ADDIS ABABA UNIVERSITY
ETHIOPIAN INSTITUTE OF WATER RESOURCES

Determinants of Public Health in Food Establishments and Health Status of Food Handlers in Addis Ababa, Ethiopia

by

Aderajew Mekonnen Girmay (MPH)

A Dissertation Submitted to
The Ethiopian Institute of Water Resources
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Presented in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy (PhD) in Water and Public Health

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Declaration

I, the researcher declare that this dissertation is my original work and it has not been presented in other universities, colleges or institutes for a degree or other purpose. All sources of materials have been duly acknowledged and cited properly.

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Dissertation Approval Sheet

Sr.No	Criteria		Acceptable	Unacceptable
1.	Contribution of the project to knowledge within the field		✓	
2.	Demonstration of knowledge of the content area and awareness of relevant research of others		✓	
3.	Appropriateness of the methodology to answer the research questions		✓	
4.	Demonstration of adequate understanding of the methodology		✓	
5.	Clarity and organization of writing		✓	
6.	Overall Recommendation	Approve as presented	✓	
		Revise and resubmit		

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Advisor 4:		16 May 2020

Addis Ababa University
School of Graduate Studies

This is to certify that the thesis prepared by Aderajew Mekonnen Girmay entitled ***determinants of public health in food establishments and health status of food handlers, in Addis Ababa Ethiopia*** is submitted in partial fulfillment of the requirements for the Degree of Doctor of Philosophy in Water and Public Health complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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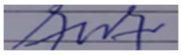
Examiner: Dr. Kassahun Alemu Signature:  Date: 18 June 2020

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Abbreviations

AA	Addis Ababa
AAFMHACA	Addis Ababa Food Medicine, Health care Administration and Control Authority
AAHB	Addis Ababa Health Bureau
AOR	Adjusted Odd Ratio
ANOVA	Analysis of Variance
AWD	Acute Watery Diarrhea
BPR	Business Process Re-engineering
CCL	Candidate Contaminant List
CFU	Colony Forming Unit
CI	Confidence Interval
COR	Crude Odd Ratio
DW	Drinking Water
E.coli	Escherichia coli
EMB	Eosine Methylene Blue
EPA	Environmental Protection Agency
EFMHACA	Ethiopian Food, Medicine Health care Administration and Control Authority
GLAAS	Global Analysis and Assessment of Sanitation and Drinking-water
IMS	Indicator Microorganisms
MEL	Monitoring, Evaluation and Learning
POU	Point of Use
SPSS	Statistical Package for the Social Science
TTC	Thermo tolerant Coli forms
USA	United State America
USEPA	United State Environmental Protection Agency
US	United State
WHO	World Health Organization
WASH	Water Sanitation and Hygiene

Abstract

Introduction: Globally, drinking water quality is continuously deteriorating and becoming non-suitable for human use and well-being. That is why, above 20% of the world, population does not have access to pure drinking water. Globally, 26% of people drink water that is, at least occasionally, contaminated with fecal bacteria. Of all human illnesses in the developing world, 80% are caused by biological contamination. Further, more than 33.3% of the world population does not have access to improved sanitation. Globally, the health burden of poor water quality, sanitation and hygiene is massive. Despite advancements in food science and technology, food and waterborne disease remains one of the major public health problems in the world. In many parts of low-income countries such as in Ethiopia, public health problems associated with deterioration of food and water safety situations are much more aggravated due to poverty and environmental related risks. Data from the previous studies indicated that several food establishments in Addis Ababa lack safe drinking water and suffer from poor sanitation and hygiene practices. Credible evidence from scientific literature substantiate that inadequate sanitation and poor hygiene conditions of food establishments are the major cause for the occurrence of food and water borne diseases. In such case, there is huge demand for good sanitation practice and proper handling of drinking water in the food establishments. In my view, this is the frame in which I derive the objectives for my PhD work, basically to investigate microbial drinking water quality, sanitation and hygiene situation of food establishments as well as health status of food handlers in Addis Ababa.

Methods: Institution based longitudinal and cross-sectional studies were conducted. Sample sizes were calculated using a single and two population proportion formulas. Stratified, simple random sampling techniques were employed. For this study, 250 drinking water samples, 420 food establishments and 420 food handlers were included to assess drinking water quality, sanitation and hygiene status of food establishments, awareness, outlook and practice of food handlers respectively. Moreover, 1058 food handlers were included to determine diarrheal disease and associated behavioral factors among food handlers. Data was analyzed by SPSS version 20. A repeated–measure ANOVA, Binary Logistic Regression, Multivariable Logistic Regression and Linear Regression Model and analysis of variance were used for data analysis.

Results: The longitudinal data analysis indicated that, 26.4% and 10.7% of the food establishments drinking water had occurrence of Escherichia coli type of bacteria in the wet and dry season respectively. The finding of the study revealed that, 3.2% and 1.6% of the food establishments drinking water had very high health risk to customers during the wet and dry season respectively. In the study, the mean score of fecal coli forms count pre100/ml were found to be 7.59 and 3.12 in the wet and dry season respectively. There was statistically significant difference between the mean values of the E. coli per 100ml between the dry and wet season with P-value <0.00. Besides, the sanitation and hygiene status of food establishments study revealed that, 57.4% of the food establishments were under poor sanitation status. In the multivariable analysis, presence of trained managers on hygiene and sanitation (AOR=6.10 with 95%CI:2.41-15.45), presence of renewed licenses (AOR=3.07 with 95% CI:1.18-7.99), absence of bureaucratic function to obtain permission to renew the food establishment buildings (AOR=2.43 with 95%CI:1.25-4.70) and presence of at least ten-meter distance between toilet and kitchen (AOR = 9.19, at 95% CI: 5.63 -15.02) were associated significantly with sanitation and hygiene status of food establishments. Moreover, the awareness, outlook and practice part of this study showed that, 55.5%, 66.1% and 60.6% of the food handlers had good awareness, outlook and proper hygiene practices respectively. Predictor variables like educational status and length of work experience were correlated positively and significantly with awareness. However, being married was correlated negatively with awareness. In addition, the diarrheal disease study result indicated that, the two-week prevalence of diarrhea was found to be 3.4%. Further, 1.6%, 10.5%, 10.7% and 9% of the food handlers had acute watery diarrhea, cough, an infection of runny nose and incidence of any fever respectively. Five behavioural factors including: regular hand washing after toilet (AOR=0.13 with 95% CI: 0.024, 0.72), using toilet while wearing protective clothes/gown (AOR=5.39 with 95% CI; 1.59, 18.32), washing glass or the material used for drinking water every event (AOR=0.009 with 95% CI: 0.001, 0.093), habit of eating raw beef and raw vegetables (AOR=6.27 with 95% CI: 1.89-20.78), type of toilet (AOR=4.07 with 95% CI: 0.29-6.67 were associated significantly with diarrhea.

Conclusion: Drinking water at the point of use in all food establishments were found to be vulnerable to microbiological contamination and had a serious health risk to those who consumes the water. The microbial load of the drinking water at the point of use differs

between the dry and rainy seasons. The occurrences of fecal coliforms and/ or E. coli were higher during the rainy season. It was concluded that, there was a significant time effect for the occurrence of fecal coli form and/or E. coli. Moreover, the finding of the longitudinal study revealed that, significant numbers of the food establishments' drinking water had high and very high health risk to customers both in the wet and dry season. Regarding the sanitation and hygiene study findings, above average of the food establishments were found to be in poor sanitation and hygiene state. In this study, many core determinant factors that influence sanitation and hygienic status of food establishments were identified. Moreover, assessing awareness, outlook and practice of food handlers regarding food and water safety is a vital activity to reduce public health problems. In the study, significant number of food handlers had poor awareness, outlook and practice towards food and water safety. There is a call for enhancing the awareness, outlook and practice of food and water safety to achieve an excellent practice. In addition, the study assessed the prevalence of diarrheal disease and identifies behavioral factors associated with diarrhea. This assessment proved to be an essential activity for reduction of community-acquired diarrheal diseases, as a significant number of food handlers had diarrhea. Therefore, good sanitation and proper handling of drinking water should be practiced in all food establishments. This includes effective drinking water treatment such as disinfection, boiling and filtration should be implemented at the food establishment level. Moreover, the government should be done continuous microbial drinking water monitoring and evaluation to improve drinking water quality. Formal training on sanitation and hygiene for managers of food establishments should be provided to reduce the occurrence of food borne diseases. Besides, strong food and water safety policy, strategy and firm regulatory actions should be promulgated to improve sanitation and hygiene status of food establishments. The government should focus on comprehensive diarrheal disease control strategy, including improvement of water quality, hygiene, and sanitation. Current public health programs of Addis Ababa city administration should develop effective approaches to promote hand washing practice and awareness creation.

Keywords: Determinats, Public Health, Food Establishment, Health Status, Food Handlers, Addis Ababa, Ethiopia

List of scientific papers

Published papers:

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3. Girmay AM, Gari SR, Alemu BM, Evans MR, Gebremariam AG. Trichotomy of awareness, outlook and practice of food handlers towards food and water safety in food establishments in Addis Ababa, Ethiopia. *AIMS Public Health.* 2020; 7(2): 241–257. DOI:10.3934/publichealth.2020021.https://www.aimspress.com/article/10.3934/publichealth.2020021

Under review paper:

4. Longitudinal study of Microbial load of drinking water and seasonal variation of water quality at the point of use in food establishments of Addis Ababa, Ethiopia.

Chapter 1
INTRODUCTION

1.1. Background

Water is the most important liquid for maintaining life on earth (Meride and Ayenew, 2016). But only 0.3% of it is available as a surface and groundwater for human use (Mohsin et al., 2013). Despite numerous efforts by governments at various levels and other agencies interested in water and its safety, waterborne diseases are still major public health and environmental concern (Forstinus et al., 2016). Microbial contamination and contaminant products in water are sources of disease outbreaks and development of cumulative toxic effect (Sweileh et al., 2016). At the global scale, food and water-associated infectious diseases are significantly correlated with socio-environmental factors, impacting all regions (Yang et al., 2012). Food and water-borne diseases have been estimated to cause more than two million deaths and four billion cases of diarrhea annually (El-Kowrany et al., 2016). Even though an adequate supply of safe and wholesome food and water is essential to the health and wellbeing of humans; there are plenty of conditions where food and water affect the health of people across the globe (World Health Organization, 2017). Poor environmental sanitation, poor personal hygiene practices, inappropriate storage of food and water and poor waste management practices may be the main causes to foster food and water contamination at food establishments (Meleko et al., 2015b). In addition to souces of the food and its quality, the chances of food and water contamination largely depend on the sanitation condition of food establishments and health status of food handlers & their hygiene behaviors and practices (Mudey et al., 2010, Ifeadike et al., 2014).

According to World Health Organization (WHO) data, globally 2.5 billion people are living without access to improved sanitation facilities, and 502,000 deaths are attributed to unsafe and insufficient drinking water. Moreover, 280,000 and 297,000 deaths result from inadequate sanitation and due to inadequate hand washing respectively (World Health Organization, 2014b). Particularly, inadequate water supplies and inadequate sanitation are responsible for a large proportion of disease transmission in developing countries (Mara, 2006, Taylor et al., 2015). Moreover, according to the 2014 WHO report, nearly 58% of all the diseases in human beings are caused by contaminated water (World Health Organization,

2014b). Water pollution is a very important problem of the 21st century which results mainly due to re-emergin microbial contaminants (Asif et al., 2018). As a result of this and other factors, to date, a large proportion of people still suffer from diarrheal diseases and the burden of diarrhea is a substantial social and economic cost (Ma et al., 2014). Outbreaks caused by the contamination of community water systems have the potential to cause extensive disease, particularly where the public infrastructure is poor and waterborne diseases are expected to rise with increases in extreme rainfall and deterioration in water quality following wider drought events (Cann et al., 2013).

In 2015, about 780 million people did not have access to a purified water source, and an estimated 2.5 billion people lacked access to improved sanitation worldwide. Moreover, it was estimated that 3.2% of deaths globally were attributable to unsafe water caused by poor sanitation and hygiene (Ramírez-Castillo et al., 2015). Especially, the levels of sanitation and water services coverage as well as health attainment are low among developing countries (Jiménez et al., 2014). Fecally contaminated drinking water, along with poor sanitation, hygiene, and inadequate water access, are generally believed to be major contributors to diarrheal disease (Eid, 2015). For this reason, WHO guidelines provide strict limits on the fecal contamination in drinking water supplies where Escherichia coli, thermo tolerant coliforms (TTC) are a WHO-approved indicator of fecal contamination (Hodge et al., 2016). The contamination of drinking water by pathogens causing diarrheal disease is the most important aspect of drinking water quality (Levy, 2015).

Globally, about 88% of diarrhea-associated deaths are attributable to unsafe water, inadequate sanitation, and insufficient hygiene (World Health Organization, 2015a). In fact, about 1.8 billion people globally drink unsafe water (Bain et al., 2014a). A study conducted in India revealed that, diarrheal risk was higher in the rainy season (Kulinkina et al., 2016). Generally, causative agent of diarrhea spread through contaminated food and drinks (Pirsaheb et al., 2017). In addition, it can be transmitted from person to person as a result of poor personal hygiene and poor environmental sanitation (Sumampouw et al., 2015). Due to the presence of many unknown determinants of public health in food outlets, food service establishments can contribute to outbreaks of food and water borne illnesses (Meleko et al., 2015b). Furthermore, there is a linkage between food establishments and approximately 60%

of food borne disease outbreaks (Akabanda et al., 2017). There are many conditions where food and water borne disease affect the health of people across the globe, especially in developing countries (World Health Organization, 2017, Meleko et al., 2015b)**.** According to the WHO Guidelines for Drinking-water Quality, ensuring safety of drinking water is basic and essential requirement to enhance the public health (World Health Organization Second Edition, 2011)**.** Competent health authority, adequate and proper management systems (adequate infrastructure, proper monitoring and effective planning and management) and a system of independent surveillance are among the basic requirements to ensure drinking water quality and food safety (World Health Organization Second Edition, 2011, World Health Organization, 2008a)**.** Moreover, clean, fresh wholesome edible food and drinking water are vital to public health and the wellbeing of people (Marriott et al., 2018)**.** To achieve this, proper assessment of food and waterborne pathogens and water quality monitoring are key factors for decision-making regarding water distribution systems' infrastructure, the choice of best water treatment, food safety and prevention of food and waterborne diseases outbreaks (Rychetnik et al., 2002, Saxena et al., 2015)**.** In addition, even though there is a vital need to study the root cause in terms of hygiene, sanitation of vendors/or food establishments and source of water contamination to prevent waterborne diseases, still there is a gap throughout the world especially in the third world (World Health Organization, 2004, World Health Organization Second Edition, 2011)**.** The WHO report revealed that, globally 26% of people drink water that is, at least occasionally, contaminated with faecal bacteria (World Health Organization, 2014b). So, assessing and monitoring the microbial quality of treated and may be untreated drinking water at food establishments is important although not common (Yard et al., 2014)**.** Evaluating drinking water quality, sanitation and hygiene practice in food establishments and health status of food handlers are fundamental to improve community health. Therefore, this study aimed to determine the determinants of public health in food establishments and health status of food handlers, in Addis Ababa Ethiopia.

1.2. Statement of the Problem

Worldwide the health burden of poor water quality, sanitation and hygiene is massive (Chauhan et al., 2017). More than 20% of the world population does not have access to pure drinking water and the death rate associated with impure drinking water consumption is more than 1.7 million per year (Zameer et al., 2015, Saxena et al., 2015). In addtion, more than 33.3% of the world population does not have access to improved sanitation (Decker and Palmore, 2013). Besides, in developing countries up to an estimated 70% of cases of diarrheal diseases are associated with the consumption of contaminated food and water (Chaib and Lawe-Davies, 2017, World Health Organization, 2015b). As a result, diarrheal diseases caused an estimated 1.3 million deaths (Hodge et al., 2016). USA based data indicated that of 9040 food and water borne disease outbreaks, approximately 4675 (52%) of these were attributed to food establishments (Boro et al., 2015a). Moreover, in Africa, it is estimated that 92 million people fall ill from consuming contaminated food and water, resulting in 137, 000 deaths each year (Waithaka, 2014). Therefore, food and water borne diseases are major public health problems, with recurrent outbreaks taking high death toll (Gostin and Wiley, 2016). Further, the chances of food and water contamination mostly depend on the health status of food handlers and their hygiene behaviors, awareness,outlook and practices (Mudey et al., 2010, Ifeadike et al., 2014).

The trichotomy of awareness, outlook and practice, of food handlers are the three important factors that play vital roles in the incidence and outbreak of food and water borne diseases (Sharif and Al-Malki, 2010). People involved in food handling and having poor personal hygiene and lacking awareness of vital issues in preventing food and water borne diseases, could be potential sources of infections (Kubde et al., 2017). Though food handlers are expected to maintain a high degree of personal hygiene and careful handling of food ; they have inadequate perception about how food and water could be contaminated, and usually have low standards of personal hygiene for the tasks they are expected to perform (Sani and Siow, 2014). Moreover, poor food handling practices among food handlers is common (Panchal et al., 2013). Due to poor hygienic practice and the nature of their work, food handlers can transmit a variety of food and water borne diseases to their customers (Kubde et al., 2017, Abdul-Mutalib et al., 2012). Food borne illnesses outbreaks can be

caused by poor hygienic practices of food handlers in conjunction with poor sanitary conditions of food outlets (Kibret and Abera, 2012).

According to the 2016 Addis Ababa health bureau (AAHB) report, there is a high prevalence of water and food borne diseases in Addis Ababa (AA) though their sources is not well known and studied in depth. According to the 2017 Addis Ababa Food, Medicine and Health Care administration and Control Authority (AAFMHACA) report, food establishments located in Addis Ababa are suspected to be major sources of diarrheal diseases which might arise from the poor quality of drinking water, poor wastewater and solid waste management, lack of wash facilities and poor water storage conditions. The sanitary and hygienic condition of small food establishments is extremely poor. Moreover, due to these and other unknown factors, the city had many health problems like high burden of typhoid fever, amoeba, acute watery diarrhea (AWD) and other diarrheal diseases (Abebe and Demoze, 2017)**.** Besides, according to the 2017 report of Federal Food, Medicine and Health Care Administration and Control Authority (FFMHACA) of Ethiopia, many unknown and unidentified determinants of public health causes to the spread of infectious communicable diseases (Temesgen and Abdisa, 2015)**.**

Despite advancements in food science and technology, food and waterborne disease remains one of the major public health problems in the world. In many parts of low-income countries such as in Ethiopia, public health problems associated with deterioration of food and water safety situations are much more aggravated due to poverty and environmental related risks. Data from the previous studies indicated that several food establishments in Addis Ababa lack safe drinking water and suffer from poor sanitation and hygiene practices (Kibret and Abera, 2012). Credible evidence from scientific literature substantiate that inadequate sanitation and poor hygiene conditions of food establishments are the major cause for the occurrence of food and water borne diseases (Mudey et al., 2010, Ifeadike et al., 2014)**..** In such case, there is huge demand for good sanitation practice and proper handling of drinking water in the food establishments. In my view, this is the frame in which I derive the objectives for my PhD work, basically to investigate microbial drinking water quality, sanitation and hygiene situation of food establishments as well as health status of food handlers in Addis Ababa.

1.3. Rationale of the Study

A large number of food establishments exist in Addis Ababa though the actual figure fluctuates from time to time. In 2012, Addis Ababa city Administration issued food medicine and health care administration regulation in order to prevent possible health problems that can arise from food establishments (Addis Ababa FMHACA proclamation NO 30, 2012). The issuance of this regulation is believed to promote the regulatory activities managed by the Ethiopian Food, Medicine Health Care Administration and Control Authority (EFMHACA) and AAFMHACA. Guidelines and code of practices were developed and implemented to establish uniform and standardized regulatory provisions. Although these and other efforts have been made to improve the sanitary status of the food establishments, the overall hygiene and sanitation status of the food establishments is not known and expected to be poor. Evidence based data for appropriate strategy formulation; planning and evaluation of food establishments are scarce in the city. Moreover, assessing and monitoring the microbial quality of treated drinking water at food establishments' drinking water reservoir and at point of use is important. Although drinking water quality and sanitation are critical to health, survival, and economic development, still there are a lot of food establishments in Addis Ababa city who lack good sanitation and quality drinking water (Meleko et al., 2015c). The government provides safe water to the food establishments despite huge discrepancies from sub-city to sub-city. The provided water is also inadequate compared to the needs of the food establishments. Due to this and other unknown factors, most of the food establishments have been subjected to poor environmental and hygiene practice. As a result, recurrent food and water borne outbreaks have occurred and many users of the food establishments are exposed to many health problems. Although food establishments in Addis Ababa believe to have extremely poor environmental sanitation and hygiene practices, no study has been conducting to curb health problems of these establishments' customers. Because of this, many customers of the food establishments have been exposed to different health problems especially diarrheal diseases including acute watery diarrhea (AWD) (the case of 2000 E.C, 2004 and 2008 E.C). Therefore, this study plans to fill the research gap on quality of drinking water at food establishments, sanitary condition and associated diarrheal diseases among food handlers of the city. Moreover, this

study has an important contribution to solving community health problems resulting from poor awareness, outlook and hygiene practice of food handlers.

Thereby this study has a significant input in the formulation of appropriate strategy for program planning and evaluation as well as serve as first hand information for policy makers to improve the sanitary status of food establishments and reduce the incidence of food and water borne diseases. Contaminated water and poor hygiene practices play an important role in the transmission of many infectious diseases, which pose a great burden on community public health. Hence, protecting public health with clean, fresh wholesome drinking water and good sanitation is vital. This study planned to assess quality of drinking water at the point of use in Addis Ababa's food establishments by conducting laboratory analysis on certain biological parameters like fecal coliforms and/or Escherichia coli. The finding of this study might assist to make sound decisions that target tackling the health problems of the food establishment customers and residents of the city. In addition, assessing sanitation status of food establishments contributed to fill the gaps of sanitation by suggesting better drinking water quality management options and environmental sanitation methods.

Because, according to the WHO report, there is no food security without food safety (World Health Organization, 2015). In general, this study has an important contribution to solving community health problems relating to poor sanitation and hygiene practice of food establishments thereby to improve the public health in general. Finally, the new results of this study can be used by policy makers and other concerned bodies as a reference, on which to base decisions.

1.4. Research Questions

The main focus of the study was to determine the determinants of public health in food establishments and health status of food handlers, in Addis Ababa Ethiopia. Thus, the following key research questions were generated in order to primarily find scientific answers as these would help and provide clue in development of appropriate design, criteria and quality issues to enhance the future public health, specially to reduce health problems that arise due to poor drinking water quality and poor hygiene and sanitation practices. Therefore, the research questions of this study indicated as bellow:

1) What is the Microbial load of drinking water at the point of use in food establishments of Addis Ababa, Ethiopia?
2) What is a difference between the dry and wet season of the year in Microbial load of drinking water at the point of use in food establishments of Addis Ababa, Ethiopia?
3) What are the determinants of sanitation and hygiene condition of food establishments in Addis Ababa?
4) How is the awareness, outlook and practice among food handlers towards food and water quality management in Addis Ababa, Ethiopia?
5) How is the health status of food handlers in the food establishments of Addis Ababa with respect to food and waterborne diseases?

1.5. Research Objectives

1.5.1. General objective

The overall objective of the study is to determine determinants of public health in food establishments and health status of food handlers, in Addis Ababa Ethiopia.

1.5.2. Specific objectives of the study

1) To determine the Microbial load of drinking water and seasonal variation of water quality at the point of use in food establishments of Addis Ababa, Ethiopia
2) To assess determinants of sanitation and hygiene conditions of food establishments in Addis Ababa, Ethiopia
3) To assess trichotomy of awareness, outlook and practice of food handlers towards food and water safety in food establishments in Addis Ababa, Ethiopia
4) To determine diarrheal disease and associated behavioural factors among food handlers in Addis Ababa, Ethiopia

1.6. Significance and benefits of the study

Good health is considered as the essence of development and the gateway to poverty alleviation. Therefore, provision of safe water supply, adequate sanitation and hygiene of food establishments could be the powerful tool to protect health and could be used by individuals, institutions and communities to improve their quality of life. Protecting health

improves productivity and leads to development. As such safe water supply, adequate sanitation and hygiene are considered among the basic human rights. Hence, studying sanitation and hygiene practice is very important action to curb public health problems as limited sanitation infrastructure, poor hygienic practices, and unsafe drinking water negatively affect the health of millions of people in the developing countries. The study identifies many major determinants of health especially concerning drinking water quality, sanitation and hygiene practice of food handlers and food establishments. Moreover, the study provided clues about the sanitation and hygiene status of the food outlets and the health impact of poor water quality, sanitation and hygiene practices. Besides studying sanitation condition has primarily benefit public health by reducing the prevalence of enteric pathogenic illnesses, which cause diarrheal diseases.

The study also used as baseline and input to policy makers, researchers and other concerned bodies as reference to enhance the public health policy, strategy and guidelines. In addition, the study indicated many gabs of food hygiene and safety practice of the food establishments. Hence, it has benefits to the government to adjust its plan, implementation and regulatory activities, which conducted on food safety practices to maintain high standards of food safety and hygiene by regular inspections of food handling establishments and ensure prevention of contamination. The beneficiaries of this study are mainly the food establishments' customers, the community, the owners' food establishments, and the Government. Because, as the drinking water quality, sanitation and hygiene status of food establishments are improved based on the findings and recommendations of the study, the health of the customers, the community and the income of the owners of food establishments could be boost. Moreover, the governments also easily provide attention to fill the gaps that indicates in the study.

1.7. Structure of the thesis

This thesis composed of six main parts supported with tables, figures and references. Part 1- introduces the research by presenting background information, problem statement, rational of the study, research questions, and objectives, hypothesis of the study, benefits and beneficiaries and structure of the thesis. Part 2 focuses on the review of the existing scientific

knowledge and identification of gaps related to the research. In addition, both theoretical and empirical literatures have been further discussed in this section. Part 3 presents the brief of the methods employed in the thesis. In this part, all appropriate methods to each objective are described. Part 4 presents the discussions of the findings for objective 1, 2, 3 and 4, respectively. All of these parts start by each specific topic related to the part. Part five of the study is the discussions of the results and findings for each specific objective. Moreover, part 6 states the main conclusion of the key findings of the research and recommendations, which point out further research and revealed enhancement in knowledge and scientific contribution of the study.

Chapter 2
LITERATURE REVIEW

2.1. Accessibility of Quality Drinking Water

Globally, drinking water quality is continuously deteriorating and becoming non suitable for human use due to high population growth, expansion in industries, discharge of wastewater and chemical effluents into canals and other water sources (Mohsin et al., 2013, Memon et al., 2011). Due to those and other factors worldwide, the health burden of poor water quality is massive (Chauhan et al., 2017). That is why, access to safe drinking water is one of the major challenges of the 21st century; because, 20% of the world population does not have access to pure drinking water and the death rate associated with impure drinking water consumption is more than 1.7 million per year (Zameer et al., 2015, Saxena et al., 2015). For several decades, many people in developing countries have not had safe and sustainable water supply (Hunter et al., 2010, World Health Organization, 2015). Although quality of drinking water and associated health risks vary throughout the world, still it is a major public health threat (Daud et al., 2017). As a result drinking water quality is a great public health concern because it is a major risk factor for high incidence of diarrheal diseases in the globe (Aryal et al., 2012). Based on the distribution of use of the different types of water sources and the associated risks of diarrhea, 502, 000 diarrheal deaths in low and middle income countries can be attribute to inadequate and unsafe drinking water. Of these deaths, 88% occur in Africa and South- East Asia (Bain et al., 2014a). Moreover, in the year 2016, water, sanitation and hygiene was responsible for 829, 000 annual deaths from diarrhea, and 1.9% of the global burden of disease (World Health Organization, 2014a).

Of all human illnesses in the developing world 80% are caused by biological contamination of drinking water (Haseena et al., 2017). Recent study revealed that, urban regions become breeding grounds for emerging and reemerging communicable diseases (Bermudez-Tamayo et al., 2016). Especially cholera remains a significant threat to global public health (Taylor et al., 2015). Worldwide, many food and water borne diseases are caused by either bacteria (Clostridium, Botulinum, *E. Coli*, Salmonella, Listeria, Vibrio Cholera); viruses (Enterovirus, Hepatitis A, Rotavirus, Norovirus); parasites (Entamoeba histolytica, Cryptosporidiosis, Giardia and Trichinosis). Developing countries are affected by

a wide range of food borne and water borne diseases like Cholera, compylobacteriosis, E.coli, gastroenteritis, salmonellosis, shigellosis, typhoid and paratyphoid (Kubde et al., 2017). The food and water borne diseases are major public health problem, with recurrent outbreaks taking high death toll (Gostin and Wiley, 2016). Developing countries are more at risk of these because of not only faulty food and water handling practices, or presence of vast number of food borne pathogens, but added burden of inadequate supply of safe drinking water and poor environmental sanitation (Boro et al., 2014). The contamination of drinking water by pathogens causing diarrheal disease is the most important aspect of drinking water quality (Levy, 2015). This problem arises as a consequence of contamination of water by faecal matter, particularly human faeces, containing pathogenic organisms (Srinivasan, 2011). Almost one third of the global population is living in developing South Asia where disease occurrence is high and people are unaware of water and food -borne diseases (Malik et al., 2012).

2.2. Bacterial contamination of Drinking Water

There are over 500 waterborne pathogens of potential concern in drinking water, identified by the United State Environmental Protection Agency (USEPA) (Chaudhry and Malik, 2017). Global water quality standards and analytical methods to detect water contamination may differ in some aspects, but they are primarily based on percentage compliance with faecal indicator bacteria levels (total coli forms, faecal coli forms, enterococci, and E. coli) (World Health Organization, 1999). Regardless of the indicator employed, all imply faecal contamination has, at least in part (Gleeson and Gray, 1997). Although water is absolutely necessity for life, it can be a carrier of many diseases including the pathogenic microbial indicators (Verhille, 2013). Now days, *E. coli* is the most reliable indicator of enteric diseases and is therefore the indicator of choice to indicate occurrence of recent fecal contamination in drinking water systems (Waithaka, 2014). Because, the presence of E. coli in drinking water easily indicates the presence of other pathogenic microbial contaminats.

On average, in developing countries, microbial load compliance with the WHO standards is close to 90% for piped water, and between 40% and 70% for other improved sources

(Forstinus et al., 2016). A study done in Bangladesh in 2017 revealed that, of the 684 samples, 41% were positive for E. coli (≥ 1 CFU/100 ml) (Sun et al., 2016). Moreover, a study done in Kenya in 2018 revealed that 80% of the treated urban water supply samples tested were positive for total coli forms and notable proportion of the samples tested positive for Escherichia coli, Clostridium perfringens and Staphylococcus Aureus (Onyango et al., 2018). In addition, a study done in Maseru District (Lesotho) drinking water sources comprising spring, open wells, boreholes and open reservoirs water sample results indicated that, the presence of total coli form and E. coli were found to be 97% and 71% respectively (Gwimbi, 2011). The quality of a water supply system can be compromised by destroying or disrupting key biological elements of the water system (Kostyla et al., 2015). Therefore, contamination is generally viewed as the most serious potential terrorist threat to water systems (Ajayi and Adejumo, 2011). Chemical or biological agents could spread throughout a distribution system and result in sickness or death among the consumers and the presence of some contaminants might not be known until emergency rooms report an increase in patients with a particular set of symptoms (Figueras and Borrego, 2010).

Sudan based data, done in Al-Butana region of Sudan revealed that, among 36 samples taken from the distribution systems of several communities, only four (11%) samples have shown positive results for the Total coli forms count test. Whereas samples taken from public water stands/tapes/ indicated that out of the 23 sample taken 8(35%) found to be positive for Total Coliforms count test and 6 (26%) of the 23 analyzed samples were positive to E. coli test (Abdellah et al., 2012). But, the WHO and the USEPA National Primary Drinking Water Standards restricted that Total Coliforms and E. coli should not be present in drinking water at all (World Health Organization, 1996, World Health Organization, 2008b, Curley et al., 1991). Moreover, the Compulsory Ethiopian Standard Fist Edition 2013: drinking water specification restricted that Total Coliforms and E. coli should not be present in drinking water at all (Ethiopian drinking water standard, first edition, 2013).

Differences were observed in drinking water pollution regimes between the well and spring sampling sites, with the spring water being more degraded than the well site (Diston et al., 2017). A study conducted in rural households of Ethiopia in 2017, revealed that, the prevalence of *E. coli* in water samples was found to be 54.9% (n=233). In most of the

analyzed samples, a higher prevalence of *E. coli* was recorded during the wet compared to the dry season (Amenu et al., 2014). Moreover, a study done in bacteriological quality of drinking water taken from sources and households of shashemenea, Ethiopia indicated that, from the total sample taken 18/42 (42.8%), 14/42 (33.3%) and 2 (4.76%) samples were positive for Fecal coliforms, E. coli and Salmonella species respectively (Haddis et al., 2017). Small non-community drinking water systems or food establishments provide water to residents across the world, as well as to transient populations of tourists and travelers at premises such as campgrounds, restaurants, hotels and cafes (Sekercioglu, 2018). Reports of outbreaks in Canada and the USA indicate that approximately 50% of all waterborne diseases occur in small non-community drinking water systems or food establishments (Pons et al., 2015). The microbiological examination of Drinking Water for the presence of Indicator Microorganisms (IMs) is a key to determining microbiological quality and ensuring public health safety (Saxena et al., 2015). Moreover, their presence represents the fecal contamination of drinking water with pathogens and quality deterioration (Fawell and Nieuwenhuijsen, 2003, Odonkor and Ampofo, 2013).

Nowadays, in most cases the drinking water applied to the in use devices is a periodical sanitization and washing by chemicals, which can offer only temporary and not satisfactory health results (Bolelli et al., 2016). A study done by Bain et al.: in 2014 estimate that, 1.8 billion people globally use a source of drinking water which suffers from fecal contamination (Bain et al., 2014a). In addition, drinking water is found to be more often contaminated in rural areas (41%) than in urban areas (12%) and contamination is most prevalent in Africa (53%) and South-East Asia (35%) (Bain et al., 2014a). A study done in Ohio River Kentucky, in 2011 revealed that, there was an increased rates of diarrheal or other illness after heavy rainfall or flooding which suggests that increased microbial loads may be present (Ell-Amin et al., 2012).

Surprising that, drinking water microbial contamination is also common in bottled and bagged drinking water and factory results (Miles et al., 2009). A study done in Kumasi, Ghana, in 2014 showed that, 82% of samples taken from the bottled drinking water were contaminated with E. coli, Salmonella or other coliforms as well as enterobacteriaceae (Awuah et al., 2014). Moreover, the bacteria contaminations have the ability of causing

diseases including Typhoid fever, Cholera, Dysentery and other gastrointestinal (Stoler et al., 2012, Obiri-Danso et al., 2003)**.** Many study results indicated that, even the sale and consumption of packaged drinking waters continues to grow rapidly in most countries of the world, it causes many health problems due to its high prevalence of microbial contaminants like other unsafe sources of drinking water (Stoler et al., 2012)**.** There is high prevalence of microbial contamination of drinking water in developing countries, but to reduce the problem many efforts were done including interrupted mode of transmission of pathogenic organisms in addition to using chemicals like chlorination and other disinfectants (Oyedeji et al., 2010).

A study conducted in Pakistan in 2017 revealed that out of 130 collected samples, microbial contamination for fecal coliforms, E. coli, and Total coliforms were found to be 23.8%, 20%, and 12.3%, respectively (Daud et al., 2017). Microbial pollution has been discovered as one of the serious problems in rural as well as urban areas (Daud et al., 2017)**.** A study done in Zambia in 2011 revealed that, among 120 household drinking water samples, Escherichia coli and Total coliform bacteria were detected in 41% and 74% of the samples, respectively (Peletz et al., 2011)**.** A study conducted in treated and stored drinking water of Kenya, in 2014 revealed that; out of the five hundred and fourty (540) samples examined 35% (189/540) were positive for all the microbial isolates. Moreover, the prevalence of Total coliforms, E coli and Salmonella was found to be 51.8 %, (32.3%) and (15.9 %) respectively (Waithaka, 2014).

2.3. Access to Sanitation and Hygiene

More than one third (1/3) of the world population does not have access to improved sanitation (Decker and Palmore, 2013)**.** Although access to water supply and sanitation in Sub-Saharan Africa has been steadily improving over the past two decades, the region still lags behind all other developing countries (World Health Organization, 2015)**.** Adequate sanitation, together with good hygiene and safe water, are fundamental to good health and to social and economic development (Mara et al., 2010). That is why many scholars said ‘‘sanitation is more important than independence’’ (Alimi, 2016). But the World Health Organization (WHO) estimated that in developed countries up to 30% of the population suffer from food borne diseases each year, whereas in developing countries up to 2 million

deaths are estimated per year (Chaib and Lawe-Davies, 2017). Moreover, in developing countries up to an estimated 70 % of cases of diarrheal diseases are associated with the consumption of contaminated food and water (Chaib and Lawe-Davies, 2017, World Health Organization, 2015b). Diarrheal diseases caused an estimated 1.3 million deaths and are the fourth leading cause of years of life lost in developing countries (Hodge et al., 2016). Between 1998 and 2004, an average of 9040 food and water borne disease outbreaks were reported to the Centre for Disease Control and Prevention (CDC) and approximately 4675 (52%) of these were attributed to food service establishment (Boro et al., 2015a). A study done in the United State of America (USA) indicated that, improper food handling practices contribute to 97% of food and water borne illness in food service establishments and absence of well-maintained and proper food handling practices in food establishments have been the causes to impart disastrous effect on human health because of their scale and complexity (Meleko et al., 2015b). A study done among food-handlers of Ghana revealed that, of the total participated food handlers, 86.4% and 72.8% of them was practiced proper cleaning of the instruments/utensils and used detergent respectively (Akabanda et al., 2017). In addition this study results indicates that 76.2% of the food- handlers did not know that, Salmonella is a food borne pathogens and 70.6% did not know that hepatitis A is a food borne pathogen (Akabanda et al., 2017). However, 81.7% handlers agreed that typhoid fever is transmitted by food and 87.7% agreed that bloody diarrhea is transmitted by food (Akabanda et al., 2017).

The transmission of infectious diseases via contaminated food and water continues to be a risk to public health all over the world (Ware and Basuri, 2011)**.** Because, source and finished drinking waters are vulnerable to microbial pathogen contamination from a variety of sources of human and animal fecal wastes and from the introduction and proliferation of non fecal pathogenic microbes (Kostyla et al., 2015)**.** Although the World Health Organization (WHO) water safety plan is emphasized in order to develop better approaches designed to meet the requirements of safe drinking water supply for all mankind, still water that looks suitable for drinking may be contaminated with pathogens that may cause serious health problems (Schriks et al., 2010)**.** In developing countries, the health burden of poor water quality is massive and caused many health problems (Chauhan et al., 2017)**.** Because water is prone to fecal contaminants which is the sources of gastrointestinal illnesses for the

public throughout the world especially in the developing countries it creates a great community health problem (Chauhan et al., 2017, Azizullah et al., 2011).

2.4. Risk Factors of Waterborne Diseases

The environmental determinants of health can include adequate amounts of fresh and uncontaminated water and oxygen as well as access to nature or green spaces (Ugochukwu et al., 2015). The ranges of social, ecological, political, commercial and cultural factors that influence health status are also known as the determinants of health. The quality of drinking water is a powerful environmental determinant of health (Ugochukwu et al., 2015). Inadequate water supply, poor sanitation and hygiene practices are the major risk factors to foster many infectious food and waterborne diseases (Verhille, 2013, Cairncross et al., 2010). Moreover, there are many factors that causes diseases especially through contact with consumption of polluted water and raw food (PATHAK, 2015).

Health hazards and risk factors related to water, sanitation and hygiene (WASH) are of a composite nature (Baig et al., 2012). Because, various determining aspects like drinking-water may be a medium that can serve to transmit pathogens and toxic chemicals; the lack of services to provide access to safe drinking-water and adequate sanitation should be taken into consideration (Hodge et al., 2016, Gruber et al., 2014). A study conducted in developing countries revealed that, the risks of diarrheal diseases related to food establishments are classified into three major categories, namely: environmental, chemical and micro-biological; however, the risk concerns mostly expressed were mainly health and spoilage/microbial related (Prabhu and Shah, 2012). The most important risk factor for poor health is lack of clean water and poor sanitation and it has major health impacts (World Health Organization and Unicef, 2015). Specially, in developing countries the poor people have a great burden of diseases due to inadequate water supply, sanitation and hygiene (Jabeen et al., 2011). But ideally the importance of water to human health and wellbeing is encapsulated in the Human Right to Water and Sanitation, which entitles everyone to ‘‘sufficient, safe, acceptable physically accessible and affordable water for personal and domestic uses’’ reaffirmed by the United Nations General Assembly and Human Rights Council (Bain et al., 2014c). This indicates access to improved drinking water, sanitation and hygiene is one of the prime

concerns around the Globe although it remains with huge gap (Joshi et al., 2014). Moreover, the most common problems at food establishments and at household-level that results in contamination of water with pathogenic microorganisms were identified in different studies which includes lack of access to potable water, storage of water condition, environmental hygiene practice and hand washing practice (Woldt and Moy, 2015).

To improve understanding of pollution patterns and to support decision making concerning effective control and prevention of disease, it is very important to be able to identify hidden sources of drinking water pollution (Cabral, 2010, Sun et al., 2016). In Africa, poor sanitation and hygienic practice is the underlying cause of food and water contamination (Hanjra and Qureshi, 2010). Moreover, food handlers with poor personal hygiene and lack of awareness about cross contamination could be potential sources of infections (Tessema et al., 2014).

Even though filtration and chemical disinfection with chlorine of water were introduced in the early 1900, it has been known that drinking water contamination causes epidemic diseases (Ngure et al., 2014). Many people in urban areas still live without access to safe drinking water and adequate sanitation and this is a primary determinant of continuing poverty (Kosoe and Osumanu, 2015). Provision of safe drinking water and food is crucial for the well-being of current and future generations although not achieved still (AL-Dulaimi and Younes, 2017). Moreover, infrastructure for community water systems and household water and sanitation facilities should be better built and maintained (Eder et al., 2012). Because water sources exhibited high levels of contamination with microbial pathogens attributed to poor sanitation (Okullo et al., 2017).

2.5. Awareness, outlook and practice of food handlers

Globally, deterioration of food and water safety practices have become major public health concern due to the spread of food and water borne diseases (Soon et al., 2011). At the global scale, food and water associated infectious diseases are significantly correlated with poverty impacting all regions (Yang et al., 2012, Nee and Sani, 2011). However, the issue of food and water safety is much more complicated in developing countries due to several reasons (Tegegne and Phyo, 2017). Poor socioeconomic status is one of the leading causes of

consumption of unsafe food and water that contributed to outbreaks of infectious diseases in communities (Tessema et al., 2014, Ssemugabo et al., 2019). As a result, consumption of contaminated food and water caused a significant number of cases of diarrheal diseases in developing countries (Chaib and Lawe-Davies, 2017, World Health Organization, 2015b). A study done in Nigeria reported that, according to 33% of the respondents, restaurant food commonly caused food borne illness (Onyeneho and Hedberg, 2013). Furthermore, there is a linkage between food establishments and approximately 60% of food borne disease outbreaks (Akabanda et al., 2017). There are abundance of conditions where food and water borne disease affect the health of people (World Health Organization, 2017, Meleko et al., 2015a). But, the chances of food and water contamination mostly depend on the health status of food handlers and their hygiene behaviors, awareness, outlook and practices (Mudey et al., 2010, Ifeadike et al., 2014).

The trichotomy of awareness, outlook and practice of food handlers are the three important factors that play vital roles in the incidence and outbreak of food and water borne diseases (Sharif and Al-Malki, 2010). People involved in food handling and having poor personal hygiene and lacking awareness of ways to preventing food and water borne diseases, could be potential sources of infections (Kubde et al., 2017). Though food handlers are expected to maintain a high degree of personal hygiene and careful handling of food; they have inadequate perception about how food and water could be contaminated, and usually have low standards of personal hygiene for the tasks they are expected to perform (Sani and Siow, 2014). Moreover, poor food handling practices among food handlers is common (Panchal et al., 2013). Due to poor hygienic practice and the nature of their work, food handlers can transmit a variety of food and water borne diseases to their customers (Kubde et al., 2017, Abdul-Mutalib et al., 2012). Food borne illnesses outbreaks can be caused by poor hygienic practices of food handlers in conjunction with poor sanitary conditions of food outlets (Kibret and Abera, 2012).

2.6. Food and water hygiene

In Africa, it is estimated that 92 million people fall ill from consuming contaminated foods, resulting in 137, 000 deaths each year (Waithaka, 2014). As a result globally, it is

noted that regulation in the area of food quality and safety protection was emerged with the objectives of safeguarding consumers from both economic and health risks (Temesgen and Abdisa, 2015). Food hygiene is the set of basic principles employed in the systematic control of the environmental conditions during production, packaging, delivery/transportation, storage, processing, preparation, selling and serving of food in such a manner as to ensure that food is safe to consume and is of good keeping quality (Ifeadike et al., 2014). Moreover, the principle of food hygiene implies that there should be minimal handling of food items and food handlers are expected to observe proper hygiene and sanitation methods as the chances of food contamination largely depend on their health status and hygiene practices (Ifeadike et al., 2014, Ko, 2011). However, food handlers with poor personal hygiene and lack of awareness of important issues in preventing food borne diseases, working in food establishments could be potential sources of infections of many intestinal helminthes of protozoa and estrogenic pathogens (Kubde et al., 2017). Approximately 60% of food borne disease outbreaks are linked to eating establishments and commercial caterers (Akabanda et al., 2017).

It has been estimated that cross-contamination in the food establishments kitchen resulting in food poisoning can be attributed to contamination from Escherichia coli O157: H7 (40%), Campylobacter (30%), and Salmonella (20%) (Ifeadike et al., 2014**).** Even though food handlers have a basic responsibility to maintain a high degree of personal hygiene and food handling practice; they have almost no knowledge about the ways and means of food and water contamination, and usually have low standards of personal hygiene for the tasks they are expected to perform (Ifeadike et al., 2014**).** Moreover, negligence in safe food handling practices among food handlers is common (Legesse et al., 2017). However, the chances of food being contaminated depend largely on the health status of food handlers, their hygiene, their knowledge, attitude and practices (Legesse et al., 2017). Because food handlers can transmit a variety of diseases (Kubde et al., 2017). This has been most famously demonstrated by the notorious case of “Typhoid Mary”, a food handler who was also a chronic carrier of Typhoid (Prabhu and Shah, 2012). In short, poor hygienic practices by food handlers coupled with poor sanitary conditions in food and drink establishments can contribute to outbreaks of food borne illnesses (Kibret and Abera, 2012). A Study done in India revealed that the statistics on food borne illnesses in various industrialized countries

show that up to 60% of cases may be caused by poor food handling techniques, and by contaminated food served in food service establishments (Prabhu and Shah, 2012). However, the risk of spread of disease through food handlers though grave has been neglecting. A study conducted in Beijing, China in 2014 indicated that, the self-reported prevalence of diarrhea among adults was 17.5% (Ma et al., 2014). Here six behavioral factors were significantly associated with diarrhea including washing hands before meals and after defecation, washing hands with soap and running water, consuming raw seafood ,using the same chopping block and knife when processing raw and cooked food , using the same chopsticks to handle raw and cooked food (Ma et al., 2014). A study done in Ethiopia, in Bahr Dar Town revealed that, the prevalence of diarrhea disease among food handlers was found to be 6.5% (Abera et al., 2010). Moreover, a study done in United Kingdom (UK) kitchens indicated that, 32% of chefs and catering students were suffering from diarrhea or vomiting (Jones et al., 2017). Haiti based research result indicated that, five out of 56 or 8.93% of the food handlers had diarrhea at the time the study was conducted (Llanes et al., 2016). This study also indicated that, food-handlers with poor personal hygiene working in food-service establishments could be potential sources of infection (Llanes et al., 2016).

2.7. Hypothesis of the study

Definition: A statistical hypothesis is an assumption or a statement, which may or may not be true concerning one or more populations (Hill, 1955). In the study, the main hypothesis that we wished to test was called the null hypothesis, since acceptance of it commonly implies “no effect” or “no difference.” It is denoted by the symbol Ho. In a formal hypothesis test, hypotheses are always statements about the population (Gaddis and Gaddis, 1990). In everyday life, we often have to make decisions based on incomplete information (Rao et al., 2007). This section is about the use of hypothesis testing to help us with these decisions where they are correct or not (Rao et al., 2007). Because, it cannot take a single step forward in any inquiry unless we begin with a suggested explanation or solution of the difficulty, which originated it (Gaddis and Gaddis, 1990). Such tentative explanations are suggested to us by something in the subject matter and by our previous knowledge (Hill, 1955). When they are formulated as propositions, they are called hypotheses (Hill, 1955). The hypothesis (plural hypotheses) is a tentative solution of a problem (Rao et al., 2007). The

research activities are planned to verify the hypothesis and not to find out the solution of the problem or to seek an answer of a question (Feinstein, 2001). It is very essential to a research worker to understand the meaning and nature of hypothesis (Rao et al., 2007). Hypothesis testing is a kind of statistical inference that involves asking a question, collecting data, and then examining what the data tells us about how to precede (Rao et al., 2007). The researcher always plan or formulate a hypothesis in the beginning of the problem (Gaddis and Gaddis, 1990).

The goal of hypothesis testing in this study is to determine the likelihood that a population parameter, such as the mean of the occurrence of fecal coliforms /or E. coli in drinking water, awareness, outlook and practice of food handlers, prevalence of diarrheal disease among food handlers, and sanitation and hygiene status of food establishments are likely to be true. In this section, the researcher describe the two types of hypothesis as follows:

The Null Hypothesis (H0): Is a method for testing a claim or hypothesis about a parameter in a population, using data measured in a sample (Feinstein, 2001). In this method, we test some hypothesis by determining the likelihood that a sample statistic could have been selected, if the hypothesis regarding the population parameter were true (Rao et al., 2007). Moreover, the null hypothesis is a characteristic arithmetic theory suggesting that no statistical relationship and significance exists in a set of given, single, observed variables between two sets of observed data and measured phenomena (Hill, 1955).

An alternative hypothesis (H1): is a statement that directly contradicts a null hypothesis by stating that that the actual value of a population parameter is less than, greater than, or not equal to the value stated in the null hypothesis (Feinstein, 2001).

Based on the above assumptions, the researcher conducted the tests depend on operational definitions and the real known facts to each objective as follows:

1.6.1. To research objective one:

H_0: $\mu = 0$ vs. H_1: $\mu \neq 0$.

Where;

H_1: $\mu \neq 0$, there is difference between the WHO drinking water standard and the result of this study related to Microbial load of drinking water at the point of use in food establishments of Addis Ababa, Ethiopia. Moreover, H_1: $\mu \neq 0$, there is difference between the dry and wet season of the year in Microbial load of drinking water at the point of use in food establishments of Addis Ababa, Ethiopia.

- However, the research result approved that, there was significant difference in microbial load between the WHO standard and the obtained resuts. Moreover, there was significant difference in microbial load between the rainy and dry season. Therefore, the alternative hypothesis was accepted.

1.6.2. To research objective two:

H_0: $\mu = 0$ vs. H_1: $\mu \neq 0$.

Where;

H_1: $\mu \neq 0$, there is poor hygiene and sanitation condition among food establishments of Addis Ababa Ethiopia.

- The finding of the study approved that, 57.4% of the food establishments were under poor sanitation and hygiene status. Therefore, as above half of the food establishments had poor satiation and hygiene status the alternative hypothesis was accepted.

1.6.3. To research objective three:

H_0: $\mu = 0$ vs. H_1: $\mu \neq 0$.

Where;

H_1: $\mu \neq 0$, there is poor awareness, outlook and practice among food handlers towards food and water quality management in Addis Ababa, Ethiopia.

- The outcome of the study approved that, 55.5%, 66.1% and 60.6% of the food handlers had good awareness, outlook and proper hygiene practices respectively. Therefore, to all measurements, as above half of the food handlers had good awareness, outlook and proper hygiene practices the null hypothesis was accepted.

1.6.4. To research objective four:

H_0: $\mu = 0$ vs. H_1: $\mu \neq 0$.

Where;

H_1: $\mu \neq 0$, there are different health problems or diarrheal diseases among food handlers of Addis Ababa, Ethiopia

- The finding of this study approved that, the two-week prevalence of diarrhea among the food handlers was found to be 3.4%. Further, 1.6%, 10.5%, 10.7% and 9% of the food handlers had acute watery diarrhea, cough, an infection of runny nose and incidence of any fever respectively. So that, as many of the food handlers had different health problems, the alternative hypothesis was accepted.

2.8. Conceptual framework of the study

The conceptual framework of the study indicated that, the primary factors that causes public health problems when they are compromised. That is, when there is poor drinking water, poor sanitation and hygiene practice in food establishments and poor health status of food handlers, public health problems can be create easily; especially food and water borne diarrheal diseases can foster in the community. Moreover, the secondary factors that impose an effect on the primary factors are assessed to estimate the health status of the community and to reveal the gap of sanitation practices at food establishments' level. Besides, the conceptual framework of the study revealed that, the outcome variables of the study can provide an advantage to policy makers and others beneficiarries on which to base decisions. Moreover, it indicated that, the outcome of the study can be assist to alleviate poverty and to enhance the public health through using effective methods of hygienic practices. Shortly, the conceptual frame work of the study indicated below in Figure 1.

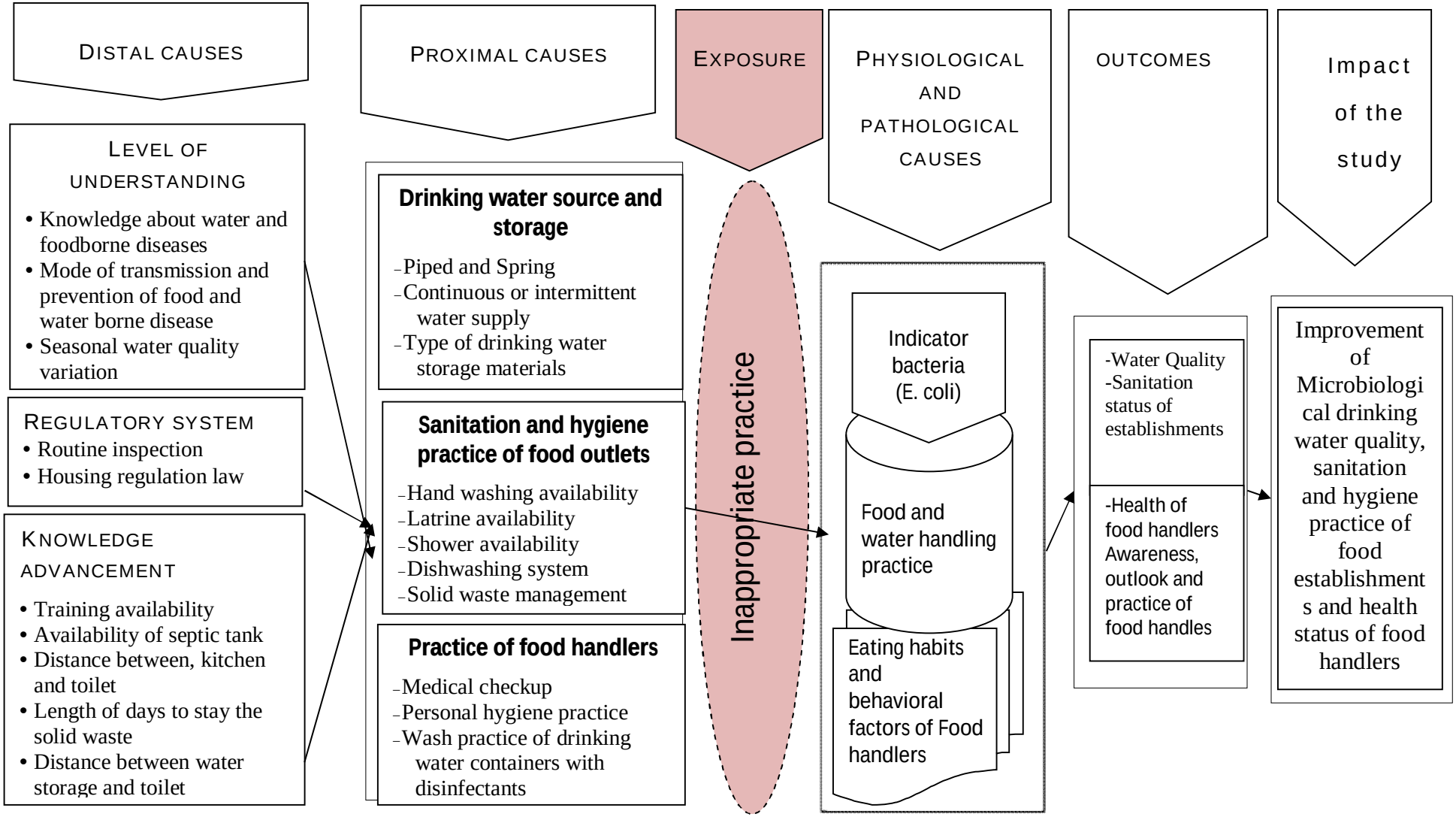

Figure 1: Conceptual framework for determinants of public health in food establishments and health status of food handlers, in Addis Ababa Ethiopia

Chapter 3
METHODS AND MATERIALS

The methodology used in this study is classified in to three major categories. The first category depicts the primary data collection and organization phase. This phase is followed by data cleanliness, analysis and interpretation phase. The final stage of the study is the result generation, and discussion phase. In this study, two major methods were applied. These include longitudinal and cross sectional study designs. Moreover, the overall procedure and methodology are discussed based on sub-topics and deliverables.

3.1. Description of the Study Area

3.1.1. Study Area

The study was conducted in Addis Ababa city located in Upper Awash River Basin, the capital of the Federal Government of Ethiopia and where the African Union Headquarters are housed. The city is located between $8^0$49’ 55.929” and $9^0$5’53.853” North latitude and between $38^0$38’16.555” and $38^0$54’19.547” East longitudes, covers an area of 51, 948.85 hectare and has a total population of 3,384,569 according to the 2007 census (Population and Housing Census, 2008). According to the 2017 AAFMHACA report, there are 1141 licensed food establishments, employing 4565 food handlers. Of the total licensed food establishments, 95 (8%) are large (hotels with one or more stars) and the remaining 1046 (92%) are small food establishments which include unranked (non-star hotels, bars, restaurants, cafes etc) (Girmay et al., 2020). According the AAFMHACA, the Addis Ababa food establishments are categorized in to slum and non-slum area based on the 12 criteria. Which are liquid and solid waste management practice, presence of improved toilet and septic tank, good housing condition (clean, ventilated), acceptable dishwashing system practice, presence of food handlers with medical checkup, availability of enough space for work, availability of continuous water supply, availability of shower, good food storage condition and presence of hand washing facility.

The government provides safe water to the food establishments despite huge discrepancies from sub-city to sub-city. The provided water is also inadequate compared to the needs of the

food establishments. Due to this and other unknown factors, most of the food establishments have been subjected to poor environmental and hygiene practice. As a result, recurrent food and water borne outbreaks have occurred and many users of the food establishments are exposing to many health problems. Because, in addition to lack of adequate quality of drinking water and sanitation; it is estimating that over 80% of Addis Ababa's population lives in slum districts with very poor housing construction quality and very small plot sizes (Birhane et al., 2014). Moreover, only 11.4% of Addis Ababa's population in the urban slums and 41.2% of the city's total population had access to improved sanitation. Most people in the urban slums (80.4%) used unimproved sanitation facilities and 8.2% practiced open defecation. Moreover, less than 44% and 30% of the city has access to clean water and sewerage services respectively (Beyene et al., 2015). Further, shortage of water supply and poor water quality are the major concerns of Addis Ababa city administration (Kidanie, 2015).The location map of Addis Ababa city is depicted below in Figure 2:

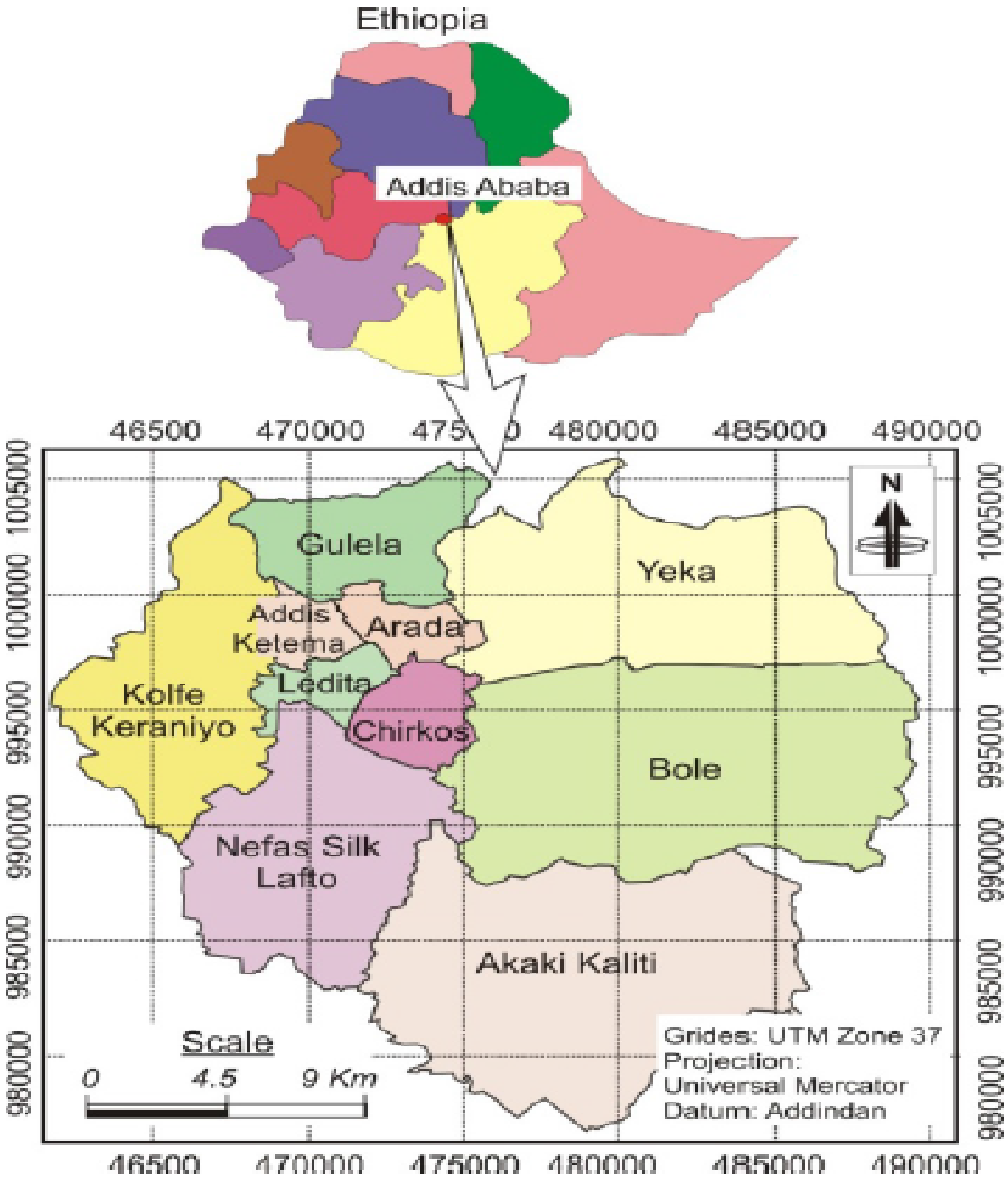

Figure 2: Map of Addis Ababa city administration

Source: Girmay AM, Evans MR, Gari SR,Alemu BM, Gebremariam AG, (2020) Diarrheal disease and associated behavioural factors among food handlers in Addis Ababa, Ethiopia.(Girmay et al., 2020).

3.1.2. Study Design

An institutional based longitudinal and cross sectional study designs were conducted to determine Microbial load and seasonal variation of drinking water quality at the point of use in food establishments, sanitation and hygiene situation of food establishments and health status of food handlers in Addis Ababa city administration.

3.1.3. Study Period

The study was conducted from half of June 2019 to half of March 2020.

3.2. Sampling strategy

3.2.1. Source Population

All food establishments and food handlers located in Addis Ababa city administration were the source population.

3.2.2. Study Population

All selected food establishments and food handles located in Addis Ababa city administration.

3.2.3. Inclusion Criteria

All food establishments that have been provide service for at least six months in the city and food handlers aged 18 years and above were the inclusion criteria.

3.2.4. Exclusion Criteria

Establishments that provide only packed and canned food and water were excluded from the study, because they are less likely to be contaminated. Moreover, casual food handlers, food establishments which were closed at the time of visit, were excluded.

3.2.5. Sample Size determination

The sample sizes were calculated using a single and two population proportion formulas (EPI INFO version 7.2.2.6, STATCALC) as follows:

3.2.5.1. Sample size determination for objective one

The sample size was calculated using unmatched cohort and cross sectional study formula (EPI INFO version 7.2.2.6, STATCALC); by considering, 95% confidence interval, 80% power to detect if there is difference, 1:1 ratio and 15.9% occurrence of microbial load or salmonella (outcome in unexposed group), based on a study result done in treated, stored and drinking water in Nauru north, Kenya in 2014, (Waithaka, 2014). Then, using the unmatched cohort and cross sectional study formula (EPI INFO version 7.2.2.6, STATCALC), the sample size was equal to 114 samples of drinking water. After adding 10% for non-response rate or to involuntary owners, the total sample size for this longitudinal study was equal to 125 sample of drinking water. For this objective, the total sample size (n) was taken in to two seasons. To assess seasonal variation of drinking water quality, 125 samples of drinking water were collected and microbiological analyses were done at the dry season. Similarly, 125 samples of drinking water were collected repeatedly taken from the same food establishments in the wet season and microbiological analyses were done. Totally, 250 samples of drinking water samples were collected to this objective.

3.2.5.2. Sample size determination for objective two

The sample size was calculated using a single population proportion formula (EPI INFO version 7.2.2.6); with the assumption of 46.2% proportion (P) of food establishments used hygienic practices observed in kitchen (wash utensils using hot water) (Boro et al., 2014), acceptable margin of error 0.05 (d), and with 95% confidence level ($Z\ \alpha/_2$), the sample size was calculated. For the non-response rate, 10% contingency was also considered. Accordingly, the required sample size was 420.

$$n = \frac{(Z^2) * P(1-P)}{d^2}$$

Where,

n = the calculated sample size,

z =standard score corresponding to 95% CI,

p = the assumed poor sanitary status of the food establishments (46.2%),

d= marginal error (5%)

Then, $n = \frac{(1.96)^2 * (0.5)^2}{}$, n = 382+ 38= 420

$(0.05)^2$

Therefore, the sample size (n) for this study was = 420.

3.2.5.3. Sample size determination for objective three

A/ Sample size for awareness of food handlers: Was calculated using a single population proportion formula (EPI INFO version 7.2.2.6, STATCALC); with the assumption of 95% confidence interval, tolerable margin of error (d) 5%, and with the pervious population proportion of knowledge heard about food borne diseases (p=27.9%) among food handlers (Kubde et al., 2017), the sample size (n) was calculated as follows:

$$n = \frac{(Z^2) * P(1-P)}{d^2}$$

Where,

n = the calculated sample size,

z =standard score corresponding to 95% CI,

p = the assumed population proportion of knowledge heard about food borne diseases among food handlers (27.9%), (Kubde et al., 2017)),

d= marginal error (5%).

Then, $n = \frac{(1.96) * (1.96) * (0.279) * (1-0.279)}{0.05*0.05} = 309$

Adding 10% non-response rate, the sample size was = 340

Therefore, the sample size (n) was = 340.

B/ Sample size for attitude of food handlers:

The sample size for attitude of food handlers was calculated using a single population proportion formula (EPI INFO version 7.2.2.6); with the assumption of 95% confidence interval, tolerable margin of error (d) 5%, and the pervious population proportion of use of tidy clothes for cleaning reduces the risk of food and water contamination (P = 46.5%) among food handlers, (Kubde et al., 2017), the sample size (n) was calculated as follows:

$$n = \frac{(Z^2) * P(1-P)}{d^2}$$

Where,

n = the calculated sample size,

z =standard score corresponding to 95% CI,

p = the assumed proportion of good attitude of food handlers (46.5%),(Kubde et al., 2017)

d= marginal error (5%).

Then, $n = \frac{(1.96) * (1.96) * (0.465) * (1-0.465)}{0.05*0.05} = 382$

Adding 10% non-response rate, the sample size for this was = 420

C/ Sample size for practice of food handlers: Was calculated using a single population proportion formula (EPI INFO version 7.2.2.6); with the assumption of 95% confidence interval, tolerable margin of error (d) 5%, and the pervious population proportion practice of washing of hands before handling food (P = 93%) among food handlers, (Kubde et al., 2017), the sample size (n) was calculated as follows**:**

$$n = \frac{(Z^2) * P(1-P)}{d^2}$$

Where,

n = the calculated sample size,

z =standard score corresponding to 95% CI,

P = percentage of food handlers with acceptable hand washing practice 93%,(Kubde et al., 2017)

d= marginal error (5%).

Then, $n = \frac{(1.96) * (1.96) * (0.93) * (1-0.93)}{0.05*0.05} = 100$

Adding 10% non-response rate, the sample size was = 110 food handlers.

Finally, from the three calculated sample size (340, 420, and 110), the largest calculated sample size (420) was taken for this study.

3.2.5.4. Sample size determination for objective four

To estimate two-week prevalence of diarrheal disease and associated behavioral factors among food handlers in the food establishments of Addis Ababa, sample size was calculated using a single and two population proportion formula (EPI INFO version 7.2.2.6) considering that:

A/ The sample size was calculated using a single population proportion formula (EPI INFO

version 7.2.2.6); with the assumptions of 95% confidence interval (two sided), tolerable margin of error (d) 5%, since no study conducted on prevalence of diarrheal disease among food handlers of Addis Ababa, the population proportion (p=50%). Adding 10% for non-response rate, the sample size was calculated as follows:

$$n = \frac{(Z^2) * P(1-P)}{d^2}$$

Where,

n = the calculated sample size,

z =standard score corresponding to 95% CI,

p = the assumed proportion food handlers free from diarrhea 50%,

d= marginal error 5%.

Then, $n = \frac{(1.96) * (1.96) * (0.05) * (1-0.05)}{0.05*0.05} = 384$

Adding 10% for non-response rate, the sample size was 422 food handlers.

B/ Sample size for the associated factors of diarrheal disease among food handlers: Was calculated using two population proportion formula (EPI INFO version 7.2.2.6) considering that:

1st. For hand washing before meals and after defecation:

- **p1** (prevalence of diarrhea among exposed group is 16.9% and p2 prevalence of diarrhea among unexposed group is 24.1% (Ma et al., 2014).
- Power to detect a significant difference between P1 and P2 if it exists (1 - β) = 80%
- Z α / 2 = 95% confidence interval
- Ratio [r] = 1: 1 and OR= 0.643 (Ma et al., 2014)
- Then, using EPI INFO version 7.2, 2.6 STATCALC, the sample size becomes **1058** sample of food handlers

2nd. For hand washing practice of food handlers after toilet use only:

- **p1** (prevalence of hand washing practice of food handlers after toilet use(exposed group to hand washing) is 89.3%) and **p2** (prevalence of no hand washing practice after toilet use among food handlers (un exposed group to hand washing) is 10.7% **(Ifeadike et al., 2014)**
- Power to detect a significant difference between P1 and P2 if it exists (1 - β) = 80%

- Z α / 2 =95% Confidence interval
- Ratio [r] = 1: 1
- The weighted average of P1 and P2 = P = $\frac{P1 + r(P2)}{1 + r} = \frac{0.893+1(0.107)}{1+1} = 0.5$
- Sample size for hand washing practice of food handlers after toilets use was = n1
- Then, using the two population proportion formulas, the sample size (n) was calculated as follows**:**
- Using, p1 = 0.893; p2 = 0.107; P = (0.893 + 0.103)/2 = 0.5; Z α / 2 = 1.96; r =1 and Z(1-β)=0.8

$$n1 = \frac{[(1.96\sqrt{(1 + 1/1)\,0.5(1 - 0.5)} + 0.8\sqrt{0.893\,(1 - 0.893) + \frac{0.107\,(1 - 0.107)}{1}}]^2}{(0.893 - 0.107)^2} = 172$$

Where,

- **p1-** (prevalence of hand washing practice after toilet use among food handlers (exposed group to hand washing),
- **p2-** prevalence of not hand washing practice after toilet use among food handlers (un exposed group to hand washing)**,**
- Z(1-β) -Power to detect a significant difference between P1 and P2 if it exists ,
- Z α / 2 - 95% Confidence interval
- r = Ratio ,
- P -The weighted average of P1 and P2,
- **n1 -** Sample size for proper hand washing with soap and water

Lastly, from the three calculated sample size (422, 172 and 1058), the largest sample size (1058 food handlers) was taken for this study.

3.2.5.5. Sampling Procedure

Different sampling procedure was used for each objective. The study participants were selected using a stratified, simple random sampling technique. To collect data, a listing of the 1141 the licensed food establishments were obtained from AAFMHACA. These 1141 food establishments were stratified in to slum and non-slum areas based on their location. Sample allocation was conducted to the slum and non-slum areas in addition to the large and small

food establishments. After the food establishments were stratified based on their location and size (large or small), the required sample was selected at random.

Similarly, the food handlers were stratified in to two based on their work location in which the slum and non-slum area. Besides, food handlers working in big and small food establishments were further stratified in to two. Then, each sample was allocated to slum and non-slum area or strata using a proportional sample allocation. Besides, samples were taken from the big and small food establishments according the sample allocation. Then, one food handler was selected from one food establishment.

A stratified random sampling technique was conducted, in both slum and non-slum area and bigness and smallness of food establishments of Addis Ababa. The main purpose of stratification was for the sake of representativeness of food establishments, which are located in different area, various statuses with different characteristics and environmental hygiene and sanitation practices. Further, it was also capture representativeness of food handlers, which are working in different area and in various types of establishments with different characteristics like educational status and work experience.

To take sample for objective one, from the 95 big food establishments and 1,046 small food establishments, 51 and 74 samples of food establishments (total of 125 samples of food establishments) were taken from the non slum and slum area respectively. Moreover, from the non-slum area (51), 7 samples from the large and 44 samples from the small food establishments were included. Also, from the slum area (74), 3 samples from the large and 71 samples from the small food establishments were collected. Totally, 10 samples from the large and 115 samples from the small food establishments (total of 125 samples of food establishments) were selected. Then, address of the selected food establishments was registered to simplify for the next visit. To assess seasonal variation of drinking water quality, 125 samples of drinking water were collected at the dry season (December–March). Similarly, 125 samples of drinking water were collected from the same or registered food establishments in the wet season (June–September). Finally, using a simple random sampling technique, from the total selected 125 food establishments, 250 drinking

water samples (250 ml from each) were collected directly from the point of use of the food establishments at both seasons.

Similarly, for objective two, three and four, stratification was done to food establishments and food handlers according their location (slum and non-slum area). In addition, stratification based on the food establishments bigness and smallness was done. Then, each sample was allocated using proportional sample allocation. Based on this, for objective two, for the 420 samples, 170 and 250 samples of food establishments were taken from the non-slum and slum area respectively. From the non-slum area (170), 23 samples from the large and 147 samples from the small food establishments were collected. Besides, from the slum area (250), 10 samples from the large and 240 samples from the small food establishments were collected. Finally, using a simple random sampling technique, 420 food establishments were selected to assess sanitation and hygiene status. A stratified random sampling technique was used in both slum and non-slum areas as well as large and small food establishments of Addis Ababa.

For objective three, food handlers were stratified based on their work location and size of food establishments in which they do (big or small). Sample allocation was done to the slum and non-sum area in addition to the big and small food establishments. Based on the sample allocation, 171 and 249 food handlers were taken from the food establishments located in the non-slum and slum area respectively. From the non-slum area (171), 24 samples from the big food establishments and 147 samples from the small food establishments were taken. Besides, from the slum area (249), 11 samples from the big food establishments and 238 samples from the small food establishments were taken. Further, based on the sample allocation of the size of the food establishments, from the slum and non-slum area a total of 35 and 385 samples of food handlers were taken from the big and small food establishments respectively. Lastly, using a simple random sampling technique, one food handler from one food establishment was selected at random to assess awareness, outlook and practice of food handlers towards food and water safety.

Similarly, for objective four, the food handlers were stratified in to two based on their work location (slum and non-slum area). Further, food handlers working in big and small food

establishments were stratified in to two. Based on this, sample allocation was done to the slum and non-sum area in addition to the big and small food establishments. Then, after the food handlers were stratified based on their work location and size of food establishments (big or small), one food handler from one food establishment was selected at random. Based on this, 428 and 630 food handlers were taken from the food establishments located in the non-slum and slum area respectively. From the non-slum area (428) samples of food handlers, 59 samples from the big food establishments and 369 samples from the small food establishments were taken. Besides, from the slum area (630) samples of food handlers, 29 samples from the big food establishments and 601 samples from the small food establishments were taken. Lastly, using a simple random sampling technique, 1058 food handlers were selected to assess prevalence of diarrheal diseases and associated behavioural factors. In summary, the sampling procedure for this study is depicted below in Figure 3 as follows:

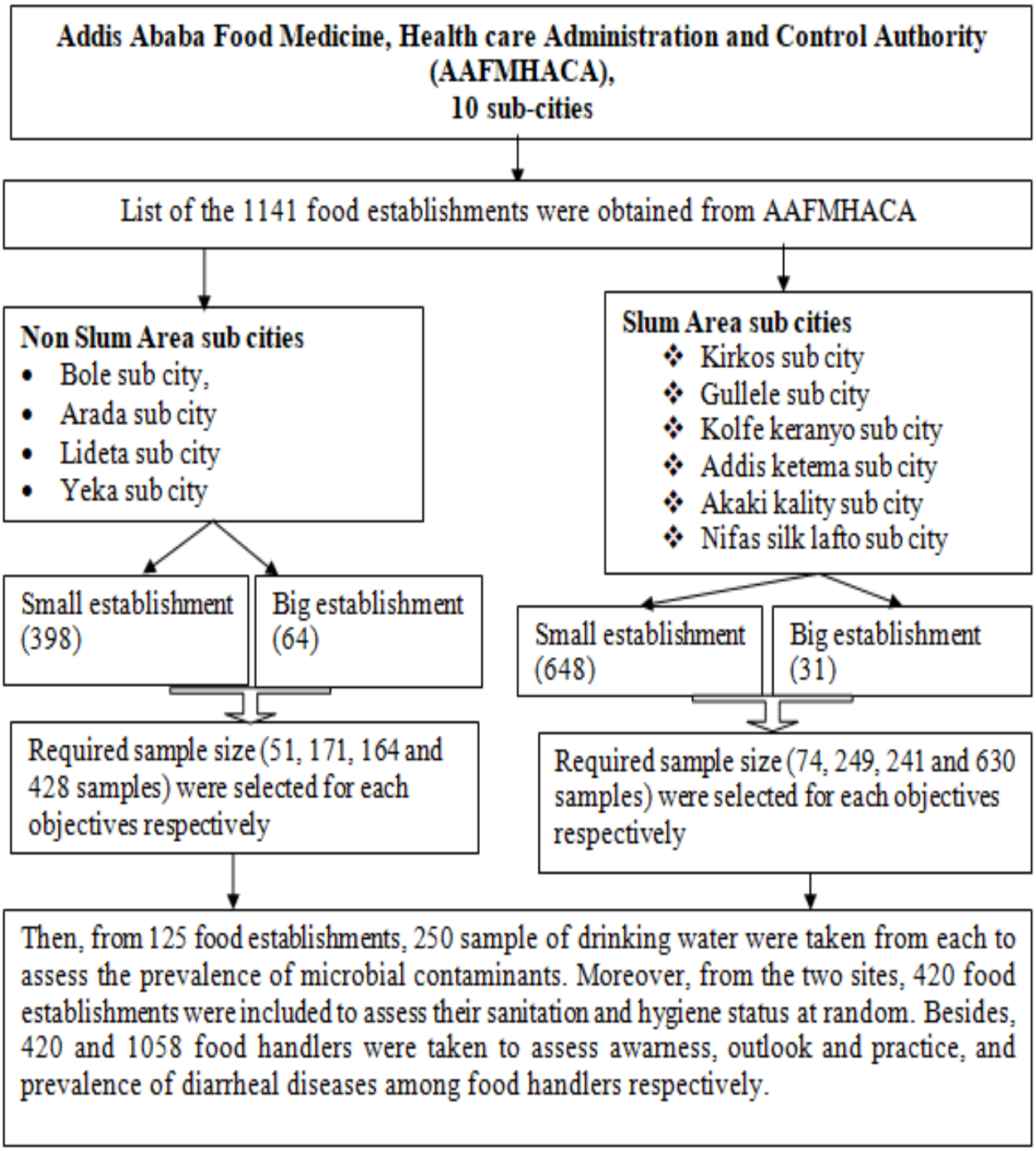

Figure 3: Systematic structure of sampling procedure of the study

Based on the data taken from AAFMHACA, business processing and re-engineering 2017, a proportional sample allocation was done for each group by using the following formula:

$$n_i = \frac{N_i * n}{N}$$ Where,

n_i = Total sample size in group i

N_i = Total number of food establishments in group i

n = Total sample size determined

The proportional sample allocation was conducted based on the location and size of the food establishments. In addition, the food handlers were proportionally allocated in the same scenario. In the study, the sample allocations were done using the above formula and presented as shown below in Table 1 and Table 2:

Table 1: Proportional sample allocation by location of food establishments

Sr.no	List of Sub- cities	Total existing food establishments (Ni)	Average no of food handlers in a food establishment	The expected no of food handlers (Ni)	Using Proportional sample allocation Formula ($n_i = \frac{N_i * n}{N}$), the required samples were taken:			
					For Drinking water samples (n=125)	For food establishment samples (n=420)	For KAP of food handlers (n=420)	For diarrheal diseases samples among food handlers (n=1058)
	Non slum area							
	Bole	125	X4	500	14	46	46	116
	Arada	132	X4	528	14	49	49	122
	Lideta	88	X4	352	10	32	33	82
	Yeka	117	X4	468	13	43	43	109
	Sub-total	462		1848	51	170	171	428
	Slum area							
	Kirkos	107	X4	428	11	39	39	99
	Gullele	109	X4	436	12	40	40	101
	Kolfe keranyo	118	X4	472	13	44	43	110
	Addis ketema	126	X4	504	14	47	46	117
	Akaki kality	110	X4	440	12	40	41	102
	Nifas silk lafto	109	X4	436	12	40	40	101
	Sub-total	679		2716	74	250	249	630
	Total	**1141**		**4564**	**125**	**420**	**420**	**1058**

Table 2: Proportional sample allocation by location and size of food establishments

Sr. no	List of Sub- cities	Total existing food establishments (Ni)	Average no of food handlers in a food establishment	The expected no of food handlers (Ni)	Using Proportional sample allocation Formula ($n_i = \frac{N_i * n}{N}$), the required samples were taken:			
					For Drinking water samples (n=125)	For food establishment samples (n=420)	For KAP of food handlers (n=420)	For diarrheal diseases samples among food handlers (n=1058)
	Non slum area							
	Big establishment	64	X4	256	7	23	24	59
	Small food establishment	398	X4	1592	44	147	147	369
	Slum area							
	Big food establishment	31	X4	124	3	10	11	29
	Small food establishment	648	X4	2592	71	240	238	601
	Total	**1141**		**4564**	**125**	**420**	**420**	**1058**

3.3. Data Collection and Analysis

3.3.1. Data Collection Procedures

Drinking water samples were collected at both seasons of the year from the Point of Use (POU) in food establishments and were bacteriologically tested in laboratory. To collect the drinking water samples from the food establishments storage, heat-sterilized bottles of 250ml capacity were used and the methods of sampling were adapted from the WHO guidelines for drinking water quality. The bottles were delivering to the laboratory within 6 hours and kept in refrigerator at 4℃ until the time of analysis. Moreover, to collect data for objective two, three and four, data enumerators were identified based on professional capability and technical experience in collecting the required data. Accordingly, fifteen health professionals with Bachelor of Science with extensive experience in a similar data collection practices were employed. In addition, four Masters' degree holders acted as supervisors were recruited for supervision of data collection. To create common understanding in the data collection process, two-days of training for each study were given to the data collectors and supervisors. To objective two, after written consent was obtained from each food establishment managers, the data was collected using observational checklist and through face-to-face interview using structured questionnaire adopted from similar literatures. Further, a meter was used to measure horizontal distance between toilet and kitchen.

Similarly, to objective three and four, first the data collectors were communicated and create agreement with the managers about the aim of the study. Then, to select the food handlers, list and address of food handlers were taken from the manager. Next to this, randomly selected food handlers were communicated with the trained data collectors to meet each other at the convenient time and place for the food handler. The data collectors were not report to managers as they meet the food handlers and were secured and anonymous as they meet the food handlers to the managers. Finally, after written consent was obtained from each study subjects, the data was collected from food handlers through face-to-face interview using structured questionnaire.

The possible emotional response of participants due to sensitive questions, lack of confidentiality and any risk that can be arising in this study was solved by providing strong training and using experienced data collectors and on spot supervision by supervisors and the principal investigator.

3.3.2. Data Quality Management

To ensure safety of data the role of food establishments, role and responsibilities of data collectors and processes with regard to the data collection or acquisition, data handling and cleaning were clearly discussed and managing effectively. Moreover, data processing, analysis and result writing were managed in every process by giving attention at all.

3.3.3. Data Quality control

A questionnaire was prepared in English and translated to Amharic and back to English to keep the consistency of questions. Standardized questionnaire adopted from WHO and different literature were developed and used. To ensure the data quality, pilot study was conducted to see the effectiveness of the questionarrer. Moreover, the quality of data was ensured through training of data collectors, close supervision, prompt feedback and daily recheck of completed questionnaire. Moreover, a brief daily activity evaluation method was established to correct problems that were arising during the course of data collection. The consent for each study and the assurance of confidentiality were ensured. The principal investigator was check and review the entire completed questionnaire to insure completeness and consistency of the information. The validity of clinical results was ensuring through following all necessary procedures by experienced laboratory professionals. The instruments and reagents used to do the test were calibrated and expire date was ensured.

3.3.4. Data Consistency and Completeness

Principal investigator and supervisors made on the spot check and reviewed all the completed questionnaires to ensure completeness and consistency of the information collected and immediate action was done. Moreover, to maintain the confidentiality of data, all completed data forms were securely stored in a locked drawer inside the offices work of the Principal Investigator of the research. Only research advisors and concerned bodies were

access to the data. To each food establishment a unique code number was giving in the first time to the longitudinal study. The facility code number that is found in the questionnaire was also labeled in to a container of each tube that contains its sample of drinking water.

3.3.5. Data Processing and Analysis Procedures

Membrane filtration method (drinking water microbial load assay)

Membrane filtration method was used for microbiological analysis of the drinking water. In this method, a measured volume of the water sample was filtered through a membrane with a pore size small enough to retain the indicator bacteria to be counted. The membrane was then placed and incubated on Eosine Methylene Blue (EMB) agar, so that the indicator bacteria grow into colonies on its surface. According to (Cowan et al., 1978, Osman et al., 2018) these colonies, which are recognized by their color, morphology and ability to grow on the selective Eosine Methylene Blue (EMB) medium, are counted as separate colonies. Briefly, 100ml of water samples were filtered using membrane filters using 0.45 µm cellulose nitrate membrane (Millipore, USA) to retain the indicator bacteria. Then, the filters were aseptically removed from the membrane holder, placed on EMB agars (Himedia) and incubated at 44.5 ^{o}C for 24 hours for isolation of fecal coliforms and /or E. coli. To confirm positive samples weather they were fecal coliform or not, they were re-inoculated into peptone broth test tubes for 24 hr at 44.5 ^{0}C. Then, drops of Kovac's reagent were added to the re-incubated peptone broth test tubes. Finally, test tubes which indicated reddish color at the top were identified as positive for fecal coliforms and/or E. coli. Then, the obtained results of the study were compared with the WHO recommended drinking water standards. The WHO standard is also equivalent to the Ethiopian drinking water compulsory standard published on 2013 and European drinking water standard. Therefore, the findings of the study were compared with standards as seen below in Table 3:

Table 3: WHO bacteriological quality of drinking water standard (WHO, 2011)

Microorganisms	Guideline values
All water intended for drinking	
E. coli or thermo tolerant coliform bacteria	Must not be detectable in any 100ml sample
Treated water entering the distribution system	
E. coli or thermo tolerant coliform bacteria	Must not be detectable in any 100ml sample
Treated water in the distribution system	
E. coli or thermo tolerant coliform bacteria	Must not be detectable in any 100ml sample

For the longitudinal study, all laboratory procedures and results were recorded and coded appropriately. For objectives one, two, three and four, all data were checked for correctness of information and code. For all data, data analyses were performed by using SPSS (Statistical Package for the Social Sciences) software version 20. Descriptive statistics, a repeated measure of Analysis of Variance (ANOVA) statistical model, Binary Logistic Regression, Multivariable Logistic Regression and Linear Regression Model and analysis of variance were conducted to analysis the data. In all analysis, p-value less than 0.05 were considered statistically significant.

3.3.6. Operational Definitions

Drinking water quality: Is the first outcome variable of the study**.** According to WHO drinking water standard 2004, water samples with <1 CFU/100 ml were considered to be uncontaminated and samples with ≥1 CFU/100 ml to be contaminated (World Health Organisation, 2004). Moreover, based on a study done by Lloyd B and Bartram J, the fecal coliform count contamination levels in the drinking water samples were categorized into 0 (no health risk), 1–10 (low health risk), 11–100 (high health risk) and >100 CFU per 100 mL (Very high health risk) (Lloyd and Bartram, 1991).

Sanitation and hygiene status: Is the second outcome variable of this study, which was computed by taking summation of 24 criteria, indicated in table 12. Each criterion was given a value of 1 for the presence of sanitary condition or correct response and 0 for the absence or

incorrect response. The sum of these conditions was calculated and the mean score of all observations and interview questions was used as a cut-off point to categorize establishments as good or poor sanitation status. Food establishments with equal to or higher than mean value (≥16.8) were categorized under good sanitation and hygiene status; whereas, food establishments which scores below mean (<16.8) were considered as poor sanitary conditions.

Good awareness, outlook and practice: were the third outcome variables of the study.

Good Awareness: To assess the level of awareness, respondents were asked 13 questions from the questionnaire and those who scored greater than or equal to the mean value were considered as having good awareness and those who scored less than the mean value were considered as having poor awareness (Tessema et al., 2014).

Good outlook: To assess the level of outlook, respondents were asked 6 questions from the questionnaire and those who scored greater than or equal to the mean value were considered as having good outlook and those who scored less than the mean value were considered as having poor outlook.

Good Practices: To assess the level of practices, respondents were asked 11 questions from the questionnaire and those who scored greater than or equal to the mean value were considered as having good practices and those who scored less than the mean value were considered as having poor practices (Tessema et al., 2014).

Diarrheal Disease: Defecation frequency of three or more loose/liquid stools in a day.

Health Status: The presence of absence of diarrheal disease in two weeks prior to the study.

Food Establishments: Institutions that provide food and drinks for selling to customers.

Food: A material consisting nutritious substances that people eat or drink in order to maintain life and growth

Food Handlers: A person who is involved in the preparation and handling of food in a food establishment.

Point of use: Is the drinking water storage of food establishments.

Large/big Food Establishment: Hotels with one or more stars.

Small Food Establishment: Small vendors, non-star hotels, bars, restaurants, cafes.

Some Definition of Sulum Area: The UN-HABITAT defines a slum household as a group of individuals living under the same roof in an urban area who lack one or more of the following:

1. Durable housing of a permanent nature that protects against extreme climate conditions.
2. Sufficient living space which means not more than three people sharing the same room.
3. Easy access to safe water in sufficient amounts at an affordable price.
4. Access to adequate sanitation in the form of a private or public toilet shared by a reasonable number of people.
5. Security of tenure that prevents forced evictions.
https://mirror.unhabitat.org/documents/media_centre/sowcr2006/SOWCR%205.pdf
However, in this study the word slum is defined based on the AAFMHACA 12 criterias. As a result, the term is defined as:

Slum Area: Area with poorer sanitation infrastructure.

Non-slum Area: Area with better sanitation infrastructure.

Easily washable: Means a floor, which is smooth and made of cement.

Good ventilation: means a class, with an openable window or similar aperture is required to be at least 10% of the floor space in that particular area.

3.3.7. Study Variables

A/ Independent or predictor or explanatory variables:

In this study, the independent study variables are defined as a factor or phenomenon that causes or influences the dependent variable. The predictor variables of this study were:

- Drinking water, time or season, type of food establishments, location of food establishments like in slum area and non-slum area, distance between toilet and kitchen, source of water supply, functional shower, functional refrigerator, functional toilet, functional hand-washing, renewed license, regulatory inspection, three dishwashing systems, separate kitchen, water storage, utensil cleanliness, bureaucratic function to obtain permission from the authorized body to renew the food establishment buildings, health examination certificate and liquid and solid waste management practice, sex, age, marital status, religion, educational status and length of work experience of the food handlers etc.

B/ Dependent or outcome or response variables:

In this study, dependent study variables are defined as phenomenon that is changing by the effect of an associated factor or independent variable. The outcome variables of this study were:

- Microbiological quality of drinking water
- Sanitation and hygiene status.
- Awareness, outlook and practice of food handlers
- Diarrheal disease

3.3. 8. Ethical Consideration

The ethical procedure followed a serious of three stage based validation processes that incorporate (1) research approval, (2) technical clearance, and (3) collaborative or consultative approaches. Firstly, a research letter of support was obtained from the Ethiopian Institute of Water Resources, Addis Ababa University. Secondly, ethical clearance and approval technical letter was collected from the Ethiopian Public Health Institute, Scientific and Ethical Review Board with reference number EPHI 613/138 in June 2019. Thirdly, in collecting the research data, a written consent of collaborative letter was obtained from the owner of each food establishments and food handles. Written consent was obtained from each respondent after explaining the objective of the study. They were informed that their participation was voluntary. Confidentiality and privacy of respondents were ensured throughout the research process. The study design does not harm those taking part and it does not include any identifying information like name, or address of a respondents on questionnaire. They were well informed by the data collectors; as the study was only for the purpose of academic and institutional research and not for any other business or illegal activities. Moreover, participants have been full right to refuse from participated in this research. They can choose not to respond to some or all questions if they do not want to give their response or water sample. They have also the full right to withdraw from this study at any time they wish, without losing any of their right. Then, data were collected after assuring the confidential nature of responses.

The principal investigator was provided 8 days training to the data collects whose background is environmental health with extensive experience on data collection. The training was emphasized on the overall process of data collection and how they were obtained the written consent from the participants. The informed consent was obtained from the participants during their convenient time in appropriate setting even it may be in their vacation or free from work. The informed consent was obtained before starting the interview with the structured questionnaire and provision of adequate time for consideration. To obtain informed consent, the participants were approached friendly and politely, in suitable environment, and using easy words. In addition, the data collectors were clearly discussed with the participants about the aim of the study. Food establishments may obtain feedback that was assisted them in improving service provision, for the benefit of participants; the feedback should be summary report of the project, with anonyms/with no identifiers of study participants and food establishments. In addition, coppy of the research will be provided to Ethiopian Public Health Institute in order to address the findings of the gaps collaborately.

3.3.9. Dissemination of Results

As the study aimed at filling the gaps of total hygiene and sanitation of food establishments, the study helps for alternative strategy or options to policy makers and may be useful to other researchers as a reference material while conducted further studies. Moreover, the study provides with new evidence based results on drinking water and environmental hygiene and sanitation status of food establishments and health status of food handlers. Therefore, the result of this study have a great impact on improving the public health by creating new public intention on food and water borne disease prevention and control mechanisms. As a result, the results obtained from this study clearly discussed and critical recommendations are forwarded to the: food establishment owners, the community, Addis Ababa city administration including sub-city administrations, Addis Ababa water and sewerage authority, Addis Ababa health bureau, federal ministry of health, other concerned bodies and stakeholders.

Chapter 4
RESULTS

In this section, the results of the research activities were categorized in to four major parts for. These include:

- Longitudinal study of microbial load of drinking water and seasonal variation of water quality at the point of use in food establishments. These findings assessed drinking water quality of the Addis Ababa food establishments and the health impact of the poor drinking water quality on the customers and in the community in general. This study was conducted for long period of time (8 Months) and samples were taken twice or repeatedly from the food establishments storage to see the seasonal variation of the drinking water quality.
- Determinants of sanitation and hygiene status of food establishments. The result of this part mainly indicated the sanitation practice of the food establishments and the occurrence of food borne disease that could be arise due to poor sanitation and hygiene practices.
- Trichotomy of awareness, outlook and practice of food handlers towards food and water safety in food establishments. These results also revealed that, the awareness, outlook and practice of food handlers towards food and water safety at the food establishments' level.
- Diarrheal disease and associated behavioural factors among food handlers. This part showed that, the health status of food handlers which is a vital activity to reduce community health problems as food handlers can transfer different causative agents to their customers.

4.1. Longitudinal study of Microbial load of drinking water and seasonal variation of water quality at the point of use in food establishments of Addis Ababa, Ethiopia

4.1.1. Microbial load and seasonal variation

In the presumptive test, 32.8% and 16.4% of the food establishments had occurrence of thermo-tolerant/fecal coliforms in their drinking water during the wet and dry season respectively. However, in the confirmatory test, 26.4% and 10.7% of the food establishments'

drinking water had occurrence of E. coli in the wet and dry season respectively. In this test, out of the total of 247 drinking water samples, 46 (18.6%) of them had fecal coli forms and/or E. coli (Table 4).

Table 4: Microbial load and seasonal variation of drinking water quality at the POU in food establishments of Addis Ababa (n=250)

Presence of indicator of contaminants (Cfu/100ml)		Rainy season (N =125)	Dry season (N=122)	WHO permissible level in number of micro-organisms (N)
Thermo-tolerant/fecal coliforms at 44.5^{o}c	Present	41(32.8%)	20(16.4%)	0
	Absent	84(67.2%)	102(83.6%)	
Escherichia coli (E. coli) at 44.5^{o}c	Present	33(26.4%)	13(10.7%)	0
	Absent	92(73.65%)	109(89.3%)	

4.1. 2. Microbial load, seasonal variation and impact of health risk implications

The finding of the study revealed that, 3.2% and 1.6% of the food establishments' drinking water had very high health risk to customers during the wet and dry season respectively. Moreover, 12% and 2.5% of the food establishments' drinking water had high health risk to customers in the wet and dry season respectively (Table 5).

Table 5: **Microbial load and seasonal variation of drinking water quality at the POU and impact of health risk in food establishments of Adds Ababa (n=250)**

Health risk categories of Fecal coliforms in drinking waters samples (CFU/100 ml) based on	Rainyseason (N =125)		Dry season (N=122)	
	Frequency	%	Frequency	%
No health risk (0)	84	67.2	102	83.6
Low health risk (1-10)	22	17.6	15	12.3
High health risk (11-100)	15	12	3	2.5
Very High health risk (>100)	4	3.2	2	1.6

4.1.3. Descriptive statistics of fecal coliforms and seasonal variation of drinking water

In the study, the mean score of thermo tolerant /fecal coliforms count pre100/ml in the food establishments' drinking water were found to be 7.59 and 3.12 in the rainy and dry season respectively (Table 6).

Table 6: **Fecal coliforms and seasonal variation of drinking water quality at the POU in food establishments of Addis Ababa (n=250)**

Thermo-tolerant or fecal coliforms and season	Mean	Std. Deviation	N
Number of thermo-tolerant or fecal coliforms at 44.5^{o}c /colony count per 100ml in rainy season	7.5902	20.46192	122
Number of thermo-tolerant or fecal coliforms at 44.5^{o}c /colony count per 100ml in dry season	3.1230	13.54855	122

4.1.4. Tests of Within-Subjects Effects of time on the number of fecal coliforms count in drinking water

Having fulfilled the assumption of the "Mauchly's Test of Sphericity" (none significant p-value), the researchers conducted "Tests of Within-Subjects Effects." Then, as observed in table 7, the value of F is 5.631, which reaches significance with a P-value of 0.019 (which is less than the 0.05 alpha levels). This indicated that, there is a statistically significant difference between the means of the number of fecal coliform count per 100ml between the dry and the rainy season (Table 7).

Table 7: **Tests of Within-Subjects Effects of time on the number of colony count in drinking water at the POU in food establishments of Addis Ababa (n=250)**

Tests of Within-Subjects Effects							
Source		Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	1217.316	1	1217.316	5.631	0.019	0.044
	Greenhouse-Geisser	1217.316	1.000	1217.316	5.631	0.019	0.044
	Huynh-Feldt	1217.316	1.000	1217.316	5.631	0.019	0.044
	Lower-bound	1217.316	1.000	1217.316	5.631	0.019	0.044
Error(time)	Sphericity Assumed	26160.184	121	216.200			
	Greenhouse-Geisser	26160.184	121.000	216.200			
	Huynh-Feldt	26160.184	121.000	216.200			
	Lower-bound	**26160.184**	**121.000**	**216.200**			

4.1.5. Pairwise Comparisons to observe the effect of time on the number of colony count in drinking water

The study showed that, the mean of thermo tolerant /fecal coliforms difference reaches significance in the different seasons (dry and rainy season). Although, there was a statistical significance in the thermo-tolerant or fecal coliform means and season of a year, it did not yet know with which season of a year the mean difference is statistical significant. A repeated-measure ANOVA determined that the mean of thermo tolerant /fecal coliforms count per 100ml scores had the same significantly across the two time points or seasons (F (1,121) =5.631, P=0.019. Therefore, to see this difference, pairwise comparisons results were needed. A post hoc pairwise comparison using Bonferroni correction showed an increased mean scores of the thermo-tolerant or fecal coliform count per 100ml between the dry and the rainy season (3.123vs 7.5902 respectively), and which was reached a statistical significant. Therefore, the results for the repeated-measure ANOVA indicated that, there was a significant time effect for the growth of thermo-tolerant or fecal coliforms or number of colony count per 100ml (Table 8).

Table 8: **Pairwise Comparisons to observe effects of time on the number of colony count in drinking water at the POU in food establishments of Addis Ababa (n=250)**

Pairwise Comparisons						
(I) time	(J) time	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	-4.467*	1.883	.019	-8.194	-.740
2	1	4.467*	1.883	.019	.740	8.194

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni

4.1.6. Tests of Within-Subjects Effects of time on E. coli in drinking water

Similar to the above stated results, after fulfilling the assumption of the "Mauchly's Test of Sphericity" (none significant p-value), the researcher conducted "Tests of Within-Subjects Effects." As indicated in table 9, the value of F is 16.244, which researches significance with

P-value of 0.000. This indicated that, there is a statistically significant deference between the means of the E. coli pre 100ml between the dry and rainy season (Table 9).

Table 9: Tests of Within-Subjects Effects of time on E. coli in drinking water at the POU in food establishments of Addis Ababa (n=250)

Tests of Within-Subjects Effects

Source		Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	1.480	1	1.480	16.244	.000	.118
	Greenhouse-Geisser	1.480	1.000	1.480	16.244	.000	.118
	Huynh-Feldt	1.480	1.000	1.480	16.244	.000	.118
	Lower-bound	1.480	1.000	1.480	16.244	.000	.118
Error(Tim)	Sphericity Assumed	11.020	121	.091			
	Greenhouse-Geisser	11.020	121.000	.091			
	Huynh-Feldt	11.020	121.00	.091			
	Lower-bound	11.020	121.00	.091			

4.1.7. Pairwise Comparisons to observe effect of time on the occurrence of E. coli in drinking water

As seen in the above table 9, there was a statistical significance in the occurrence of E. coli and season of the year though it was not yet known in which season was the mean difference significant. A repeated–measure ANOVA determined that the mean of occurrence of E. coli had the same statistical significance across the two time points or seasons F (1,121) =16.244, P=0.000. A post hoc pairwise comparison using Bonferroni correction showed an increased mean of occurrence of E. coli per 100ml scores between dry and rainy season (0.1066 vs 0.2623 respectively) and statistical significance with P-value<0.00. Therefore, the results for the repeated-measure ANOVA indicated that, there was a significant time effect for the occurrence of E. coli per 100ml (Table 10).

Table 10: **Pairwise Comparisons to observe effects of time on fecal coliform counts in drinking water at the POU in food establishments (n=250)**

Pairwise Comparisons						
(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	-0.156*	0.039	0.000	-0.232	-0.079
2	1	0.156*	0.039	0.000	0.079	0.232

Based on estimated marginal means

*. The mean difference is significant at the 0.05 level.

b. Adjustment for multiple comparisons: Bonferroni.

4.2. Determinants of sanitation and hygiene status among food establishments in Addis Ababa, Ethiopia

4.2.1. Socio-demographic characteristics of food establishment managers

The study assessed a total of 413 licensed food establishments. Which includes: 7.7% hotels with one or more stars, 13.3% non-star hotels, 27.1% bar and restaurants, 7% cafe and restaurants, 38% restaurants, 2.2% groceries and 4.6% cafe and others. However, only 28.1% of the food establishments had renewed license. Of the total observed food establishments, 92.3% of these were small food establishments. The mean year of service of the food establishments was 6.98 years' ranges from 1- 22 years. Out of the 420 managers representing those food establishments, 413 were participated in the study with a response rate of 98.33%. From the total participated managers of the food establishments, (62.5%) of them were male. Two-third of the managers, (66.3%) was found to be above age group of 39 years. The age of participants representing the food establishments ranges from 21-78 years with a mean age of 45.2 years. Nearly all (94.9%) of the food establishment managers were found to have ability at least reading and writing. However, only 31.2% and 32.7% of the food establishment managers and food handlers took training about sanitation and hygiene in the past one year respectively. Further, only (27.6%) of the managers owned the food establishment building (Table 11).

Table 11: **Socio-demographic characteristics of food establishment managers (n=413)**

Study variables	Category	Frequency	Percent (%)	Mean	Standard deviation
Sex of managers	Male	258	62.5		
	Female	155	37.5		
Age group of managers	< 25 years	11	2.7	45.3	11.34
	25-29 years	14	3.4		
	30-34 years	53	12.8		
	35-39 years	61	14.8		
	>39 years	274	66.3		
Educational status of managers	Illiterate	21	5.1		
	At least read and write	392	94.9		
Trained managers about hygiene and sanitation in the past one year	Yes	129	31.2		
	No	284	68.8		
Trained food handlers about hygiene and sanitation in the past one year	Yes	135	32.7		
	No	278	67.3		
Ownership of food establishment building	Private	114	27.6		
	Rent	299	72.4		
Service year of food establishments	< 5 years	165	40.0	8.26	16.043
	5-9 years	155	37.5		
	10-14 years	58	14.0		
	15-19 years	23	5.6		
	>19 years	12	2.9		
Renewed license by authorized body	Yes	116	28.1		
	No	297	71.9		
Type of food establishment managers owned	One star and above hotels	32	7.7		
	Non-star hotels	55	13.3		
	Bar and restaurant	112	27.1		
	Cafe and restaurant	29	7.0		
	Restaurant	157	38.0		
	Grocery	9	2.2		
	Cafe and others	19	4.6		
Type of food establishments	Small	381	92.3		
	Large	32	7.7		

4.2.2. Sanitation and hygiene status of food establishments

In this study, the researcher assessed the overall sanitation and hygiene condition of the food establishments. The percentages mean score of availability of sanitation and hygiene facility questions was found to be 70.1% ±20.19**.** Moreover, the mean of correct answer questions to sanitation and hygiene status of food establishments was found to be 16.8. However, based on the cutoff point, only 42.6% of food establishments had good sanitation and hygiene status. Above three-forth (83.3%) of managers of the food establishments faced bureaucratic function to obtain permission from the authorized body to renew the food establishment buildings. Most of the food establishments (98.1%) source of the drinking water was municipality. Further, 91% of the food establishments had private piped water. However, only 28.3% of the food establishments were received continuous piped drinking water supply. 90.8% of those had disinfectants for washing water storage equipment. Two-third (65.6%) of the food establishments had three dishwashing systems which assisted to reduce contamination and food borne disease. However, only 38.4% of the food establishments had a functional shower facility. Nearly all (93.7%) and above three-fourth (77.7%) of the food establishments had a functional toilet and a functional refrigerator respectively. Moreover, 87.2% and 93.5% of the food establishments had a functional hand washing facility near the toilet and a separated kitchen respectively. Meanwhile, 45.8% of the food establishments had not a running tap water for food preparation and equipment washing in the kitchen. In addition, 48.4% of the food establishments had not at least ten-meter horizontal distance between toilet and kitchen.

Of the assessed food establishments, 83.8%, 79.2% and 97.8% had an inspection by regulatory body at least within a month, a septic tank for liquid waste and a temporary solid waste storage container /receptacles respectively. Further, 66.1% of the food establishments had practice of segregation of combustible and non-combustible solid wastes. Though 65.4% of the food handlers had personal protective devices like white gown and hair protective cloth, only 21.1% of the food handlers had health examination certificate at least within the past three month prior to the study. Moreover, only 38.3% of the food handlers had a dressing room. From the observed food establishments, 66.1% and 69.7% of these had storage room for non-perishable food items and adequate ventilation respectively (Table 12).

Table 12: **Availability of sanitation and hygiene facilities among food establishments (n=413)**

No	Criteria for sanitation and hygiene status of food establishments	Answers % (n)	
		Present	Absent
1.	Absence of bureaucratic function to obtain permission from authorized body to renew food establishment buildings	16.7(69)	83.3(344)
2.	Source of the drinking water from municipality	98.1(405)	1.9(8)
3.	Private piped water in food establishments	91(376)	9(37)
4.	Continuous piped drinking water supply in food establishments	28.3(117)	71.7(296)
5.	Disinfectants for washing water storage equipment in food establishments	90.8(375)	9.2(38)
6.	Three dishwashing systems in food establishments	65.6(271)	34.4(142)
7.	Functional shower facility in food establishments	38.7(160)	61.3(253)
8.	Functional refrigerator in food establishments	77.7(321)	22.3(92)
9.	Functional toilet in food establishments	93.7(387)	6.3(26)
10.	Functional hand-washing facility near toilet in food establishments	87.2(360)	12.8(53)
11.	Soap near hand washing facility in food establishments	72.6(300)	27.4 (113)
12.	Separate kitchen in the food establishments	93.5(386)	6.5(27)
13.	Running tap water for food preparation and equipment washing in kitchen	45.8(189)	54.2(224)
14.	At least ten-meter distance between toilet and kitchen	51.6(213)	48.4(200)
15.	Inspection by regulatory body at least within a month	83.8(346)	16.2(67)
16.	Septic tank for liquid waste	79.2(327)	20.8(86)
17.	Presence of temporary solid waste storage containers in the food establishments	97.8(404)	2.2(9)
18.	Solid wastes taken from the food establishments containers within 7 days	85.5(353)	14.5(60)
19.	Practice of segregation of combustible and non- combustible solid wastes	66.1(273)	33.9(140)
20.	Food handlers having health examination certificate at least within the past three month	78.9(326)	21.1(87)
21.	Personal protective devices during the time of this questionnaire filled (white gown, hair protective cloth)	65.4(270)	34.6(143)
22.	Dressing room to food handlers	38.3(158)	61.7(255)
23.	Storage room for non-perishable foods	66.1(273)	33.9(140)
24.	Adequate ventilation	69.7(288)	30.3(125)
		70.1%±20.19	
Percentages mean score of correct answer to availability of sanitation and hygiene facilities			

4.2.3. Determinants of hygiene and sanitation status among food establishments

In the binary logistic regression analysis, six (6) predictor variables: Educational status of managers, presence of trained managers about sanitation and hygiene, presence of trained food handlers, presence of renewed license, absence of bureaucratic function to obtain permission from the authorized body to renew the food establishment buildings, presence of at least ten-meter horizontal distance between toilet and kitchen were significantly associated (P-value <0.028) at 95%CI with sanitation and hygiene status of the food establishments. To control confounders, the six significant explanatory variables were fitted to the condensed model of multivariable analysis. However, in the multivariable analysis only four (4) explanatory variables including: presence of trained managers, presence of renewed licenses, absence of bureaucratic to obtain permission to renew the food establishments, presence of at least ten-meter horizontal distance between toilet and kitchen were significantly associated (P-value < 0.022 at 95% CI) with sanitation and hygiene status. The final condensed model of multivariable analysis was conducted to identify the explanatory variables of sanitary condition of the food establishments.

Accordingly, food establishments which owned trained managers about sanitation and hygiene had 6.10 times higher to have good sanitation and hygienic condition when compared to food establishmentswhich had not (AOR=6.10, with 95%CI: 2.41-15.45). Further, food establishments which have renewed license by authorized body were 3.07 times more likely to be in good sanitation and hygiene condition than those which were not renewed their license (AOR = 3.07 with 95%CI: 1.18-7.99). On the other hand, food establishments which had not faced bureaucratic function to obtain permission from the authorized body for renewal of the food establishment buildings were 2.43 times more likely to be in good sanitation and hygiene condition than those which were faced bureaucratic function (AOR = 2.43 with 95%CI: 1.25-4.70). Besides, food establishments which had at least ten-meter horizontal distance between toilet and kitchen were 9.19 times more likely to be in good sanitary condition compared to those which had not (AOR = 9.19 with 95% CI: 5.63-15.02) (Table 13).

Table 13: **Multivariable logistic regression analysis of determinants of sanitation and hygiene status among food establishments (n=413)**

Study variables		Sanitation status		COR with 95% CI	AOR with 95%CI
		Good	Poor		
Trained managers about sanitation and hygiene in the past one year	Yes	76	53	2.64 (1.72-4.04)	6.10(2.41-15.45)
	No	100	184	1.00	1.00
Renewed license by authorized body	Yes	67	49	2.36 (1.52-3.65)	3.07(1.18-7.99)
	No	109	188	1.00	1.00
Absence of bureaucratic to obtain permission to renew the food establishments	Yes	157	187	1.00	1.00
	No	19	50	2.21(1.25-3.90)	2.43(1.25-4.70)
At least ten-meter distance between toilet and kitchen	Present	139	74	8.28(5.25-13.04)	9.19(5.63-15.02)
	Absent	37	163	1.00	1.00

4.3. Trichotomy of awareness, outlook and practice of food handlers towards food and water safety in food establishments in Addis Ababa, Ethiopia

4.3.1. Socio-demographic characteristics of the food handlers

Out of the 420 food handlers 416 were consented to this study providing 99.1% response rate. There were 76.9% female and 23.1% male respondents. Above half of the respondents were in the age group of 18-22 years old (51.7.1%) followed by the age group of greater than 27 years old (25%). The mean age of the respondents was 24.93 years. More than, three-fourth or (76%) of the food handlers had ability of at least reading and writing while 24% of them were illiterate. Nearly all (93%) of the food handlers were single and 5% of them were married. Regarding religion, most of the participants (82.5%) were Orthodox Christians followed by Muslim (11.1%) and other religions (6.5%). The average length of food handlers work experience was found to be 2.46 years (Table 14).

Table 14: **Socio-demographic characteristics of the food handlers (n=416)**

Study variables	Category /Item	Frequency	Percent (%)
Sex of the food handlers	Male	96	23.1
	Female	320	76.9
Age group of the food handlers	18-22 years	215	51.7
	23-27 years	97	23.3
	>27 years	104	25.0
Educational status of the food handlers	Illiterate	100	24.0
	At least read and write	316	76.0
Marital status of the food handlers	Single	387	93.0
	Married	21	5.0
	Divorced and others	8	1.9
Religion of the food handlers	Orthodox	343	82.5
	Muslim	46	11.1
	Others	27	6.5
Work experience of the food handlers	Above three month and below one year	205	49.3
	Between 1-3 years	82	19.7
	Above 3 years	129	31.0
Mean and standard deviation of the age of the respondents		24.93±7.59	
Mean and standard deviation of the work experience of the respondents		2.46±3.02	

4.3.2. Awareness of food handlers on food and drinking water safety

The finding of the study revealed that, the percentages mean score of awareness questions was found to be 78.18. However, based on the cut off point, only 55.5% of the food handlers had good awareness. In this study, 17.5% and 23.1% of respondents did not know about food and water borne disease respectively. Majority of food-handlers in this study (86.8%) knew contaminated food and water causes public health problem and 83.7% of them had awareness about water contamination if it is not handled properly. Further, nearly 70% of the food handlers had awareness about acute watery diarrhea. In addition, 63.5% and 62.3% of the food handlers knew about Salmonella, hepatitis “A” virus as food and water borne pathogens respectively; and 62% of them knew that bloody diarrhea is transmitted through food and water borne pathogens. Further, 73.1% of the food handlers had awareness of typhoid fever as it is transmitted by contaminated food and water. Of the total respondents, 66.6% of them knew food and water could be easily contaminated at the point of use. Almost all of the

respondents (95.7%) and (95%) knew mode of food and water borne diseases transmission and prevention mechanisms respectively (Table 15).

Table 15: **Awareness of food handlers on food and water safety (n=416)**

No	Questions or study variables	Answers % (n)	
		Correct awareness	Incorrect awareness
1.	Do you know about food borne diseases?	82.5(343)	17.5(73)
2.	Do you know about water borne diseases?	76.9(320)	23.1(96)
3.	Do you know contaminated food and water causes public health problem?	86.8(361)	13.2(55)
4.	Do you know water can be contaminated if it is not handling properly?	83.7(348)	16.3(68)
5.	Do you know about Acute watery diarrhea (AWD)?	69.5(289)	30.5(127)
6.	Do you know Salmonella is a food and water borne pathogen?	63.5(264)	36.5(152)
7.	Do you know hepatitis "A" virus is a food borne pathogen?	62.3(259)	37.7(157)
8.	Do you know bloody diarrhea is transmitted by contaminated food and water?	62.0(258)	38.0(158)
9.	Do you know typhoid fever is transmitted by contaminated food and water?	73.1(304)	26.9(112)
10.	Do you know food and water can be easily contaminated at the point of use or at food establishment?	66.6(277)	33.4(139)
11.	What is the source of your awareness about food and water borne diseases? Health professionals….1 Radio and television…2 Formal training…3 Posters…4 Sanitary inspectors…5 Absence of training….6	99.0(412)	1(4)
12.	What is the mode of transmission of food and water borne diseases? Through contaminated water…1 Through contaminated food……2 Through contaminated hand….3 Through utilizing improved toilet....4 Dirty work environment……5	95.7(398)	4.3(18)
13.	What is the prevention mechanism of food and water borne diseases? Washing hand with soap and safe water before meal……1 Washing hand with soap and safe water after defecation ….2 Isolate sick food handler until he/she treated…….3 Properly cooking food and safe water handling……4 Habit of eating raw beef and vegetables……..6	95(395)	5(21)
	Total percentage mean score of correct answer to awareness	**78.18 ±22.02**	

4.3.3. Outlook of food handlers on food and drinking water safety

The result of the study indicated that, the percentages mean score of outlook questions was 72.88. However, depending on the cutoff point, only 66.1% of the food handlers had good outlook. Of the total participants, 71.9% of the food handlers had correct outlook about using protective tidy clothes that it minimizes contamination of food and water. Further, 76.9% and 78.4% of the food handlers believed that, taking treatment is mandatory when food handler is sick and washing hands should be obligatory before handling cooked food and drinking water respectively. Moreover, 27.9%, 33.9% and 28.1% of the food handlers did not believe that raw food should be separated from cooked food, treated water cannot be easily contaminated if not properly stored at safe container and food and water borne diseases can not arise from food establishments respectively (Table 16).

Table 16: **Outlook of food handlers on food and drinking water safety (n=416)**

Sr.no	Questions or study variables	Answers % (n)	
		Correct outlook	Incorrect outlook
1.	Do you believe using protective tidy clothes minimizes both for food and water contamination at food establishment?	71.9(299)	28.1(117)
2.	Do you believe taking treatment is mandatory when food handler sick?	76.9(320)	23.1(96)
3.	Do you believe washing hands should be obligatory before holding food and touching drinking water?	78.4(326)	21.6(90)
4.	Do you believe raw food should be separated from cooked food?	72.1(300)	27.9(116)
5.	Do you believe treated water can be easily contaminated if not properly stored at safe container?	66.1(275)	33.9(141)
6.	Do you believe food and water borne diseases can be arising from food establishments?	71.9(299)	28.1(117)
	Total percentage mean of correct answer to outlook	**72.88 ±35.50**	

4.3.4. Practice of food handlers on food and drinking water safety

The study result revealed that, the percentages mean score of practice questions was found to be 67.48. But, based on the cut off point, only 60.6% of the food handlers had good or proper hygiene practices. Of the total participants, 67.5% of them washed drinking water

containers with sanitizers regularly. The action of putting food and drinking water in clean containers had the highest score (91.3%) followed by regular washing of drinking water glass (89.9%) with sanitizers. Further, 79.8% of the food handlers had a practice of washing hands with soap and clean water before meal and after defecation. Out of the total participants, 75.5% of food handlers had a practice of washing food utensils with sanitizers and disinfectants before serving with it. In addition, 71.2% of them used tidy clothes for cleaning food utensils regularly. Of the total respondents, 82% washed their hands with soap and clean water before holding cooked foods. In the study, only 39.4% of the food handlers had proper practice of covering mouth with tidy cloth when they cough, whereas 32.79% cut their nail when it becomes tall. Moreover, 75.7% of the food handlers reported that they did not wear personal protective devices like white gown and gloves during the working time (Table 17).

Table 17: **Practice of food handlers on food and drinking water safety (n=416)**

Sr.no	Questions or study variables	Answers%(n)	
		Proper practice	Improper practice
1.	Do you wash drinking water containers with sanitizing and disinfectants regularly?	67.5(281)	32.5(135)
2.	Do you wash drinking water glass with sanitizing and disinfectants after every customer use it regularly?	89.9(374)	10.1(42)
3.	Do you wash your hands with soap and clean water before meal and after defecation?	79.8 (332)	20.2 (84)
4.	Do you wash food utensils with sanitizing and disinfectants before serving with it?	75.5 (314)	24.5 (102)
5.	Do you use tidy clothes for cleaning food utensils regularly?	71.2 (296)	28.8(120)
6.	Do you wash your hands with soap and clean water before holding cooked food?	82.0 (341)	18.0(75)
7.	Do you put food and drinking water in clean containers?	91.3 (380)	8.7(36)
8.	Do you cook food thoroughly before ready for consumption?	88.7 (369)	11.3(47)
9.	Do you cover your mouth with tidy clothe while you coughing?	39.4(164)	60.6(252)
10.	Do you cut your nail when it becomes tall (short nail at the time of interview?	32.79(136)	67.3(280)
11.	Do you wear at least white gown or made glove during the work days?	24.3(101)	75.7(315)
	Total percentage mean percentage of correct answer to practice	**67.48 ±22.65**	

4.3.5. Linear Regression Analyses

In the Linear Regression analysis of this study, five predictor variables were identified to test their impact on the obtained results. Moreover, one additional model (mean score awareness of food handlers of this study) was testing its impact on food and water safety practice and outlook (Table, 18, 19, 20).

4.3.6. Association between awareness mean score and explanatory variables

As shown below in table 18, associations between awareness mean score and sex, age, educational status, marital status and work experience of food handlers exists. Except sex and age, all the independent (educational status, marital status/being married and work experience of food handlers) variables had significant relationship (P-value < 0.02) with the dependent variable (awareness). The predictor variables (Educational status and length of work experience) of the food handlers had a significant positive correlation with awareness. Beta (β) is significant (p = 0.00) for the first predictor and (P = 0.02) for the second predictor. However, being married was significantly negatively correlated with awareness**.** Beta (β) is significant (P = 0.00) for being married. This indicated that, the effect of increased educational status had increased the awareness of the respondents on average by 0.39 or by 3.9%. Similarly, the expected awareness of food handles increased on the average by 0.11 or by 1.1% due to increased length of work experience as food handler. However, being married decreased the awareness of the food handlers by 0.16 or by 1.6% (Table 18).

Table 18: Association of awareness mean score with the predictable variables using Linear Regression Model (n=416)

Predictor/ independent variables	Percentage of Awareness mean score of the food handlers							
	Standardized Coefficient (Beta)	F	df	Std. error	T	P-value	95% Confidence Interval (CI)	
							Lower Bound	Upper Bound
Sex	0.02	0.13	1	0.04	0.353	0.72	-4.137	5.95
Age	-0.04	0.57	1	0.14	-0.75	0.45	-0.39	0.17
Education	0.39	76.16	1	2.33	8.73	0.00	15.72	24.86
Marital status	-0.16	10.30	1	3.09	-3.21	0.00	-15.98	-3.84
Length of work experience	0.11	5.12	1	0.36	2.26	0.02	0.11	1.50

4.3.7. Effect of food and water safety awareness on food and water safety practice

The result of the study showed that, food and water safety awareness had a significant effect on food and water safety practices. The linear regression analysis established that food and water safety awareness could statistically predict food and water safety practices (F = 183.53; df = 1; P = 0.00) with Standardized Coefficient (Beta) = 0.55 at 95% CI (Table 19).

Table 19: Effect of awareness on food and water safety practice using a Linear Regression Model (n=416)

Predictor/ independent variables	Practice							
	Standardized Coefficient (Beta)	F	Df	Std. error	T	P value	95% CI Lower Bound	Upper Bound
Awareness mean score	0.55	183.53	1	0.04	13.55	0.00	0.49	0.65

4.3.8. Effect of food and water safety awareness on food and water safety outlook

The finding of the study revealed that, food and water safety awareness had a significant effect on food and water safety outlook. The linear regression analysis indicated that, food and water safety awareness could statistically predict food and water safety outlook (F = 252.5; df = 1; P = 0.00) with Standardized Coefficient (Beta) = 0.62 at 95% CI (Table 20).

Table 20: Effect of awareness on food and water safety outlook using a Linear Regression Model (n=416)

Predictor/ independent variables	Outlook							
	Standardized Coefficient (Beta)	F	df	Std. error	T	P value	95% CI Lower Bound	Upper Bound
Awareness mean score	0.62	252.49	1	0.06	15.89	0.00	0.87	1.12

4.4. Diarrheal disease and associated behavioural factors among food handlers in Addis Ababa, Ethiopia

4.4.1. Socio-demographic characteristics of the food handlers

A total of 1,050 food handlers participated in the study with a response rate of 99.2%. In the current study, 77% of the participants were female. Of the total participants, 43.4% and 28.7% were between the age group of 18 to 22 and 23 to 27 years old respectively. The mean age of the respondents was 25.695 years. 82.7% of the food handlers had the ability to read and write, while 17.3% were illiterate. The majority of the participants (81.2%) were single. Of the total respondents, 73% of participants were Orthodox Christians and 13.1% were Muslims. Regarding work experience, 46.3% and 35.3% of the respondents had 1 to 5 years and <1 year of work experience as food handlers respectively. Furthermore, 17.8% of the food handlers had above 5 years of work experience as food handlers. The average length of food handlers work experience was found to be 3.34 years (Table 21).

Table 21: **Socio-demographic characteristics of the food handlers (n = 1050)**

Study variables	Category	Frequency	Percent
Sex of the food handlers	Male	242	23.0
	Female	808	77.0
Age group of the food handlers	18–22 years	456	43.4
	23–27 years	301	28.7
	28–32 years	127	12.1
	>32 years	166	15.8
Mean age of the food handles	25.695 years with SD of ±7.576		
Minimum age of the food handlers	18.00 years		
Maximum age of the participants	65.00 years		
Educational status of the food handlers	Illiterate	182	17.3
	At least read and write	868	82.7
Marital status of the food handlers	Single	853	81.2
	Married	180	17.1
	Divorced and others	17	1.6
Religion of the food handlers	Orthodox	766	73.0
	Muslim	138	13.1
	Others	146	13.9
Work experience of the food handlers	<1 year	371	35.3
	1 to 5 years	492	46.9
	>5 years	187	17.8
Mean work experience of the food handlers	3.34 years with SD of ±3.37 years		

4.4.2. Food handlers work profile, medical checkup practice and training situation

The study found 45.1% and 44% of the food handlers' role was cooking and serving as waiters respectively. Of the total participants, 85% and 15% of the food handlers live and sleep in their home and at the food establishments respectively. More than half (57.4%) of the food handlers had no medical checkup or health examination certificate within the past three months prior to the study. From the total respondents, 61.3% of the food handlers reported that there was a mechanism of isolation for sick food handlers from the workplace. However, a greater number of food handlers (83.1%) had no training on food and water safety at least once in the past year prior to the study (Table 22).

Table 22: Food handlers work profile, medical checkup practice and training situation (n = 1050)

Study variables	Category	Frequency	Percent
Role of food handlers in the food establishment	Cook	474	45.1
	Waiter	462	44.0
	Both cooker and waiter	114	10.9
Place of food handlers living and sleeping	At the food establishment	158	15.0
	At her/his home	892	85.0
Type of employee in the food establishment	Permanent	177	16.9
	Temporary	873	83.1
Medical checkup or health examination certificate at least within every three month	Yes	447	42.6
	No	603	57.4
Isolation of sick food handlers from the work place when food handler is ill	Yes	644	61.3
	No	406	38.7
Training of food handles on food and water safety at least once in a year	Yes	177	16.9
	No	873	83.1

4.4.3. Type of disease symptom and morbidity among the food handlers

Out of the 1,050 food handlers, 36 had diarrhea two-week before the interview or a prevalence of 3.4%. Further, from the total participants, 17 (1.6%) of the food handlers had Acute Watery Diarrhea confirmed by a laboratory in the past year prior to this study. Moreover, 10.5%, 10.7% and 9% of the food handlers had a cough, infection or runny nose (influenza) and the incidence of fever within the past two weeks prior to this study respectively (Table 23).

Table 23: Type of disease symptom and morbidity among the food handlers(n = 1050)

Study variables	Category	Frequency	Percent (%)
Diarrheal diseases within the past two weeks prior to this study	Yes	36	3.4
	No	1014	96.6
Acute Watery Diarrhea (AWD) confirmed by laboratory for the past one year prior to this study	Yes	17	1.6
	No	1033	98.4
Cough within the past two weeks prior to this study	Yes	110	10.5
	No	940	89.5
An infection of runny nose within the past two weeks prior to this study	Yes	112	10.7
	No	938	89.3
Incidence of any fever within the past two weeks prior to this study	Yes	95	9.0
	No	955	91.0

4.4.4. Factors that may be contribute to diarrheal diseases among food handlers

Of the total participants, 94.5% and 93.8% washed their hands regularly after using the toilet and before meal respectively. However, 39% of the respondents used the toilet wearing protective clothes/gown. Additionally, 81.9% of the food handlers washed their hands immediately after handling raw foods. Further, 91.6% and 92% of the participants regularly closed their drinking water container to prevent contamination, and regularly washed their drinking water container and utensils with sanitizers and disinfectants. Almost all (96.7%) of the participants were washed glasses or the materials used for drinking water at every event. Also, 82.3% of the respondents put cooked foods separately from raw foods. Although 91.1% of the respondents did not use the same chopping block and knife during processing raw food and cooked food, 24.1% of the participants had habits of eating raw beef and raw vegetables. The food handlers reported that 89% of them ate a meal regularly in the food establishments. However, only 33.3% of the participants used proper waste disposal methods. Further, 62.5% of the respondents utilized unimproved or traditional toilets (Table 24).

Table 24: **Factors that may be contribute to diarrheal diseases among the food handlers(n = 1050)**

Study variables	Category	Frequency	Percent
Regular hands washing after toilet used (defecation)	Yes	992	94.5
	No	58	5.5
Washing hands before meal regularly	Yes	985	93.8
	No	65	6.2
Used toilet while wearing protective clothes/gown	Yes	409	39.0
	No	641	61.0
Hand washing immediately after handling raw foods	Yes	860	81.9
	No	190	18.1
Take precaution/close drinking water container regularly	Yes	962	91.6
	No	88	8.4
Washing drinking water container and food service utensils with sanitizers and disinfectants regularly	Yes	966	92.0
	No	84	8.0
Washing glass or the material used for drink water every event with safe water	Yes	1015	96.7
	No	35	3.3
Put cooked foods separately from raw foods	Yes	864	82.3
	No	186	17.7
Habit of eating raw Beef and raw vegetables	Yes	253	24.1
	No	797	75.9
Used the same chopping block and knife during the time of processing raw food and cooked food	Yes	93	8.9
	No	957	91.1
Feed regularly in the food establishment	Yes	935	89.0
	No	115	11.0
Type of food establishment that the food handlers work	One and above one star Hotel	86	8.2
	Non star Hotel	69	6.6
	Bar and restaurant	194	18.5
	Cafe and restaurant	76	7.2
	Restaurant	424	40.4
	Cafe and others	201	19.1
Used proper waste disposal methods(pedal dust bin, septic tank)	Yes	350	33.3
	No	700	66.7
Type of toilet most of the time used by food handlers	Unimproved or traditional toilet	656	62.5
	Improved toilet	394	37.5
Presence of sanitary inspection by authorized bodies in the food establishment	Yes	865	82.4
	No	185	17.6
Type of the establishment in size the food handlers work	Small food establishment	964	91.8
	Big food establishment	86	8.2

4.4.5. Behavioral factors associated with diarrhea

In the binary logistic regression analysis, thirteen (13) explanatory variables like educational level of food handlers, regular hand washing after toilet used (defecation), regular hand washing before meal, used toilet with wearing protective clothes/gown, regular hand washing immediately after holding raw foods, closing drinking water container regularly, washing drinking water container with safe water and food service utensils with sanitizers and disinfectants, washing glass or the material used for drink water every event, separation of cooked foods from raw foods, habit of eaten raw beef and raw vegetables, used the same chopping block and knife during the time of processing raw food and cooked foods, type of toilet most of the time used by food handlers and presence of sanitary inspection by authorized bodies in the food establishment were significant associated (P-value < 0.028) with diarrheal disease in the past two weeks prior to this study. However, only five (5) predictor variables including: regular hand washing after toilet used (defecation), toilet use while wearing protective clothes/gown, washing glass or the material used for drink water every event, habit of eating raw beef and raw vegetables and type of toilet used by food handlers were appeared in the final condensed model of the multivariable analysis with P-value < 0.05 (Table 25).

Table 25: Multivariate logistic regression analysis of diarrheal disease with selected explanatory variables among the food handlers (n=1050)

Study variables		Diarrhea		B	Wald	P-Value	AOR with 95%CI
		Yes	No				
Regular hand washing after toilet used or defecation	Yes	9	983	−2.029	5.496	0.019	0.13(0.024–0.72)
	No	27	31				Reference
Used toilet while wearing protective clothes/gown	Yes	28	381	1.684	7.283	0.007	5.39(1.59–18.32)
	No	8	633				Reference
Washing glass or the material used for drink water every event with safe water	Yes	11	1004	−4.724	15.532	0.000	0.009(0.001–0.093)
	No	25	10				Reference
Habit of eating raw Beef and raw vegetables	Yes	30	223	1.836	9.010	0.003	6.27(1.89–20.78)
	No	6	791				Reference
Improved or water flush Toilet used by food handler	Yes	7	387	1.405	4.079	0.043	Reference
	No	29	627				4.07(0.29–6.67)

Chapter 5
DISCUSSIONS

In this section the results of the research activities were catigorized in to four major parts. These includes:

- Longitudinal study of microbial load of drinking water and seasonal variation of water quality at the point of use in food establishments.
- Determinants of sanitation and hygiene status of food establishments.
- Trichotomy of awareness, outlook and practice of food handlers towards food and water safety in food establishments.
- Diarrheal disease and associated behavioural factors among food handlers.

In the first part, the results of the drinking water at the point of use (POU) in food establishments was discussed as it was found to be vulnerable to microbiological contamination and imposed different health risks to consumers. Moreover, the second and third part of the findings of the study were discussed as of the food establishments and food handlers were owned and practiced in a condition of poor sanitation and hygiene status respectively. Finally, the fourth part of the study finding was discussed about the health status of food handlers as many of food handlers had diarrheal disease though they were expected to be free from health problems. Because, served by healthy food handlers is a vital activity to reduce community health problems as food handlers can transfer different causative agents to their customers.

5.1. Longitudinal study of Microbial load of drinking water and seasonal variation of water quality at the POU in food establishments of Addis Ababa

The results of the longitudinal study showed that, the occurrence of fecal coliforms and /or E. coli, were identified throughout the study period. Though WHO 2004 drinking water quality standard specify 0 CFU/100 ml as the limit for fecal coliforms and /or E. coli in potable water, the mean values of the fecal coliforms and /or E. coli in this study were above the acceptable level for drinking water that is required for human use and consumption. The results of the study showed that, the drinking water at the point of use (POU) in food

establishments was vulnerable to microbiological contamination and imposed serious health risks to consumers of such kind of water. This could be due to poor handling practice of the drinking water at the food establishments level. Moreover, multiple research shows that the causes could be due to the leakage of water supply pipelines, pollutions from sewage lines entered into drinking water supplies (Point-of Entry-POE), at the food establishment level (Daud et al., 2017). Moreover, in this study, the source of drinking watr contamination for the water quality in the food establishments could be from the source, distribution system and handling practice. The quality of the drinking water at the point of use in food establishments differs between the dry and rainy seasons; higher fecal coliforms and/or E. coli were observed during the rainy season. The occurrence of fecal coli forms during the rainy season in the presumptive test (32.8%) was two time higher when compared to the occurrence of thermo tolerant or fecal coli form during the dry season (16.4%). Moreover, in the confirmatory test, 26.4% of the food establishments drinking water had occurrence of E. coli in the rainy season. Which was greater than two times as compared to occurrence of E. coli in the dry season (10.7%). These results indicated that, time variation had an impact on the drinking water quality of the food establishments. This could be due to effect of flooding that can cause water contamination through leakages during the wet season. Moreover, the effluents of wastes from different toilets can be the cause.

Out of the total of 247 drinking water samples, 46 (18.6%) of them did not comply with the WHO drinking water standards (World Health Organization, 2006, 2008). The microorganisms might have found their way into the drinking water through anthropogenic actions and represent potential threats to human health, causing diseases such as acute gastroenteritis, water borne diarrheal disease, and other infections (Figueras and Borrego, 2010). The finding of the study revealed that, the highest health risk to customers that might arise from the occurrence of pathogenic microorganisms in the drinking water of the food establishments (3.2%) was found to be in the rainy season. The possible causes can be the suitability of air humidity or an air which enhanced growth of microbes, cross contamination and poor practice of sanitation in the rainy season. Moreover, the cause can be due to the poor sanitation system installation, absence of drinking water treatment at food establishments, and lack of continuous monitoring and evaluation of drinking water quality (Daud et al., 2017). The higher number of coli forms in the wet season could be due to poor practice of washing

drinking water reservoirs and utilization of disinfectants to reduce contamination during this season. Moreover, utilization of unimproved source, a probably of contamination of the drinking water by vendors in their off premises, during storage and handling can be the cause (Kirianki et al., 2017, AL-Dulaimi and Younes, 2017, Bain et al., 2014b).

5.2. Determinants of sanitation and hygiene status among food establishments of Addis Ababa

The findings of the study revealed that, above half (57.4%), of the food establishments were in a condition of poor sanitation and hygiene status. The major reasons might be the presence of bureaucratic function from the authorized body to renew the food establishment buildings, absence of continuous piped drinking water supply, absence of functional shower facility and poor liquid and solid waste management practice. Especially, absence of continuous piped drinking water supply could be the leading cause to poor sanitation and hygiene status. Moreover, it might be a main factor to foster food borne disease in the city. The finding of the current study is lower than a study conducted in Bahirdar town. In this study, 78.7% of food establishments had not good sanitation and hygiene (Kibret and Abera, 2012). However, even though time varation, the current study is higher than a study conducted in the Mekelle town, Tigray, north Ethiopia in which only 17.1% of the food establishments had good sanitary status (Kumie and Zeru, 2007). This difference might be due to the rapid development and urbanization in the capital city in addition to socio-economic status of the research areas. In the study, presence of trained food establishment managers on sanitation and hygiene, presence of renewed license, absence of bureaucratic of housing regulation law to renew the food establishments, presence of at least ten-meter horizontal distance between toilet and kitchen were significantly associated predictor variables (P-value <0.028 at 95%CI) with sanitation and hygiene status. The finding of the study indicated that, the proportion of food establishments that had a renewed formal license certificate were 28.1%. The main reason could be due to ineffective effort of authorized health inspectors (concerned regulatory bodies) and absence of strong law and rule of the trade and industry of the city. Moreover, involuntariness of food establishment managers to renew their license might a second factor. However, the observed food establishments that renewed their license certificate have improved sanitation status compared to these, which had not. The finding

revealed that, only 31.2% and 32.7% of the food establishment managers and food handlers took training about sanitation and hygiene in the past one year respectively. Though presence of trained food handlers and managers can reduce food borne disease and enhanced sanitation and hygiene practice of food establishments (Boro et al., 2015b). The result of the the study indicated that, a significant number of food handlers and managers had no received training. This indicated that, there is a gap in creation of awareness and attention provision by the Government and concerned bodies to combat food borne disease. Further, the finding of this study revealed that, food establishments with managers, who took training on sanitation and hygiene were 6.10 times higher to have good sanitation and hygiene status when compared to their counter parts (AOR=6.10 with 95%CI:2.41-15.45). Many studies indicated that, knowledge and training of managers and staffs on sanitation and hygiene have a direct relationship on the overall sanitation and hygiene improvement of food establishments (Meleko et al., 2015a, Fawzi et al., 2009). This revealed that, gaining knowledge through training had a positive effect on ensuring sanitation and hygienic condition of food establishments and food safety practices thereby reduce food borne illness. This is supported by a study conducted by Hedberg et al: 2006 which stated that, managers who took food hygiene and sanitation training were associated with a reduced risk for food borne illness (Hedberg et al., 2006). Moreover, different studies showed that managers' knowledge and training about hygiene and sanitation have a direct influence on the sanitation and hygiene condition of food establishments. They play a paramount role by ensuring availability and cleanliness of sanitary facilities, proper waste management and food safety practices (Kibret and Abera, 2012, Olumakaiye and Bakare, 2013).

In the study, the odds of food establishments which have renewed license were 3.07 times higher to have good sanitation and hygiene status than the odds of those which had not (AOR=3.07 with 95%CI:1.18-7.99). This could be due to the role of inspection by the regulatory body since food establishment license is renewed after conducted firm regulatory inspection. However, opposite to this study, a study done in Adwa town states that, licensing had no significant association with sanitary status (Gebremariam et al., 2019). This might be due to the difference in the level of awareness creation and economic status of the cities. The odds of food establishments which had not received bureaucratic function to obtain permission from the authorized body to renew the food establishment buildings were 2.43

times higher to have good sanitation and hygiene status than the odds of those which had obtained (AOR=2.43 with 95%CI:1.25-4.70). This indicated that, to renew the food establishment buildings, the presence of bureaucratic function to obtain permission from the authorized body created an influence on the sanitation and hygiene of the food establishments. However, suitable formal permission to renew the food establishments without bureaucratic could be a basic instrument to improve the sanitation and hygiene status of the food establishments although this needs additional studies. The study also revealed that, the odds of food establishments with more than 10-meter distance between their toilet and kitchen had 9.19 times higher to have good sanitation and hygienic condition than the odds of those with 10 meter or less (AOR = 9.19, at 95% CI: 5.63 -15.02). This indicates that, distance between toilet and kitchen might a core determinant factor that influences sanitation and hygiene of food establishments. Moreover, adequate distance between toilet and kitchen can prevent cross contamination and reduced food borne disease.

5.3. Trichotomy of awareness, outlook and practice of food handlers towards food and water safety in food establishments of Addis Ababa

In this study, 17.5% and 23.1% of respondents did not know about food and water borne diseases respectively. The higher lack of awareness about food and water borne diseases could be due to the lack of formal and informal training. Moreover, most of the food establishment managers and owners of food establishments hired food handlers who come from rural part of the country, where they did not have any experience and awareness regarding food and water borne disease. The finding of the study revealed that, 27.9% of the food handlers did not consider separation of raw food and cooked food important and 33.9% thought that treated water could not be easily contaminated at the food establishment level. This indicated that, there is poor outlook on the causes of cross contamination, which could arise due to keeping cooked and raw food together. As a result of this, many customers can be exposed to different health problems. Moreover, even they believe the drinking water comes from secured and treated water supply, it can be a source of many water borne diseases if it is not stored properly in clean places. The study revealed that, only 39.4% and 32.79% of the food handlers had proper practice of covering mouth with tidy cloth while coughing and cut their nail when it becomes tall respectively. This indicated that, most of the food handlers did

not have good practice to reduce communicable disease that can be transferred through droplets and sneezing. As a result of this, many customers of food outlets might be exposed to different health problems. Moreover, their tall nail can accumulate various diseases causing agents and can be a reason of disease outbreaks among them and their customers. In addition, 75.7% of the food handlers reported that they did not wear personal protective devices like white gown and gloves during the working time. This indicated that, there was negligence to hygiene and sanitation practice both by the food handlers and by the owners of the outlets.

In this study, 78.2% of the food handlers had a mean percentage score of awareness on food and water safety. This was consistent with the study done in Nigerian food handlers (Aluh and Aluh, 2017). This might be due to similarity of economic status and educational provision. However, the finding was lower than a study done in Salvador, Brazil (Rebouças et al., 2017). This can be due to differences in development and attention given to food and water safety. The World Health Organization recommends that food handlers should have enough awareness to protect food from all kinds of contamination (Asmawi et al., 2018). However, the study result indicated that, only 55.5% of the respondents had good awareness. This could be due to lack of formal training and strong attention on food and water borne diseases by the concerned bodies. The finding of the study indicated that, the level of food handlers' percentage mean score of practices was 67.48%. This was higher when compared to a study done in Malaysia (Lee et al., 2017). Furthermore, in this finding, 60.6% of the food handlers had proper practice. However, this result was lower than the study done in Brazil (Souza et al., 2018). This could be due to low attention of Government and other stakeholders in creating strong regulatory body and awareness among the food handlers in Addis Ababa**.** Moreover**,** the second probable reasons for the differences might be due to differences in socio-demographic status and environmental factors.

The result of the study revealed that, of the explanatory variables sex and age had not significant association with awareness. This indicates that, if once a person is an adult, age might not be important influencing factor on awareness. Because once a person reaches adulthood, the subsequent awareness acquiring solely depends on formal and non-formal education, experience and other personal efforts. On the contrary, others claimed presence of

significant associations (P < 0.05) between age and awareness of food safety (Moreb et al., 2017). This result needs future research to obtain additional evidence.

In the study, educational status of food handlers was significantly and positively associated with food and water safety awareness (P<0.00). The finding of this study revealed that, 76.0% of the participants with the ability of at least to read and write had a higher level of awareness of food and water safety. This is supported with research outcomes (Sibanyoni et al., 2017, Abdul-Mutalib et al., 2012). Similarly, in the study, length of work experience as food handlers was positively and significantly associated (P=.02) with awareness. This result was consistent with the study done in Salvador, Brazil (Rebouças et al., 2017). However, in the study, marital status or being married (P< 0.00) was negatively and significantly associated with awareness of food handlers. This may need further study to obtain additional information. Further, the linear regression model analysis indicated that, having awareness on food and water safety (F = 252.49; df = 1; P = 0.00) with Standardized Coefficient (Beta) = 0.62 at 95% CI) correlates positively and significantly with having good outlook. This indicated that, having good awareness had significant positive effect on outlook although it needs further studies to obtain additional evidences.

5.4. Diarrheal disease and associated behavioural factors among food handlers

The aims of this study were to identify the prevalence of diarrheal disease and associated behavioral factors among food handlers. The self-reported prevalence of diarrheal disease in the two-weeks before the interview was 3.4%. This finding was lower than studies performed in Ethiopia and Haiti (Abera et al., 2010, Llanes et al., 2016). This could be due to difference in attention given to health status and environmental risk factors. However, this result was consistent with a similar study conducted in Ireland (Scallan et al., 2005). This could be due to presence of good awareness among the food handlers towards diarrheal diseases. Further, this result was nearly consistent with a study conducted in South India where the prevalence of diarrhea among food handlers was 5.52% (Mt et al., 2014). The slight difference might be due to the presents of recurrent food and water borne diseases in Addis Ababa and made alerted the food handlers about diarrheal diseases. From the total participants, 17 (1.6%) of the food handlers had Acute Watery Diarrhea confirmed by laboratory testing in the past year

prior to this study. Because, I did not found information from literature on the prevalence of acute watery diarrhea among food handlers. Therefore, this result needs further research as it is a major public health problem. Moreover, 10.5%, 10.7% and 9% of the food handlers had a cough, infection or runny nose (influenza) or the incidence of fever within the past two weeks prior to this study respectively. This indicates the health status of food handlers was poor though they were expected to be healthy and not transmit any infection to customers.

This study revealed that food handlers who had washed their hands after defecation or toilet use were 13% less likely to report diarrhea than those who did not report hand washing. This finding was supported by a study from low and middle income countries (World Health Organization, 2014b)**.** As expected, this may be due to removal of pathogenic organisms during proper hand washing after toilet use. Therefore, washing hands properly at the most recommended times is the key preventive mechanism of diarrheal disease. Not only diarrheal diseases but also, proper hand washing can prevent from Corona Virus-19 (COVID-19) infection. However, food handlers who used toilet while wearing protective clothes/gown had 5.39 times higher risk of diarrheal disease (AOR = 5.39 with 95% CI; 1.59, 18.32) relative to those who had not used the toilet while wearing personal protective device. This indicates personal protective equipment can carry pathogenic organisms or might be vehicles although no study reported this. Therefore, this needs future research to obtain additional information. Moreover, the finding of the study revealed that food handlers who utilized washed glass or the material used for drinking water had prevented risk of diarrhea by 0.9% times higher (AOR = 0.009 with 95% CI: 0.001, 0.093) than those who did not. This indicates that, using safe water-washed glass reduces the risk of diarrheal disease. The odds of having diarrheal disease was 6.27 times higher among food handlers who had the habit of eating raw beef and raw vegetables (AOR = 6.27 with 95% CI: 1.89–20.78) than those who did not. This finding was supported by a 2017 study done in Bejing, China (Ma et al., 2014). Further, the odds of having diarrheal disease was 4.07 times higher among those food handlers who used unimproved/traditional pit toilet (AOR = 4.07 with 95%CI: 0.29–6.67) than those who used improved or water flush toilet. Although in general the presence of a sanitary facility prevents different communicable diseases (World Health Organization, 2014b), this result shows using a traditional pit latrine had its own health impact on a community.

5.5. LIMITATION OF THE STUDY

Although microbial contamination is the most and dominant determinant of health in developing countries, chemical and physical properties of water have been using as indicator of drinking water quality. However, due to their priority and budget constraints, this study was measured the drinking water quality only with respect to microbial contaminants. Therefore, not studying chemical and physical properties of drinking water is the main limitation of this study. Moreover, due to lack of information on the number of food establishments'in the new expanding area of the city, differentiating the water quality condition between the new expanding area and the old part of the city was not possible though the study try to include representative samples using stratification. So, this is another limitation of this study. In addition, lack of assssing financial level of the food establishments is also the limitation of the study. Besides, selection bias may be also a limitation of the study.

Chapter 6
CONCLUSIONS AND RRCOMMNDATION

6.1. Conclusion

Drinking water at the point of use in food establishments was found to be vulnerable to microbiological contamination and had serious health risks to consumers. The microbial load of the drinking water at the POU in food establishments greatly differs between the dry and rainy seasons. A significant number of food establishments' drinking water had E. coli in the rainy and dry seasons. However, the occurrences of fecal coliforms and/or E. coli were higher during the rainy season. It was concluded that, there was a significant time effect for the occurrence of fecal coli form and/or E. coli. The levels of selected indicator bacteria (fecal coliforms and/or *E. coli*) exceeded the WHO recommended guidelines for drinking water. Moreover, the finding of the longitudinal study revealed that, significant numbers of the food establishments drinking water had high and very high health risk to customers both in the wet and dry season.

Above average of the food establishments were found to be in poor sanitation and hygiene state. Assessing sanitation and hygiene status of food establishments is an important activity to curbed food borne diseases. In the finding, presence of trained managers, presence of renewed licenses, absence of bureaucratic function to obtain permission from the authorized body to renew the food establishment buildings, presence of at least ten-meter horizontal distance between toilet and kitchen, absence of continuous piped drinking water supply, absence of functional shower facility and poor liquid and solid waste management practice were the main determinant factors that influence the sanitation and hygienic status of food establishments. The study introduces core determinants useful for increasing community awareness, financing in the water sanitation and hygiene (WASH) sector as well as enhancing the capacity training programs in water sanitation and hygiene (WaSH), monitoring, evaluation and learning (MEL) system among the food establishments, which have a paramount importance for the sustainability of the sector.

Assessing awareness, outlook and practice of food handlers regarding food and water safety is a vital activity to reduce public health problems. In this study, food and water safety

awareness had a significant effect on food and water safety practices of the food handlers. Significant number of food handlers had poor awareness, outlook and practice towards food and water safety. There is a call for enhance the awareness, outlook and practice of food and water safety to achieve an excellent practice. To alleviate this, better food and water safety policy and firm regulatory actions are needed.

The study also assessed the prevalence of diarrheal disease and identifies behavioral factors associated with diarrhea. This assessment proved to be an essential activity for reduction of community- acquired diarrheal diseases, as a significant number of food handlers had diarrhea. Good sanitation, hygiene practice and a healthy lifestyle behavior can prevent diarrhea. A strong political commitment with appropriate budgetary allocation is essential for the control of diarrheal diseases and implementation of sanitation practices.

6.2. Recommendation

The researcher suggests that:

1. There should be massive awareness creation mechanisms on food establishments' drinking water management to curb outbreak of water borne diseases. Some of the mechanisms could be on establishing enough and suitable selected monitoring stations, secured drinking water storage and utilization of easily washable drinking water storage materials bearing in mind the objective of drinkink water use.
2. Appropriate enforcement mechanisms like institutionalize independent regulatory body assisted with strong law and rule to safeguard food and water safety should be implemented effectively through the Government.
3. Good sanitation and proper drinking water handling should be appropriately practiced in the food establishments.
4. Effective drinking water treatment such as disinfection and boiling as well as others methods should be implemented at the food establishments' level.
5. All concerned decision making bodies; in particular, the government should conduct regular and continuous microbial drinking water monitoring, evaluation and learning (MEL) practices to improve drinking water quality at the food establishments level.
6. Formal and informal training on sanitation and hygiene for managers of food establishments should be provided to reduce the occurrence of food borne diseases.

7. Strong food and water safety policy and strategy should be properly implemented to improve sanitation status of food establishments.
8. The Government should be allocating adequate and continuous water supply to the food establishments to upgrade the sanitation and hygiene status; thereby enhance the health of the residents.
9. The mangers/owners of the food establishments should provide attention to fulfill hygienic facilities.
10. To explore additional determinants of sanitation and hygiene status among the food establishments, further studies should be done in the study area by the government and other concerned bodies to improve food safety practice.
11. Firm regulatory body assisted with law enforcement, guidelines and manuals should be in place to upgrade awareness, outlook and practice of food handlers and make food establishments adhere to the policy, strategy, guidelines and manuals requirements.
12. Governmental and Non-Governmental organizations should conduct continuous transformational information management system and capacity building through formal training on food and water safety to food handlers and owners of food establishments to reduce food and waterborne diseases in the community.
13. The government should focus on a comprehensive diarrheal disease control strategy including improvement of water quality, hygiene behavior, and sanitation practices.
14. Current public health programs of the Addis Ababa city administration should develop effective approaches to promote hand washing practice and creation of awareness. Moreover, other interventions like education on healthy eating behaviors should be strengthened to reduce the occurrence of diarrhea.
15. Improved interventions combined with formal training on food safety practice should be strengthened to reduce occurrence of diarrhea among the food handlers and to reduce health problems of their customers.
16. Routine inspections should be conducted by authorized bodies to enhance hygiene and sanitation practices of food handlers and food establishments.

6.3. Enhancement in knowledge and scientific contribution of the study

a) Scientific communities:

- ***Publications***: The findings of the study were published for wider research and scientific communities in internationally reputable journals of *Environmental Health Insights, AIMS Public Health,* indexed in major journals data base systems and serve as references to many scholars.

b) Advancement in Knowledge:

- ***Knowledge inputs:*** The study ascertains additional inputs for declarative, procedural, contextual, and somatic parts of knowledge that the microbial load of the drinking water at the Point of Use (POU) in food establishments significantly differs between the dry and rainy seasons.
- ***Knowledge gaps:*** The study identifies availability of significant knowledge gaps of drinking water quality at the POU in food establishments requiring due attention by the food establishments owners, managers, food handlers and decision makers. It opens a door for future studies in relation to food establishments.
- ***Health risks:*** *The* study assured that, significant number of the food establishments' drinking water had very high health risk to customers in developing countries.

c) Public Health data and Information:

- ***WaSH infographics:*** The study provides evidence based data for appropriate strategy formulation; planning and evaluation mechanisms to the findings and poor implementations of sanitation and hygiene practice of food establishments.
- ***Prevalence of diarrheal disease data:*** The study provides additional start-up information on the prevalence of diarrheal disease among the food handlers.

d) Public Awareness

- ***Awareness:*** The study findings assured the existence of interrelated three dimensional factors such as poor awareness, outlook and practices of food handlers towards food and water safety, planning and management.
- ***Medical checkups***: The study provides clue on the health status of food handlers and it indicates the poor practices of hygienic activities and medical checkup practice of food handlers that opens a door for further research to researchers.

e) Indicators

- ***Public health determinant factors:*** The study identifies many core determinant factors that have significant influence on the sanitation and hygienic practices and status of food establishments.
- ***Behavioral factors:*** The study manifests significant number of behavioral factors that has a capacity to influence health status of the food handlers in their daily routine activities.

f) Food and water safety

- ***Safety:*** The study indicates the gap of food and water safety practices at food establishments' level, which will reduce health risk by improving health status of the food handlers, safe eating and drinking habits.

g) Policy recommendations

- ***Implementation tools***: The study provides a baseline data and informatics useful to policy makers, decision makers, planners and other researchers.
- ***Decision making inputs:*** The result of the study provides a clue to concerned primary and secondary stakeholders to make sound decisions that target tackling the health problems of the food establishment customers and residents of the city in particular and developing countries in general.

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ANNEXES

Appendix 1: Information sheet and consent form

Information sheet and consent form is prepared for Addis Ababa food establishment owners and food handlers who are going to participate directly or indirectly in the Research project. A cross-sectional and longitudinal studies on "***determinants of public health in food establishments and health status of food handlers, in Addis Ababa Ethiopia***'' was conducted in Addis Ababa food establishments and food handlers.

Name of Principal investigator: Aderajew Mekonnen Girmay

Name of the organization: Ethiopian Institute of Water Resources, Addis Ababa University, PhD program in water and public health

Name of the Sponsor: Addis Ababa city administration Gulele sub city department of food, medicine and health care administration and control authority.

Introduction: This information sheet and consent form was prepared to explain the study subjects to cooperate and to join to this study. Please listen carefully and ask any questions about the study before you agree to join. You may ask questions at any time after joining the study. The investigator is a PhD fellow in water and public health at the Addis Ababa University Ethiopian Institute of Water Resources.

Purpose of Research: The purpose of this study was to determine ***determinants of public health in food establishments and health status of food handlers, in Addis Ababa Ethiopia.***

Procedure: To determine microbial load of drinking water quality, environmental sanitation and hygiene situation of food establishments and the health status of food handlers in Addis Ababa, you are invite to take part in this study, if you are willing to participate in this project. Then, you are asking to give your response by the data collectors and to take water samples. For all questionnaire and water samples, the study participants are food establishments and food handlers from the randomly selected areas. You do not need to tell your name or name of your food establishments to the data collectors and all your responses and the results obtained were kept confidentially by using coding system whereby no one have access to your response except the principal investigator.

Risk/ Discomfort: By participating in this research project, you may feel that it has some discomfort especially on wasting time ranged 30 to 60 minutes. I hope you are participating in

the study for the sake of the benefit of the research result. Really, there is no risk in participating in this research project.

Benefits: If you are participating in this research project, there may not be immediate benefit to you. But your participation is likely to help the principal investigator in assessing what a significant microbial load of drinking water, environmental sanitation and hygiene situation of food establishments and the health status of food handlers in the study area. Ultimately, this helps the investigator to identify the gap related to the intervention going to be done by the authorized bodies and stakeholders. Therefore, the future benefit of the study is towards promoting your health status.

Incentives: You are not provided any incentives or payment to take part in this project.

Confidentiality: The information collected from this research project was kept confidential. Information about you and about the food establishment collected by this study was stored in a file, without your name, except a code number assigned to it. Generally, all information that was collected do not revealed to anyone except the principal investigator and was kept in a secure, protected place.

Right to refuse or withdraw: You have full right to refuse from participating in this research. You can choose not to respond to some or all questions if you do not want to give your response or water sample. You have also the full right to withdraw from this study at any time you wish, without losing any of your right.

If you are voluntary to participate pleases put your signature

Signature_____

Date_____

Persons to contact:

If you have any question to ask, please contact me without hesitate.

- **Aderajew Mekonnen**

  Tel: +251-0910-86-29-16/ 0941-26-64-75

Appendix 2: Questionnaire of the studies

In general, the questionnaire of this study is dividing in to four parts. The first and second parts are using to measure and assess both the microbial load of drinking water at the point of use in food establishments and determinants of sanitation and hygiene conditions of food establishments respectively. Moreover, the third and fourth parts of the questionnaire are prepared to determine the prevalence of diarrheal diseases and to assess knowledge, attitude and practice of food handlers towards food and water quality management in the food establishments of Addis Ababa, Ethiopia.

Part 1 **Code----------**

Questionnaire for objective one (To determine the Microbial load of drinking water and seasonal varation of water quality at the point of in food establishments of Addis Ababa**).**

Questionnaire for objective one: An institutional based longitudinal study to determine Microbial load drinking water and seasonal variation of water quality at the point of use in food establishments of Addis Ababa, Ethiopia

Section 1: Laboratory results of microbiological examination of drinking water samples of the different food establishments

Sr.no	**Microbiological parameters**	**Coding category**
1.	From what time of food establishment the sample taken?	Small…1 large…2
2.	Are there growths of thermo-tolerant micro organisms at 45^{O}c in a 100ml sample (CFU/100 ml)?	Yes …1 No….0
3.	How many thermo-tolerant /fecal coliforms bacteria grow in 100ml at 45^{O}c (CFU/100 ml)?	_____
4.	Is there sample of the drinking water positive to E.coli?	Yes …1 No….0

Name of data analyser _____ signature_____

Part 2 **Code----------**

Questionnaire for objective two (To assess determinants of sanitation and hygiene status of food establishments in Addis Ababa, Ethiopia)

Section 2.1: Socio-Demographic Characteristics of the food establishment managers of Addis Ababa, Ethiopia

S.no	Study variables	Response and coding category
Q1	Sex	Male……..1 Female ……..2
Q2	Age in years	_____yrs
Q3	How many years serving the food establishment to customers?	_____yrs
Q4	Educational status	Illiterate ……...1 At least read and write……2
Q5	Marital status	Single.…1 Married …2 Divorced and others ….3
Q6	Condition of the ownership of the food establishment building	Private……1 Rent…….2
Q7	Do you take training about sanitation and hygiene in the past one year?	Yes…..1 No …..2
Q8	Do your food handlers have taken training about hygiene and sanitation in the past one year?	Yes..…1 No …..2
Q9	Renewed license by food and medicine control authorized body	Licensed…..1 Not licensed….2
Q10	Type of the establishment he/she owned	one stared and above hotels) ….1 non star hotel…….2 bar and restaurant .....3 cafe and restaurants…….4 Restaurants…….5 Grocery…… ….6 Café and others……7
Q11	Type of the establishment in size	**Small** or non star hotels and other small food establishments…2 **Big** or star hotels…1

Section2.2: Availability hygiene and sanitation facilities among the food establishments

S.no	Study variables	Response
Q12	Is the housing regulation law having bureaucratic to renew the food establishment?	Yes (incorrect **ans**) ….1 No (correct ans)....2
Q13	What is the source of the drinking water used by the food establishments?	Municipality…….1 Spring water and others…2
Q14	Is there privately piped water at the food establishments?	Yes…….1 No ……2
Q15	Does the food establishment have continuous piped drinking water supply?	Yes…….1 No ……2
Q16	Does the food establishment have disinfectants for washing water storage equipments?	Yes..……1 No ……..2
Q17	Does the food establishment have three dishwashing systems?	Yes..……1 No ……..2
Q18	Is there functional shower facility in the food establishments?	Yes ……..1 No……..2
Q19	Does the food establishment have functional refrigerator?	Yes ……..1 No……..2
Q20	Does the food establishment have functional toilet?	Yes ……..1 No……..2
Q21	Does the food establishment have functional hand-washing facility near the toilet?	Yes ……..1 No……..2
Q22	Is there soap near the hand washing facility?	Yes ……..1 No……..2
Q23	Does the food establishment have separated kitchen?	Yes ……..1 No……..2
Q24	Does the kitchen have accessed to running tap water for food preparation and equipment washing?	Yes..……1 No ……..2
Q25	Is there approximately at least ten-meter distance between the toilet and the kitchen?	Yes ……..1 No……..2
Q26	Does the food establishment inspected by regulatory body at least within a month?	Yes ……..1 No……..2
Q27	Does the food establishment have septic tank for liquid waste?	Yes ……..1 No……..2
Q28	Is there temporary solid waste storage containers/receptacles?	Yes ……..1 No……..2
Q29	How many days stay the solid waste in the food establishments' container?	Less than 7 days……1 Above 7 days……2
Q30	Do the food establishments have a practice of segregation of combustible solids and non-combustible solid wastes?	Yes ……..1 No……..2
Q31	Do the food handlers have health examination certificate at least within the past three month?	No …..1 Yes….2

Q32	Does the food handles have personal protective devices during the time of this questionnaire filled (white Gown, hair protective cloth…etc?	Yes..……1 No ……..2
Q33	Do the food handlers have dressing room?	Yes..…1 No ……..2
Q34	Is their food storage room for non perishable foods?	Yes..…1 No ……..2
Q35	Does the food establishment have adequate ventilation?	Yes..…1 No ……..2

Name of data collector _____ signature_____

Part 3 **Code----------**

Questionnaire for objective three (To assess knowledge, attitude and practice of food handlers towards food and water quality management at food establishments in Addis Ababa, Ethiopia)

Section 3.1: Socio-Demographic Characteristics of the food handlers

S.no	Study variables	Response and Coding category
Q1	Sex	Male……..1 Female ……..2
Q2	Age in years	_____
Q3	Educational level	Illiterate …..1 At least read and write --------2
Q4	Marital status	Single…1 Married …….2 Divorced and others ……..3
Q5	Religion	Orthodox...1 Muslim…..2 Other …3
Q6	How many years you work as food handlers?	**_____years**

Section 3.2: Knowledge of food handlers about food hygiene and water safety

S.no	Study variables	Response and Coding category
Q7	Do you know about food borne diseases?	Yes …..1 No …..2
Q8	Do you know about water borne diseases?	Yes …..1 No …..2
Q9	Do you know contaminated food and water causes public health problem?	Yes …..1 No …..2
Q10	Do you know water can be contaminated if it is not handling properly?	Yes …..1 No …..2
Q11	Do you know about Acute watery diarrhea (AWD)?	Yes …..1 No …..2
Q12	Do you know Salmonella is a food and water borne pathogen?	Yes …..1 No …..2
Q13	Do you know hepatitis A is a food borne pathogen?	Yes …..1 No …..2
Q14	Do you know bloody diarrhea is transmitted by contaminated food and water?	Yes …..1 No …..2
Q15	Do you know typhoid fever is transmitted by contaminated food and water?	Yes …..1 No …..2
Q16	Do you know food and water can be easily contaminated at the point of use/food establishment?	Yes …..1 No …..2

Section 3.3: Knowledge of food handlers about transmission and prevention of food and water borne diseases

S.no	Study variables	Response and Coding category
Q17	What is the source of your awareness about food and water borne diseases?	Health professionals….1 Radio and television…2 Formal training……3 Posters……4 Sanitary inspectors…5 Absence of training….6
Q18	What is the mode of transmission of food and water borne diseases?	What is the mode of transmission of food and water borne diseases? Through contaminated water…1 Through contaminated food……2 Through contaminated hand….3 Through utilizing improved toilet....4 Dirty work environment……5
Q19	What is the prevention mechanism of food and water borne diseases?	What is the prevention mechanism of food and water borne diseases? Washing hand with soap and safe water before meal……1 Washing hand with soap and safe water after defecation ….2 Isolate sick food handler until he/she treated…….3 Properly cooking food and safe water handling……4 Habit of eating raw beef and vegetables……..6

Section 3.3: Attitude of food handlers about food hygiene and drinking water handling

S.no	Study variables	Response and Coding category
Q20	Do you believe protective tidy clothe minimizes both for food and water contamination?	Yes ……1 No……..2
Q21	Do you believe taking treatment is mandatory when food handler sick?	Yes ……1 No……..2
Q22	Do you believe washing hands should be obligatory before holding food and water?	Yes ……1 No……..2
Q23	Do you believe raw food should be separated from cooked food?	Yes ……1 No……..2
Q24	Do you believe treated water can be easily contaminated if not properly stored at safe container?	Yes ……1 No……..2
Q25	Do you believe food and water borne diseases can be arising from food establishments?	Yes ……1 No……..2

Section 3.5: Practice of food handlers about food hygiene and drinking water handling

S.no	Study variables	Response and Coding
Q26	Do you wash drinking water containers with sanitizing and disinfectants regularly?	Yes ……1 No…..2
Q27	Do you wash drinking water glass with sanitizing and disinfectants after every customer use it regularly?	Yes ……1 No…..2
Q28	Do you wash your hands with soap and clean water before meal and after defecation?	Yes ……1 No…..2
Q29	Do you wash food utensils with sanitizing and disinfectants before serving with it?	Yes ……1 No…..2
Q30	Do you use tidy clothes for cleaning food utensils regularly?	Yes ……1 No…..2
Q31	Do you wash your hands with soap and clean water before holding cooked food?	Yes ……1 No…..2
Q32	Do you put food and drinking water in clean containers?	Yes ……1 No…..2
Q33	Do you cook food thoroughly before ready for consumption?	Yes ……1 No…..2
Q34	Do you cover your mouth with tidy clothe while you coughing?	Yes ……1 No…..2
Q35	Do you cut your nail when it becomes tall(using observing)?	Yes ……1 No…..2
Q36	Does the food handler wear at least white gown or made glove during the visit time?	Yes ……1 No…..2

Name of data collector _____

Part 4 **Code----------**

Questionnaire for objective four (To determine the prevalence of diarrheal diseases and associated behavioral factors among food handlers in the food establishments of Addis Ababa, Ethiopia)

Section 4.1: Socio-Demographic Characteristics of the food handlers

S.no	Study variables	Response and Coding category
Q1	Sex	Male……..1 Female ……..2
Q2	Age in years	_____
Q3	Educational level	Illiterate ……..1 At least read and write ----------2
Q4	Marital status	Single..……..…1 Married …...…2 Divorced and others ……3
Q5	Religion	Orthodox……..1 Muslim……..2 Other ……3

Section 4.2: Food handlers work profile at the food establishment

S.no	Study variables	Response and Coding category
Q6	How many years you work as food handlers?	_____years
Q7	What is your type of work in the food establishment?	Cooker……1 Waiter……2 Both cooker and waiter……3
Q8	Where are you living and sleeping?	At the food establishment….1 At her/his home……2
Q9	What is your type of employee in the food establishment?	Permanent……1 Temporary….2

Section 4.3: Medical checkup practice and training situation of the food handlers

S.no	Study variables	Response and Coding category
Q10	Do you have medical checkup or health examination certificate at least within every three month?	Yes……1 No…….2
Q11	Does the food establishment have a practice of isolation from the work place when the food handler is ill?	Yes……1 No…….2
Q12	Do you take food and water safety training at least once in a year?	Yes……1 No…….2

Section 4.4: Type of disease symptom among the food handlers

S.no	Study variables	Response and Coding category
Q13	Do you have diarrheal diseases within the past two weeks?	Yes……1 No…….2
Q14	Do you have acute watery diarrhea (AWD) confirmed by laboratory for the past one year?	Yes……1 No…….2
Q15	Do you have cough within the past two weeks?	Yes……1 No…….2
Q16	Do you have an infection of runny nose within the past two weeks?	Yes……1 No…….2
Q17	Do you have incidence of any fever within the past two weeks?	Yes……1 No…….2

Section 4.5: Factors that may be contribute to diarrheal diseases among the food handlers

S.no	Study variables	Response and Coding
Q18	Do you wash your hands after defecation regularly?	Yes……1 No…….2
Q19	Do yo wash your hands before meal regularly?	Yes……1 No…….2
Q20	Do you use toilet while wearing protective clothes/gown?	Yes……1 No…….2
Q21	Do you wash your hands immediately after handling raw foods?	Yes……1 No…….2
Q22	Do you regularly close your drinking water container?	Yes……1 No…….2
Q23	Do you wash the water container and food service utensils you used with sanitizers and disinfectants regularly?	Yes……1 No…….2
Q24	Do you wash the glass or the material you drink water with it every event?	Yes……1 No…….2
Q25	Do you put cooked foods separately from raw foods?	Yes……1 No…….2
Q26	Do you have habit of eating raw seafood and raw vegetables?	Yes……1 No…….2
Q27	Do you use the same chopping block and knife during the time of processing raw food and cooked food?	Yes……1 No…….2
Q28	Do you feed regularly in the food establishment?	Yes……1 No…….2
Q29	What is the type of food establishments that you work?	One and above one-star hotel….1 Non star hotel…….2 Bar and restaurant…….3 Café and restaurant……4 Restaurant…….5 Café and others…….6
Q30	Do you use proper waste disposal methods(pedal dust bin, septic tank)	Yes……1 No…….2
Q31	What type of toilet most of the time you use?	Improved or water

		flush……..…1 unimproved/traditional pit……..…2
Q32	Is there sanitary inspection by authorized bodies in the food establishment?	Yes……1 No…….2
Q33	What is the type of the establishment in size he or she work?	**Small** or non star hotels and other small food establishments…1 **Big** or star hotels…2

Name of data collector _____ signature_____

Appendix 3: consent form and Information (Amharic version)

የምርምር/ጥናት/ ማብራሪያና የስምምነት መግለጫ ቅጽ

ይህ ቅፅ የተዘጋጀው በአዲስ አበባ ዩኒቨርሲቲ የኢትዮጵያ ወሀ ሀብት ኢንስቲቱት የድህረ ምረቃ ፕሮግራም በወሀና የማህበረሰብ ጤና የትምህርት ክፍል የሶስተኛ ዲግሪ ተማሪ ሲሆን የጥናቱ ርዕስም፡- "በምግብና መጠጥ አገልግሎት ሰጪ ተቋማት የሚቀርበው የመጠጥ ወሀ ንጽህና፣ የምግብና መጠጥ አገልግሎት ሰጪ ተቋማት ሀይጂንና ሳኒቴሽንን እና በምግብ ዝግጅት የሚሰሩ ሰዎች የጤና ሁኔታ በአዲስ አበባ ከተማ መመዘን" ነው።

የጥናቱ ባለቤት ስም፡ አደራጅው መኮንን

የተቋሙ ስም፡ የኢትዮጵያ ወሀ ሀብት ኢንስቲቱት፣አዲስ አበባ ዩኒቨርሲቲ፣ወሀ እና የህ/ሰብ ጤና አጠባበቅ የትምህርት ክፍል

መግቢያ

የዚህ የምርምር ማብራሪያና የስምምነት ቅጽ ዓላማ አሁን እርሰዎ እንዲሳተፉበት የምንጠይቀዎትን የምርምር ጥናት ምንነት ማብራራት ነው። በዚህ የምርምር ፕሮጀክት ለመሳተፍ ከመወሰንዎ በፊት ይህንን የማብራሪያ ቅጽ ሲነበብ ጥያቄዎች ካሉዎት ይጠይቁ። በተጨማሪም በጥናቱ መሳተፍ ከጀመሩ በኃላ በማንኛውም ጊዜ ጥያቄዎች ካሉዎት መጠየቅ ይችላሉ።

የጥናቱ ዓላማ

የጥናቱ ዓላማ በአዲስ አበባ ከተማ አስተዳደር "በምግብና መጠጥ አገልግሎት ሰጪ ተቋማት የሚቀርበው የመጠጥ ወሀ ንጽህና፣ የምግብና መጠጥ አገልግሎት ሰጪ ተቋማት ሀይጂንና ሳኒቴሽንን እና በምግብ ዝግጅት የሚሰሩ ሰዎች የጤና ሁኔታ በአዲስ አበባ ከተማ መመዘን" ነው።

<u>የአስራር ሂደት</u>

መረጃ ሰብሳቢው ባለሙያ ከዚህ በታች የተዘረዘሩ ነጥቦችን በተገቢው ምላሹን ለሚሰጡ ተሳታፊዎች ማስረዳት ይጠበቅበታል። በአዲስ አበባ ከተማ ውስጥ "በምግብና መጠጥ አገልግሎት ሰጪ ተቋማት የሚቀርበው የመጠጥ ወሀ ንጽህና፣ የምግብና መጠጥ አገልግሎት ሰጪ ተቋማት ሀይጂንና ሳኒቴሽንን እና በምግብ ዝግጅት የሚሰሩ ሰዎች የጤና ሁኔታ በአዲስ አበባ ከተማ መመዘን" ነው።እርስዎ በዚህ ጥናት ውስጥ እንዲሳተፉ ተመርጠዋል። ፈቃደኛ የሚሆኑ ከሆነ ለመረጃ ሰብሳቢው እንዲሰጡ ቃለ መጠይቅ

ይቀርብልዎታል፡፡ስምዎን ለመረጃ ሰብሳቢው የመስጠት ግዴታ አይኖርብዎትም፡፡የሚሰጡት ምላሽም ምስጢራዊነቱ የተጠበቀ ይሆናል፡፡

ሊኖሩ የሚችሉ አደጋዎችና ጉዳቶች

በጥናቱ ውስጥ በመሳተፍ ወርቃማ የሆነ ጊዜዎን መጠይቁን በሚሞላበት ወይም በሚጠየቁበት ወይም በሚወሰድበት ጊዜ ከ10 ደቂቃ እስከ 15 ደቂቃ የሚጠጋ ጊዜ ከማጥፋትዎ በስተቀር ምንም አይነት ጉዳት የለውም፤ በመሆኑም በጥናቱ የሚገኘውን ውጤት መሰረት በማድረግ ለመሳተፍ ፈቃደኛ እንደሚሆኑ ዕምነታችን ነው፡፡

ከጥናቱ የሚያገኙት ጥቅም

በጥናቱ ውስጥ እርስዎ በመሳተፍዎ በቀጥታ አሁን የሚያገኙት ጥቅም ባይኖርም "በምግብና መጠጥ አገልግሎት ሰጪ ተቋማት የሚቀርበው የመጠጥ ወሀ ንጽህና፣ የምግብና መጠጥ አገልግሎት ሰጪ ተቋማት ሀይጂንና ሳኒቴሽንን እና በምግብ ዝግጅት የሚሰሩ ሰዎች የጤና ሁኔታ ላይ በሚያደርገው ጥናት የራስዎን አስተዋዕጾ ያደርጋሉ፡፡ ይህም እየተከናወነ ባለው ተግባር ላይ ያሉትን ክፍተቶች በመለየት ለቀጣይ ጤናን በመጠበቅና በማሻሻል ረገድ ከሚኖረው ከፍተኛ ሚና ከሚያገኙት የአእምሮ እና የመንፈስ እርካታ ውጪ ሊከፍልዎት የሚችል ዋጋ አይኖርም፡፡ በተጨማሪ ከጥናቱ ለሁሉም አስተማሪ የሆነ እውቀት እና የህ/ሰቡን ጤና ለማሻሻል ይረዳል፡፡ የተቋማት ባለቤቶች ፈቃደኛኛ ከሆኑ ከጥናቱ የሚገን ውጤት መሰረት ተደርጎ ግብረመልስ እንዲያገኙ በማድረግ የአገልግሎት ጥራታቸው እንዲጨምሩ ያገዛል፡

ማካካሻ

በዚህ ጥናት እርስዎ በመሳተፍዎ ምንም ዓይነት ማካካሻ አይሠጥዎትም፡፡ ነገር ግን በጥናቱ በመሳተፍዎ ምስጋናችን ከፍተኛ ነው፡፡

ምስጢር ጠባቂነት

የሚሰጡት መረጃ ምስጢራዎነቱ በሚገባ የሚጠበቅና ለማንም ይፋ የማይደረግ መሆኑን ስም አልባ በሆነ የመጠይቅ ቅፅ መሞላቱ ከምንም በላይ ማስረጃ ይሆኖታል፡፡

የመቃወም ወይም ከጥናቱ የመውጣት መብት

በጥናቱ ላለመሳተፍ ሙሉ መብት ያለዎት ሲሆን እንደ ፈቃድዎ ለአንዳንድ ጥያቄዎች ሙሉ በሙሉም ምላሽ ላይሰጡባቸው ለሚፈልጉት ጉዳይ መልስ አለመስጠት የሚችሉ ሲሆን በዚህም የሚደርስብዎት ችግር አይኖርም:

በዚህ ጥናት መሳተፍም ሆነ አለመሳተፍ በእርስዎ ልባዊ ፈቃድ የሚወሰን ነው። ስለሆነም በቅድሚያ ለፈቃደኝነትዎት እያመሰገንኩ ለማቀርብልዎ ጥያቄዎች ተገቢውንና ትክክለኛውን መልስ በመስጠት እንዲተባበሩኝ በትህትና እጠይቃለሁ።

ለበለጠ መረጃ

አደራጀው መኮንን፡- +251-910 86 29 16 /09 41 26 64 75

ለትብብርዎ ከፍተኛና ልባዊ ምስጋና አቀርባለሁ!!

ይህንን ቅጽ ተነቦና ተብራርቶለዎት ከሆነ ለመሳተፍ ከተስማሙ እባክዎ ፊርማዎን ብቻ ከዚህ በታች ያስቀምጡ።

የተሳታፊው ፊርማ _____

ቀን _____

Appendix 4: Questionnaire of the studies (Amharic version)

የጥናቱ መጠይቆች በአጠዋላይ በአራት ክፍሎች የተከፈለ ሆን የመጀመርያውን እና የሁለተኛውን ክፍል ጥናቶች በቅደም ተከተል በምግብና መጠጥ አገልግሎት ሰጪ ተቋማት የሚቀርበው የመጠጥ ወሀ ንጽህና እና የምግብና መጠጥ አገልግሎት ሰጪ ተቋማት የሀይጂንና ሳኒቴሽንን ሁኔታ የሚዳስሱ ናቸው። በተጨማሪ ሶስተኛው እና አራተኛው ክፍል ጥናቶች ደግሞ በቅድመ ተከተል በምግብ ዝግጅት የሚሰሩ ሰዎች የጤና ሁኔታ እና በምግብ እና ወሀ አያያዝ ያላቸው እውቀት፣ ግንዛቤ እና ተግባር የሚዳስሱ ናቸው።

<u>ክፍል 1</u> **መለያ ቁጥር----------**

መጠይቅ ቁጥር አንድ፡ በአዲስ አበባ ከተማ በምግብና መጠጥ አገልግሎት ሰጪ ተቋማት የሚቀርበው የመጠጥ ውሀ ንጽህና ለመመዘን የተዘጋጀ መጠይቅ

ክፍል 1.1. ከተለያዩ የምግብ እና መጠጥ ተቋማት የተወሰዱ የውሀ ናሙና የላቦራቶሪ /ስነ-ረቂቅ ታህዋስያን ውጤት

ተ.ቁ	**የታህዋሲያን መለኪያ(Microbiological parameters**	መልስና መለያ ቁጥር/ኮድ/
1	የተቋሙ ዓይነት	ትንሽ....1 ትልቅ /ባለኮከብ……2
2	የመጠጥ ውሀ ናሙናው በ45^{O}c በ 1ml ላይ የታህዋሲያን እድገት አለው?	አዎ……1 አይ……..0
3	በ100ml የመጠጥ ወሀውን ምንያህል ባክተሪያ አደጉ?	_____
4	ናሙናው የወሀ ጥራት አመልካች ታህዋሲያን (E.coli) እድገት አለው?	አዎ……1 አይ……..0

የመረጃ ሰብሳቢው

ስም_____**ፊረማ**_____

ክፍል 2 **መለያ ቁጥር----------**

በአዲስ አበባ ከተማ በምግብና መጠጥ አገልግሎት ሰጪ ተቋማት ወሳኝ ሀይጂን እና ሳኒቴሽን ኩነቶች ለመመዘን የተዘጋጀ መጠይቅ

2.1: የምግብና መጠጥ ተቋማት ስራ አስከያጆች ማህበራዊና ስነ ማህበራዊ ባህሪያት ላይ ያተኮሩ መጠይቆች

ተቁ	መጠይቅ	መልስና መለያ ቁጥር/ኮድ/
1	ጾታ	ወንድ.....1 ሴት.....2
2	እድሜ በዓመት	_____አመት
3	ተቋሙ አገልግሎት የሰጠበት ጊዜ በዓመት	_____አመት
4	የትምህርት ሁኔታ	ያልተማረ/ች.....1 ቢያንስ ማንበብና መጻፍ ------2
5	የጋቢቻ ሁኔታ	ያላገባ/ች...1 ያገባ/ች...2 የተፋታ/ች እና ሌሎች...3
6	የተቋሙ የባለቤትነት ሁኔታ	የግል.....1 የክራይ 2
7	እርስዎ በለፈው አንድ ኣመት ውስጥ የሀይጂንና ሳኒቴሽን ስልጠና ወስደዋል?	አዎ.....1 አይ.....2
8	የምግብ ሰራተኞቻቹ ባለፈው አንድ ዓመት በሀይጂንና ሳኒቴሽን ስልጠና ወስደዋል?	አዎ.....1 አይ.....2
9	በምግብና መድሀኒት ተቆጣጣሪ አካል የታደሰ ፈቃድ አለው?	አዎ.....1 አይ.....2
10	የተቋም ዓይነት	ባለ አንድ ከከውና በላይ ሆቴል....1 ከከብ የሌላቸው ሆቴሎች....2 ምግብና መጠጥ ቤት...3 ካፌ እና ምግብ ቤት....4 ምግብ ቤት...5 ግሮሰሪዎች....6 ካፌ እና ሌሎች...7
11	የተቋም ዓይነት በደረጃ	**ትንሽ**...1 **ትልቅ** (ባለኮኮብ ሆቴል)....2

2.2 : የምግብና መጠጥ አገልግሎት ሰጪ ተቋማት ሀይጂንና ሳኒቴሽ አቅርቦት ሁኔታ

ተቁ	መጠይቅ	መልስና መለያ ቁጥር/ኮድ/
12	ተቋሙ ለማደስ የቤቶች አስተዳደር ህግ እንቅፋት ይፈጥርላቸዋል?	አዎ.....1 አይ.....2
13	የመጠጥ ውሀውን ምንጩ ምንድን ነው?	ማዘጋጃቤታዊ...1 የምንጭ ወሀ...2
14	ተቋሙ የግል የቧንቧ ውሀ አለው?	አዎ.....1 አይ.....2
15	ተቋሙ የማይቆራረጥ የውሀ አቅርቦት አለው?	አዎ.....1 አይ.....2
16	የወሀ ማጠራቀሚያ ማጽጃ ኬሚካሎች አሉ?	አዎ.....1 አይ.....2
17	ተቋሙ ባለ ሶስት ሲንክ የእቃ ማጠቢያ አለው?	አዎ.....1 አይ.....2

18	ተቋሙ የሚሰራ የገላ መታጠቢያ አለው?	አዎ……1 አይ……..2
19	ተቋሙ የሚሰራ ፍሪጅ አለው?	አዎ……1 አይ……..2
20	ተቋሙ የሚሰራ መጸዳጃቤት አለው?	አዎ……1 አይ……..2
21	ተቋሙ መጸዳጃቤት አጠገብ የሚሰራ የእጅ መታጠቢያ አለው?	አዎ……1 አይ……..2
22	በእጅ መታጠቢያ አጠገብ ሳሙና አለ?	አዎ……1 አይ……..2
23	ተቋሙ የተለየ ኩሽና አለው?	አዎ……1 አይ……..2
24	ኩሽናው ውስጥ ወራጅ የቧንቧ ወሀ አለ?	አዎ……1 አይ……..2
25	በኩሽናውና በመጸዳጃቤቱ መካከል በአማካይ 10 ሜትር ርቀት አለው?	አዎ……1 አይ……..2
26	ተቋሙ ቢያንስ በወር አንዴ በንጽህና ተቆጣጣሪ አካል ቁጥጥር ይደረግለታል?	አዎ…1 አይ…..2
27	ተቋሙ የፍሳሽ ቆሻሻ ማጠራቀሚያ (septic tank) አለው?	አዎ……1 አይ……..2
28	ተቋሙ ጊዚያዊ ደረቅ ቆሻሻ ማጠራቀሚያ አለው?	አዎ……1 አይ……..2
29	በተቋሙ ደረቅ ቆሻሻ ለምን ያህል ቀን ይቆያል?	ከ7 ቀን በታች..1 ከ7 ቀን በላይ..2
30	ተቋሙ የሚበሰብሱና የማይበሰብሱ ቆሻሻዎች ይለያል?	አዎ……1 አይ……..2
31	የምግብ ሰራተኞች ባለፉት ሶስት ወራት ውስጥ የጤና ምርምራ የተመረመሩበት ካርድ አለ?	አይ……1 አዎ……2
32	የምግብ ሰራተኞች የስራ ልብስና የጸጉር መሸፈኛ አላቸው?	አዎ……1 አይ……..2
33	የሰራተኞች ልብስ መቀየሪያ ክፍል አለ?	አዎ……1 አይ……..2
34	ተቋሙ ተሎ ለማይበሰብሱ ምግቦች መጋዘን አለው?	አዎ……1 አይ……..2
35	ተቋሙ በቂ ያአየር ዝውውር አለው?	አዎ……1 አይ……..2

የመረጃ ሰብሳቢው

ስም_____**ፊረማ**_____

ክፍል 3 **መለያ ቁጥር----------**

መጠይቅ ቁጥር ሶስት፡ በአዲስ አበባ ከተማ በምግብና መጠጥ አገልግሎት ሰጪ ተቋማት የሚሰሩ ምግብ አዘጋጆች እውቀት፣ዝንባሌ እና ተግባር ለመመዘን የተዘጋጀ መጠይቅ

ክፍል 3.1፡ በምግብና መጠጥ አገልግሎት ሰጭ ተቋማት ሚሰሩ የምግብ ሰራተኞች ማህበራዊና ስነ ማህበራዊ ባህሪያት ላይ ያተኮሩ መጠይቆች

ተ.ቁ	መጠይቅ	መልስና መለያ ቁጥር/ኮድ/
1	ጻታ	ወንድ ……..1 ሴት……..2
2	እድሜ	_____
3	የትምህርት ሁኔታ	ያልተማረ/ች...1 ቢያንስ ማንበብና መጻፍ --------2
4	የጋቢቻ ሁኔታ	ያላገባ/ች……1 ያገባ/ች……..2 የተፋታ/ች…….3
5	ሀይማኖት	ኦርቶዶስ…..1 ሙስሊም…..2 ሌሎች……3
6	ለምን ያህል ኣመት በምግብ ሰራተኝነት ሰርተሻል/ህል?	_____ኣመት

ክፍል 3.2፡ የምግብ ሰራተኞች ምግብና ውሀ በጥንቃቄ ከመያዝ አንጻር ያላቸው እውቀት ለማዳሰስ የተዘጋጁ መጠይቆች

ተ.ቁ	መጠይቅ	መልስና መለያ ቁጥር
7	ምግብ ወለድ በሽታዎች እንደሉ እውቀት ለህ/ለሽ?	አዎ…1 አይ…..2
8	ውሀ ወለድ ሽታዎች እንደሉ እውቀት ለህ/ለሽ?	አዎ…1 አይ….2
9	የተበከለ ውሀ እና ምግብ ለህ/ሰብ ጤና ጠንቅ መሆኑ ታቃለህ/ሽ?	አዎ…1 አይ...2
10	ውሀ በጥንቃቄ ካልተያዘ በቀላሉ ሊበከል እንደሚችል ታቃለህ/ሽ?	አዎ…1 አይ…..2
11	ስለ አጣዳፊ ተቅማጥና ትውከት መንነት ታቃለህ/ሽ?	አዎ…1 አይ…..2
12	ታይፎይድ አምጪ ታህዋስ ወይም ሳልሞኔላ በምግብና ወሀ እንደሚገኝ ታቃለህ/ለሽ?	አዎ…1 አይ…..2
13	የጉበት በሽታ ኤ አምጪ ታህዋስ በምግብና ወሀ እንደሚገኝ ታቃለህ/ለሽ?	አዎ…1 አይ…..2
14	ደም የተቀላቀለ ተቅማጥ በምግብና ወሀ እንደሚተላለፍ ታቃለህ/ለሽ?	አዎ…1 አይ…..2
15	የታይፎይድ በሽታ በምግብና ወሀ እንደሚተላለፍ ታቃለህ/ለሽ?	አዎ…1 አይ…..2
16	ምግብና ውሀ በተቋሙ ውስጥ ሊበከል እንደሚችልታቃለህ/ለሽ?	አዎ…1 አይ…..2

ክፍል 3.3፡ የምግብ ሰራተኞች በምግብና ውሀ ወለድ በሽታዎች መተላለፊያና መከላከያ መንገዶች ያላቸው እውቀት ለመዳሰስ የተዘጋጁ መጠይቆች

ተ.ቁ	መጠይቅ	መልስና መለያ ቁጥር/ኮድ/
17	የምግብና ውሀ ወለድ በሽታዎች እውቀት ምንጭህ/ሽ ምንድ ነው?	ከጤና ባለሙያዎች…….1 ከረድዮና ተለቪዥን…….2 ከስልጠና……..3 ከፖሰተሮች……..4 ከጤና ተቆጣጣሪ አካላት……5 አላቅም……..6
18	የምግብና ውሀ ወለድ በሽታዎች መተላለፊያ መንገድ ምንድ ነው?	በተበከለ ወሀ…1 በተበከለ ምግብ…2 ባልታጠበ እጅ…….3 ባልታጠበ እቃ…….4 ከቆሻሻ አከባቢ……5 አላቅም……..6
19	የምግብና ውሀ ወለድ በሽታዎች መከላከያ መንገድ ምንድን ነው?	ከምግብ በፊት እጅ መሳሙና መታጠብ…1 ከመጸዳጃቤት መልስ እጅ መሳሙና መታጠብ…2 የታመመ ሰራተኛ በመለየት …….3 ምግብ በደንብ ማብሰልና ውሀ በጥንቃቄ መያዝ…….4 አላቅም…….5 ለመመለስ ፍቃደኛ አደለሁም…..6

ክፍል 3.4፡ የምግብ ሰራተኞች ምግብና ወሀ በጥንቃቄ ከመያዝ አንጻር ያላቸው ዝንባሌ ለመዳሰስ የተዘጋጁ መጠይቆች

ተ.ቁ	መጠይቅ	መልስና መለያ ቁጥር/ኮድ/
20	ምግብና ውሀ ከድነህ ማስቀመጥ ከብክለት ይከላከላል ብለሽ/ህ ታምናለህ?	አዎ……1 አይ……..2
21	የታመመ ሰራተኛ ህክምና መውሰድ ግድ ነው ብለህ ታምንያለሽ/ህ?	አዎ……1 አይ……..2
22	ውሀ እና ምግብ ከመያዝ በፊት እጅ መታጠብ ግድ ነው ብለህ ታምንያለሽ/ህ?	አዎ……1 አይ……..2
23	ያልበሰሉ ምግቦች ከበሰሉ ምግቦች መለየት አለበት ብለህ ታምንያለሽ/ህ?	አዎ……1 አይ……..2
24	የታከመ ውሀ በንጹህ ማጠራቀሚያ በጥንቃቄ ካልተያዘ በቀላሉ እንደሚበከል ታምንያለሽ/ህ?	አዎ……1 አይ……..2
25	ምግብና ውሀ ወለድ በሽታዎች ከምግብ አቅራቢ ድርጅቶች እንደሚነሱ ካሁን በፊት ስምታሻል/ል?	አዎ……1 አይ……..2

ክፍል 3.5፡ የምግብ ሰራተኞች ምግብና ወሀ በጥንቃቄ ከመያዝ አንጻር ያላቸው ተግባር ለመዳሰስ የተዘጋጁ መጠይቆች

ተ.ቁ	መጠይቅ	መልስና መለያ ቁጥር
26	የውሀ ማጠራቀሚያው ሁሌ በኦሞና በሌሎች ኬሚካሎች ይታጠባል?	አዎ…1 አይ…..2
27	ደንበኞች እሚጠቀሙበት ብርጭቆ ሁሌ አንድ ሰው ከተጠቀመባቸው በኃላ ታጥቡት አላችሁ?	አዎ…1 አይ…..2
28	እጆቻችሁ ከምግብ በፊትና ከመጸዳጃቤት መልስ ሁሌ ትታጠቡ አላችሁ?	አዎ…1 አይ…..2
29	የምግብ እቃዎች ሁሌ በኦሞና በሌሎች ከሚካሎች ታጥቡት አላቹ?	አዎ…1 አይ…..2
30	የታጠቡ የምግብ እቃዎች ለማድረቅ ሁሌ ንጹህ ጨርቅ ትጠቀሙ አላችሁ?	አዎ…1 አይ…..2
31	የበሰሉ ምግቦች ከመያዛችሁ በፊት ሁሌ እጆቻችሁ በሳሙናና ንጽህ ወሀ ትታጠቡ አላችሁ?	አዎ……1 አይ…..2
32	ምግብና ውሀ በንጹህ እቃና እና ማጠራቀሚያ ነው እምታስቀምቱት?	አዎ…1 አይ…..2
33	ምግብ ለምግብነት ከመቅረቡ በፊት በደንብ ታበስሉት አላችሁ?	አዎ…1 አይ…..2
34	በምግብ ዝግጅት ግዜ ስትስሉ አፋቹሁ እና አፍንጫቹ በንጹህ ጨርቅ ትሸፍኑት አላችሁ?	አዎ…1 አይ…..2
35	መጠይቁ ሲሞላ ከምግብ ንክኪ ያላቸው ስራተኞች ጥፍራቸው ተቆርጦ ነበር?	አዎ…1 አይ…..2
36	መጠይቁ ሲሞላ ከምግብ ንክኪ ያላቸው ስራተኞች ነጭ ጋቦን ለብሶ ነበር?	አዎ…1 አይ…..2

የመረጃ ሰብሳቢው

ስም-

_____ፊረማ_____

ክፍል 4 **መለያ ቁጥር----------**

መጠይቅ ቁጥር አራት፡ በአዲስ አበባ ከተማ በምግብና መጠጥ አገልግሎት ሰጪ ተቋማት የሚሰሩ ምግብ አዘጋጆች **የተቅማጥ በሽታና ተያያዝ** ሁኔታዎች ለመመዘን የተዘጋጀ መጠይቅ

ክፍል 4.1፡ በምግብና መጠጥ አገልግሎት ሰጪ ተቋማት ሚሰሩ የምግብ ሰራተኞች ማህበራዊና ስነ ማህበራዊ ባህሪያት ላይ ያተኮሩ መጠይቆች

ተ.ቁ	መጠይቅ	መልስና መለያ ቁጥር/ኮድ/
1	ጻታ	ወንድ ……..1 ሴት……..2
2	እድሜ	_____አመት
3	የትምህርት ሁኔታ	ያልተማረ/ች……...1 ቢያንስ ማንበብና መጻፍ --------2
4	የጋቢቻ ሁኔታ	ያላገባ/ች……1 ያገባ/ች……2 የተፋታ/ች…….3
5	ሀይማኖት	ኦርቶዶክስ……..1 ሙስሊም……..2 ሌሎች……..3

ክፍል 4.2: የምግብ ሰራቶኞች አጭር የግል ታሪክ መግለጫ

ተ.ቁ	መጠይቅ	መልስና መለያ ቁጥር/ኮድ/
6	ለምን ያህል አመት በምግብ ሰራተኝነት ሰርተሻል/ሀል?	_____ኣመት
7	በተቋሙ የስራ ድርሻሽ/ህ ምንድ ነው?	ምግብ አብሳይ……1 አስተናጋጅ……2 ምግብ አብሳይና አስተናጋጅ ……3
8	መኖሪያሽ/ህ እና መኝታሽ/ህ የት ነው?	እዚህ ተቋም…….1 እራሴ ቤት…….2
9	የቅጥርህ/ሽ ሁኔታ ምንድ ነው?	ቋሚ……..1 ግዚያዊ……2

ክፍል 4.3: የምግብ ሰራቶኞች የጤና ምርመራ እና ስልጠና በተመለከተ

ተ.ቁ	መጠይቅ	መልስና መለያ ቁጥር/ኮድ/
10	ቢያንስ በየሶስት ወሩ የጤንነት ሁኔታሽ/ህ የሚያሳይ ካርድ አለሽ/ለህ?	አዎ…1 አይ……..2
11	በተቋሙ የሚሰራ ሰራተኛ ሲታመም ስራ እንዳይሰራ ተለይቶ የሚያርፍበት የተለየ አሰራር አለ?	አዎ…1 አይ……..2
12	ቢያንስ በዓመት አንዴ በምግብና ውሀ ድህንነት ላይ ያተኮረ ስልጠና ወስደሻል/ሀል?	አዎ……..1 አይ……..2

ክፍል 4.4: የምግብ ሰራቶኞች የበሽታ ሁኔታ እና ምልክቶች

ተ.ቁ	መጠይቅ	መልስና መለያ ቁጥር/ኮድ/
13	ባለፉት ሁለት ሳምንታት ውስጥ በተቅማጥ በሽታ ተይዘሽ/ህ ነበር?	አዎ……1 አይ……..2
14	ባለፈው አንድ አመት ውስጥ በላቦራቶሪ የተረጋገጠ አጠዳፊ ተቅማጥና ትውከት ይዞሽ/ህ ነበር?	አዎ……1 አይ……..2
15	ባለፉት ሁለት ሳመንታት ውስጥ በጉንፋን ተይዘሽ/ህ ነበር?	አዎ……1 አይ……..2
16	ባለፉት ሁለት ሳምንታት ውስጥ በሀይለኛ አፍንጫሽን/ህን የሚያዝረበርብ ህመም ያለው ጉንፋን መሰል(ኢንፍሉኢንዛ) ይሆሽ/ህ ነበር?	አዎ……1 አይ……..2
17	ባለፉት ሁለት ሳምነታት ውስጥ ድንገተኛ የሆነ ሀይለኛ ትኩሳት ይዞሽ/ህ ነበር?	አዎ……1 አይ……..2

ክፍል 4.5: የምግብ ሰራቶኞች ለተቅማጥ በሽታ ሊያጋልጡ የሚችሉ ሁኔታዎች

ተ.ቁ	መጠይቅ	መልስና መለያ ቁጥር
18	ከመጸዳጃቤት መልስ ሁሌ እጅሽን/ህን ትታጠቢያለሽ/ህ?	አዎ……1 አይ…..2
19	ከመመገብሽ/ህ በፊት ሁሌ እጅሽን/ህን ትታጠቢያለሽ/ህ?	አዎ……1 አይ…..2
20	የስራ ልብስሽ/ህ ለብሰሽ/ህ መፀዳጃቤት ትገቢያለሽ/ትገባለህ?	አዎ……1 አይ…..2
21	ጥሬ ምግቦች ከያዝሽ/ክ በኃላ ሁሌ እጅሽን/ህን በሳሙና ትታጠብያለሽ/ባለህ?	አዎ……1 አይ…..2
22	የመጠጥ ውሀ ማስቀመጫ ሁሌ በጥንቃቄ ትከድኚያለሽ/ህ?	አዎ……1 አይ…..2
23	ውሀ ማጠራቀሚና የምግብ እቃዎች ሁሌ በአሞና በሳሙና ይታጠባሉ?	አዎ……1 አይ…..2
24	የመጠጥ ብርጭቆ ከጠጣሽበት/ህበት በኃላ ሁሌ ይታጠባል?	አዎ……1 አይ…..2
25	የበሰሉና ያልበሰሉ ምግቦች ለያይታችሁ ታስቀምጣላችሁ?	አዎ…1 አይ…..2
26	ያልበሰሉ ጥሬ ምግቦችና አትክልት የመብላት ልምድ አለሽ/ህ?	አዎ…1 አይ…..2
27	ያልበሰሉ እና የበሰሉ ምግቦች ሲዘጋጁ ተመሳሳይ መክተፊያ ነው የምትጠቀሙ?	አዎ…1 አይ…2
28	በቋሚነት ምግብሽ/ህ በዚህ ተቋም ነው የምትመገቢው/በው?	አዎ…1 አይ…..2

29	የምትሰሪበት /ምትሰራበት ተቋም በአይነት ምንድ ነው?	ከኮብ \ያለው ሆቴል.....1 ኮኮብ የሌለው ሆቴል....2 ባር እና ሬስቶራንት.....3 ካፌ እና ሬስቶራንት.....4 ሬስቶራንት.....5 ካፌ እና ሌሎች.....6
30	ክዳን ያለው የደረቅ ቆሻሻ ማጠራቀሚያ ነው የምትጠቀሙ?	አዎ...1 አይ.....2
31	ሁል ጊዜ የምትጠቀሙት የመጸዳጃቤት አይነት ምንድን ነው?	በውሀ የሚሰራ...1 ባህላዊ.....2
32	ምትሰሪበት/ራበት ተቋም በጤና ተቋጣጣሪ አካል ቁጥጥር ይደረግለታል?	አዎ.....1 አይ.....2
33	የተቋም ዓይነት በደረጃ	ትንሽ (ከኮብ የሌላቸው ሆቴሎች፣ ምግብና መጠጥ ቤት፣ ካፌ እና ምግብ ቤት፣ ምግብ ቤቶች፣ ግሮሰሪዎች፣ ካፌ እና ሌሎች) .....1 ትልቅ (ቢያንስ ባለ አንድ ከከው እና በላይ) 2

የመረጃ ሰብሳቢው

ስም_____ ፊረማ_____

Appendix 5: Letter of support to obain the Ethical clearance

ETHIOPIAN INSTITUTE OF WATER RESOURCES

ADDIS ABABA UNIVERSITY

Ref. No: . EiWR/4/711/19

Addis Ababa, 26 March 2019

Ethiopian Public Health Institution (EPHI)
Federal Democratic Republic of Ethiopia
P. O. Box 1242
Addis Ababa, ETHIOPIA

Subject: Request for Cooperation to Mr. Aderajew Mekonnen (ID. No GSR/1068/10)
Ethical Clearance Case

Dear Sir/Madam

The Ethiopian Institute of Water Resources (EiWR) mission is to enhance capacity of higher education institutes in Ethiopia for an improved and sustainable water resources use and management. Currently the institute enrolled about 104 PhD and 26 MSc students from different Ethiopian universities and government organizations.

As part of capacity building program, Aderajew Mekonnen from Haramaya University joined the Ethiopian Institute of Water Resources (EiWR), Addis Ababa University and registered to conduct his PhD in Water and Health program of study. Accordingly, Mr. Aderajew successfully defended his research proposal entitled "Assessment of microbial load in drinking water, environmental sanitation and hygiene status of food establishments and health status of food handlers in Addis Ababa, Ethiopia" and working under the supervision of Dr. Sirak Robele, Dr. Bezatu Mengistie, Dr Martin Evans and Dr. Azage Gebreyohannes.

Mr Aderajew requested our Institute to write him a support letter related to research ethics clearance matters. However, as there is no Ethical Review Committee in our institute, we request your esteemed office to consider his Ethical clearance for his PhD research proposal.

We would like to appreciate your cooperation in advance.

Sincerely,

Dr. Bayou Chane Tegegne
Assistant Professor in Water Resources Engineering and Management
Director, Ethiopian Institute of Water Resources
Addis Ababa University, ETHIOPIA
Addis Ababa, ETHIOPIA

ETHIOPIAN INSTITUTE OF WATER RESOURCES
AKAKI CAMPUS, P.O.BOX 150461
ADDIS ABABA UNIVERSITY
ADDIS ABABA, ETHIOPIA

Tel: 251-114-341698
Fax: 251-114-349417

Website: www.eiwr.org
www.aau.edu.et

Appendix 6: Letter of support to use laboratory facility

ETHIOPIAN INSTITUTE OF WATER RESOURCES
ADDIS ABABA UNIVERSITY

Ref. Ng: EiWR/096 /11/19

Addis Ababa, Monday 8 July 2019

Addis Ababa Health Bureau
Public Health Research and Emergency Management
P.O. Box 30738
t: +251 (0) 115520189
e: addisababafem@gmail.com
Addis Ababa, ETHIOPIA

Subject: Request for using the laboratory facilities and other relevant assistance

Dear Sir/Madam:

The Ethiopian Institute of Water Resources mission is to enhance capacity of higher education institutes in Ethiopia for an improved and sustainable water resource use and management. Currently the institute enrolled about 104 PhD and 26 MSc students from different Ethiopian universities and government organizations.

As part of capacity building program, **Mr. Aderajew Mekonnen** (ID. No. GSR/1086/10) a full time PhD student in Water and Public Health (WaHe), Addis Ababa University is currently conducting his PhD research entitled "*Assessment of Microbial Load in Drinking Water, Environmental Sanitation and Hygiene Situation of Food Establishments and Health Status of Food Handlers in Addis Ababa, Ethiopia*" and working under the supervision of Dr. Sirak Robele, Dr Bezatu Mengstie, Dr Martin Evans and Dr Azage Gebreyohannes.

Therefore, on behalf of the Ethiopian Institute of water Resources and myself, I am writing to request permission to have access to your laboratory facility for examining microbial drinking water quality parameters for a research conducted by Mr Aderajew, a PhD fellow in Water and Public Health specialty.

Thank you for your kind attention to this support.

With Regards,

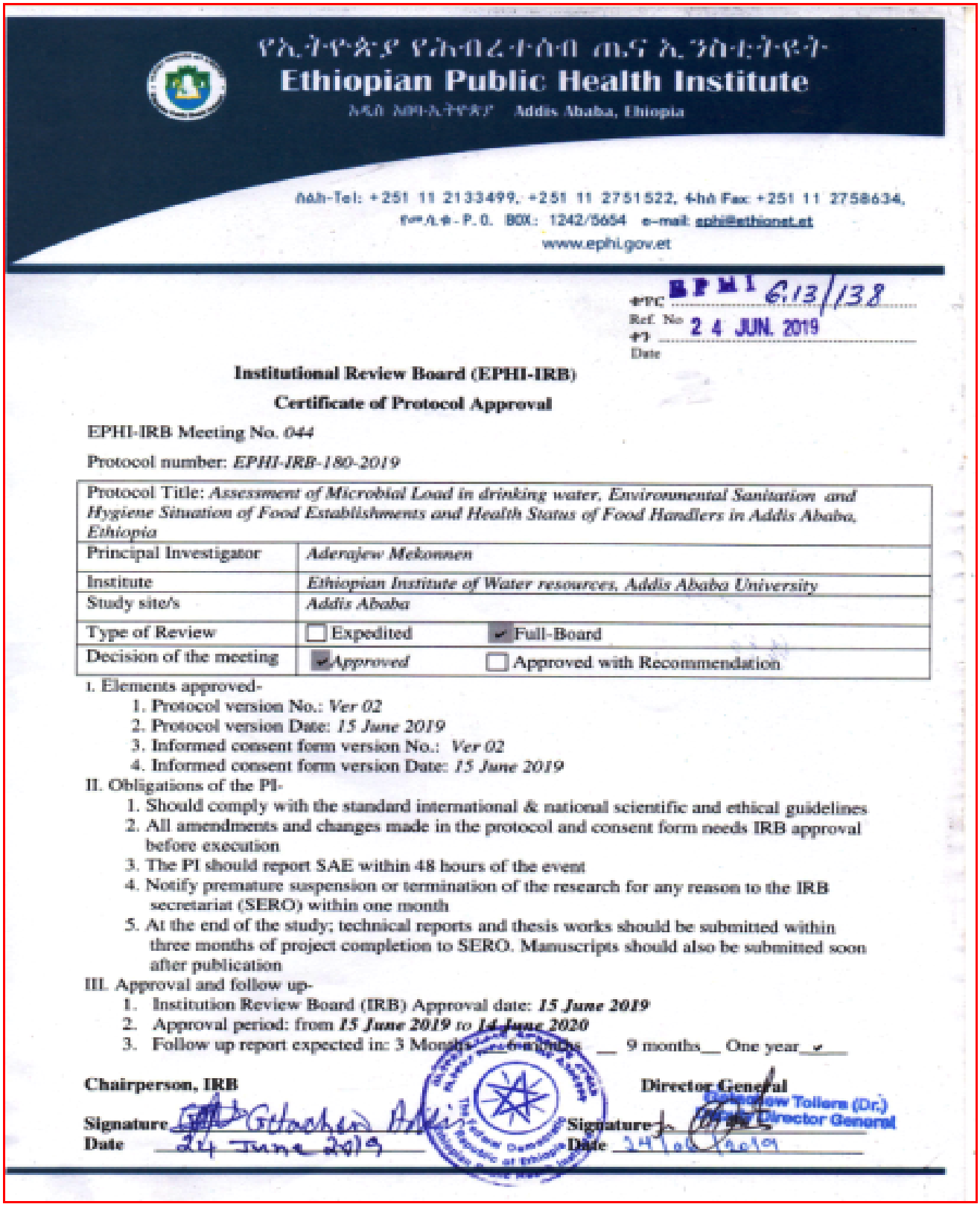
Azage G. Gebremariam (PhD)
Assistant Professor in Transboundary Water Management
Ethiopian Institute of Water Resources
Addis Ababa University

ETHIOPIAN INSTITUTE OF WATER RESOURCES
AKAKI CAMPUS, P.O.BOX. 150461
ADDIS ABABA UNIVERSITY
ADDIS ABABA, ETHIOPIA

Tel: 251-114-341698
Fax: 251-114-349417

Website: www.eiwr.org
www.aau.edu.et

Appendix 7: Ethical approval of the study



የኢትዮጵያ የሕብረተሰብ ጤና ኢንስቲትዩት
Ethiopian Public Health Institute
አዲስ አበባ-ኢትዮጵያ Addis Ababa, Ethiopia

ስልክ-Tel: +251 11 2133499, +251 11 2751522, ፋክስ Fax: +251 11 2758634,
ፖ.ሣ.ቁ-P. O. BOX: 1242/5654 e-mail: ephi@ethionet.et
www.ephi.gov.et

ቁጥር Ref. No EPHI 613/138
ቀን Date 24 JUN. 2019

Institutional Review Board (EPHI-IRB)

Certificate of Protocol Approval

EPHI-IRB Meeting No. *044*

Protocol number: *EPHI-IRB-180-2019*

Protocol Title: *Assessment of Microbial Load in drinking water, Environmental Sanitation and Hygiene Situation of Food Establishments and Health Status of Food Handlers in Addis Ababa, Ethiopia*		
Principal Investigator	*Aderajew Mekonnen*	
Institute	*Ethiopian Institute of Water resources, Addis Ababa University*	
Study site/s	*Addis Ababa*	
Type of Review	☐ Expedited	☑ Full-Board
Decision of the meeting	☑ *Approved*	☐ Approved with Recommendation

I. Elements approved-
1. Protocol version No.: *Ver 02*
2. Protocol version Date: *15 June 2019*
3. Informed consent form version No.: *Ver 02*
4. Informed consent form version Date: *15 June 2019*

II. Obligations of the PI-
1. Should comply with the standard international & national scientific and ethical guidelines
2. All amendments and changes made in the protocol and consent form needs IRB approval before execution
3. The PI should report SAE within 48 hours of the event
4. Notify premature suspension or termination of the research for any reason to the IRB secretariat (SERO) within one month
5. At the end of the study; technical reports and thesis works should be submitted within three months of project completion to SERO. Manuscripts should also be submitted soon after publication

III. Approval and follow up-
1. Institution Review Board (IRB) Approval date: ***15 June 2019***
2. Approval period: from ***15 June 2019*** to ***14 June 2020***
3. Follow up report expected in: 3 Months__ 6 months__ 9 months__ One year_✓_

Chairperson, IRB

Signature Getachew Assefa
Date 24 June 2019

Director General

Signature
Date 24/06/2019

Getachew Tollera (Dr.)
Director General

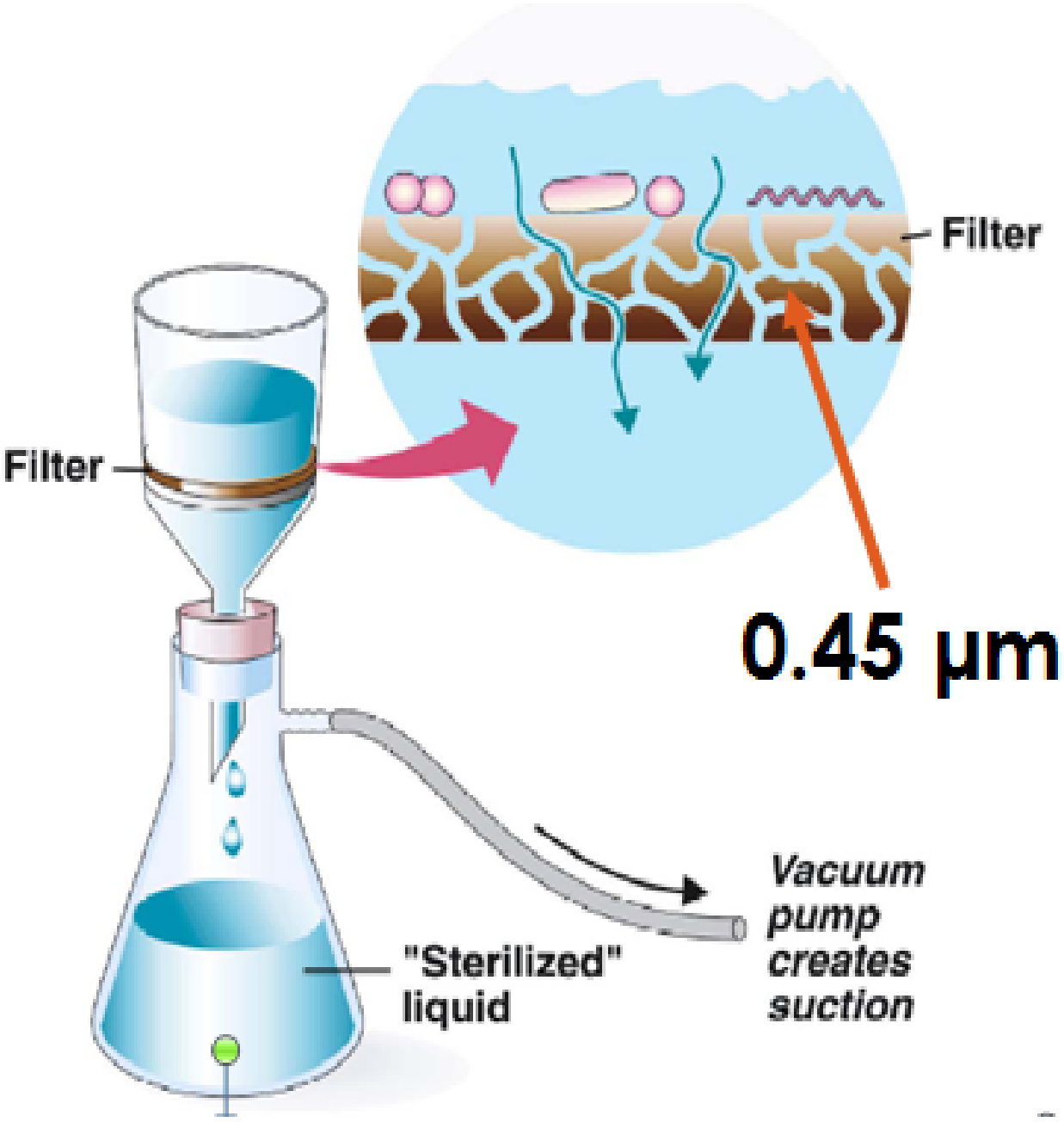


Figure 4: Membrane Filter Technique

http://www.biology.lsu.edu/webfac/rgayda/biol1011/Lecture_notesF2004/lecture8.pdf

Appendix 8: Sanitation and hygiene status of Addis Ababa food establishments

According to the Annual report of AAFMHACA, 2016**,** the problem of sanitation and hygiene practices of food establishments of Addis Ababa depicted as below:

Source: Annual report of AAFMHACA, 2016

Figure 5: Drinking water storage and housing condition in Addis Ababa food establishments

Source: Annual report of AAFMHACA, 2016

Figure 6: Proximity of dishwashing sites to toilets in Addis Ababa food establishments

Source: Annual report of AAFMHACA, 2016

Figure 7: Number of dishwashing system in Addis Ababa food establishments

Source: Annual report of AAFMHACA, 2016

Figure 8: Kitchen-Toilet proximity in Addis Ababa food establishments

Source: Annual report of AAFMHACA, 2016

Figure 9: Sanitation conditions of dishwashing system in Addis Ababa food establishments

Although the sanitation condition of dishwashing system is expecting to be clean and far from dirty places (Abdellah et al., 2012), most of the food establishments' dishwashing systems here in Addis Ababa are placing as the above picture shown. Moreover, the figure indicated that, the drinking water storage and housing condition of the food establishments were very poor.

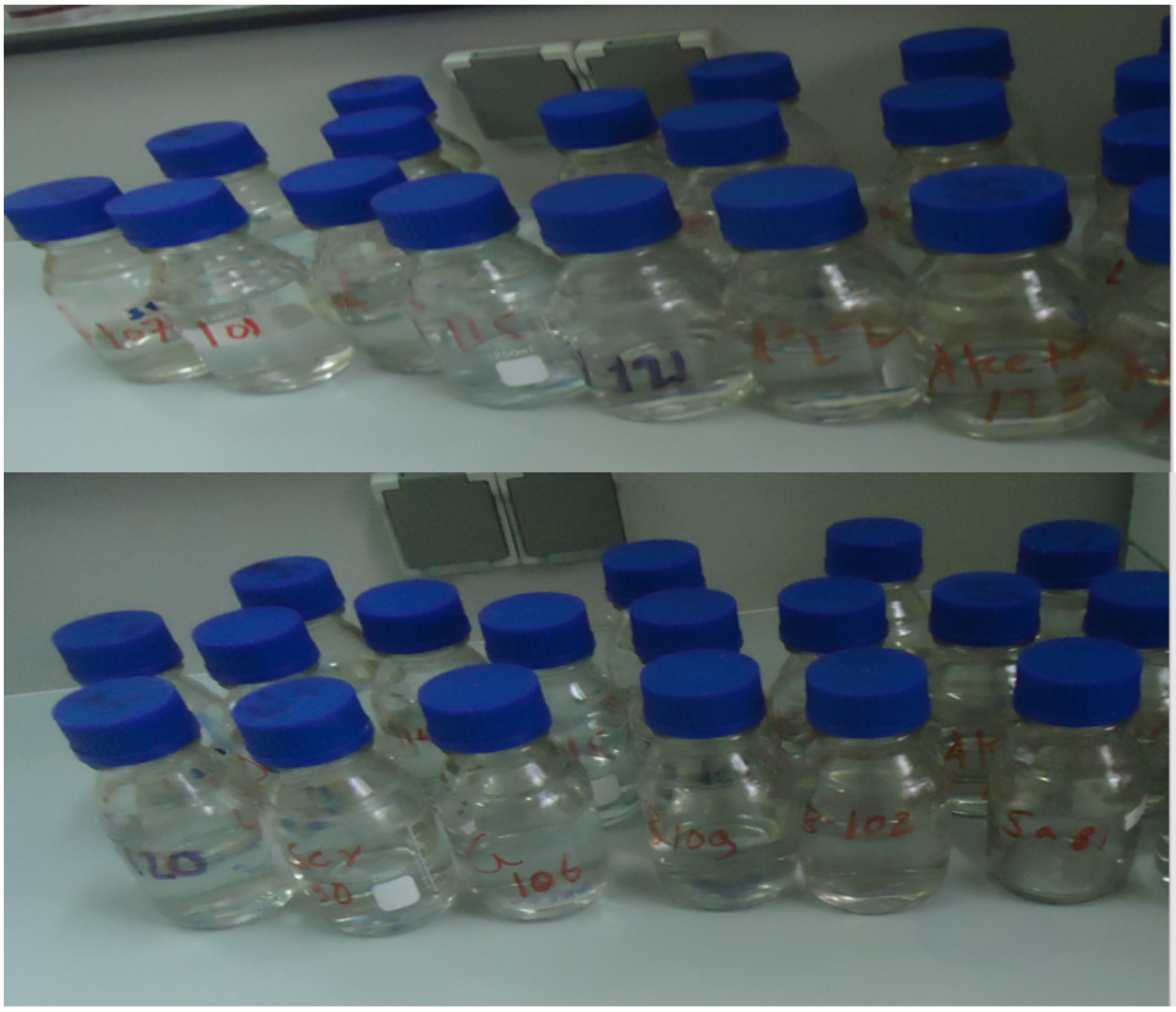


Figure 10: Some of the drinking water sample taken

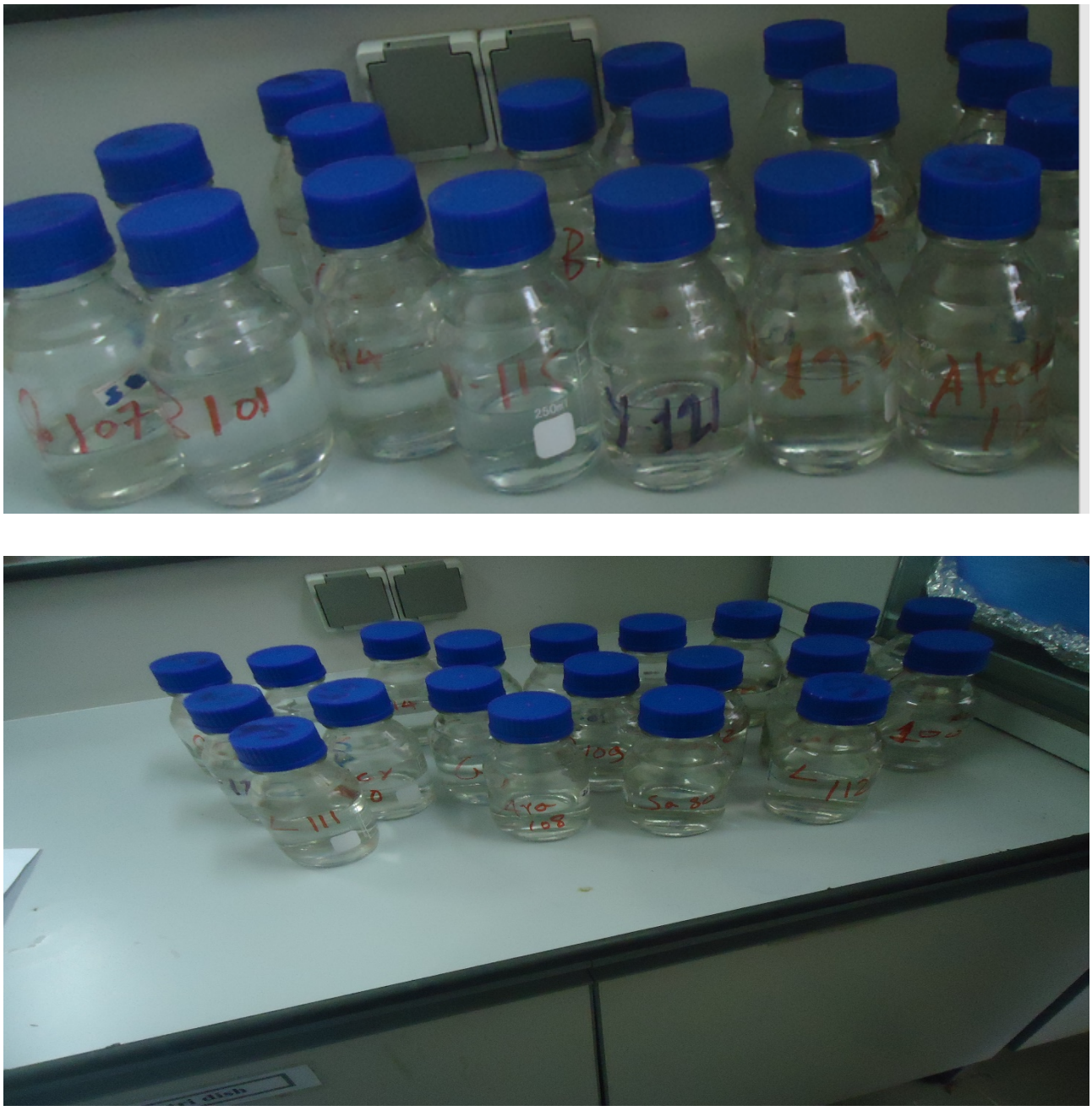
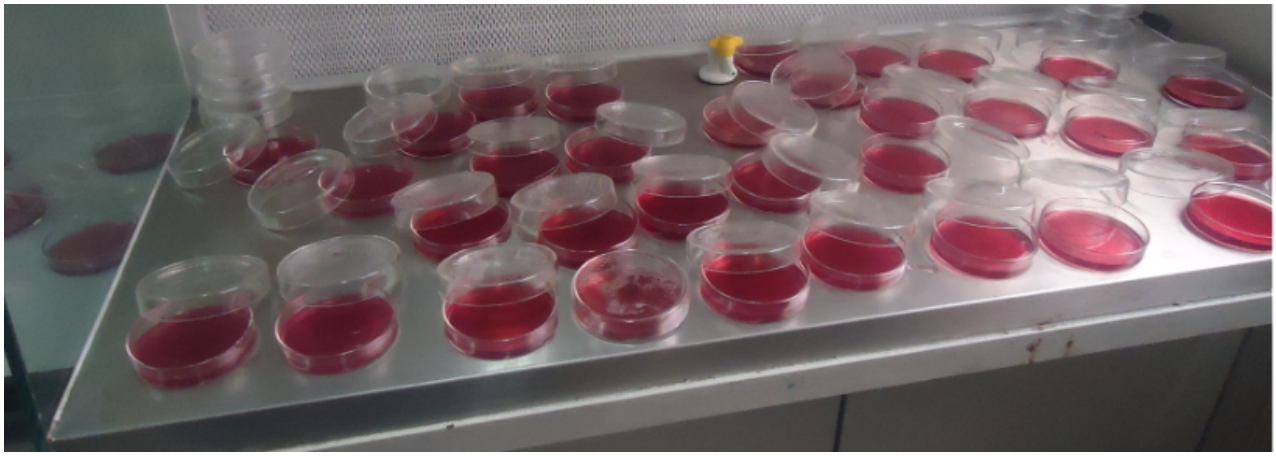


Figure 11: Some of the drinking water sample taken

Figure 12: Media preparation



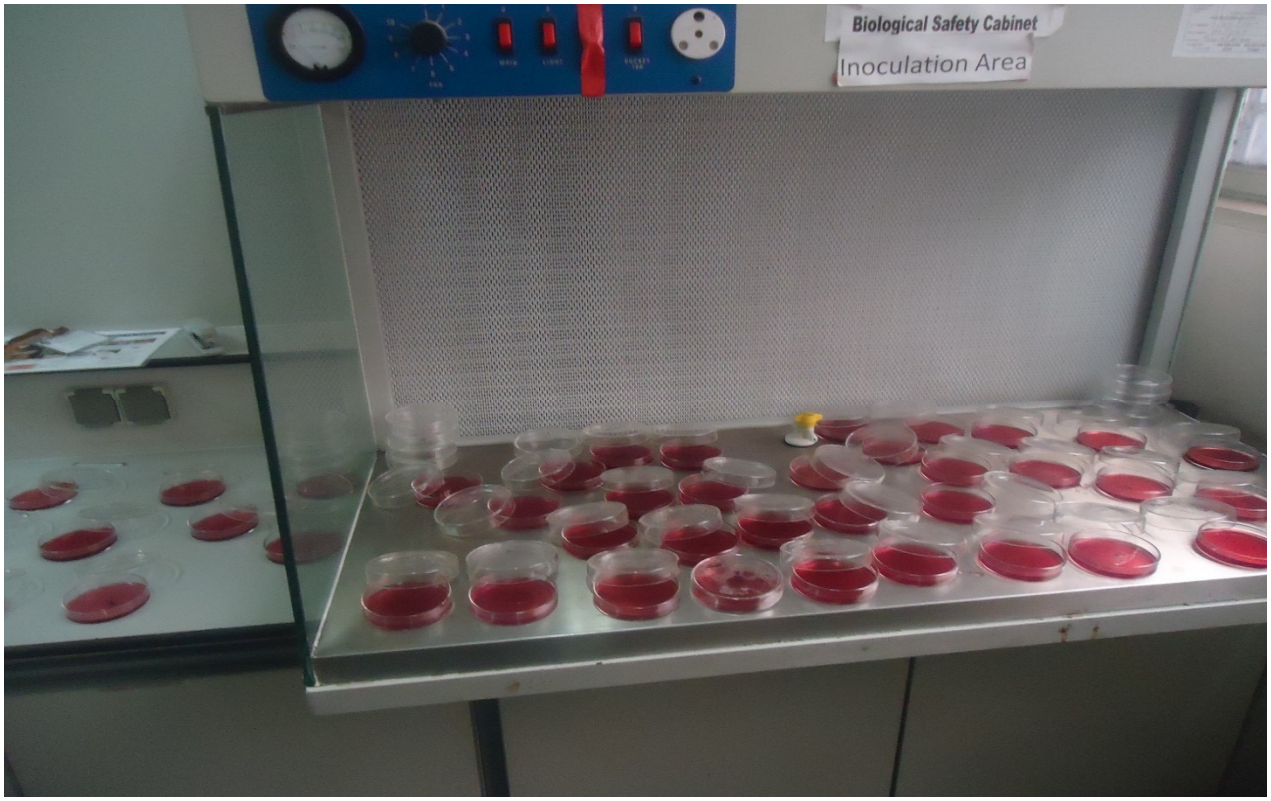


Figure 13: Prepared media

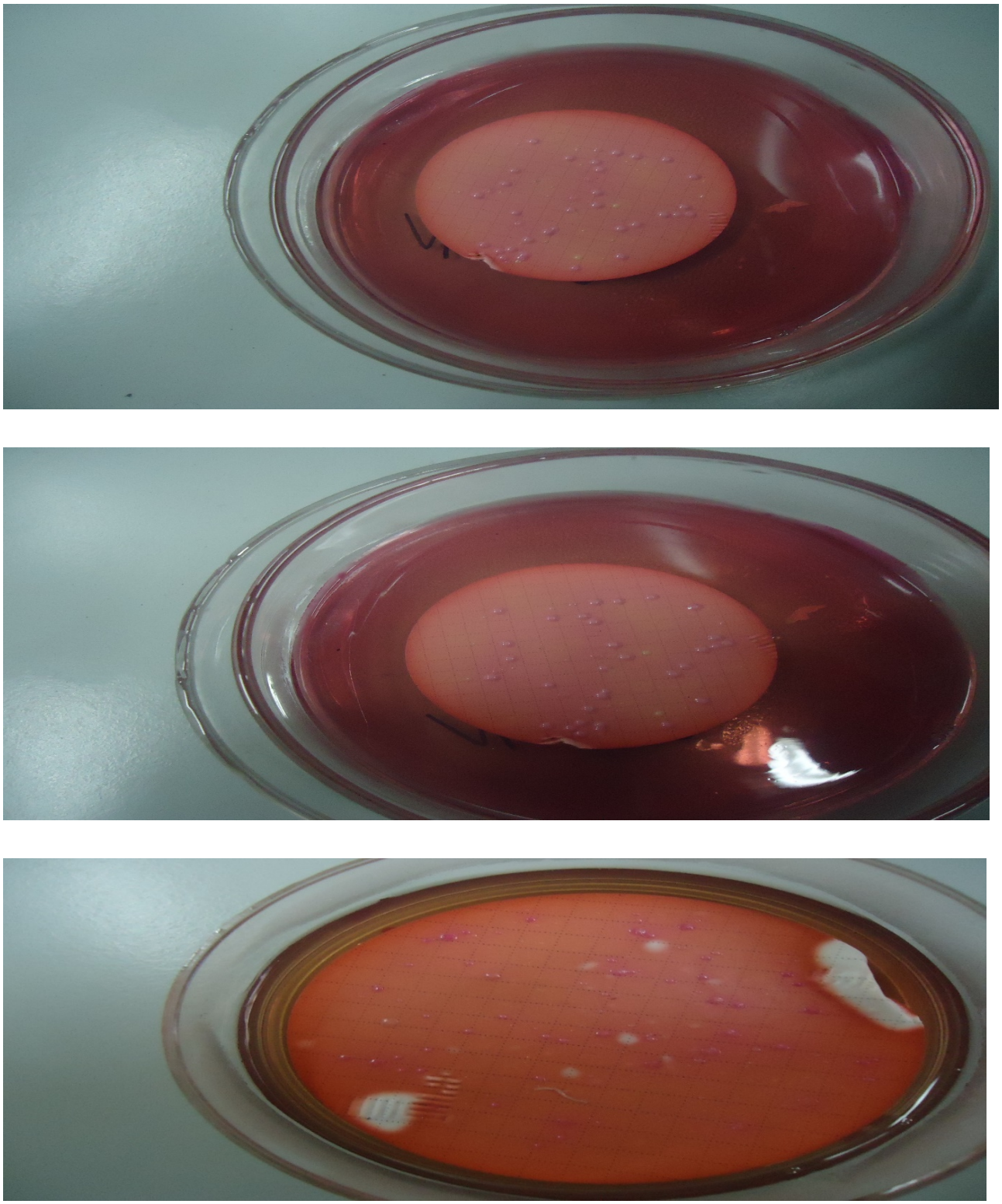


Figure 14: Growth of coloni forming unit

Figure 15: Coloni count in the drinking water samples

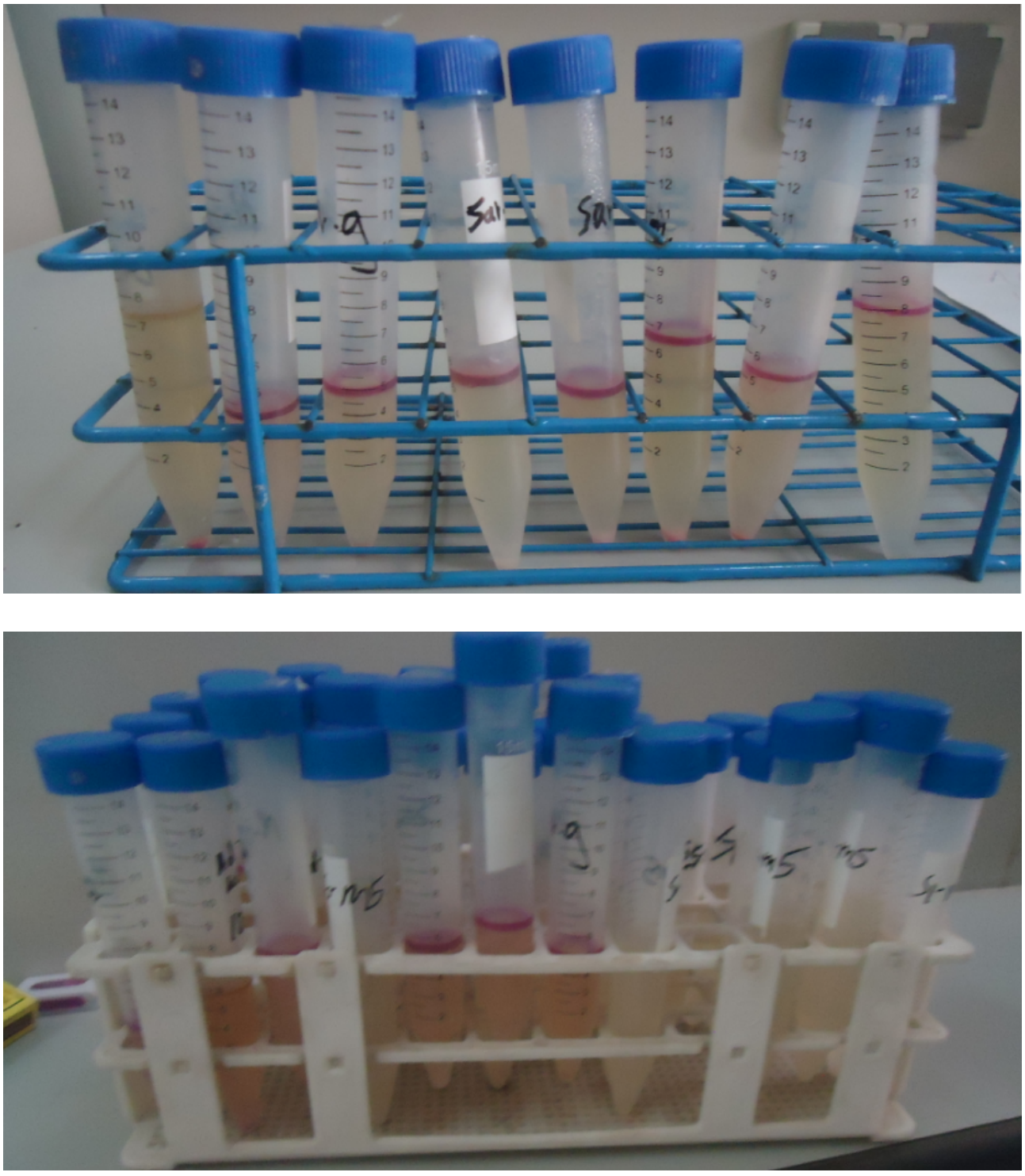


Figure 16: Confirmatory analysis to identify E. coli in the drinking water samples