar Zuira	76 (13.0)
Debre Tabor	148 (25.3)
Farta	116 (19.8)
Libo KemKem	2 (0.34)
Mecha	11 (1.9)
Kebele Type	**(n=586)**
Urban	422 (72.0)
Peri-Urban	36 (6.1)
Rural	128 (21.8)
Age of the mother (years)	
≤24	168 (28.3)
25-39	415 (70.0)
≥40	10 (1.7)
Head of household religion [a]	**(n=585)**
Christian Orthodox	563 (96.2)
Muslim	18 (3.1)
Christian Protestant	4 (0.68)
Head of household ethnicity [b]	**(n=584)**
Amhara	583 (99.8)
Mothers' educational level [c]	**(n=432)**
Primary 1-8	171 (39.6)
Secondary 9-12	119 (27.5)
Technical/Vocational Certificate	61 (13.2)
Degree or Higher	36 (8.3)
None	34 (7.9)
Mother's ability to read and write	**(n=586)**
Yes	434 (74.1)
No	152 (26.0)
Occupational status of the mother [d]	**(n=585)**
Housewife	305 (52.1)
Farmer	111 (18.7)
Skilled Labor	41 (7.0)
Unskilled Labor	19 (3.3)
Professional	54 (9.2)
Merchant	12 (2.1)
Petty Trade	40 (6.8)

Table 1: Socioeconomic and Demographic Characteristics Continued

Age of the father (years)	(n=530)
≤29	178 (33.3)
30-40	307 (57.4)
≥41	50 (9.4)
Fathers' educational status [e]	**(n=465)**
Primary 1-8	127 (27.3)
Secondary 9-12	149 (32.0)
Technical/Vocational Certificate	61 (10.2)
Degree or Higher	92 (15.5)
None	35 (7.5)
Father's ability to read and write	**(n=586)**
Yes	465 (79.3)
No	121 (20.7)
Occupational status of the father [f]	**(n=584)**
Farmer	170 (29.1)
Skilled Labor	151 (25.8)
Unskilled Labor	70 (12.0)
Professional	96 (16.4)
Merchant	64 (11.0)
Petty Trade	18 (3.1)
Religious Leader	10 (1.7)
Is the father currently staying with the family?	**(n=581)**
Yes	568 (96.6)
No	20 (3.4)
House Ownership	**(n=576)**
Yes	446 (77.0)
Household family size	**(n=581)**
Mean ±SD	3.30 ± 1.4
Total family income per year (birr)	**(n=539)**
≤20,000	157 (28.8)
20,001-39,000	192 (35.2)
39,001-59,000	133 (24.4)
≥59,001	64 (11.72)

Information not included in the table:
[a] Four respondents identify as being a Protestant follower 4 (0.68)
[b] One respondent identifies as Oromo 1(0.17).
[c] Two respondents have some level of education (0.46).
[d] One respondent is a religious leader(0.17), and two respondents are students(0.34)
[e] One respondent reports to have some level of education (0.17)
[f] One respondent identifies as being a police officer (0.17) and two respondents are students(0.34).

Based on the analysis of the baseline survey, respondent lived in various woredas in the Amhara region, including Bahir Dar City (39.7%), Debre Tabor (25.3%), and Bahirdar Zuira (13%) (Table 1). In terms of kebele, 72% of respondents reported living in urban kebeles and 21.8% of respondents lived in rural kebeles. The majority of the respondents are from the Amhara ethnic group (99.8%). Literacy was high among mothers (74.1%) and fathers (79.35%). For educational level, the majority of mothers reported to have primary education, and most fathers had a secondary education (32.0). Common occupations for mothers included farmer (18.7%) and housewife (52.1%); for fathers, occupations included skilled laborer (25.8%) and farmer (29.1%). The mean age of mothers was 27± (4.9 SD) years, and for fathers 32± (6.12 SD) years. The average household size among respondents was 3.30 ± (1.40 SD). The average reported household income per year among respondents was 34,605.38 ± (19,616.85 SD) birr (Table 1.).

Obstetric History

Analysis of reported obstetric history indicated that the percentage of mothers who reported having either one or more low birth weight newborns (n=592), was 9% for mothers living in Bahir Dar City. For mothers living in Debre Tabor, 3% reported having either one or more newborns with low birth weight. For mothers residing in Bahirdar Zuira, 29% reported having low birth weight of one or newborns. When looking at the reported number of preterm infants born, among 584 mothers sampled, 8.5% in Bahir Dar City and 2.7% in Debre Tabor reported having one or more newborns that are preterm.

The percentage of mothers who reported having either one or more newborns that had died in the first 28 days of life was 1.4% for mothers residing in Bahir Dar City and 1.2% for mothers in Debre Tabor (n=592).

Table 2: Antenatal Care History

Variable	n(%)	Urban n(%)	Peri-Urban n(%)	Rural n(%)	Bahir Dar City n(%)	Bahirdar Zuira n(%)	Debre Tabor n(%)	Farta n(%)
Mothers who reported to have received at least one antenatal care visit at a health facility [a] (n=585)								
	565(96.6)[1]	413(73.1)[2]	35(6.1)[3]	116(20.5)[4]	229(98.2)[5]	74(97.3)[6]	145(98.6)[7]	104(89.6)[8]
Mothers who reported to have received information from health facility on preterm and/or low birth weight newborns(n=560)								
	98(17.5)[9]	82(20.0)[10]	9(25.7)[3]	6(5.2)[11]	68(29.6)[7]	18(24.3)[8]	5(3.5)[9]	6(5.8)[12]
Mothers who reported to have received information from health facility on newborn hygiene (n=561)								
	213(38.0)[2]	166(77.9)[10]	18(51.4)[3]	28(13.1)[13]	122(57.3)[7]	36(48.6)[8]	29(20.4)[14]	26(24.2)[15]

[1] N=585, [2]N=421 [3] N= 35 [4] N=128 [5]N=233, [6]N=76, [7]N=147, [8]N=116, [6]N=560, [7]N=229, [8]N=74, [9]N=142, [10] N=410, [11]N=114, [12]N=98, [13]N=115, [14]N=142, [15] N=103

[a] Two Respondents from Libo KemKem reported receiving antenatal care visit from a health facility
[b] Ten Respondents from Mecha reported receiving at least antenatal care visit from a health facility

Overall, the mothers who reported receiving antenatal care at a health facility was high (96.6%). Information acquisition concerning preterm and low birth weight infants was higher for respondents residing in Bahir Dar City compared to respondents living in Debre Tabor (Table 2).

Table 3: Newborn Care Characteristics

Variable	n(%)	Urban n(%)	Peri-Urban n(%)	Rural n(%)	Bahir Dar City n(%)	Bahirdar Zuira n(%)	Debre Tabor n(%)	Farta n(%)
Percentage of respondents that bath the newborn [a]								
	463(86.5)[1]	343(87.5)[2]	31(100.0)[3]	88(79.2)[4]	205(94.5)[5]	60(95.2)[6]	116(81.7)[7]	77(72.0)[8]
How often do you bath the newborn?								
Every few days	46(10.0)[9]	11(3.2) [10]	N/A	35(39.7)[12]	1(0.5)[13]	N/A	9(7.9)[15]	36(46.8)[16]
Once per day	208(45.1)[9]	157(46.0)[10]	17(54.8)[11]	34(38.6)[2]	89(43.4)[13]	32(53.3)[14]	55(48.3)[15]	30(39.0)[16]
Twice per day	207(45.0)[9]	173(50.7)[10]	14(45.1)[11]	19(21.5)[12]	115(56.1)[13]	28(46.7)[14]	50(43.9)[15]	11(14.3)[16]
Bath Water Source [b]								
Body of water (Surface Water)	14(3.0)[17]	4(1.7)[10]	1(3.2)[3]	9(10.2)[12]	N/A	N/A	2(1.7)[20]	10(13.0)[21]
Bore hole	7(1.5)[17]	7(2.0)[10]	N/A	N/A	1(0.5)[18]		5(4.4)[20]	1(1.3)[21]
Piped into compound	113(24.5)[17]	100(29.3)[10]	1(3.2)[3]	12(13.6)[12]	11(5.3)[18]	4(6.7)[19]	81(71.7)[20]	17(22.1)[21]
Piped into dwelling	202(43.8)[17]	187(54.8)[10]	11(35.4)[3]	4(4.5)[12]	178(86.4)[18]	12(20.0)[19]	10(9.0)[20]	N/A
Piped outside compound	29(6.3)[17]	12(3.5)[10]	3(9.6)[3]	13(14.7)[12]	2(0.97)[18]	8(13.3)[19]	8(7.1)[20]	10(13.0)[21]
Protected spring	50(11.0)[17]	19(5.5)[10]	12(38.7)[3]	19(21.5)[12]	11(5.3)[18]	27(45.0)[19]	1(0.88)[20]	10(13.0)[21]
Protected Well	26(5.6)[17]	8(2.3)[10]	N/A	18(20.4)[12]	2(0.97)[18]	3(5.0)[19]	4(3.5)[20]	17(22.1)[21]
Water Treatment Method								
Boiled	95(20.6)[22]	79(23.1)[23]	9(31.0)[24]	7(7.9)[12]	73(35.6)[13]	16(27.6)[25]	4(3.5)[26]	1(1.30)[27]
Heated, not boiled	256(55.6)[22]	178(52.0)[23]	6(20.6)[24]	71(80.6)[12]	54(26.3)[13]	14(24.1)[25]	109(94.7)[26]	76(98.7)[27]
No preparation or treatment	109(23.7)[22]	85(24.8)[23]	14(48.2)[24]	10(11.3)[12]	78(38.1)[13]	28(48.3)[25]	2(1.74)[26]	N/A

[1]N=535, [2] N=392, [3]N=31, [4]N=111 [5]N=217, [6]N=63, [7]N=142, [8]N=107, [9]N=461,[10] N=341, [11] N=31, [12] N=88, [13]N=205, [14]N=60, [15]N=114, [16]N=77,[17]N=461, [18]N=206, [19]N=60, [20]N=113,[21]N=77, [22]N=460, [23] N= 342 [24]N=29, [25]N=58, [26]N=115, [27]N=77

Information not included in the table:
[a] Three and three respondent in Mecha report bathing the newborn.
[b] Twelve respondents use an unprotected spring (rural), and eight respondents use an unprotected well as bath water source for the newborn (peri-urban(n=3) rural(n=1) urban(n=4)).
N/A: No observations

Table 3: Newborn Care Characteristics Continued

Breastfeeding	**n(%)**	**Urban n(%)**	**Peri-Urban n(%)**	**Rural n(%)**	**Bahir Dar City n(%)**	**Bahirdar Zuira n(%)**	**Debre Tabor n(%)**	**Farta n(%)**
Percentage of newborns who are exclusively breastfed [c]								
	515(97.0)[27]	379(97.4)[28]	29(96.6)[29]	106(95.5)[30]	211(96.1)[31]	59(95.2)[32]	135(94.4)[33]	104(97.2)[34]
Do you wash your hands with soap and water or hand sanitizer before breastfeeding?								
Always	69(13.0)[35]	56(14.3)[36]	5(16.1)[37]	7(6.3)[38]	43(20.0)[39]	6(9.5)[40]	13(9.2)[41]	4(3.8)[42]
Sometimes	349(65.5)[35]	261(66.9)[36]	16(51.6)[37]	72(64.8)[38]	131(61.0)[29]	26(41.3)[40]	109(76.8)[41]	82(76.6)[42]
No	115(21.6)[35]	73(18.7)[36]	10(32.2)[37]	32(28.8)[38]	41(19.1)[39]	31(49.2)[40]	20(14.1)[41]	21(19.6)[42]
Diaper Care								
Percentage of respondents that use a diaper (disposable/local) for the newborn								
	368(69.0)[43]	291(74.4)[44]	24(77.4)[37]	53(47.7)[38]	199(92.6)[39]	47(74.6)[33]	75(52.4)[34]	44(41.1)[42]
Type of diaper used								
Disposable Diaper	117(31.8)[45]	112(38.6)[46]	4(3.4)[47]	1(0.85)[48]	87(43.7)[49]	5(10.5)[50]	20(20.1)[51]	2(4.6)[52]
Locally Prepared/Reusable Diaper	250(68.1)[45]	178(61.3)[46]	20(8.0)[47]	52(20.8)[48]	112(56.3)[49]	42(89.4)[50]	54(73.0)[51]	42(95.5)[52]
Newborn Care								
Who cares (bathing, breastfeeding, changing the diaper) for the newborn? [d]								
Mother	531(98.7)[53]				215(98.2)[54]	62(98.4)[55]	143(100.0)[54]	106(99.1)[55]
Father	89(16.5)[53]				54(24.7)[54]	2(3.2)[55]	25(17.5)[54]	8(8.0)[55]
Grandmother	77(14.3)[53]				15(7.0)[54]	11(17.5)[55]	30(21.0)[54]	21(19.6)[55]
Sister	38(7.1)[53]				18(8.2)[54]	7(11.1)[55]	6(4.2)[54]	6(5.2)[55]
Caregiver(maid)	13(2.4)[53]				10(4.6)[54]	2(3.2)[55]	1(0.7)[54]	N/A

[27]N=531,[28]N=389, [29]N=30, [30]N=11 [31]N=213, [32]N=62, [33]N=143, [34]N=107, [35]N=533,
[36] N=390, [37]N=31, [38]N=111 [39]N=215, [40]N=63, [41]N=142, [42]N=107,[43]N=534, [44]N=391, [45]N=367, [46] N=290, [47] N=24,
[48] N=53, [49]N=199, [50]N=47, [51]N=74, [52]N=44, [53]N=538, [54]N=219, [55]N=63, [54]N=143, [55]N=107

Information not included in the table:
[c] Four respondents for Mecha report to exclusively breastfeed newborn
[d] Two respondents report that a neighbor cares for the newborn
N/A: No observations

Table 3: Newborn Care Characteristics Continued

Cord Care	n(%)	Urban n(%)	Peri-Urban n(%)	Rural n(%)	Bahir Dar City n(%)	Bahirdar Zuira n(%)	Debre Tabor n(%)	Farta n(%)
Percentage of respondents that clean newborn's cord								
	135(25.4)[56]	89(22.8)[57]	3(2.2)[58]	42(31.3)[59]	26(12.1)[60]	4(6.4)[61]	49(35.5)[62]	53(50.0)[63]
What is used to clean the cord? [d]								
Chlorohexidine	3(0.93)[64]	2(0.92)[65]	1(12.5)[66]	N/A	1(2.0)[68]	N/A	N/A	N/A
Oil	26(8.1)[64]	10(4.6)[65]	N/A	16(16.6)[67]	N/A	N/A	8(5.6)[70]	18(17.0)[71]
Wash with water/soap	54(16.8)[64]	30(13.8)[65]	2(25.0)[66]	21(21.8)[67]	9(18.0)[68]	3(15.0)[69]	19(13.4)[70]	22(20.8)[71]
Nothing, left to dry on its own	229(71.1)[51]	170(78.3)	3(37.5)	56(58.3)	39(78.0)[68]	15(75.0)[69]	110(77.5)[70]	64(60.4)[71]
What was applied to make the cord dry? [e]								
Butter	50(15.2)[72]	20(8.9)[73]	1(11.1)[74]	29(29.9)[75]	N/A	N/A	17(12.2)[78]	31(29.3)[79]
Cow dung	9(2.7)[72]	4(1.7)[73]	N/A	5(5.1)[75]	N/A	N/A	3(2.2)[78]	6(5.7)[79]
Nothing - left open to dry	265(80.3)[56]	193(86.5)[73]	8(88.8)[74]	63(64.9)[75]	54(93.1)[76]	23(100.0)[77]	118(85.0)[78]	68(64.2)[79]
Percentage of mothers received any orientation/counseling from the hospital on cord care?								
	113(21.3)[80]	89(22.8)[81]	3(9.6)[82]	20(18.3)[83]	41(19.0)[84]	13(12.3)[85]	36(25.5)[86]	19(18.0)[87]

[56]N=532, [57]N=390, [58]N=31, [59]N= 110 [60]N=215, [61]N=63, [62]N=142, [63]N=106, [64]N=322, [65]N=217, [66]N=8, [67]N=96 [68]N=50, [69]N=20, [70]N=142, [71]N=106, [72]N=330, [73]N=223, [74]N=9 [75]N=97 [76]N=58, [77]N=23, [78]N=139, [79]N=106, [80]N=530, [81]N=389, [82]N=31, [83]N=109, [84]N=216, [85]N=61, [86]N=141, [87]N=106

Information not included in the table:
[d] Ten respondents report cleaning the cord with something else(not specified) (Urban (n=5) peri-urban (n=2))
[e] Six respondents (urban)report using another substance (not specified) to dry cord
N/A: No observations

We then evaluated the WASH conditions in the newborn households and reported newborn care practices (Table 3). Overall, 463 out of 535 respondents reported that they bathed the newborn since returning home from the hospital. For bath water, 92.7% of respondents reported using a safely managed water source. The majority of respondents reported to have obtained bath water from pipes in the dwelling (43.8%). In Bahir Dar City, the common bath water source was on

premise piped water (86.4%), In contrast, a common bath water source that respondents reported to use in Debre Tabor was water piped into the compound (71.7%). Respondents reported to practice good cord care practice such as leaving the cord alone or using Chlorohexidine to clean the newborn's cord which is considered to a recommended practice for newborn care in low- and middle-income countries. However, few mothers reported having received information on the orientation and cord care . Out of the 530 respondents, only 113 (21.3%) reported to have received orientation/counseling on cord care from the hospital (Table 3).

Tables 4a and 4b. Hand Hygiene Practices (n=538)

Table 4a.

Household Member	After Changing the Newborn's Diaper	After Using the Toilet	Before Breastfeeding	Does Not Wash Hands
Mother	361 (67.1)	503 (93.5)	103 (19.1)	14 (2.6)
Father	37 (6.8)	138 (26.6)	N/A	2(0.37)
Grandmother	15(2.7)	71(13.2)	2(0.37)	7(1.30)
Sister	22(4.0)	51(9.4)	1(0.19)	3(0.56)
Caregiver	16(2.9)	23 (4.2)	1 (0.19)	1 (0.19)
Neighbor	3 (0.56)	3 (0.56)	3 (0.56)	2(0.37)

N/A: No Observations

Table 4b.

Household Member	Soap and Water	Water Only
Mother (n=522)	377(72.2)	145 (27.7)
Father (n=150)	108 (72.0)	42(28.0)
Grandmother (n=81)	28(34.5)	53(65.4)
Sister (n=57)	36(63.1)	21 (36.8)
Caregiver (n=25)	13 (52.0)	12 (48.)
Neighbor (n=3)	2(66.6)	1(33.3)

N/A: No Observations

The main reported caregiver for newborns was mothers, and the majority of mothers reported washing their hands after using the toilet and after changing the newborn's diaper. For handwashing, 72.2% of mothers reported using soap and water (Table 4a. and Table 4b.).

Figure 1a and 1b. Primary Drinking Water Sources for Households (n=537)

Figure 1a.

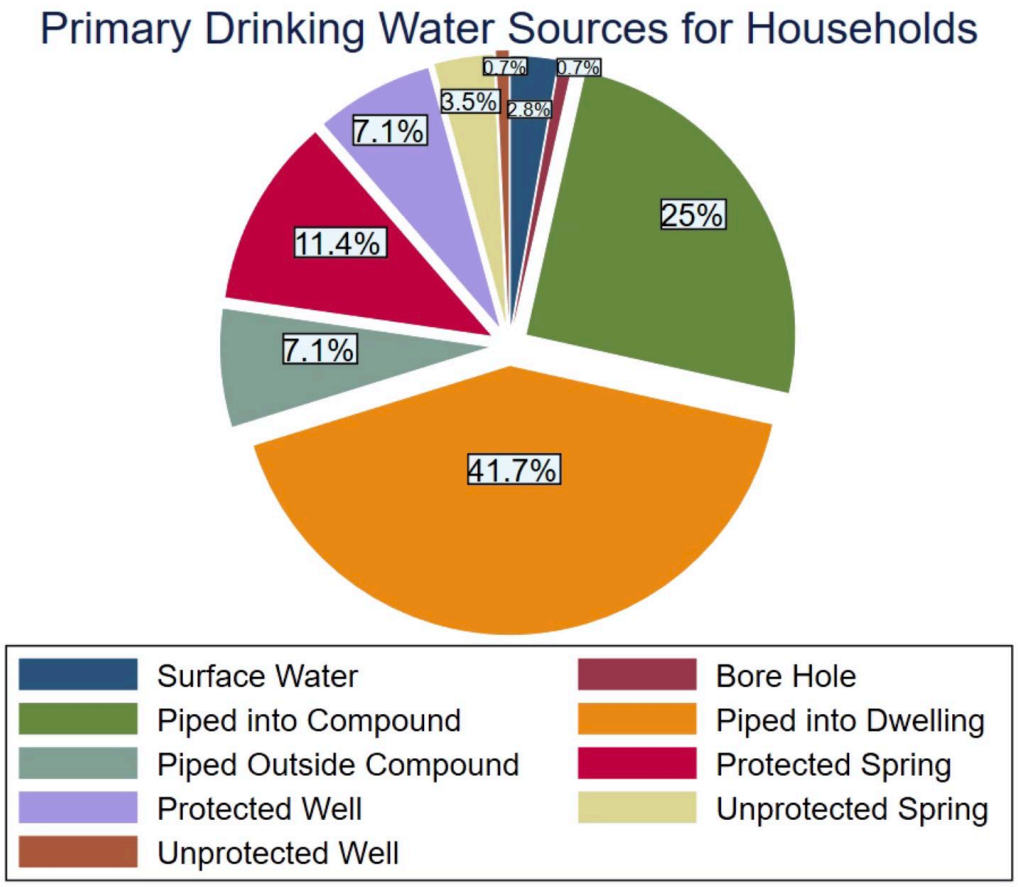
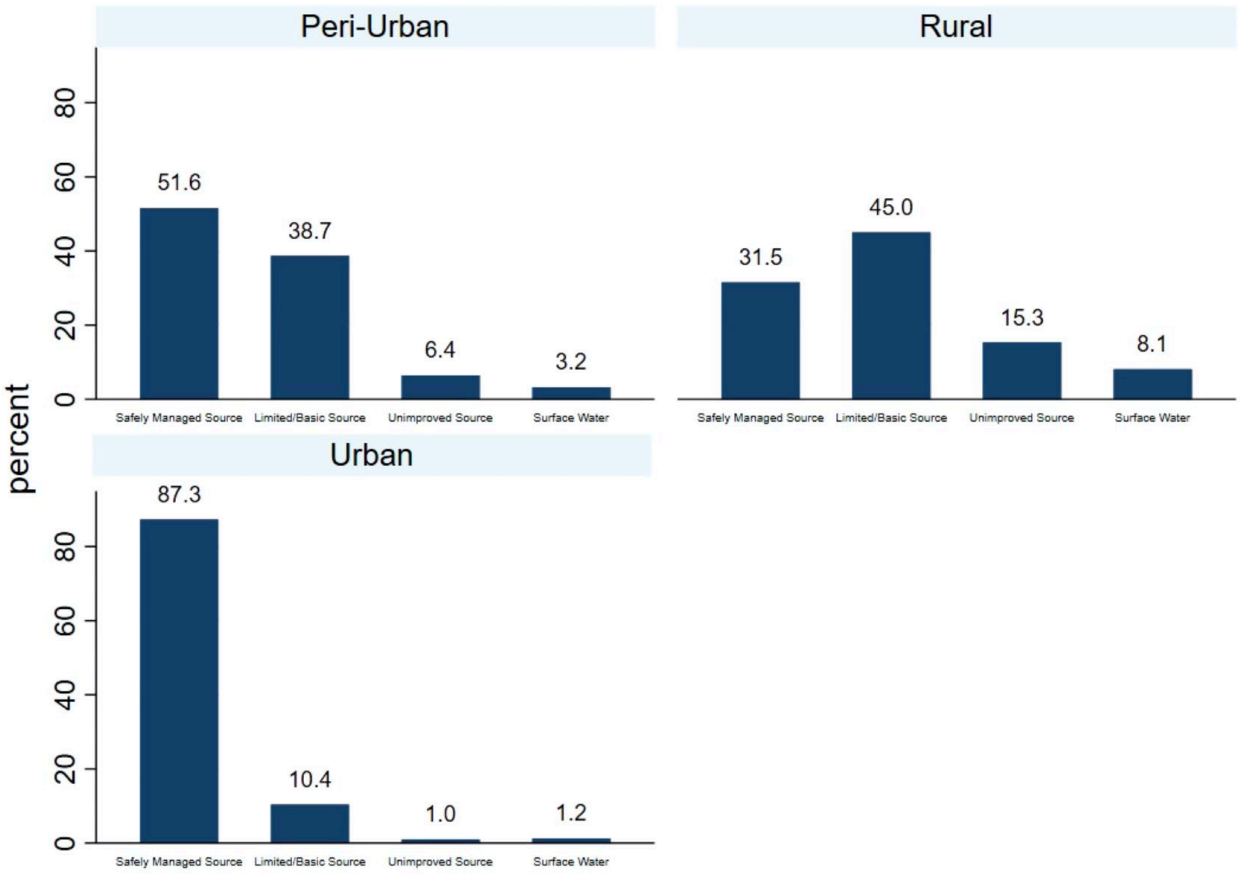


Figure 1b. Drinking Water Sources by Type and Setting



Most study households reported using drinking water from a piped system into their dwelling (41.7%) (Figure 1a.). Urban households acquired their drinking water from a safely managed water source (piped into dwelling, piped into compound, and piped outside compound) (Figure 1b.). In contrast, rural households primarily acquired drinking water from a limited/basic water source (bore hole, protected spring, and protected well) (Figure 1b.).

Table 5. Household Drinking Water Characteristics

Variable	n(%)	Urban n(%)	Peri-Urban n(%)	Rural n(%)
Household water access type (n=538)				
Water taps in house or on premise	293(54.5)	262(66.3)[1]	8(25.8)[2]	23(20.7)[3]
Water collected outside the house	319(59.3)	204(51.6)[1]	24(77.4)[2]	90(81.0)[3]
The average time it takes for households to collect water (min) (n=243)				
Mean± SD	14± 0.02	19.4±0.26[4]	39.6 ±0.23[5]	1.6±0.01[6]
Drinking Water Storage				
Piped Water	92(17.1)	90(22.7)[1]	2(6.4)[2]	
Jerry Can	502(93.3)	368(93.1)[1]	30(96.7)[2]	103(92.7)[3]
Pot	74(13.6)			
Water Storage Cleaning Frequency (n=535)				
Daily	73(13.6)	64(16.2)[7]	3(9.6)[2]	6(5.4)[8]
Several times of a Week	238(44.5)	185(47.0)[7]	21(67.7)[2]	32(29.0)[8]
Weekly	65(12.2)	50(12.7)[7]	3(9.6)[2]	12(10.9)[8]
When needed	158(29.5)	94(23.9)[7]	4(12.9)[2]	59(53.6)[8]
Water Treatment Frequency [b] (n=536)				
Always	22(4.1)	12(3.0)[9]		10(9.0)[2]
Sometimes	20 (3.7)	15(3.8)[9]	2(6.4)[8]	2(1.8)[2]
Not Treated	494(92.1)			
Household Water Treatment Methods(n=34) [c]				
Boil	10(29.4)	9(34.6)[10]	1(50.0)[2]	
Chemical	22(64.7)	11(42.3)[10]	1(50.0)[2]	9(75.0)[2]

[1]N= 395, [2]N=31, [3]N=111, [4]N=152, [5]N=9, [6]N=82,[7]N=393, [8]N=110,[9]N=394, [10]N=26, [11]N=2

Information not included in the table:

[a] One respondent (urban)reports using a Roto storage tank

[b] One respondent (rural) reported to never clean water storage tank (0.19%)

[c] One respondent identifies using the filter method(rural) (2.4%) and another respondent reports using the stand and settle method(rural)(2.9%)

Type of household water access was separated for collecting water outside the house vs. using water taps on the premise and in the household. For respondents that reported collecting water outside of the house, the average time was 14 minutes to collect water. Drinking water storage types ranged from piped water to pot. A commonly reported drinking water storage method for households was using jerry cans (93.3%). A commonly reported water treatment method was usage of chemicals (64.7%). For respondents that reported storing water, a common practice was to clean the water storage vessel several times a week (Table 5).

Table 6: Newborn Care Practices Stratified by Drinking Water Access

Variable	n(%)	Water Access: Piped into compounds, piped into dwelling, and piped outside compound	Water Access: Protected Spring and Well	Water Access: Unprotected Well, Unprotected Spring, and Body of Water
Percentage of respondents that bath the newborn (n=534)	462(86.5)	349(88.8)[1]	97(82.2)[2]	16(69.5)[3]
Bath Days of Life (n=460)				
1-7 Days	398(87.2)	293(85.1)[4]	90(93.7)[5]	15(3.2)[6]
8-14 days	32(7.0)	27(7.8)[4]	4(4.1)[5]	1(0.22)[6]
15-28 Days	26(5.7)	24(6.9)[4]	2(2.0)	
How often do you bath the newborn? (n=461)				
Every few days	46(10.0)	16(4.6)[7]	24(24.7)[8]	6(37.5)[9]
Once per day	208(45.2)	149(42.9)[7]	51(52.5)[8]	8(50.0)[9]
Twice per day	206(44.7)	182(52.4)[7]	22(22.6)[8]	2(12.5)[9]
Bath Water Source (n=461)				
Body of water (Surface Water)	14(3.0)	N/A	14(14.4)[11]	N/A
Bore hole	7(1.5)	3(0.86)[10]	4(4.1)[11]	N/A
Piped into compound	113(24.5)	112(32.1)[10]	1(1.03)[11]	N/A
Piped into dwelling	202(43.8)	199(57.1)[10]	3(3.09)[11]	N/A
Piped outside compound	29(6.2)	29(8.3)[10]	N/A	N/A
Protected spring	50(10.8)	N/A	49(50.5)[11]	1(6.2)[12]
Protected Well	26(5.6)	1(0.29)[10]	25(25.7)[11]	N/A
Unprotected Spring	12(2.6)	N/A	1(1.0)[11]	11(68.7)[12]
Unprotected Well	8(1.7)	4(1.1)[10]	N/A	4(25.0)[12]
Water Treatment Method (n=459)				
Boiled	95(20.7)	76(21.8)[13]	17(17.7)[14]	2(13.3)[15]
Heated, not boiled	255(55.5)	190(54.6)[13]	54(56.2)[14]	11(73.3)[15]
No preparation or treatment	109(23.7)	82(23.5)[13]	25(26.0)[14]	2(12.3)[15]
Breastfeeding				
Percentage of newborns who are exclusively breastfed (n=530)	514(96.9)	380(97.4)[16]	111(94.8)[17]	23(4.4)[18]

Table 6: Newborn Care Practices Stratified by Drinking Water Access, Continued

Do you wash your hands with soap and water or hand sanitizer before breastfeeding? (n=532)	n(%)	Water Access: Piped into compounds, piped into dwelling, and piped outside compound	Water Access: Protected Spring and Well	Water Access: Unprotected Well, Unprotected Spring, and Body of Water
Always	69(12.9)	54(13.8)[19]	14(11.8)[20]	1(4.3)[21]
Sometimes	348(65.4)	262(67.0)[19]	74(62.7)[20]	12(52.1)[21]
No	115(21.6)	75(19.1)[19]	30(25.4)[20]	10(43.4)[21]
Do you clean breast before breastfeeding?(n=528)	79(14.9)	60(15.5)[22]	18(15.2)[23]	1(4.3)[24]
Do you wash your hands before breastfeeding?(n=537)	103(19.1)	73(18.4)[25]	27(22.8)[26]	3(13.0)[27]
Hygiene				
Percentage of mothers that wash hands after using the toilet (n=537)	502(93.4)	373(94.1)[28]	109 (92.3)[29]	20(86.9)[30]
Percentage of mothers that do not wash hands (n=537)	14(2.6)	9(2.2)[31]	3(2.5)[32]	2(8.7)[33]
Diaper Care				
Percentage of respondents that use a diaper (disposable/local) for the newborn (n=533)	367(68.8)	282(71.9)[34]	76(64.4)[35]	9(39.1)[36]
What type of diaper do you use? (n=366)				
Locally Prepared/Reusable Diaper	249(68.0)	172(60.9)[37]	68(90.65)[38]	9(100.0)[39]
Disposable Diaper	118(31.9)	110(39.0)	7(9.3)	
Percentage of mother's that wash your hands after changing the newborn's diaper (n=537)	360(67.0)	293(73.9)[40]	65(55.0)[41]	2(8.7)[42]
Cord Care				
Percentage of respondents that clean newborn's cord (n=531)	135(25.4)	88(22.4)[43]	37(31.9)[44]	10(43.4)[45]
What is used to clean the cord? (n=321)				
Chlorohexidine	3(0.93)	2(0.87)[46]	1(0.31)[47]	N/A
Oil	26(8.1)	8(3.4)[46]	13(3.7)[47]	6(33.3)[48]
Wash with water/soap	54(16.8)	38(16.5)[46]	12(3.7)[47]	4(22.2)[48]
Nothing, left to dry on its own	228(71.0)	176(76.5)[46]	45(14.0)[47]	7(38.8)[48]
Other	10(3.1)	6(5.56)[46]	3(4.1)[47]	1(5.5)[48]

Table 6. Newborn Care Practices Stratified by Drinking Water Access, Continued

	n(%)	Water Access: Piped into compounds, piped into dwelling, and piped outside compound	Water Access: Protected Spring and Well	Water Access: Unprotected Well, Unprotected Spring, and Body of Water
What was applied to make the cord dry? (n=329)				
Butter	50(15.2)	25[49](10.5)	19(25.3)[50]	6(33.3)[51]
Cow dung	9(2.7)	2[49](0.85)	6(8.0)[50]	1(5.5)[51]
Nothing - left open to dry	264(80.2)	204[49](86.4)	49(65.3)[50]	11(61.1)
Percentage of mothers received any orientation/counseling from the hospital on cord care? (n=530)	113(21.3)	87(28.3)[52]	22(18.9)[53]	4(17.3)[54]

[1] N=393, [2] N=118, [3]N=23, [4]N=344, [5]N=96, [6]N=16 [7] N=347, [8]N=97, [9] N=16 [10]N=348, [11]N=97 [12]N=16, [13] N=348,[14] N=96, [15] N=15, [16] N=390, [17]N=117, [18] N=23, [19] N= 391, [20]N=118, [21]N= 23 [22]N=387, [23] N=118, [24]N=23, [25]N=396, [26]N=118, [27]N=23, [28]N=396, [29]N=118 [30] N= 23, [31]N=396,[32] N=118 [33] N= 23, [34] N=392 [35] N= [36] N=23, [37]N= 282, [38] N=75, [39]N=9, [40] N=396, [41] N=118,[42]N= 23,[43]N=392 [44]N=116,[45]N =23 [46]N=230, [47] N=73,[48]N=18, [49] N=236, [50]N=75 [51] N= 18 [52]N= 309, [53]N=116, [54] N=23
N/A: No observations

We examined how differences in water access may affect the newborn care practices reported by respondents using bivariate analysis. For all three categories of water accessibility, respondents generally reported practicing safe newborn care such leaving the cord leaving the cord alone to dry, washing hands after changing the newborn's diaper, and practicing exclusive breastfeeding. However, most respondents reported to wash their hands only sometimes wash their hands before breastfeeding the newborn (Table 6).

Figure 2a and 2b Household Toilet Type Access (n=533)

Figure 2a.

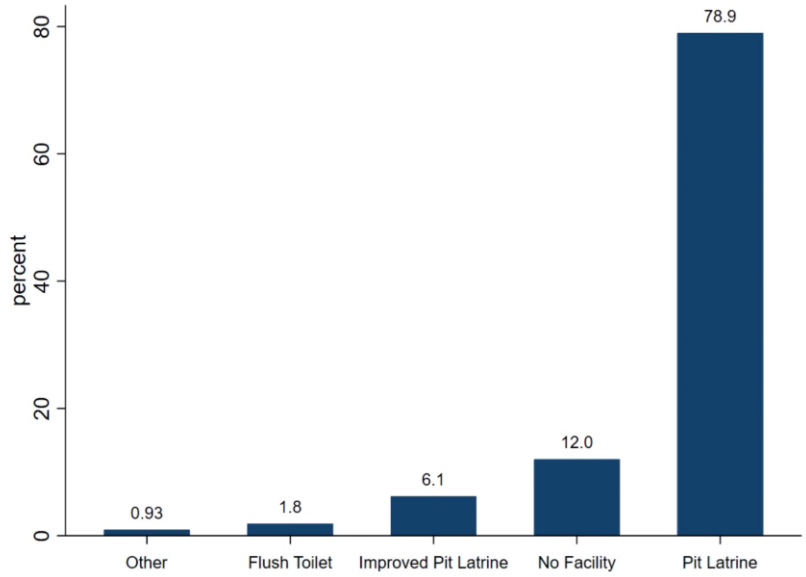
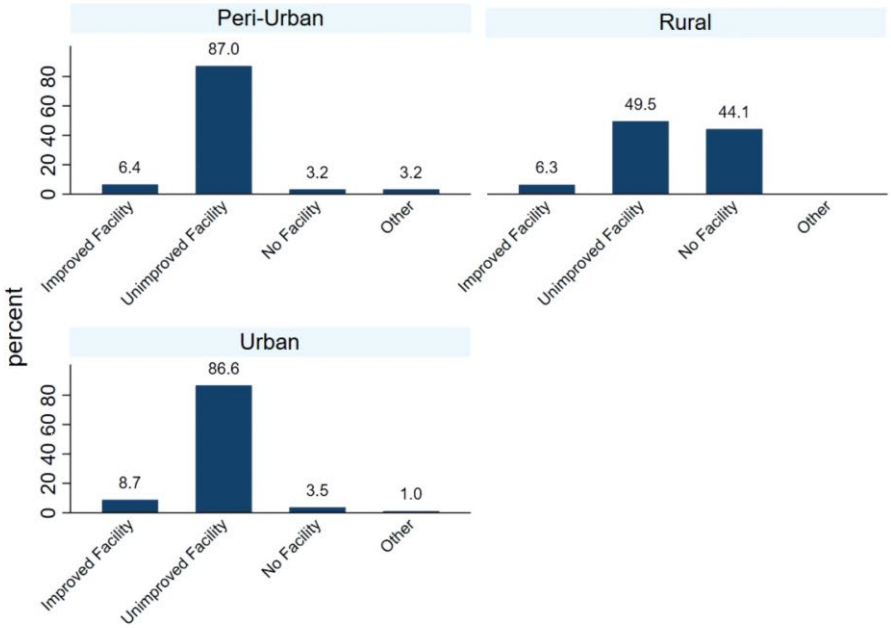


Figure 2b.



Type of household toilet was analyzed and categorized according to the JMP sanitation ladder. The majority of respondents reported having a sanitation facility in their household (86.8%). However, 87.0% of urban households and 49.5% of rural households reported having an unimproved sanitation facility (Figure 2a. and 2b.).

Figure 3a. and 3b. Toilet Ownership (n=482)

Figure 3a.

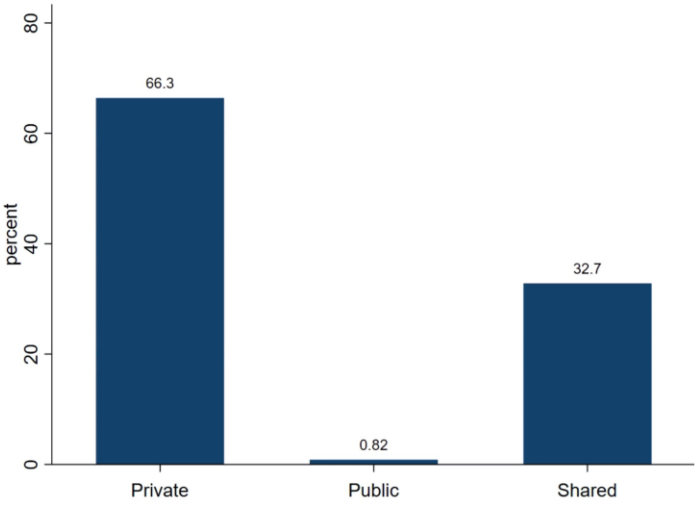
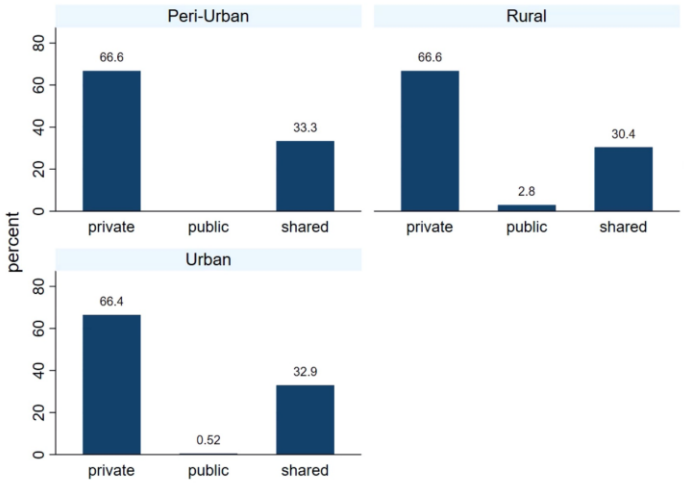


Figure 3b.



Private ownership of a toilet was high among respondents living urban households. Most respondents living in rural areas of Amhara also reported having access to a private household toilet (Figure 3a and 3b.).

Table 7: Household Environment Observations

Variables	n(%)	Urban n(%)	Peri-Urban n(%)	Rural n(%)
Is the general condition of the family's house clean? (n=535)				
Yes	379(70.8)	223(56.6)[1]	20(64.5)[2]	24(21.6.)[3]
No	156(29.2)	171(43.4)[1]	11(35.4)[2]	87(78.3)[3]
Is the general condition of the compound clean? (n=537)				
Yes	268(49.1)	312(79.3)[4]	22(70.9)[2]	44(40.4)[5]
No	269(50.1)	80(20.6)[4]	9(29.0)[2]	66(60.6)[5]
What handwashing supplies are available in the household ? (n=538)				
Water Only	147(27.3)	105(26.5)[6]	21(67.7)[2]	21(18.9)[3]
Soap Only	8(1.5)	1(1.7)[6]		1(0.90)[3]
Water and Soap	170(31.6)	151(38.2)[6]	6(19.3)[2]	12(10.8)[3]
Hand Sanitizer	2(0.37)	2(0.51)[6]		
No Handwashing Facility	228(42.4)	150(37.9)[6]	4(12.9)[2]	74(66.6)[3]
Is the toilet in use? (n=534)				
Yes	457(85.6)	369(93.6)[1]	25(80.6)[2]	62(57.1)[3]
No	11(2.1)	8(2.0)[1]	2(6.4)[2]	1(0.93)[3]
Not applicable	66(12.4)	17(4.3)[1]	4(12.9)[2]	45(41.6)[3]
Is the toilet visibly clean? (n=533)				
Yes	270(50.7)	230(58.3)[1]	16(53.3)[8]	23(21.3)[7]
No	194(36.4)	145(36.8)[1]	10(33.3)[8]	39(36.1)[7]
Not applicable	69(13.0)	19(4.8)[1]	4(13.3)[8]	46(42.5)[7]
Is there presence of feces in the toilet? (n=534)				
Yes	178(33.3)	135(34.3)[4]	8(25.8)[2]	34(31.9)[9]
No	288(54.0)	240(61.0)[4]	19(61.2)[2]	29(26.6)[9]
Not applicable	68(12.7)	18(4.5)[4]	4(12.9)[2]	46(42.2)[9]
Are there flies in the toilet? (n=534)				
Yes	301(56.4)	236(59.9)[1]	15(50.0)[8]	49(44.9)[9]
No	165(31.0)	140(35.3)[1]	11(36.6)[8]	14(12.8)[9]
Not applicable	68(12.7)	18(4.5)[1]	4(13.3)[8]	46(42.2)[9]
Is there an unpleasant smell in the toilet? (n=535)				
Yes	275(51.4)	218(55.3)[1]	16(53.3)[8]	40(36.3)[5]
No	194(36.3)	159(40.3)[1]	11(36.6)[8]	24(21.8)[5]
Not applicable	66(12.3)	17(4.3)[1]	3(10.0)[8]	46(41.8)[5]

[1]N= 394, [2]N=31, [3]N=111,[4]N=393, [5]N=110,[6]N=395, [7]N=108, [8]N=30, [9]N=109

In general, the household and compound conditions appeared clean to the study staff members who conducted the household surveys. Handwashing facilities were absent in 42.4% of

the households, but the survey team reported that 31.6% of households did have hand washing supplies such as water and soap. Toilet usage was high among the households and most toilets were visibly clean (Table 7).

Table 8: Newborn Care Practices Stratified by Sanitation Access

Variable	n(%)	No Access to Sanitation Facility	Access to Sanitation Facility
Percentage of respondents that bath the newborn (n=525)	454(86.4)	52(11.4)[1]	402(87.2)[2]
Bath Days of Life (n=449)			
1-7 Days	392(87.3)	47(10.4)[3]	345(89.9)[4]
8-14 days	31(6.9)	4(0.89)[3]	27(6.0)[4]
15-28 Days	26(5.7)	1(0.22)[3]	25(5.5)[4]
How often do you bath the newborn? (n=452)			
Every few days	46(10.1)	47(90.3)[5]	345(86.9)[6]
Once per day	201(44.4)	4(7.6)[5]	27(6.8)[6]
Twice per day	205(45.3)	1(1.92)[5]	25(6.3)[6]
Bath Water Source (n=452)			
Body of water (Surface Water)	14(3.1)	13(25.0)[7]	1(0.25)[8]
Bore hole	6(1.3)		6(1.5)[8]
Piped into compound	112(24.7)	3(5.77)[7]	109(27.2)[8]
Piped into dwelling	197(43.5)	1(0.22)[7]	196(49.0)[8]
Piped outside compound	29(6.4)	3(5.7)[7]	26(6.5)[8]
Protected spring	48(10.6)	8(15.3)[7]	40(10.0)[8]
Protected Well	26(5.7)	11(21.1)[7]	15(3.7)[8]
Unprotected Spring	12(2.6)	12(23.0)[7]	
Unprotected Well	8(1.77)	1(0.22)[7]	7(1.5)[8]
Water Treatment Method (n=451)			
Boiled	94(20.8)	7(13.4)[9]	87(21.8)[10]
Heated, not boiled	252(55.8)	43(82.6)[9]	209(52.3)[10]
No preparation or treatment	105(23.2)	2(3.8)[9]	103(25.8)[10]
Breastfeeding			
Percentage of newborns who are exclusively breastfed (n=523)	505(96.9)	61(95.3)[11]	444(97.1)[12]
Do you wash your hands with soap and water or hand sanitizer before breastfeeding? (n=523)			
Always	67(12.8)	2(3.1)[13]	65(14.1)[14]
Sometimes	345(65.9)	37(58.7) [13]	87(18.9)[14]
No	111(21.2)	24(38.1)[13]	308(66.9)[14]

Table 8: Newborn Care Practices Stratified by Sanitation Access, Continued

Variable	n(%)	No Access to Sanitation Facility	Access to Sanitation Facility
Do you clean breast before breastfeeding? (n=520)	79(15.1)	6(9.5)[15]	73(15.9)[16]
Percentage of mothers that wash hands before breastfeeding (n=528)	102(19.3)	14(21.8)[17]	88(19.6)[18]
Hygiene			
Percentage of mothers that wash hands after using the toilet (n=528)	494(93.5)	54(84.3)[19]	440(94.8)[20]
Percentage of mothers that do not wash hands (n=528)	14(2.6)	5(7.8)[21]	9(1.9)[22]
How does the mother wash her hands? (n=512)			
water only	140(27.3)	33(54.1)[23]	107(23.7)[24]
soap and water	372(72.6)	28(45.9)[23]	344(76.2)[24]
Diaper Care			
Percentage of respondents that use a diaper (disposable/local) for the newborn (n=524)	361(68.8)	21(33.3)[25]	340(73.7)[26]
What type of diaper do you use? (n=360)			
Locally Prepared/ Reusable Diaper	243(67.5)	20(95.2)[27]	223(65.7)[28]
Disposable Diaper	117(32.5)	1(4.7) [27]	116(32.2)[28]
Percentage of mothers that do not wash hands after changing newborn's diaper (n=528)	354(67.0)	15(23.4)[29]	339(73.0)[29]
Cord Care			
Percentage of respondents that clean newborn's cord (n=522)	131(25.1)	33(52.3)[30]	98(21.3)[31]
What is used to clean the cord? (n=315)			
Chlorohexidine	3(0.95)	N/A	3(1.1)[33]
Oil	26(8.2)	17(29.8)[32]	9(3.4)[33]
Wash with water/soap	52(16.5)	7(12.2) [32]	45(17.4)[33]
Nothing, left to dry	226(71.7)	30(52.6)[32]	196(75.9)[33]

Table 8: Newborn Care Practices Stratified by Sanitation Access, Continued

Variable	n(%)	No Access to Sanitation Facility	Access to Sanitation Facility
What was applied to make the cord dry? (n=323)			
Butter	48(14.8)	20(34.4)[34]	28(10.5)[35]
Cow dung	9(2.7)	7(12.0)[34]	2(0.75)[35]
Nothing - left open to dry	260(80.5)	31(53.4)[34]	229(86.4)[35]
Percentage of mothers received any orientation/counseling from the hospital on cord care? (n=521)	112(21.5)	11(17.4)[36] n=63	101(22.0)[37] n=458

[1] N=64, [2] N=461, [3]N=52, [4]N=397, [5]N=52, [6]N=400 [7] N=52, [8]N=400, [9] N=52, [10]N=399, [11]N=64, [12]N=457,[13] N=64, [14] N=460, [15] N=63, [16] N=457, [17]N=64, [18] N=464, [19] N=64, [20]N=464, [21]N=64, [22]N=464,[23] N=61, [24]N=451, [25]N=63, [26]N=461 ,[27]N=21, [28]N=64, [29]N=464, [30] N=63 [31]N=459, [32] N=57,[33] N= 258,[34] N= 58,[35] N= 265,[36] N=63, [37]N=458

Respondents with access to a sanitation facility usually reported to also have access to a safely managed water source. More respondents who reported having access to a sanitation facility reported having received orientation and counseling from the hospital on cord care and were practicing safer cord care compared to those who reported having no access to a facility (Table 8).

Table 9: Association Between Household Demographic Factors and Improved Toilet Ownership in Study Households (n=362)

Variable	Adjusted Odds Ratio	Reference
Education Status of Mother		
Primary Education	0.35 (0.06,1.98)	None
Secondary Education	0.27 (0.04, 1.83)	None
Degree or Higher	0.59 (0.06, 5.50)	None
Technical/Vocational Certificate	0.39 (0.04, 3.36)	None
Household Income		
≤20,000	0.53 (0.14, 1.99)	20,001-39,000
39,001-59,000	**3.31 (1.12, 9.69)**	**20,001-39,000**
≥59,001	0.80 (0.12, 5.01)	20,001-39,000
Woreda		
Debre Tabor	**6.43 (2.07, 19.91)**	**Bahir Dar City**
Farta + Libokekem	1.96 (0.37, 10.39)	Bahir Dar City
Occupation of Mother		
Merchant + Petty Trade	3.05 (0.98, 9.50)	Housewife
Professional + Religious Leader	2.91 (0.60, 9.50)	Housewife
Skilled + Student	0.20 (0.01, 2.37)	Housewife
Unskilled	1.51 (0.16, 14.0)	Housewife

Bolded aORs were significant at p<0.05.

Information not included in the table:
Observations are few for the woreda category: Bahirdar Zuira + Mecha (AOR <0.001 (<0.001, >999.99)) Reference: Bahir Dar City.
Observations are few for the occupation category: Farmer (AOR <0.001 (<0.001, >999.99)) Reference: Housewife
Observations are few for the occupation category: Student (AOR <0.001 (<0.001, >999.99)) Reference: Housewife

Using logistic regression, we examined the factors that affected whether a study household had an improved toilet as defined by the JMP (Table 9). Covariates in this model included a range of socioeconomic factors. The odds of owning an improved toilet type were 6.43 (CI: 2.07, 19.91) times higher among respondents living in Debre Tabor compared to respondents living in Bahidar city when controlling for educational status, household income, and occupation. The odds of owning an improved toilet type were 3.05 (CI: 0.98, 9.50) times higher for mothers that reported they were merchants and petty traders compared to housewives (Table 9).

Table 10: Association Between Household Demographic Factors and Having a Safely Managed Drinking Water Source in Study Households (n=364)

Variable	Adjusted Odds Ratio	Reference
Education Status of Mother		
Primary Education	0.37 (0.03, 4.04)	None
Secondary Education	0.46 (0.03, 6.58)	None
Degree or Higher	0.35 (0.009, 14.47)	None
Technical/Vocational Certificate	0.50 (0.01, 13.04)	None
Household Income		
≤20,000	2.24 (0.579, 8.72)	20,001-39,000
39,001-59,000	**12.36 (1.32, 115.41)**	**20,001-39,000**
Woreda		
Bahirdar Zuira + Mecha	**0.08 (0.01, 0.69)**	**Bahir Dar City**
Debre Tabor	0.98 (0.11, 8.62)	Bahir Dar City
Farta+ Libokekem	0.05 (0.009,0.38)	Bahir Dar City
Occupation of Mother		
Farmer	2.04 (0.34, 12.03)	Housewife
Merchant + Petty Trade	1.54(0.15,15.44)	Housewife
Professional + Religious Leader	0.77 (0.07, 8.06)	Housewife
Skilled	0.25 (0.018, 3.60)	Housewife

Bolded aORs were significant at p<0.05

Information not included in the table:
Observations are few for household income category : ≥59,001 (AOR >999.99 (<0.001, >999.99)) Reference: 20,001-39,000.
Observations are few for the occupation category: skilled (AOR >999.99 (<0.001, >999.99)) Reference: Housewife
Observations are few for the occupation category: student (AOR >999.99 (<0.001, >999.99)) Reference: Housewife

In order to assess the association between safely managed drinking sources and socioeconomic characteristics, a logistic regression analysis was conducted. Improved drinking water source was the outcome variable for this model and was dichotomized based on the JMP definition of safely managed drinking water. Covariates in this model included a range of socioeconomic factors. Reported household income was an important predictor of household drinking water source. The odds of households having access to an improved drinking water source were 12.36 (95% CI: 1.32, 115.41) times higher for respondents who reported to have income of 39,001-59,000 birr compared to respondents that reported to have a lower income when controlling for

occupation status, woreda, and educational status. The odds of households having access to an improved drinking water were 2.04 (95% CI: 0.34, 12.03) times higher for respondents who reported to be a farmer compared to respondents who were housewives when controlling for woreda, household income, and educational status of mother (Table 10).

Table 11: Association between Neonatal Sepsis and Reported Newborn Care Practices

Variable	Crude Odds Ratio	Reference Group
Water Source (n=146)		
Unimproved Source (unprotected spring and well, and body of water)	0.45(0.14,1.36)	improved source (piped into dwelling, piped outside compound piped into compound, borehole, protected spring, and protected well)
Water Source Collected(n=146)		
yes	1.54 (0.75,3.03)	no
Water Storage Method (n=146)		
Uses a jerry can	**0.33(0.11,0.95)**	**Does not use Jerry Can**
Uses a pot	**0.38(0.15,0.96)**	**Does not use pot**
Water Storage Cleaning Frequency (n=146)		
Several Times a Week	1.0(0.44, 2.71)	**Daily**
Weekly	3.2(0.89, 12.13)	Daily
When Needed	**3.3(1.22,9.34)**	**Daily**
Water Treatment Frequency (n=146)		
Sometimes	0.18(0.01,2.91)	Always
Not treated	0.24(0.02,1.99)	Always
Wash Newborn (n=145)*		
No	**3.7(1.0,13.27)**	**Yes**
Bath Days of Life (n=111)		
8-14 days	3.10(0.83,11.58)	1-7 days
15-28 Days	1.2(0.34,4.46)	1-7 days
Bath Frequency (n=114)		
Every Few Days	6.2(0.73,52.39)	Twice per day
Once per day	0.76(0.33,1.73)	Twice per day
Bath Water Source		
Unimproved Source (unprotected spring and well, and body of water) (n=114)	0.62(0.15,2.47)	improved source (piped into dwelling, piped outside compound piped into compound, borehole, protected spring, and protected well)
Bath Water Treatment Method (n=114)		
Heated	1.69(0.69,4.09)	Boiled
None	0.88(0.26,2.96)	Boiled

Bolded cORs were significant at $p<0.05$.

Table 11: Association between Neonatal Sepsis and Reported Newborn Care Practices, Continued

Variable	Crude Odds Ratio	Reference Group
Washing Hands to breastfeed (n=143)		
Sometimes	0.46(0.14,1.50)	Always
No	**0.2(0.08, 0.99)**	**Always**
Clean Breast before Breastfeeding (n=143)		
No	0.43(0.13,1.36)	Yes
Toilet Type in household (n=144)		
Unimproved Sanitation (pit latrine)	0.69(0.17,2.67)	Improved Sanitation Facility (improved pit latrine and flush toilet)
Diaper Usage (n=143)		
no	0.76(0.37,1.57)	Yes
Diaper Type (n=89)		
Reusable	0.76(0.30,1.89)	Disposable
Hygiene		
Mother does not wash hands after changing diaper (n=146)	1.4 (0.66,3.02)	Mother does wash hands after changing diaper
Mother does not wash hands after using the toilet (n=146)	1.2(0.23,6.61)	Mother does wash hands after using the toilet
Mother does not hands before breastfeeding (n=146)	0.49 (0.21,1.15)	Mother does hands before breastfeeding
Mother does not wash hands (n=146)		Mother does wash hands
Mother uses water only to wash hands (n=143)	0.65(0.30,1.37)	Mother uses soap and water to wash hands
Cord is not cleaned (n=144)	0.70(0.30,1.60)	Cord is cleaned
Cleaning material for cord (n=106)		
oil	0.63(0.14,2.77)	nothing
soap and water	0.31(0.09,1.09)	nothing
Material used to dry cord(n=108)		
butter	0.67(0.22,2.04)	nothing
cow dung	1.6(0.17,15.15)	nothing

Table 11: Association between Neonatal Sepsis and Reported Newborn Care Practices, Continued

Variable	Crude Odds Ratio	Reference Group
Cord Care Counseling		
Did not receive cord care counseling (n=144)	0.95(0.45,2.00)	Received cord counseling

Bolded cORs were significant at $p<0.05$.

In order to assess the association between neonatal sepsis and newborn care practices, logistic regression analysis was conducted to determine the household factors influencing this diagnosis. Respondents that reported to store water via a jerry can were 0.33 (95% CI: 0.11,0.95) times less likely to have a newborn diagnosed with sepsis compared to respondents that stored their water in an open pot. Respondents who reported to clean the water storage vessel only when needed, had an increased odds of a newborn being diagnosed with sepsis (cORs: 3.3, 95% CI:1.22, 9.3) compared to respondents who reported that they cleaned their water storage vessel daily. Households who reported to not wash the baby had an increased odds of neonatal sepsis diagnosis (cOR:3.7, 95% CI:1.0,13.27) (Table 11).

Table 12: Association between Early-Onset Neonatal Sepsis and Reported Newborn Care Practices

Variable	Crude Odds Ratio	Reference Group
Water Source (n=146)		
Unimproved Source	0.54(0.16,1.82)	improved source (piped into dwelling, piped outside compound piped into compound, borehole, protected spring, and protected well)
Water Source Collected(n=146)		
yes	0.53(0.27,1.05)	no
Water Storage Method (n=146)		
Uses a jerry can	0.3(0.12,1.09)	Does not use Jerry Can
Uses a pot	0.71(0.32,1.55)	Does not use pot
Water Storage Cleaning Frequency (n=146)		
Several Times a Week	**0.40(0.15,1.00)**	**Daily**
Weekly	0.34(0.11,0.79)	Daily
When Needed	**0.30(0.11,0.79)**	**Daily**
Water Treatment Frequency (n=146)		
Sometimes	12.00(0.77, 186.26)	Always
Not treated	5.8(0.71, 48.4)	Always
Wash Newborn (n=145)		
No	**3.0(1.21,7.47)**	**Yes**
Bath Days of Life (n=111)		
8-14 days	**3.5(1.2, 10.24)**	**1-7 days**
15-28 Days	**4.0(1.14,13.97)**	**1-7 days**
Bath Frequency (n=114)		
Every Few Days	**0.18(0.03,0.91)**	**Twice per day**
Once per day	**0.42(0.18,0.96)**	**Twice per day**
Bath Water Source		
Unimproved Source (unprotected spring and well, and body of water (n=114)	0.2(0.02,1.68)	improved source (piped into dwelling, piped outside compound piped into compound, borehole, protected spring, and protected well)
Bath Water Treatment Method (n=114)		
Heated	1.1(0.48,2.81)	Boiled
None	0.86(0.24,3.31)	Boiled
Washing Hands to breastfeed (n=143)		
Sometimes	0.69(0.21,1.74)	Always
No	0.80(0.28,2.260	Always

Bolded cORs were significant at $p<0.05$

Table 12: Association between Early-Onset Neonatal Sepsis and Reported Newborn Care Practices, Continued

Variable	Crude Odds Ratio	Reference Group
Clean Breast before Breastfeeding (n=143)		
No	0.81(0.32,2.03)	Yes
Toilet Type in household (n=144)		
Unimproved Sanitation (pit latrine)	0.46(0.14,1.54)	Improved Sanitation Facility (improved pit latrine and flush toilet)
Diaper Usage (n=143)		
no	0.79(0.39,1.58)	Yes
Diaper Type (n=89)		
Reusable	**0.39(0.15,0.94)**	**Disposable**
Hygiene		
Mother report who does not wash hands after changing diaper (n=146)	0.76(0.38,1.52)	Mother does wash hands after changing diaper
Mother reports who do not wash hands after using the toilet (n=146)	1.07(0.23,5.00)	Mother does wash hands after using the toilet
Mother does not hands before breastfeeding (n=146)	0.80(0.38,1.67)	Mother does hands before breastfeeding
Mother does not wash hands (n=146)	0.80(0.38,1.67)	Mother does wash hands
Mother uses water only to wash hands (n=143)	0.83(0.39,1.73)	Mother uses soap and water to wash hands
Cord is not cleaned (n=144)	1.6(0.74,3.58)	Cord is cleaned
Cleaning material for cord (n=106)		
oil	0.30(0.06,1.57)	nothing
other	0.53(0.09,3.11)	nothing
soap and water	1.0(0.32,3.63)	nothing
Material used to dry cord(n=108)		
butter	**0.20(0.05,0.77)**	nothing
cow dung	0.22(0.02,2.07)	nothing
Cord Care Counseling		
Did not receive cord care counseling (n=144)	**0.27(0.13, 0.56)**	**Received cord counseling**

Bolded cORs were significant at $p<0.05$.

In order to assess the association between early-onset sepsis and newborn care practices, logistic regression analysis was conducted to determine factors influencing this diagnosis. The odds of a newborn diagnosed with early-onset sepsis were significantly higher when respondents reported to have not washed the newborn (cOR:3.0, 95% CI:1.21,7.47) compared to households that

reported bathing their newborn. Day of life when the newborn was reported first have a bath was also associated with diagnosis of early-onset sepsis of newborns. The odds of a newborn diagnosed with early-onset sepsis were more likely when the respondents report to bathe the newborn during 8-14 days of life and 15-28 days of life (cOR:3.5 95%CI:1.2, 10.24) (cOR:4.0 95% CI:1.14,13.97) compared to newborns who were bathed in the first seven days of life. Cord care counseling, diaper type, bathing frequency, and cleaning frequency of the household water storage vessels were weakly associated with diagnosis of early-onset neonatal sepsis (Table 12).

Table 13: Association between Late-Onset Neonatal Sepsis and Reported Newborn Care Practices

Variable	Crude Odds Ratio	Reference Group
Water Source (n=146)		
Unimproved Source (unprotected spring, unprotected well)	1.8(0.54,6.17)	Improved Source (piped into dwelling, piped outside compound piped into compound, borehole, protected spring, and protected well)
Water Source Collected(n=146)		
yes	1.8(0.95,3.61)	no
Water Storage Method (n=146)		
Uses a jerry can	2.6(0.91, 7.79)	Does not use Jerry Can
Uses a pot	1.3(0.64,3.03)	Does not use pot
Water Storage Cleaning Frequency (n=146)		
Several Times a Week	**2.5(0.99,6.29)**	**Daily**
Weekly	2.9(0.91,9.46)	Daily
When Needed	**3.2(1.26,8.46)**	**Daily**
Water Treatment Frequency (n=146)		
Sometimes	0.08(0.05,1.29)	Always
Not treated	0.17(0.02,1.39)	Always
Wash Newborn (n=145)		
No	0.33(0.13, 0.82)	Yes
Bath Days of Life (n=111)		
8-14ays	**0.28(0.09,0.80)**	**1-7 days**
15-28 Days	**0.25(0.07, 0.87)**	**1-7 days**
Bath Frequency (n=114)		
Every Few Days	**5.4(1.09,27.74)**	**Twice per day**
Once per day	**2.2(1.03, 5.33)**	**Twice per day**
Bath Water Source		
Unimproved Source (unprotected spring and well, and body of water (n=114)	0.20(0.02,1.68)	improved source (piped into dwelling, piped outside compound piped into compound, borehole, protected spring, and protected well)
Bath Water Treatment Method (n=114)		
Heated	0.85(0.35,2.07)	Boiled
None	1.1(0.31,4.16)	Boiled
Washing Hands to breastfeed (n=143)		
Sometimes	1.4(0.57,3.68)	Always
No	1.2(0.44,3.47)	Always
Clean Breast before Breastfeeding (n=143)		
No	1.2(0.49,3.05)	Yes

Table 13: Association between Late-Onset Neonatal Sepsis and Reported Newborn Care Practices, Continued

Variable	Crude Odds Ratio	Reference Group
Toilet Type in household (n=144)		
Unimproved Sanitation (pit latrine)	2.1(0.64,7.14)	Improved Sanitation Facility (improved pit latrine and flush toilet)
Diaper Usage (n=143)		
no	1.2(0.63, 2.52)	Yes
Diaper Type (n=89)		
Reusable	**2.5(1.06,6.04)**	**Disposable**
Hygiene		
Mother does not wash hands after changing diaper (n=146)	1.3(0.65,2.60)	Mother does wash hands after changing diaper
Mother does not wash hands after using the toilet (n=146)	0.92(0.20,4.29)	Mother does wash hands after using the toilet
Mother does not hands before breastfeeding (n=146)	1.2(0.59, 2.59)	Mother does hands before breastfeeding
Mother does not wash hands (n=146)	1.4(0.08, 23.49)	Mother does wash hands
Mother uses water only to wash hands (n=143)	1.2(0.57,2.51)	Mother uses soap and water to wash hands
Cord is not cleaned (n=144)	0.61(0.27,1.34)	Cord is cleaned
Cleaning material for cord (n=106)		
oil	3.2(0.63,15.59)	nothing
other	1.8(0.32,10.70)	nothing
soap and water	0.92(0.27, 3.12)	nothing
Material used to dry cord(n=108)		
butter	**4.8(1.29,18.27)**	**nothing**
cow dung	4.4(0.48,41.72)	nothing
Cord Care Counseling		
Did not receive cord care counseling (n=144)	**3.6(1.77,7.58)**	**Received cord counseling**

Bolded cORs were significant at $p<0.05$.

In order to assess the association between late-onset neonatal sepsis and newborn care practices a logistic regression was conducted to determine the factors influencing this diagnosis. The odds of

newborn being diagnosed with late-onset sepsis were 4.8 (95% CI:1.29,18.27) times higher when the respondents reported to use butter as a drying material for the cord when compared to respondents who reported using nothing. Respondents that reported not to have received cord care counseling was associated with an increased risk of diagnosis with late-onset neonatal sepsis 3.6 cOR (95% CI:1.77,7.58). Compared to those who reported to bath their newborn, the odds of late-onset sepsis were 5.4 (95% CI:1.09,27.74) times higher for respondents that reported to not bath the newborn (Table 13).

Chapter 4: Discussion

Overview

The purpose of this study was to: 1) characterize household WASH conditions and socio-economic factors, 2) identify determinants of safe and unsafe household WASH conditions, and 3) examine the associations between household WASH conditions, newborn care practices, and sepsis for a cohort of infants who were recruited at birth at Felege Hiwot Hospital in Bahir Dar City and Debre Tabor General Hospital in Debre Tabor in the Amhara Region of Ethiopia. The household WASH survey demonstrated that most study households had access to a toilet facility, but in most cases this was an unimproved sanitation facility as classified by the JMP (JMP, n.d). In the analyses of household factors that may be associated with neonatal sepsis, both early-onset sepsis, and late-onset sepsis were examined in association with newborn care practice and household WASH practices. Cleaning frequency of household drinking water storage vessels, newborn cord care practices, and infant bathing practices were associated with one or more of the neonatal sepsis outcomes.

Access to Toilet Facility Outcome

The study revealed that access to a toilet facility was high among respondents. This study observed that 85.6% of households have a toilet in use. Toilet facility coverage for households was at 86.8%. However, the majority of respondents reported to have an unimproved toilet facility in their household. Our study found that toilet coverage was higher than what was reported in Community-Led Total Sanitation and Hygiene Survey (2015-2016) conducted by UNICEF in Ethiopia. UNICEF reported that in the Amhara Region, 51.5% of households have a toilet in their household (United Nations Children's Fund and World Health Organization (UNICEF), 2017). Toilet infrastructure varied among rural, peri-urban, and rural households. Pit

latrines were commonly reported as a type of toilet facility in the household, which is consistent with a study conducted by Nakagiri et al., which reported that pit latrines are used by more than half of the urban population in sub-Saharan Africa (Nakagiri et al., 2016). An explanation for why pit latrines may be popular among households may include cost, requires little to no water, and easy installation.

Our study found that household income was significantly associated with having access to an improved toilet facility (flush toilet and improved pit latrine). Respondents who reported a yearly household income between 39,001-59,000 birr (930.76- 1408.03 USD) were 3.3 times (95% CI: 1.08, 9.29) more likely to have an improved toilet facility in their household when controlling for mother's occupational status, mother's educational status, and woreda compared to respondents who reported having a yearly income of 20,001-39,000 birr (477.32- 930.73 USD). This finding is reiterated by Andualem et al. (2021) who observed a similar socioeconomic factor, wealth index. They found that independent of the household head's educational level, wealth was significantly associated with improved toilet ownership. This may be because economically better-off households can afford to install improved toilet facilities in their house. Based on our finding, increasing access to improved toilet facilities is needed to ensure adequate sanitation practices can be maintained in the household.

Frequency of Cleaning Drinking Water Storage Container

The frequency of cleaning the household drinking water storage container was associated with newborn sepsis outcomes. This study explored three different sepsis outcomes that included newborns with early-onset sepsis (the event of sepsis with the first 72 hours of life or less than three days), late-onset sepsis (the event of sepsis occurring after 72 hours or after more than three

days), or any neonatal sepsis in the first 28 days of life. The frequency of cleaning the water storage container was significantly associated with all of the sepsis outcomes. This is a unique finding because previous literature has only examined sepsis outcomes acquired within a health care facility, as opposed to this study's focus on newborn care practices influencing the health outcomes of newborns once they are in the household. Further research is needed to understand the role of drinking water storage and newborn health among this particular study population.

Cord Care Practice, Cord Drying and Late-Onset Neonatal Sepsis Outcome

Among newborn care practices, most respondents practiced good cord care. The results of our study show that 71.0% of respondents reported to leave the newborn's cord alone. Our finding was consistent with a study conducted in Dessie Referral Hospital in Northeast Hospital in Ethiopia, which found that 97.6% of respondents did not apply anything to the newborn's umbilical cord after being cut (Semanew, Etaye, Tizazu, Abebaw, & Gebremedhin, 2019).

Among newborn care practices, an important factor associated with the health outcome, late-onset sepsis, was cord drying. Using butter as a drying material was significantly associated with late-onset sepsis (4.8 cOR CI 95% 1.29,18.27). Although there no studies in sub-Saharan Africa that examined the association between late-onset sepsis and the application of a substance on the newborn's cord, a possible explanation for why respondents in our study reported using butter to dry the cord could be linked to local beliefs and postnatal advice. A systematic review of neonatal care practices in sub-Saharan Africa found that mothers applied substances such as butter to the newborn's cord to soften the cord and keep the cord moist, prevent pain, protect the wound from the environment, and reduce smell (Bee, Shiroor, & Hill, 2018). Another study conducted by Amare in Ethiopia, found that mothers learned newborn care practices through observation and advice from family members such as grandmothers (Amare, 2014). Mothers

reported to apply butter to the newborn's cord in order to keep the newborn's clothes from sticking to the cord (Amare, 2014). Another study conducted by Degefie et al. in Ethiopia found that substances such as butter were applied to the cord because mothers believed it could speed up the cord drying process (Degefie, Amare, & Mulligan, 2014). Although most of our study households reported good cord care practices, our finding indicates that the importance of good cord care practice by postnatal mothers and caregivers needs to be emphasized while at health facilities.

Delayed Bathing Practice and Early and Late-Onset Neonatal Sepsis Outcomes

Our study found that the number of days after which a respondent first bathed the newborn was significantly associated with the clinical diagnosis of both early-onset sepsis and late-onset sepsis. As part of the 2013 Postnatal Care for Mothers and Newborns guidelines, the WHO recommends that bathing should be delayed for 24 hours after birth(World Health Organization, 2015b). However, some respondents exceeded the timing of this bathing recommendation. Bee et al. found that a possible reason why newborn bathing was delayed in countries such as Ethiopia, Ghana, and Malawi were to keep the baby warm (Bee et al., 2018). However, our study did not explore the reasons why respondents reported to delay newborn bating. An explanation for why delayed bathing might have taken place for this study group may be linked to newborns showing signs of sickness which may lead to the caregiver delaying bathing until the infant gets better. This could be a possible explanation, but based on this study, we are unable to determine which came first: did the mother delay bathing because the newborn was sick? Or did the delay in bathing contribute to the development of sepsis in the newborn?

Study Limitations

A limitation of this study is the self-reported aspect of the household WASH survey. Respondents were asked questions about their WASH practices and newborn care practices. Social desirability may have impacted the responses to our survey. Respondents may not report what they actually practiced at home. Also, recall bias may have impacted survey responses. Respondents may not be able to recall information such as when the newborn was first bathed or how often hands were washed when taking care of the newborn.

Study Strengths

Our study is unique in that it assesses possible relationships between household WASH characteristics and newborn care practice and neonatal sepsis. Because of the high rates of neonatal sepsis observed in this study and reported in other studies and surveys in Ethiopia, it is worthwhile to further explore household conditions and practices that may contribute to neonatal sepsis in this study population.

Chapter 5: Conclusions and Recommendations

The present study indicated that respondents generally incorporate safe WASH and newborn care practices into their household routine. However, there is need to strengthen the use of good newborn care practices after leaving the health facility. Our findings indicate the need for interventions geared to promoting safe and maintainable newborn care among newborns in the Amhara region. Newborn care practices that should be prioritized, whether through an intervention at the healthcare facilities or during postnatal care check-ups, are good cord care practices, cord care counseling, and education about infant bathing practices. Promotion of safe newborn care practices may to help reduce newborn infection in the first 28 days of life. Future studies should explore reasons as to why respondents prolonged bathing past the WHO

recommendation. In addition to newborn care, given the low access to improved toilet facilities among the study households, it may be important to focus on interventions that aim to improve sanitation infrastructure in Amhara communities.

Lessons Learned and Recommendations

- Reusable diapers were reported to be used by most respondents. Future studies should examine how reusable diapers are cleaned. It would also be beneficial to understand reusable and disposable diaper practices and where child feces are disposed.
- Our findings show that there were respondents who reported to have inadequate cleaning practices for their household water storage containers. Future studies could test stored household water quality and examine the relationship with reported cleaning practices of the water storage containers.
- There is a gap in scientific literature about household WASH conditions and impact on newborn care practices for newborns and risk of late-onset sepsis. Further research should be conducted to gain understanding about the factors that may influence late-onset sepsis among newborns in Amhara and other regions in Ethiopia and sub-Saharan Africa. A continuation of this study may help to improve the National Newborn Child Strategy Program in Ethiopia.

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Appendix A: Baseline Survey

Form 2A KMC Baseline Information

Study ID _____

No	questions	Response
1	Date of filling	_____
2	Research Assistant Code	_____
3	Woman ID	_____
5	Number of family members residing in the house	_____
6	In what year and month were you born?	_____ (dd/mm/yy)
7	What is your age (years)? (Compare and correct Q. #6 and/or 7 if inconsistent. Probe using local calendar/historical events.)	_____
8	Are you able to read and/or write?	Yes No
9	Did you ever attend formal school?	Yes No
10	What is the highest level of school you attended?	o Primary /1-8/ o Secondary/9-12/ o Technical/vocational certificate o Degree or higher
11	What is your current occupation?	o House wife o Farmer o Skilled Labor o Unskilled Labor o Professional o Merchant o Petty trade o Other Specify
11a	If occupation of mother is "other", specify	_____
12	In what year and month was the baby's father born? (If not known, 99 = Don't know)	_____ (dd/mm/yyyy)
13	What is the age of the baby's father (years)? if not known, 99 = Don't know) Compare and correct 14 and/or15 if inconsistent. Probe using local calendar/historical events.	_____(in years)
14	Does the father able to read and/or write?	yes No Don't know
15	Did the father ever attend formal school?	Yes No Don't know
16	What is the highest level of school the father attended?	o Primary /1-8/ Secondary/9-12/ o Technical/vocational certificate o Degree or higher o Don't know
17	What is the current occupation of the father?	o Farmer o Skilled Labor o Unskilled Labor o Professional o Merchant o Petty trade o Other Specify
17.a	If occupation of father is "other", specify	_____

18.	Is father currently staying with the family?	Yes No
19.	What is the religion of the head of the household?	○ Christian orthodox ○ Muslim ○ Christian protestant ○ Christian Catholic ○ Christian other ○ Traditional ○ Other
19.a	If other religion, specify	_____
20.	What is the ethnic group of the head of the household?	○ Amhara ○ Agew ○ Tigre ○ Oromo ○ Other (specify)
20.a	If other ethnic group, specify	_____
21	Do you own the house that you live in?	Yes No
22	What is the total income of your family per year? (in birr)	_____(in birr)
	Obstetric history	
23.	How many times have you been pregnant including this birth?	_____
24.	Did you ever have any miscarriages or abortion (termination of pregnancy)?	Yes No
25.	How many times did you have miscarriages or abortion?	_____
26.	How many times have you given birth including this birth?	_____
27.	How many of the babies were pre-term (born too soon) including this birth, if any?	_____
28.	How many of the babies were low birth weight (born too small) including this birth, if any?	_____
29.	How many live births have you had during your lifetime?	_____
30.	How many stillbirths (babies who were born and never breathed) have you ever have, if any?	_____
31.	How many newborn deaths (a child who died in the first 28 days of life) have you ever have, if any?	_____
32.	How many living children do you have now? (Review this against Q29 - 32 and correct inconsistencies)	_____
	Antenatal Care	
33.	In your recent pregnancy, did you receive at least one care (ANC) at a health facility during pregnancy (at least one)?	Yes No
34.	How many times did you get care (ANC) during your last pregnancy from the health facility? (If not known, 99 = Don't know)	_____(# of visits)
35.	When you got ANC at the health facility, did you get any information on preterm and/or LBW baby born?	Yes No
36.	When you got ANC at the health facility, did you get any information on KMC?	Yes No
	Delivery	
37.	Where did you give birth to (Baby name)?	○ Your home ○ Other home ○ Health post

		○ Health centre ○ This hospital ○ Different Government hospital ○ Private hospital/clinic ○ NGO health facility ○ On the way to health facility ○ Other
37.a	If the place of birth is "Other place of delivery", specify	_____
38.	Who (what kind of professional) conducted the delivery?	○ Skilled health care provider ○ HEW ○ CHW/HDAs ○ TBA ○ Family/Friend/relatives ○ Neighbor ○ No one was present ○ Other (Specify)
38.a	If "Other " attendant specify	_____
39.	Was the delivery normal, assisted (forceps or vacuum extraction), or by caesarian (surgery)?	○ Normal ○ Assisted ○ Caesarian
40.	If home birth, who told you to bring your baby to health facility?	○ Myself /No one ○ HEW ○ HDA/vCHW ○ Family/Friend/relatives ○ Neighbor ○ Others (specify)
40.a	If other person told her, specify	_____
	Gestational Age	
41.	What was the date of first day of your last menstrual period ?(if don't remember, write 97 = Don't Remember)	_____ (dd/mm/yyyy)
42.	At which month of pregnancy was your infant born? ask the mother or other care givers; If not remember, 97 = Don't Remember)	_____(in months)
43.	At which month of pregnancy was the infant born? take Gestational age from records (observation)	_____(in weeks)
44.	What was the source document?	○ ANC Card ○ Delivery register ○ USG (Ultrasound) if available ○ Other records (discharge record)
45.	What was the birth order of the child?	_____ (in months)
46.	If birth order is >1, what was the interval between the birth of this child, and the previous child?	_____(in months)
47.	Was the infant born single, twins or triplets?	○ single birth ○ twins ○ triplets ○ >triplets
	Birth Weight	
47a.	Birth weight of infant_1 reported by mother?	_____ (in grams)
47b.	Birth weight of infant_1, from record?	_____ (in grams)
47c.	Birth weight of infant_2 reported by mother?	_____ (in grams)

47d.	Birth weight of infant_2, from record?	_____ (in grams)
47e.	Birth weight of infant_3 reported by mother?	_____ (in grams)
47f.	Birth weight of infant_3, from record?	_____ (in grams)
48.	Specify the name of the document where weight is recorded?	o Delivery register o Referral slip o KMC register o NICU register o Others (specify)
49.	Weight (gm) of baby as measured by study team	_____ (in grams)

Appendix B: WASH Household Survey

WASH Household Survey

Instructions: Interview with Mother and anyone else available who cares for the baby, then observe the family toilet and handwashing facility, if available.

	Study ID	
No	**Questions**	**Response**
1	Date of filling	
2	Research Assistant Code	
3	Woman ID	
4	Child ID	
5	Type of Visit	1 = 7 Days After Discharge 2 = 28 Days of Life
6	How does the household access water? Circle all that apply	1 = Water tap in house or on premises 2 = Water collected from outside the house
7	If outside, how long does it take you to get drinking water and bring it home?	_____ (in minutes)
8	What is the primary source of drinking water for the family? (Select one)	01 = Piped into dwelling 02 = Piped into compound 03 = Piped outside compound 04 = Protected Well 05 = Unprotected Well 06 = Bore Hole 07 = Protected Spring 08 = Unprotected Spring 09 = Surface water (River, pond/lake) 10 = Rainwater
9	How do you store the drinking water? (Select multiple)	1 = Piped water 2 = Jerry can 3 = Pot 4 = No water storage 5 = Other (specify
9a	If other, please specify	
10	How frequently do you clean the water storage? (Select one)	1 = Daily 2 = Several times a week 3 = Weekly 4 = When needed 5 = Never clean 6 = Other (specify)
11	Do you do any household treatment of your drinking water?	1 = Yes, always

		2 = Yes, sometimes 3 = No
12	If yes, how do you treat your household drinking water?	1 = Boiling 2 = Adding chemicals like Wuha-agar 3 = Use water filter *(ceramic, sand, ...)* 4 = Strain it through a clean cloth 5 = Using sand and gravel filter 6 = Solar disinfection 7 = Let it stand and settle 8 = Other (*specify*) 99 = Do not Know
12.a	If other, please specify	
13	Do you bathe the baby? (Select one)	1 = Yes 2 = No 3 = Not Applicable
14	If yes, after how many days of life did you bathe the baby?	_____ (in days)
15	How often do you bathe the baby? (Select one)	1 = Every day, once 2 = Every day, twice 3 = Every few days, once 4 = Once a week 5 = Less than once a week
16	What is the source or sources of water for bathing the baby? (Select multiple)	01 = Piped into dwelling 02 = Piped into compound 03 = Piped outside compound 04 = Protected Well 05 = Unprotected Well 06 = Bore Hole 07 = Protected Spring 08 = Unprotected Spring 09 = Surface water (River, pond/lake) 10 = Rainwater
17	How is the bathing water prepared/treated? (Select multiple)	1 = Boiled 2 = Heated, but not boiled 3 = Chlorinated 4 = No preparation or treatment
18	Is the baby being exclusively breastfed?	1 = Yes 2 = No
19	Do you wash your hands with soap and water or hand sanitizer before breastfeeding?	1 = Yes 2 = No
20	If no, why?	
21	Do you clean your breasts before breastfeeding the baby?	1 = Yes 2 = No
22	If no, why?	

23	What type of toilet does the family have access to? (Select one)	01 = Pit Latrine/traditional pit toilet 02 =Ventilated improved pit latrine 03 = Flush toilet 04 = No facility/Bush/Field 88 = Other(Specify)
24	What is the ownership of the toilet? (Select one)	01 = Private 02 = Shared with other compounds 03 = Public toilet
25	Do you use a diaper (disposable/local) for the newborn? (Select one)	1 = Yes 2 = No
26	What type of diaper are you using? (Select multiple)	1 = Disposable diaper 2 = Locally prepared/reusable diaper
26	Who cares (bathing, breast feeding, changing diaper, …) for the baby? (select all that apply)	1 = Mother 2 = Father 3 = Grandmother 4 = Sister 5 = Caregiver (maid) 6 = Neighbor 7 = Other (specify)
27	For each person selected ask: When does this person wash his/her hands? Read aloud and select all that apply.	1 = After changing the baby's diaper 2 = After using the toilet 3 = Before breastfeeding 4 = Does not wash hands 5 = Other (specify)
28	For each person who washed hands: ask , How does this person wash his/her hands? (Select one)	1 = Water only 2 = Water with soap 3 = Water with ash 4 = Hand sanitizers
29	What is used to clean the cord? (Select one)	1 = Chlorohexidine 2 = Oil 3 = Wash with water/soap 4 = Nothing, left to dry on its own 5 = Other (specify)
30	What was applied to make the cord dry? (Select one)	1 = Butter 2 = Cow dung 3 = Nothing - left open to dry 4 = Other (specify)
31	Did the mother receive any orientation/counseling from the hospital on cord care? (Select one)	1 = Yes 2 = No
32	Do you have a separate house for the animals (cattle, sheep, etc)? (Select one)	1 = Yes 2 = No 3 = NA
33	Do you have a separate kitchen house? (Select one)	1 = Yes 2 = No

	Observations:	
34	Observe the cleanliness of the family's house [floors, roof, general living space, etc.]. Is the general condition of the family's house clean?	1 = Yes 2 = No
35	Observe the cleanliness of the compound [general living space, etc.]. Is the general condition of the compound clean?	1 = Yes 2 = No
36	Observe the hand washing facility in the house. What handwashing supplies are available? (Select one)	1 = Water only 2 = Soap only 3 = Ash only 4 = Water and soap 5 = Water and ash 6 = Hand sanitizer 7 = No hand washing facility
37	Observe the toilet used by the family. Is the toilet in use?	1 = Yes 2 = No 3 = NA
38	Is the toilet visibly clean?	1 = Yes 2 = No 3 = NA
39	Is there presence of feces in the toilet?	1 = Yes 2 = No 3 = NA
40	Are there flies in the toilet?	1 = Yes 2 = No 3 = NA
41	Is there an unpleasant smell in the toilet?	1 = Yes 2 = No 3 = NA

Appendix C: Logistic Regression -Improved Toilet Ownership in Study Households Output

Logistic Regression of the outcome variable: Improved toilet facility

Parameter	Reference Group	Wald Chi-Square	Pr>Chisq
Intercept		10.1928	0.0014
Bahirdar Zuira + Mecha	Bahir Dar City	0.0034	0.9534
Debre Tabor	Bahir Dar City	10.4788	0.0012
Libo KemKem + Farta	Bahir Dar City	0.6288	0.4278
Primary Education + Some Education	None	1.3563	0.2442
Secondary Education	None	1.9483	0.1628
Degree or Higher	None	0.1747	0.675
Technical/Vocational Certificate	None	0.7335	0.3918
≤20,000	20,001-39,000	0.8838	0.3472
39,001-59,000	20,001-39,000	4.3966	0.036
≥59,001	20,001-39,000	0.0838	0.7723
Merchant + Petty Trade	Housewife	3.7029	0.0543
Professional + Religious Leader	Housewife	1.7659	0.1839
Skilled + Student	Housewife	1.6114	0.2043
Farmer	Housewife	0.0002	0.9894
Unskilled	Housewife	0.135	0.7133

Appendix D: Logistic Regression- Safely Managed Drinking Water Source in Study Households

Logistic Regression of the outcome variable: Improved Drinking Water Source

Parameter	Reference Group	Wald Chi-Square	Pr>Chisq
Intercept		9.5618	0.002
Bahirdar Zuira + Mecha	Bahir Dar City	5.3179	0.0211
Debre Tabor	Bahir Dar City	0.0006	0.9809
Libo KemKem + Farta	Bahir Dar City	8.7375	0.0031
Primary Education + Some Education	None	0.6632	0.4154
Secondary Education	None	0.3159	0.5741
Degree or Higher	None	0.3957	0.5293
Technical/Vocational Certificate	None	0.1659	0.6837
≤20,000	20,001-39,000	1.4075	0.2355
39,001-59,000	20,001-39,000	4.9221	0.0265
≥59,001	20,001-39,000	0.0044	0.9473
Merchant + Petty Trade	Housewife	0.1383	0.71
Professional + Religious Leader	Housewife	0.0464	0.8295
Skilled + Student	Housewife	0.8285	0.3627
Farmer	Housewife	0.6275	0.4283
Unskilled	Housewife	0.0006	0.981

Appendix E : Logistic Regression Sepsis Output

Logistic Regression of the outcome variable: Sepsis

Parameter	Reference Group	Wald Chi-Square	Pr>Chisq
Intercept		17.9672	<.0001
Unimproved Water Source	Improved Water Source	1.9795	0.1594
Intercept		4.4033	0.0359
Water Collected	Water Not Collected	1.3692	0.2419
Intercept		0.2487	0.618
Water Stored in a Jerry Can	Water not stored in a jerry can	4.1533	0.0416
Intercept		6.5472	0.0105
Water stored in a pot	Does not use pot	4.1863	0.0408
Intercept		0.2894	0.5906
Several Times a Week	Daily	0.041	0.8396
Weekly	Daily	3.2099	0.0732
When needed	Daily	5.5414	0.0186
Intercept		3.843	0.05
Sometimes	Always	1.43	0.1872
Not Treated	Always	1.7397	0.1872
Intercept		10.3082	0.0013
Newborn not bathed	Newborn Bathed	1.049	13.276
intercept		4.3729	0.0365
Bathing: 8-14 days	Bathing: 1-7 days	2.8303	0.0925
Bathing:15-28 Days	Bathing: 1-7 days	0.1083	0.7421
Intercept		4.2967	0.0382
Bathing: every few days	bathing: twice per day	2.8139	0.0935
Bathing: once per day	bathing: twice per day	0.4139	0.52
Intercept		11.2106	0.0008
Unimproved Bath Water Source	Improved Water Source	0.4483	0.5032
Intercept		1.1115	0.2917
Bath water: heated	bath water: boiled	1.3609	0.2434
Bath water: none	bath water: boiled	0.0428	0.836

Intercept		8.0223	0.0046
Wash hands before breastfeeding : Sometimes	Wash hands before breastfeeding : always	1.6419	0.2001
Wash hands before breastfeeding: no	Wash hands before breastfeeding : always	3.8949	0.0484
Intercept		7.4037	0.0065
Does not clean breast before breastfeeding	cleans breast before breastfeeding	2.039	0.1533
Intercept		2.7152	0.0994
Unimproved Toilet Facility	Improved Toilet Facility	0.2875	0.5918
Intercept		13.5685	0.0002
Diaper not used	Diaper Used	0.5219	0.4701
Intercept		8.6924	0.0032
Reusable diaper	Disposable Diaper	0.3371	0.5615
Intercept		7.1445	0.0075
Mother does not wash hands after changing the diaper	Mother does wash hands after changing the diaper	1.0047	0.3162
Intercept		15.2517	<.0001
Mother does not wash hands after using the toilet	Mother does wash hands after using the toilet	0.0615	0.8041
Intercept		10.6688	0.0011
Mother does not wash hands before breastfeeding	Mother does wash hands before breastfeeding	2.6308	0.1048
Intercept		0.0002	0.9877
Mother does not wash hands	Mother does wash hands	0.0002	0.9883
Intercept		14.2537	0.0002

Mother uses water only to wash hands	Mother uses soap and water to wash hands	1.2652	0.2607
Intercept		7.1987	0.0073
Cord is not cleaned	Cord is cleaned	0.7092	0.3997
Intercept		19.0796	<.0001
Cord is cleaned with oil	Cleaned with Nothing	0.3664	0.545
Cord is cleaned with other substance	Cleaned with Nothing	1.7956	0.1802
Cord is cleaned with soap and water	Cleaned with Nothing	3.2821	0.07
Intercept		14.6971	0.0001
Cord Is dried with butter	Cord dried with nothing	0.4893	0.4842
Cord is dried with cow dung	Cord dried with nothing	0.175	0.6757
intercept		6.4083	0.0114
Did not receive cord care counseling	Received Cord Counseling	0.0159	0.8997

Appendix F Logistic Regression Early-Onset Sepsis Output

Logistic Regression of the outcome variable: Early- Onset Sepsis

Parameter			**Pr>Chisq**
Intercept		3.0069	0.0829
Unimproved Water Source	Improved Water Source	0.9786	0.3225
Intercept		0.0555	0.8137
Water Collected	Water Not Collected	3.2854	0.0699
Intercept		0.9785	0.3226
Water Stored in a Jerry Can	Water not stored in a jerry can	3.2156	0.0729
Intercept		2.0511	0.1521
Water stored in a pot	Does not use pot	0.7242	0.3948
Intercept		1.553	0.2127
Several Times a Week	Daily	3.7829	0.0518
Weekly	Daily	3.2699	0.0706
When needed	Daily	5.9824	0.0144
Intercept		3.8436	0.0499
Sometimes	Always	3.1531	0.0758
Not Treated	Always	2.7225	0.0989
Intercept		9.199	0.0024
Newborn not bathed	Newborn Bathed	5.6234	0.0177
intercept		17.1442	<.0001
Bathing: 8-14 days	Bathing: 1-7 days	5.6015	0.0179
Bathing:15-28 Days	Bathing: 1-7 days	4.7202	0.0298
Intercept		0	1
Bathing: every few days	bathing: twice per day	4.2621	0.039
Bathing: once per day	bathing: twice per day	4.1902	0.0407
Intercept		5.8368	0.0157
Unimproved Bath Water Source	Improved Water Source	2.1801	0.1398

Intercept		3.0184	0.0823
Bath water: heated	bath water: boiled	0.1138	0.7359
Bath water: none	bath water: boiled	0.0468	0.8287
Intercept		0.0435	0.8349
Wash hands before breastfeeding : Sometimes	Wash hands before breastfeeding : always	0.606	0.4363
Wash hands before breastfeeding: no	Wash hands before breastfeeding : always	0.1676	0.6823
Intercept		0.1813	0.6702
Does not clean breast before breastfeeding	cleans breast before breastfeeding	0.1885	0.6642
Intercept		0.3302	0.5656
Unimproved Toilet Facility	Improved Toilet Facility	1.5715	0.21
Intercept		1.5904	0.2073
Diaper not used	Diaper Used	0.4306	0.5117
Intercept		0.1912	0.6619
Reusable diaper	Disposable Diaper	4.3939	0.0361
Intercept		1.5563	0.2122
Mother does not wash hands after changing the diaper	Mother does wash hands after changing the diaper	0.582	0.4455
Intercept		4.4471	0.035
Mother does not wash hands after using the toilet	Mother does wash hands after using the toilet	0.0095	0.9222
Intercept		0.3987	0.5278
Mother does not wash hands before breastfeeding	Mother does wash hands before breastfeeding	0.3463	0.5562

Intercept		0	1
Mother does not wash hands	Mother does wash hands	0.0657	0.7977
Intercept		2.2112	0.137
Mother uses water only to wash hands	Mother uses soap and water to wash hands	0.2453	0.6204
Intercept		4.3675	0.0366
Cord is not cleaned	Cord is cleaned	1.4871	0.2227
Intercept		0.1139	0.7358
Cord is cleaned with oil	Cleaned with Nothing	1.9966	0.1576
Cord is cleaned with other substance	Cleaned with Nothing	0.4757	0.4904
Cord is cleaned with soap and water	Cleaned with Nothing	0.015	0.9024
Intercept		0.287	0.5921
Cord Is dried with butter	Cord dried with nothing	5.4795	0.0192
Cord is dried with cow dung	Cord dried with nothing	1.7391	0.1873
intercept		2.9355	0.0867
Did not receive cord care counseling	Received Cord Counseling	12.2867	0.0005

Appendix G: Logistic Regression Late-Onset Sepsis Output

Logistic Regression of the outcome variable: Late- Onset Sepsis

Parameter	Reference Group	Wald Chi-Square	Pr>Chisq
Intercept		3.0069	0.0829
Unimproved Water Source	Improved Water Source	0.9786	0.3225
Intercept		0.0555	0.8137
Water Collected	Water Not Collected	3.2854	0.0699
Intercept		0.9785	0.3226
Water Stored in a Jerry Can	Water not stored in a jerry can	3.2156	0.0729
Intercept		2.0511	0.1521
Water stored in a pot	Does not use pot	0.7242	0.3948
Intercept		1.553	0.2127
Several Times a Week	Daily	3.7829	0.0518
Weekly	Daily	3.2699	0.0706
When needed	Daily	5.9824	0.0144
Intercept		3.8436	0.0499
Sometimes	Always	3.1531	0.0758
Not Treated	Always	2.7225	0.0989
Intercept		9.199	0.0024
Newborn not bathed	Newborn Bathed	5.6234	0.0177
intercept		17.1442	<.0001
Bathing: 8-14 days	Bathing: 1-7 days	5.6015	0.0179
Bathing:15-28 Days	Bathing: 1-7 days	4.7202	0.0298
Intercept		0	1
Bathing: every few days	bathing: twice per day	4.2621	0.039
Bathing: once per day	bathing: twice per day	4.1902	0.0407

Intercept		5.8368	0.0157
Unimproved Bath Water Source	Improved Water Source	2.1801	0.1398
Intercept		3.0184	0.0823
Bath water: heated	bath water: boiled	0.1138	0.7359
Bath water: none	bath water: boiled	0.0468	0.8287
Intercept		0.0435	0.8349
Wash hands before breastfeeding : Sometimes	Wash hands before breastfeeding : always	0.606	0.4363
Wash hands before breastfeeding: no	Wash hands before breastfeeding : always	0.1676	0.6823
Intercept		0.1813	0.6702
Does not clean breast before breastfeeding	cleans breast before breastfeeding	0.1885	0.6642
Intercept		0.3302	0.5656
Unimproved Toilet Facility	Improved Toilet Facility	1.5715	0.21
Intercept		1.5904	0.2073
Diaper not used	Diaper Used	0.4306	0.5117
Intercept		0.1912	0.6619
Reusable diaper	Disposable Diaper	4.3939	0.0361
Intercept		1.5563	0.2122
Mother does not wash hands after changing the diaper	Mother does wash hands after changing the diaper	0.582	0.4455
Intercept		4.4471	0.035
Mother does not wash hands after using the toilet	Mother does wash hands after using the toilet	0.0095	0.9222

Intercept		0.3987	0.5278
Mother does not wash hands before breastfeeding	Mother does wash hands before breastfeeding	0.3463	0.5562

Intercept		0	1
Mother does not wash hands	Mother does wash hands	0.0657	0.7977
Intercept		2.2112	0.137
Mother uses water only to wash hands	Mother uses soap and water to wash hands	0.2453	0.6204
Intercept		4.3675	0.0366
Cord is not cleaned	Cord is cleaned	1.4871	0.2227
Intercept		0.1139	0.7358
Cord is cleaned with oil	Cleaned with Nothing	1.9966	0.1576
Cord is cleaned with other substance	Cleaned with Nothing	0.4757	0.4904
Cord is cleaned with soap and water	Cleaned with Nothing	0.015	0.9024
Intercept		0.287	0.5921
Cord Is dried with butter	Cord dried with nothing	5.4795	0.0192
Cord is dried with cow dung	Cord dried with nothing	1.7391	0.1873
intercept		2.9355	0.0867
Did not receive cord care counseling	Received Cord Counseling	12.2867	0.0005