FACTORS ASSOCIATED WITH FOODBORNE PATHOGENS AMONG FOOD HANDLERS IN THIKA, KIAMBU COUNTY, KENYA

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DECLARATION AND APPROVAL

Declaration by the student

To the best of my knowledge this thesis has never been submitted for a degree at a different university nor to get any other kind of recognition.

Signature ..... Date …**20-06-2023**……

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Approval by the supervisors

As faculty advisors, we attest that the student who worked under our supervision completed the activities detailed in this thesis.

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DEDICATION

This project is dedicated to my family. Special thanks to my late grandpa, Mr. Joseph Maina, for his words of wisdom and motivation.

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ABSTRACT

Increasing risks of infections with foodborne pathogens may occur as a result of poor food handling practices. The present cross-sectional study employed a mixed-methods approach to determine the factors associated with foodborne pathogens among food handlers working in food establishments in Thika, Kiambu County, Kenya. Random sampling was used to enrol respondents in the survey. A single stool specimen was collected from each study participant. Laboratory analysis of the specimen was done to test for selected foodborne pathogens. Overall, 44 out of the 285 food handlers who took part in the study had at least one food-transmitted pathogen, putting the prevalence of foodborne infections among the food handlers at 15.4% (95% confidence interval (CI) 11.7%–20.1%). The findings from binary logistic regression indicated the following protective factors for foodborne pathogens among the studied food handlers: being female (adjusted odds ratio (AOR) 0.098 (95% CI 0.0304 to 0.315, p< 0.001); having a valid medical examination certificate (AOR 0.141 (95% CI 0.141 to 1. 0.439, p = 0.001)); not boiling or treating water before serving the water to customers was a risk factor for having infections with foodborne pathogens (AOR 3.043 (95% CI 1.2225 to 7.577, p = 0.017)). The presence of foodborne pathogens among the food handlers in the study area potentially highlights the need to address the spread and transmission of foodborne infections in the study area. There is a need to institute appropriate control measures, including reducing the duration of regular screening of food handlers for foodborne illnesses in addition to training them on safe food handling practices, hand hygiene practices with provision of running water should be mandatory, regular monitoring of the food handling practices and policies on antimicrobial resistance of foodborne pathogens should be included in food safety control.

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LIST OF ABBREVIATIONS AND ACRONYMS

CAC	**:**	Codex Alimentarios Commission
CDC	**:**	Centre for Disease Control and Prevention
CIDP	**:**	County Integrated Development Plan
COR	**:**	Crude Odds Ratio
DPH	**:**	Department of Public Health
FBD	**:**	Foodborne diseases
FDG	**:**	Focus Group Discussion
ISO	**:**	International Organization for Standardization
KEBS	**:**	Kenya Bureau of Standards
KII	**:**	Key Informant Interview
LMICs	**:**	Lower middle-income economies
OFSP	**:**	Orange Fleshed Sweet potato
PPEs	**:**	Personal Protective Equipment
SCFHs	**:**	Street Cooked Food Handlers
SPSS	**:**	Statistical Package for Social Sciences
TCBS	**:**	Thiosulfate Citrate Bile Salts Sucrose
WHO	**:**	World Health Organization

CHAPTER ONE

INTRODUCTION

Chapter one provides an introduction to the study by discussing the background and context of the research, including the problem that the study aims to address. It also outlines the objectives of the study and explains the meaning and scope of the research. Additionally, the chapter discusses the limitations and delimitations of the study, which may affect the generalizability and applicability of the findings.

1.1 Background of the study

Food safety is an essential public health matter to prevent foodborne diseases. To respond to the expanding cases of foodborne diseases, governments in different parts of the world are increasing their strategies for improving food safety Dagne et al., (2019). Both food producers, processors, distributors, and customers are interested in having safe food for healthy living. Those foods that do not cause injury or sickness to the customer have been defined as safe food. In the context of food safety, handling, preparing, and storing food in such a way as to prevent contamination by harmful chemicals is referred to as food safety. Pathogenic microorganisms that cause food-borne illnesses are also included in Mekonnen et al., (2021b).

Food that has been contaminated with toxins or bacteria may be the source of food poisoning. If insufficient preservation measures are performed, the food may also get contaminated due to the bacteria that are present on the nails or skin of the person handling the food. This may also happen if incorrect handling practices are used, as can filthy contact surfaces. In an environment that is polluted due to improper food preparation and storage practices, disease-causing microbes including viruses, bacteria, and other food-borne pathogens have the potential to flourish and spread Zyoud et al., (2019). Signs and symptoms of toxigenic food poisoning mostly appear within the first

24 hours after consumption of filthy foods, symptoms of contaminated food include vomiting, nausea, fever, severe headache, pain in the abdomen, and diarrhea. Life-threatening conditions such as hepatic failure, neurological and renal failure may occur which can cause severe morbidity and mortality depending on the virulence of pathogens and microbes ingested Tshipamba et al., (2018).

Foodborne pathogens are rampant in developing nations, including Kenya, due to the current poor food handling methods, poor regulatory systems, and inadequate safety laws on food, lack of education among handlers, and inadequate funds to buy safety equipment for use in food industries Karari, (2019). Between the years 2017 and 2018, there was an outbreak of *Listeriosis* in South Africa from a company that was processing meat and it led to 978 people being infected and 183 people dying while 15 countries that imported the meat from the processing company were put at risk Smith et al., (2019). Consequently, this reveals how the core activities of food safety such as control and assurance policies have been neglected. It is the lack of precautionary measures, inadequate oversight systems, poor certification as well the absence of training on proper hygiene measures that contribute to food-borne disease outbreaks, Boatemaa et al., (2018).

In Kenya, the informal food sector largely accounts for at least 80% of the local markets. The hygiene control of this sector is limited because monitoring is difficult. It is because of inadequate hygiene control in these informal sectors that promotes the incidences of food-borne illnesses Oloo, (2015).

In the Kenyan context, guided by Kenyan law (food drugs and chemical substances Act, Cap 254), every food handler must be subjected to routine medical examination of food handlers to reduce the spread of foodborne diseases. This entails Stool and urine tests for Salmonella Enterica, Campylobacter spp, Entamoeba histolytica, parasites, and urethra infections.

Studies on the factors related to food safety practices among food handlers have been carried out in specific regions of Kenya, such as hospital environments Abuga et al., (2017). These studies are important because they provide a countrywide analysis of foodborne diseases, safe food knowledge practices, training and awareness on food safety, safe food handling practices, and compliance levels of food handlers on regulatory bodies of food safety. However, published information concerning food safety in Thika sub-County is lacking. It is from this backdrop that this study aims to shed more light.

1.2 Statement of the Problem

In both developed and developing countries, food safety is still a menace. According to WHO 2021 reports, over 200 infections reported were as a result of consuming food contaminated by pathogens. Food contamination can occur at any stage of the food chain leading to foodborne illnesses Jung et al., (2021).

The careless handling of food by food handlers can increase the transmission of foodborne pathogens. Studies suggest that approximately 10% to 20% of foodborne illness outbreaks occur due to contamination of food by food handlers Dagne et al., (2021). According to Erick Yen et al., (2020), in Kenya, contaminated food contributed to recent cholera outbreaks that killed 76 and 3967 hospitalizations in the initial months of 2017. Studies have reviewed the cost of care among those affected by food-borne illness as at KSH 1,034 and KSH 4,136 in Nigeria and Ethiopia per case respectively Hoffmann & Baral, (2019).

However, data concerning foodborne diseases in Africa is still rare Legesse et al., (2017). Research has confirmed that food poisoning can result from the absence of knowledge on food safety practices and failure to implement the acquired knowledge. Additionally, inadequate training and awareness of hygiene and handling techniques among traders and

retailers can also play a role in the spread of foodborne diseases WHO (2016). The role of food handlers to ensure food safety practices in food premises is highly significant. Likewise, it is paramount to understand their level of food handling knowledge.

Different cross-sectional studies have been conducted. However, foodborne illnesses among food handlers in food premises have been rarely studied in the Kenyan context Carron et al., (2018). Therefore, it is significant to comprehend the association of the existing food safety practices, and knowledge of food handlers with food-borne illnesses to reduce foodborne outbreaks. From the above backdrop, the study aimed to determine factors associated with food-borne pathogens among food handlers in food premises of Thika, Kiambu County, Kenya.

1.3 Objetives of the Study

1.3.1 General Objetive

To assess factors associated with food-borne pathogens among food handlers of Thika Sub County, Kiambu County, Kenya.

1.3.2 Specific Objectives

1. To determine the prevalence of selected foodborne pathogens among food handlers in Thika, Kiambu County.
2. To assess the level of knowledge on food hygiene and safety practices among food handlers in Thika, Kiambu County.
3. To examine social-demographic characteristics of food handlers associated with food-borne pathogens in Thika, Kiambu County.
4. To determine the association between food handling practices and the prevalence of foodborne pathogens among food handlers in Thika, Kiambu County.

1.4 Research Questions

1. What are the most prevalent selected foodborne pathogens among food handlers of Thika, Kiambu County?
2. What is the level of knowledge on food hygiene and safety practices among food handlers in Thika, Kiambu County?
3. What are the social-demographic factors associated with foodborne pathogens among food handlers in Thika, Kiambu County?
4. What is the association between food handling practices and the prevalence of foodborne pathogens among food handlers in Thika, Kiambu County?

1.5 Justification of the Study

In Africa particularly Kenya, little research work has focused on the surveillance of foodborne pathogens. There may be a far larger number of cases of foodborne illness than the Ministry of Health reports, due to both underreporting and a lack of proper diagnostic facilities.

A report by WHO on foodborne diseases in 2015 reported that FBDs in LMICs are a menace due to poor hygienic practices, inappropriate food handling methods, and lack of infrastructure. This is connoted by ignorance, poor food sanitation practices, poor enactment of food safety laws, inadequate regulatory systems, and inadequate financial resources.

Even though governments worldwide have different approaches to improving food safety in the food supply, the prevalence of foodborne disease continues to be a considerable issue. In this regard, the safety of food handlers is thus one of the most indispensable health and safety aspects that many developing countries experience in food-eating premises that it results in social and public health problems. These foodborne diseases pose a big public health challenge and are foreseeable to be of concern in the future

despite some global and local successes in fighting them due to the increase of local food-eating premises. Based on the above background, it is imperative to determine the factors associated with food foodborne pathogens among food handlers in the food premises of Thika, Kiambu County, Kenya.

1.6 Significance of the Study

The findings derived from this research may be used to formulate interventions at the community level aimed at deepening the knowledge and food handling practices of food handlers concerning the prevention and control of foodborne pathogens, and information on safe practices on food handling to reduce the cases of food poisonings and the outbreak of foodborne diseases at the communities. Likewise, from these research outcomes, the government can establish the effectiveness of regulatory bodies in food safety practices among food handlers. If the policies are not well implemented, the government can put stricter measures to ensure food safety. The findings and suggestions from this study may also contribute to the formulation of policies that fund extensive educational initiatives on food safety and cleanliness. The study will also provide important information to current and potential scholars on the factors associated with foodborne illnesses among handlers. It will enable them to expand their knowledge on the same topic, identify gaps and find specific areas to conduct further research. The information from the study will aid in bridging the gap in information on the prevalence of foodborne pathogens, and the association with food safety practices among food handlers in food-eating premises of Thika, Sub-County through documentation of the research findings.

1.7 Scope of the Study

The study examined the factors related to foodborne pathogens among food handlers working in Thika Sub County, located in Kiambu County, Kenya. The participants of the study were food handlers working in specific food establishments within the selected

areas. These premises must have been licensed to operate by the local county government, and there is a record of their existence. The study covered social demographic factors, knowledge of foodborne pathogens, and food handlers' practices that are associated with foodborne pathogens in selected food establishments.

1.8 Study Limitations

The present study is not without limitations. Time limitation when collecting data was a big challenge due to busy working hours. Only one stool specimen was collected from each participant. However, it is known that the studied foodborne pathogens are transmitted intermittently in the stool of chronic carriers (Salvato, et, al, 2005) Thus, our study may have underestimated the prevalence of foodborne pathogens infections among food handlers.

1.9 Delimitations

Time limitation was addressed by employing more data collection team members to help in data collection. The study was delimited to licensed food handlers of the Thika sub-county, the prevalence of selected foodborne pathogens, socio-demographic factors, and knowledge of food handlers on factors associated with foodborne pathogens. The study was further delimited to a questionnaire, checklist, and laboratory analysis of stool samples, focus group discussion guide, and key informants interview guide as tools for data collection.

1.10 Study Assumptions

The study assumed that the participants willingly collaborated and, in the right conscience, provided genuine responses to the questionnaires provided to them. Further, the researcher assumed that the conclusions derived from the study sample were adequate to give a general deduction concerning the factors connected with foodborne pathogens among food handlers in Thika, Kiambu County, Kenya.

1.11 Definitions of Operational Terms

Eating and drinking premises: In this study, this applies to licensed premises where food is prepared and served for commercial purposes (Cap 242 laws of Kenya).

Food handler: This refers to any person who works in the kitchen as a cook, chef, waitress, or waiter; this person comes into close contact with food and food substances during its preparation, processing, production, packaging, and distribution (Cap 254 laws of Kenya)

Food handling: Refers to those aspects involved in the preparation, storage, transport, packaging, covering, or delivery of food (Cap 254 laws of Kenya)

Food premises: Includes both eating and drinking establishments (Cap 254 laws of Kenya)

Food safety: Guarantee that the food provided will not cause any health danger to the consumers after its preparation and consumption to satisfy their needs. Dagne et al., (2019)

Foodborne disease outbreak -this is defined as: -Two or more people suffering from a similar disease, usually gastrointestinal after consuming a common food and epidemiological analysis links food as the common source of illness CDC, (2019).

Foodborne diseases: These are the disease that arises after consuming contaminated food. Various disease-causing pathogens or microbes can contaminate food; thus, there are various kinds of foodborne diseases. Many foodborne illnesses are due to contaminations caused by parasites, bacteria, and viruses CDC, (2019).

Knowledge: An awareness, understanding, or familiarity of something, for instance, skills or information, which is attained through learning, education, or discovering Mekonnen et al., (2021).

Licensed: limited under the county government.

Personal hygiene: It is a personal protective responsibility practice that enhances cleanliness and reduces infectious diseases, mainly those spread through direct contact. These practices include cleaning hands with sanitizer, soap, and water and keeping clothes and the body always clean (Cap 242 laws of Kenya).

Regulatory bodies: They are government entities, for example, the Kenya Bureau of Standards (KEBS) and the Public Health that ensure the safety of food products.

Selected food establishments: Includes hotels, restaurants, and butcheries licensed by the county government of Kiambu.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

The conceptual framework and empirical review are presented in this chapter. This is followed by a criticism of the examined literature, the identification of research gaps, and, ultimately, a summary of the reviewed literature

2.1 Theoretical Framework

The epidemiological triangle model is the theoretical framework. The model has three corners: the host, the agent, and the environment. The agent produces the illness, the host has the sickness, and the environment allows the disease to spread. In public health, this model is often used to examine the transmission of infectious illnesses Merrill, (2012). The chain of infection occurs when an infectious agent reaches a susceptible host after leaving the source, whether via indirect or direct contact CDC, (2015). The microorganism is the agent, the food handler is the host, and the food premise is the setting in which this research will be conducted.

It is possible to have a food-borne epidemic in a hotel if two or more guests become sick after eating anything from the same dish. The Centers for Disease Control and Prevention, (2012) food can be contaminated by biological, chemical, or physical means. ServSafe, (2013)

Working with raw and cooked food on the same tabletop while cleaning food-contact surfaces is a common way for food handlers to contaminate both the food they prepare and the food they serve. Other ways include touching soiled surfaces, being ill at the time of the job, and cooking the food incorrectly ServSafe, (2013).

People with Escherichia Coli infections are more likely to have eaten ground beef from a fast-food restaurant, according to a study by Kassenborg et al. Over half of the hotel

managers failed to use a thermometer to verify the meal's temperature before serving, and a third failed to wash and rinse food-contact surfaces before serving, according to research on food handling procedures conducted by Brown et al. (2013). According to Summer and co-authors Summer et al. (2011), 20% of respondents experienced working while unwell with symptoms including vomiting and diarrhea at least once, while another 12% reported working while ill for more than two shifts.

Foodborne infections are caused by food handlers' ignorance, simple errors, and unsafe food handling methods in food outlets. Interfering with the chain of transmission destroys the relationship between the agent, host, and environment and thereby prevents the food-borne disease from spreading CDC, (2012).

2.2 Empirical Literature

2.2.1 Prevalence of foodborne pathogens

Global prevalence

Globally one person in ten falls ill from foodborne pathogens, and 420,000 people die yearly, WHO, (2015). The Centers for Disease Control and Prevention (CDC) reported that in the United States, approximately 9 million instances of foodborne illness, 56,000 hospitalizations, and 1,300 deaths occur each year as a result of foodborne infections. This is an indication that the prevalence of foodborne infections is a challenge for not only underdeveloped but also developed nations CDC, (2019).

Globally, the prevalence of food-borne pathogens is high and most of them remain undetected and untreated. A study done in Pakistan reported a 9.1% prevalence of Salmonella typhi among food handlers Siddiqui et al., (2015). Different research conducted in Ethiopia revealed a salmonella prevalence rate of 5.04% across the board and *Shigella spp* Marami et al., (2018). In Nigeria, a high prevalence of 31.5% was reported among food handlers JO et al., (2015).

Regional Prevalence

Food safety continues to be an essential requirement for the protection of public health all over the world. Both developed and developing countries are equally at risk from the widespread threat posed by food-borne infectious diseases, which pose a serious threat to public health. According to a report published by the WHO in 2018, there were approximately two million deaths among children under the age of five that were attributed to diarrheal disease. It is important to remember that hundreds of millions of children do suffer from frequent episodes of diarrhea and the associated effects. This has been strongly linked to the presence of food or waterborne pathogens WHO, (2009). Around 290 million people are living in the United States of America, and according to research published by the Center for Disease Control and Prevention in those states, food-borne diseases are responsible for more than 76 million infections each year. It is important to keep in mind that approximately 18% of cases of the disease and 36% of mortality cases are caused by known pathogens, while the remaining cases are caused by unrecognized agents. There are more than 325,000 cases of diseases caused by food contamination that results in hospitalizations, resulting in more than 5000 cases of mortality. Figure 1 and Figure 2 present similar data on the international problem of foodborne diseases despite being collected at different timeframes.

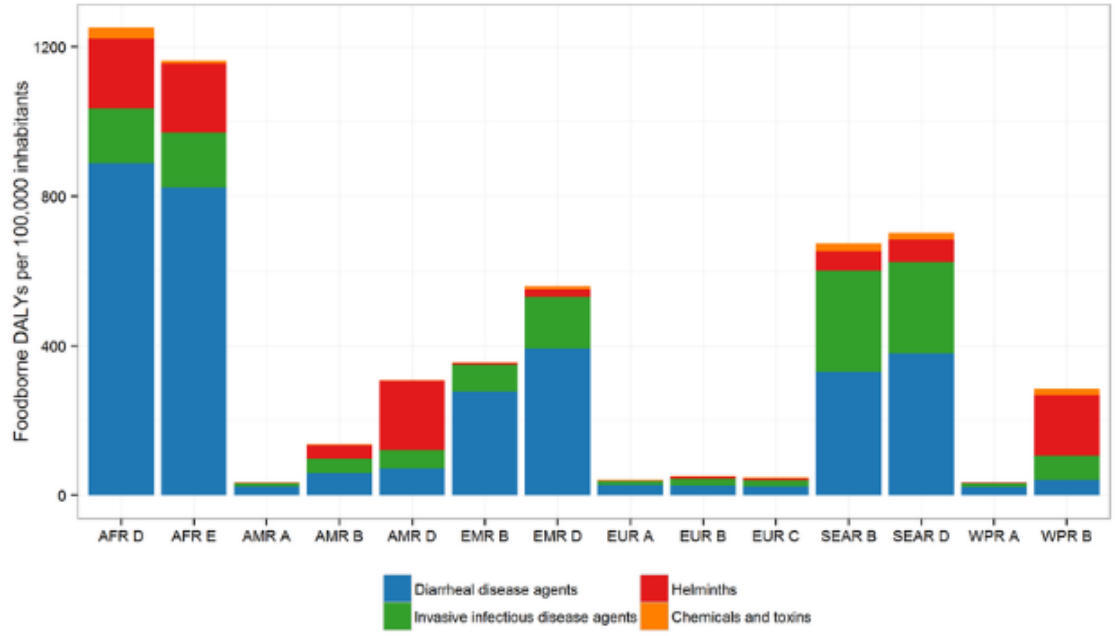

Figure 1: The worldwide problem of foodborne ailment (DALYs per 100,000 population) by risk clusters and subregions for 2010.

Source: Havelaar et al., (2015)

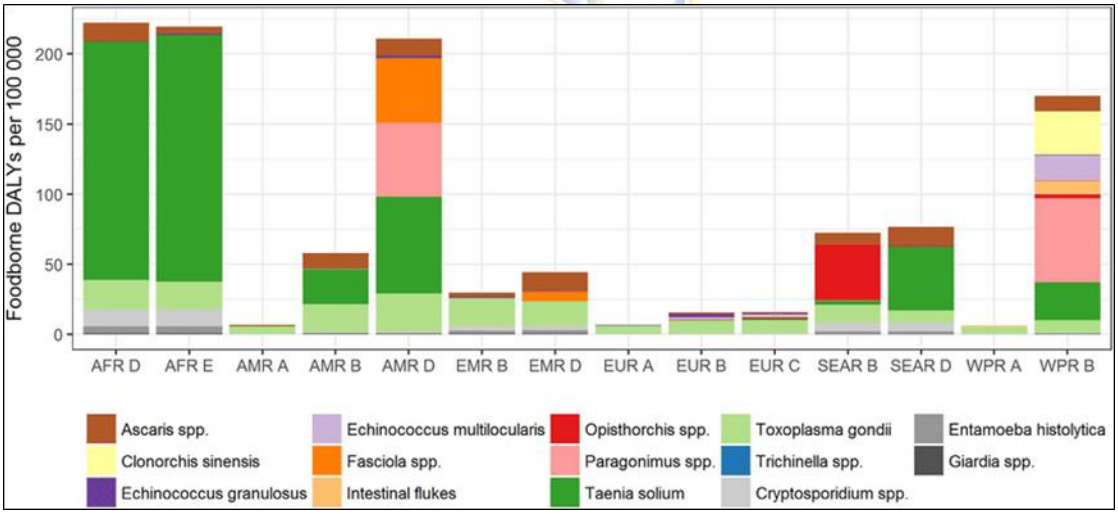

Figure 2: Foodborne Disability-Adjusted Life Years (DALYs) per 100,000 population, per World Health Organization sub-region.

Source: Torgerson et al., 2015; Kirk et al., (2015).

Africa Prevalence

Foodborne pathogens are rampant in developing nations, including Kenya, due to the current poor food handling methods, poor regulatory systems, and inadequate safety laws on food, lack of education among handlers, and inadequate funds to buy safe equipment Karari, (2019). Studies carried out in the Northern area of Ethiopia indicate that 30.3 percent and 52.5 percent among handlers of food had effective food handling methods in Dangila and Gondar town correspondingly Gizaw, (2014). The study done in humans Metropolis Ghana found that the majority of the incidents leading to foodborne deaths are linked to poor knowledge and lack of awareness attributed to lack of food handlers' pieces of training Ababio & Adi, (2012). Between the years 2017 and 2018 there was an outbreak of *Listeriosis* in South Africa from a company that was processing meat and it led to 978 people being infected and 183 people died while 15 countries that imported the meat from the processing company were put at risk Smith et al., (2019).

Prevalence in Kenya, Kiambu County

A demographic health survey of 2014 reported that over 15% of Kenyans were reported suffering from diarrhea two weeks before this survey was undertaken, of these cases, 4.4% were foodborne. The survey concluded that 1,328 Kenyans die yearly due to diarrheal Infections.

Hospital data from 4 health centers in Thika Sub-County revealed that 725 cases of foodborne illnesses were reported between February 2021 and August 2021 as follows; Salmonella-200,campylobacter-165, E.histolytica-156 and parasitic infections-100 and UTIs-104 respectively.

On 19th Oct 2022, the Ministry of Health Kenya announced the multi-County cholera outbreak alert as follows; Kiambu(31), Nairobi(17), Muranga(1), Kajiado(2), Nakuru(2), Uashi Gishu(8) resulting from a wedding occasion that was held in Kiambu County. This

led to thirteen(13) cases being hospitalized and forty (40) treated as outpatients. MOH,(2022).

2.2.2 Food-borne pathogens

A great number of diseases have been caused by different types of Foodborne pathogens causing substantial effects on human health and the entire population. Some of these pathogenic micro-organisms include; (Bacillus cereus, Campylobacter jejunitis, Clostridium botulinum, Clostridium perfringens, Cronobacter sakazakii, Escherichia coli, Listeria monocytogenes, Salmonella spp., Shigella spp., Staphylococcus aureus, Vibrio spp., and Yersinia enterocolitica), viruses (Hepatitis A and Noroviruses) and parasites (Cyclospora cayetanensis, Toxoplasma gondii, and Trichinella spiralis), together with other outbreaks. Foodborne pathogens studied in this research included Salmonella Enterica, Campylobacter spp, and Entamoeba histolytica.

Salmonella Enterica

This bacterium is gram-negative and is responsible for causing typhoid fever. It has a rod-like shape, is flagellated, and can only survive within the human body. The prevalence of this bacterium is particularly high in developing countries due to inadequate sanitation and insufficient food safety measures Siddiqui et al., (2015). This microorganism belongs to the Enterobacteriaceae family. There are more than 2,500 distinct serotypes, or serovars, that have been identified among the two main species of Salmonella, Salmonella enterica, and Salmonella bongori. Salmonella is a type of bacteria that is widely distributed and very hardy, capable of surviving for many weeks in dry conditions and several months in water Siddiqui et al., (2015).

On the other hand, each serotype has the capability of causing disease in people. When some serotypes of bacteria infect people, the resulting illness is frequently severe and in some cases can even be fatal. On the other hand, the overwhelming majority of serotypes

can be found in several different hosts. These serotypes are responsible for the majority of instances of gastroenteritis, which is typically a basic condition that does not require any treatment from a doctor. Those who are young, old, or who have a damaged immune system are more likely to experience severe symptoms from this illness. The most widespread serovars of Salmonella that can be transmitted from animals to humans globally are Salmonella enterica serovar Typhimurium and Salmonella enterica serovar Enteritidis. Both of these serovars can result in severe sickness in humans Siddiqui et al., (2015).

The World Health Organization (WHO) identifies these two serovars in this classification. Salmonellosis, an illness characterized by abrupt onset of symptoms such as fever, abdominal pain, diarrhea, nausea, and occasional vomiting, is caused by the Salmonella bacterium. Other symptoms may also be present. The development of sickness symptoms may occur anywhere from 6 to 72 hours (typically between 12 and 36 hours) after consumption of Salmonella, and the duration of the illness can range anywhere from 2 to 7 days. Salmonellosis is characterized by relatively moderate symptoms, and in the majority of instances, patients will recover even in the absence of any special therapy.

Nevertheless, the related dehydration may sometimes progress to a severe state, which poses a significant risk to the patient's life, especially in younger patients and those who are older. Instances of salmonellosis may not be identified as part of a known outbreak and are categorized as sporadic cases, or they may not be recognized as such at all, even though significant Salmonella outbreaks often draw media attention. The percentage of sporadic cases ranges from 60–80 percent of all salmonellosis cases. WHO,(2018). Children and young adults in nations with low per capita income have a higher risk of contracting typhoid fever Crump et al., (2015). It is projected that there were 11.9 million

cases of typhoid fever in the year 2010 and that there were 129 thousand deaths that happened as a direct consequence of typhoid fever in poor and middle-income nations Mogasale et al., (2014). On the other hand, these cases may be underreported because the majority of cases are not reported because they are treated on an outpatient basis, and some of them are not treated at all. A person contracts typhoid fever by ingesting food contaminated with excreta and can survive in the stomach before attaching it to the small intestine.

Campylobacter spp.

Campylobacter spp is one of the most common infectious infections, and it is anticipated that it will continue to provide a threat to the health of people all over the world in the years to come. Both the incidence and prevalence have seen a significant rise in recent years around the globe, particularly in the Americas, Europe, Australia, and Africa. *Campylobacter spp* is an endemic disease that affects children across Asia and the Middle East. The primary reservoir of the disease and its primary route of transmission to people is poultry Legesse et al., (2017a). In 1886, Theodor Esherich may have detected campylobacters in the intestines of infants who had died of cholera infantum. Esherich named this condition "cholera infantum" Skirrow and Butzler (2019). Although Campylobacter was recognized in the 1940s, it was not until 1972 that it was identified by Dekyser and Butzler from the feces and blood of a young, previously healthy woman with acute febrile hemorrhagic enteritis Skirrow and Butzler (2019). Members of the Campylobacteraceae family, such as Campylobacter, Arcobacter, and Bacteroides ureolyticus, are generally benign commensal organisms present in humans and domestic animals Vandamme (2017).

Individuals often move around either of the extremities of their cells with a single polar unsheathed flagellum in a distinctive corkscrew-like motion Vandamme (2017).

Menaquinones are the sole respiratory quinones that have been detected, and the primary components are menaquinone-6 and menaquinone-5. The Campylobacteraceae family does not ferment or oxidize carbohydrates to produce energy but instead relies on amino acids or tricarboxylic acid cycle intermediates for energy Vandamme (2017). All 14 Campylobacter spp. except for Campylobacter gracilis, exhibit oxidase activity Fitzgerald et al; Vandamme (2017). Since campylobacters are typically microaerophilic, they may be grown in environments that include 3–15% oxygen and 1–10% CO2 Forsythe (2016). Human gastrointestinal sickness is most often linked to the thermophilic campylobacters C. jejuni, C. coli, C. lardis, and C. upsaliensis. In the United Kingdom, C. coli and C. jejuni ssp. jejuni accounts for 95% of all clinical isolates Silva, Jet. al (2011). There is a preferred host for each strain of Campylobacter; for example, C. jejuni, the most frequent human pathogen, is strongly linked to chickens and has adapted to thrive in the digestive tract of birds kept at temperatures about 42 degrees Celsius van Igwaran, A., & Okoh, A. I. (2019). Because of its relatively high minimum growth temperature (>30°C), C. jejuni often does not replicate once ejected into the environment Wagenaa et al. (2015). Contrary to Salmonella, campylobacters are often unable to proliferate in food and are not typically associated with significant outbreaks of campylobacteriosis. In the summer, sporadic instances account for more than 90% of all cases. However, campylobacters, are to blame for the bulk of intestinal infectious disorders around the globe. Due to underreporting, the real public health incidence is thought to be up to ten times greater than the number of reported cases Allos (2015). Campylobacteriosis causes significant yearly losses due to medical expenses and missed workdays, amounting to $1 to $2 billion annually in the USA Forsythe (2016).

Entamoeba histolytica

Protozoa known as ***Entamoeba histolytica*** is responsible for amoebic dysentery and amoebiasis. There is a possibility that a Sanskrit account of bloody mucoid diarrhea from 3000 BCE was the earliest episode of amebiasis ever recorded. 50 million individuals around the world are afflicted with ***amoebiasis,*** and the disease is responsible for over 100,000 fatalities each year, most of which occur in underdeveloped nations. At the worldwide level, ***Entamoeba histolytica*** is the third biggest cause of death from parasite diseases. Infection with E. histolytica is often asymptomatic; nonetheless, the parasite has the potential to cause severe disease. The origins, advantages, and precipitating factors of amoebic virulence are all quite complicated. The pathophysiology of the amoebic disease involves the breakdown of the mucosal barrier of the host, adhesion to the lumen of the colon, cytotoxicity, and invasion of the epithelium of the colon. Damage caused by the parasite might manifest as colitis and, in certain instances, as widespread illness. Both the genotypes of the host and the parasite, as well as the regulatory responses that each genotype is responsible for regulating at the interface between the host and the pathogen, have an effect on the course of the sickness. The environmental components of the host have an effect not only on the transmission of the parasite but also on the intestinal microenvironment that is influenced by E. histolytica infection. In this article, we focus on research that provides fresh light on previously undiscovered links between the host, the parasite, and environmental variables in the control of E. histolytic's virulence. This research was conducted by a team of scientists from the United States and the United Kingdom. Transmission may take place via the consumption of food and water infected with cysts as well as through fecal-oral pathways Kantor et al., (2018).

2.2.3 Sociodemographic factors

Concerning age, a study done in Ethiopia significantly linked age with food safety practices Legesse et al., (2017a). However, other studies reported no significant difference between age and food safety practices Addo-Tham et al., (2020). Regarding gender, diverse results have been reported from previous research. One study done in Ethiopia reported that the female gender was more likely to have good food hygiene practices as compared to their male counterparts Lema et al., (2020). Contrary to this, several other studies did not have any significant relationship between gender and food hygiene and practices Oumer, (2019). Marital status, a study in Ghana reported a significant association between marital status and food safety practices Addo-Tham et al., (2020). However, some studies did not report any statistical association between marital status and food safety practices Lema et al., (2020). Concerning education status, a study done in Nigeria reported no significant association between education status and food hygiene knowledge and practices (Amelia Ngozi). This is dissimilar to a study in Ethiopia that significantly linked education status and food hygiene practices Lema et al., (2020). A study was done on the prevalence and associated factors of intestinal parasitic infections work experience were associated with intestinal parasitic infections Kumma et al., (2019). However, another study done in Ghana revealed no significant association between working experience and food safety practices Legesse et al., (2017b). Income was significantly associated with food hygiene practices among street vendors (Sarawak).

2.2.4 The level of knowledge of food hygiene and safety practices

According to the WHO, contaminated food is responsible for 1.5 billion incidents of diarrhea in children and adults each year.

The occurrence of food-borne diseases depends on food hygiene measures applied in the food production chain. However, this can also be affected by inadequate unhygienic

measures by the consumers. Studies carried out in the Northern area of Ethiopia indicate that 30.3 percent and 52.5 percent among handlers of food had effective food handling methods in Dangila and Gondar town correspondingly Gizaw, (2014). The study done in humans Metropolis Ghana found that the majority of the incidents leading to foodborne deaths are linked to poor knowledge and lack of awareness attributed to lack of food handlers' pieces of training Ababio & Adi, (2012). Studies have recommended the use of different safeguarding measures to ensure the safety of humans during food consumption Eshetu et al., (2020). This includes washing hands after using the toilet, before touching any food, and after coming into contact with raw food by the use of soap and water for at least 15 seconds. It is also necessary to separate cooked and raw foods. Washing vegetables and fruits and other preventive measures. Studies done in Ethiopia have indicated that people fail to comply with hygiene and preventive techniques Eshetu et al., (2020).

In the upcoming nations, many cases of food poisoning have risen due to the uptake of unhygienic foods, pesticide residues in water, and animal food products. Food poisoning does not only affect developing nations but also developed countries. This has been linked to a rise in demand for low-priced food and the inability to provide ideal care under the unhygienic condition when cooking and packaging foods Zyoud et al., (2019). The ability to comply with the lessons of food safety in the population should be highlighted and endorsed. Food consumers together with food handlers have been recognized as a critical factor in foodborne disease outbreaks which may arise from poor food handling in the process of planning, processing, and packaging.

Foodborne illnesses can happen both in homes and at social events. In developing countries, a lack of knowledge regarding food safety can lead to a decrease in personal hygiene practices, poor handling of food, and inadequate household food preparation,

which all contribute to the outbreak of foodborne illnesses. This is often due to the contamination of raw foods with processed foods. Household preparation of food usually has a vital role in foodborne pathogens Tshipamba et al., (2018).

Recognizing and understanding the significance of individuals' food safety knowledge, attitudes, and actions involved in food handling is a crucial step in assessing approaches to mitigate the incidence of foodborne illnesses. Therefore, food safety education is key to ensuring positive practices and good knowledge which can lead to increased food safety issues and thereby reduce the occurrence of foodborne pathogens Eshetu et al., (2020).

2.2.5 Association between food handling practices and prevalence of foodborne pathogens.

Most food-borne infections caused by pathogens in humans are a result of the person handling that food having transmitted the pathogen to the food through improper handling of the food or poor sanitation of the environment in which the food is being kept. Food-borne infections have been recognized as a public health problem on a global scale and have been linked to the unsanitary handling of food and lack of sanitation procedures among those who work in the food industry Hossen et al., (2020). Foodborne illness results from the consumption of contaminated food, which can lead to the multiplication of pathogens in the human body or the ingestion of toxins produced by toxigenic pathogens in food. There are two main types of foodborne diseases: foodborne infection and foodborne intoxication. Foodborne infection typically involves an incubation period and a long time from ingestion to the onset of symptoms compared to foodborne intoxication Bintsis, (2017). Some of the common practices in handling food that results in to spread of pathogens include; inadequate handwashing, cross-contamination, storage and cooking temperatures, and lastly food contamination by animal wastes. There is a

need to advocate for good hygiene practices, especially on premises where food is being handled. This has been viewed as an effective strategy for protecting consumers from various public health risks. Insufficient and unhygienic handling practices account for a bigger proportion of food-borne disease outbreaks within society. Studies have estimated that 200 types of illnesses can be spread through food and water Hossen et al., (2020). For instance, in a study done in Bangladesh, the manifestation of foodborne illnesses and other food safety hazards was noticeably high due to the presence of dense populations, poor water sanitation, underdeveloped infrastructure, and unhygienic conditions. This has led to the occurrence of more than 30 million cases of foodborne illness in Bangladesh, of which the most occurring disease are diarrhea, hepatitis, and enteric fever. To keep the food free of contamination by microorganisms, chemicals, or other impurities that may render it unsuitable for human consumption, a variety of philosophies and practices have emerged around food safety Murimi & Waweru, (2020). The association between food handling practices and the prevalence of foodborne pathogens is very essential to prevent the spread of infectious pathogens linked to food and food processing, as well as to guarantee that food served to customers is not deceived Dagne et al., (2021).

2.3 Conceptual Framework

Figure 3 shows the conceptual framework. The independent variables are social demographic factors, knowledge and awareness, and food handling practices related to food handlers in selected food premises. The intervening variable is law enforcement, while the dependent variable connotes the decrease in the prevalence of selected foodborne pathogens.

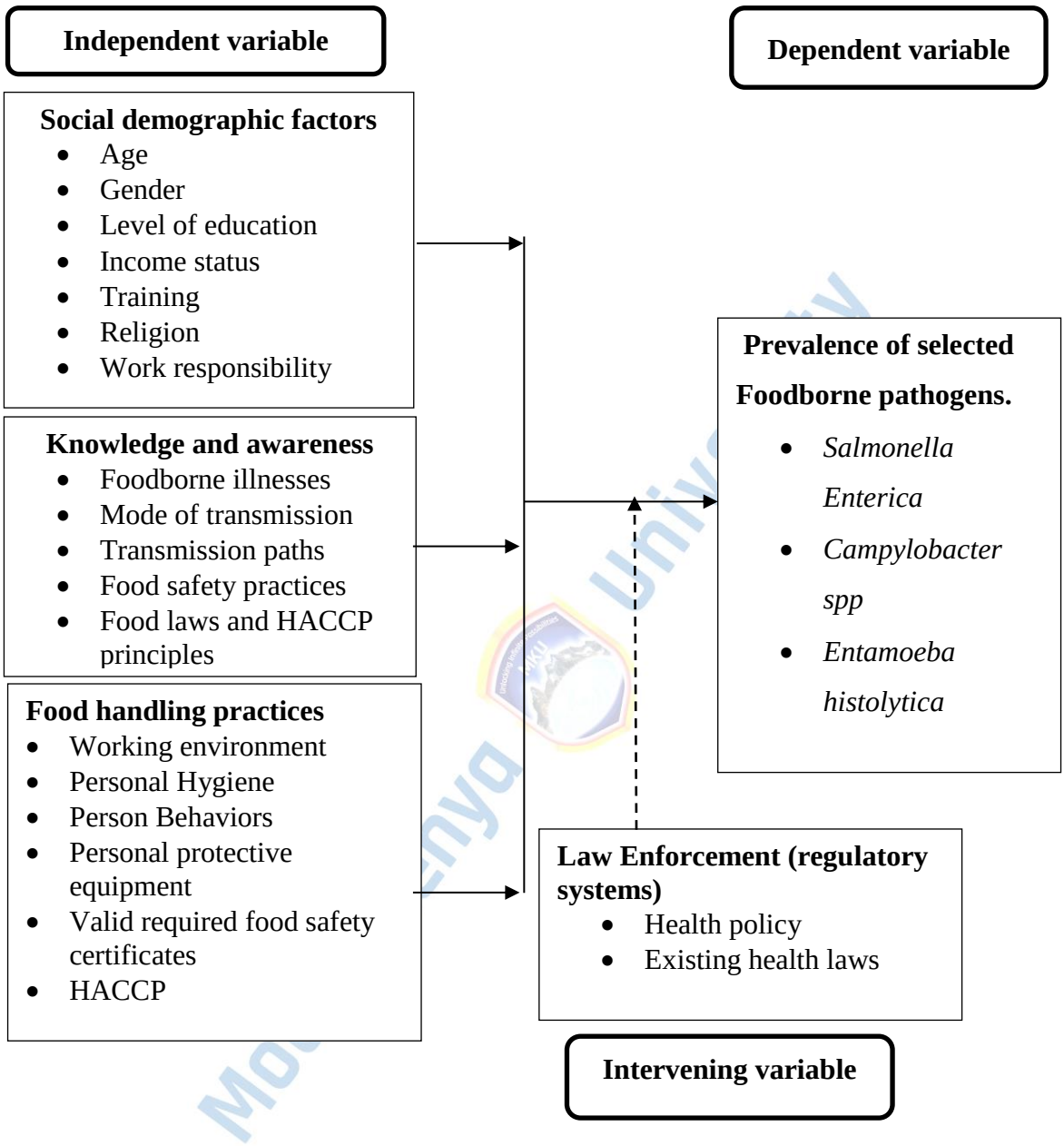

Figure 3: Conceptual Framework

2.4 Summary of Literature Review

In Kenya, the majority population is in the middle-income and low-income groups who majorly work in the informal sector. Most of these populations eat their breakfast, lunch, and supper in the local food premises. Local food establishments constitute restaurants,

market stalls, fast foods, and temporary food eateries. These premises are on arise especially in urban centers.

Internationally and regionally, food-borne infections remain a serious public health problem. Every year, contaminated food is responsible for around 600 million cases of foodborne illness and 420,000 deaths in the United States. The World Health Organization (WHO) estimates that each year, 33 million healthy years of life are lost all over the world as a consequence of ingesting dangerous food, and this statistic is most definitely an understatement. World Health Organization, (2022)

To ensure food safety, food handlers play a crucial role since they may introduce infections into foods during manufacturing, processing, and distribution (Ansari-Lari, Soodbakhsh & Lakzadeh, 2010). According to Siobhan S.reilly, Ph.D. Norovirus, Entamoeba histolytica, Salmonella, Clostridium perfringens, Campylobacter, and Staphylococcus aureus are the most frequent foodborne infections in Kenya. Foodborne infections are often caused and transmitted by food workers who lack enough expertise and engage in improper procedures. Food-borne disease transmission risks may be reduced in restaurants by enforcing strict food safety measures. To minimize the spread of food-borne diseases, all workers engaged in food preparation and handling must get proper training. Food safety knowledge, personal behaviors, limited resources, accessibility, equipment, training, and management all play key roles in improving food workers' knowledge and behavior, but education is also shown to be an important aspect of the process Phillips et al. (2014). Additionally, Pragelet al. (2013) revealed that food handling methods are influenced by management, training, and education. It was observed that certification affected food handling procedures Cates et, al., (2009).

At the international level, a significant number of studies concerning the topic have been published. However, in the Kenyan context, there are scanty published works; further,

the same studies have focused on a few areas of the food industry. For example, Abuga, Nyamari, and Njagi (2017) focused on consumer food hygiene and safety practices in households while Malavi (2017) focused on the OFSP puree processing plant and bakery. There is limited information on the state of food safety in the food premises of Thika Sub-County.

Therefore, this study intends to close the knowledge gap in information on the prevalence of foodborne pathogens in the sub-county by extending its focus to these premises. Recommendations will aid in the future development of policies that will provide a wide-ranging of training programs on food safety and hygiene practices.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

This chapter focuses on various aspects of the methodology section such as the study design, study area, target population, study population, sampling techniques, data collection tools, reliability and validity, data analysis, and ethical considerations.

3.1 Study design

A research design is a strategy or framework for conducting a study. As a consequence of this, the strategy is recommended since it allows respondents to express their views in a setting that is more natural Mugenda & Mugenda, (2010). A combination of qualitative and quantitative techniques was used in a descriptive analytical study design to investigate the factors associated with food-borne pathogens among food handlers in licensed food establishments located in Thika Sub-County, Kiambu County, Kenya. Employing a descriptive cross-sectional study enabled the researcher to collect data that made it possible to portray the relationship between food-borne pathogens and associated factors. Quantitative methods, according to Creswell (2009), are based on meticulous observation and measurement of the world's objective reality by generating numerical measurements of observation Creswell, (2009).

3.2 Study Variables

The independent variables included socio-demographic attributes, knowledge, medical certification, working environment, personal hygiene and food safety practices while the dependent variable was the prevalence of selected foodborne pathogens.

3.3 Study Area

Kiambu County is one of the 47 Counties in the country. It is adherent to Nairobi county and it is a fast-growing town. Geographically, the County is found in the Central region,

it covers an area of 2543.5 km^2 of the region of which approximately one-fifth of this area is forest (NBS,2009). The geo-coordinates of Kiambu County are 1°8′46.28″ S and 36°57′59.4″ E.

Thika Sub-County is one of Kiambu County's twelve sub-counties, and it is located in the western part of the county with five administrative wards namely, Hospital ward, Township ward, Gatuanyaga ward, Kamenu, and Ngoliba ward. According to the 2019 National census, Thika has a population of 279,429 with a total area of 217.5 km^2 and an elevation of 5,351 ft from sea level.

Thika Sub-County is the commercial hub and industrial town of Kiambu County. The economy of the Thika depends on agriculture, Industries like textile industries, bakeries, oil industries, pharmaceutical and chemical industries, moto vehicle dealers, and cigarette manufacturing industries. Thika sub-County is home to three universities, tens and hundreds of middle-level colleges, and secondary and primary schools consecutively, the sub-county also has many financial institutions. This makes the sub-county have a big number of food and drinking establishments which amounts to around 2000, bringing the importance of conducting this kind of research in this fast-growing area.

3.4 Target Population

"Population" is defined by Sekaran, (2010) as the total number of units from whom a sample will be drawn. In the work of Schindler and Cooper (2006), the individuals or items being measured are referred to as "population elements". The study targeted food handlers in licensed food eateries (eating premises) within Thika Sub-County, Kiambu County, Kenya. Key informants comprised public health officers and hotel managers.

3.4.1 Inclusion Criteria

The research included food handlers in the area of study, working in the sampled licensed food eating premises for at least a month and who have consented to take part in the study.

3.4.2 Exclusion Criteria

The research excluded food eateries which had not been approved for operation by Kiambu county government and food handlers who were recently employed (had worked less than 3 weeks).

3.5 Sample Size

The minimum sample size was calculated using the Yamane formula (1967) at a 95% confidence level and p-value of 0.05

$$n = \frac{N}{1 + N(e)^2}$$

Whereby;

$$n = \frac{994}{1 + 994(0.05)^2}$$

N = is the total number of food handlers (N=994, obtained from Kiambu County revenue office and Sub-County Public Health Office)

e = is the degree of precision. (0.05)

then n(sample size) was **285 study participants**

3.6 Sampling Technique

From the perspective of Kumar (2012), research sampling procedures describes how cases are going to be selected. Kiambu county was purposively selected as it is the second-most populous county after Nairobi county*(KNBS,2022).* Thika sub-county was randomly selected from a list of 12 sub-counties that constitute Kiambu county *(CADP,2021.22).* All the wards of Thika Sub-County were sampled. Using a list of licensed food premises in all five wards in the Thika sub-county, obtained from the county revenue office, probability proportion to size was used to determine the number of

licensed food premises that participated in the study. Further, the probability proportional to size sampling technique was used to determine the number of food handlers enrolled in the research from the selected food premises.

Simple random sampling by use of rotary method was used to sample individual food handlers per premise. Two key informant interviews were conducted and the key informants were selected purposively. The key informants included one public health officer per ward. A total of eight focus group discussions, comprising eight to ten individuals, were also conducted. Table 1 shows the distribution of the study participants by ward.

Table 1: Sampling framework

Ward	No. of licensed food premises by county government	No. of food handlers per ward	No.of sampled food handlers per ward
Township	63	357	102
Kamenu	40	209	60
Hospital	32	230	66
Gatuanyaga	15	90	26
Ngoliba	15	108	31
Total	**165**	**994**	**285**

Source: Kiambu county Revenue office and Sub-County Public Health Office November (2021)

3.7 Data Collection method and procedures

3.7.1 Questionnaire

The equipment used to gather data, according to Oso and Onen (2009), is referred to as a research instrument. An interviewer-administered questionnaire was used to capture data from the participants. A questionnaire is a trustworthy research tool because it allows the researcher to collect information that would otherwise be impossible to get via open observation. After all, they probe deeper into the motives, experiences, sentiments, and

successes of those involved Bryman & Bell, (2015). It is an appropriate instrument for data collection to gather objective information since it does not allow for the respondents to the study to be under the control of the investigator.

The questionnaire had closed-ended questions. It was divided into four sections, including Section A, which covered socio-demographic characteristics, Section B, which covered the knowledge of food hygiene and safety practices, Section C, which covered food safety practices and Section D, which covered the Effectiveness of regulatory bodies.

3.7.2. Focus group discusión guides and key informant interview

FGD and KII were used to obtain qualitative data from the participants to answer research questions and the conversation was recorded digitally. One Public health officer in every ward and hotel managers were included in the Key informant interviews. Sampled food handlers were included in the focused group discussions.One supervisor and 10 research assistants with background training in environmental health and medical laboratory were hired and trained to familiarize themselves with data collection tools, procedures, and research ethics.

3.7.3 Observation Checklist

An observation checklist was used to evaluate the cleanliness of the surroundings, the overall cleanliness of the food, and the practices of food handlers when it comes to handling food. The observation was carried out using a developed and standardized scoring methodology by the main principles of Codex Alimentarius food hygiene. This study adopted the checklist used by Fields (2014). Study participants were issued with a checklist to fill on arrival to laboratory being tested for foodborne pathogens. Variables like the presence of running water, toilet, hand sink, ordinary or antibacterial soap, refrigerators, slicing board for chapati, meat, and vegetables, insect traps, sleeping rooms for workers, lavatories for males and females, cooking in an open environment, having a

municipal license and a fence to ward off animals. All mentioned variables were examined to assess the vendor's commitment to ensuring good food handling practices.

3.7.4 Sample collection and laboratory procedures.

The prevalence of foodborne pathogens among the food handlers was conducted through laboratory testing of stool samples of consenting food handlers from licensed food premises in the area of study. The stool sample collection was matched with respondents when filling out questionnaires. A stool specimen was collected from each food handler in a tight-lid plastic container. Participants were instructed to collect a spoonful of stool samples in the provided containers and take the samples to the Thika level 5 hospital where the food handlers go for their routine food handler's medical examination. Stool processing and examination were conducted at Thika level 5 hospital laboratory department by qualified laboratory technicians.

For *salmonella* specimen's rapid antigen test cassette was used. This rapid test was used for the qualitative identification of *S. typhi* antigens in human feces specimens to help in the diagnosis of *S. typhi* infections. In the absence of any T lines (IgM and IgG), the test results are considered negative. The presence of a colored control line (C) should always be shown whether a positive or negative result is obtained. Its absence suggests that the test findings were faulty. (Source: Biozek Medical.) To detect Campylobacter, a stool culture (inoculated onto Mac-agar, Conkey's xylose lysine deoxycholate, and TSCB agar according to the World Health Organization protocol was done. Negative results (no bacteria found) were reported while positive results (bacteria found) were reported (campylobacter infection). Entamoeba histolytic: A direct microscopic examination test (formol ether concentration (Ritchie), and staining with modified acid-fast staining procedures) was done for the detection of cysts and trophozoites in the stool for Entamoeba. Positive (amoebiasis), negative (amoebiasis) (No amoebiasis). This was done

from May 2022 to July 2022 until all the food handlers were subjected to laboratory testing. Sample collection was per the Ministry of Health Kenya laboratory sample collection guidelines.

3.8 Testing for Validity and Reliability

3.8.1 Pilot Testing

According to Mugenda and Mugenda (2003), a pilot test is a test run of the methods and tools that the researcher intends to use throughout the study. The researcher can avoid making costly blunders by first conducting an inexpensive pilot study. Piloting is vital for eliminating any ambiguity, finding items that are expressed wrongly, and identifying occasions when there is not enough room to type responses. Pilot testing was conducted among 29 food handlers (10% of the sample size) randomly selected in a neighboring county (Murang'a County). Their views were analyzed, and results were used to improve the validity of the questions.

3.8.2 Testing for Validity and Reliability

The researcher's questions should be able to be answered by the data that was obtained using the data gathering equipment. To ensure the questionnaire's validity, the feedback received from the experts was included in the final version. To ensure the validity and reliability of the laboratory tests, known samples were compared to the tests performed on an unknown patient's sample.

3.9 Data Analysis Techniques and Procedures

After being imported into a sheet in Microsoft Excel, the quantitative data was then transferred into IBM SPSS version 24 for further analysis. To describe the categorical data, we employed both frequencies and percentages. The summary of the data was derived using the mean and the median for continuous data. Knowledge of food safety procedures was evaluated using a binary scale based on a set of 21 items to conduct an

inferential analysis. Those who answered correctly received a score of one, while those who did not receive any got 0. After the summation of all the scores, the respondents were dichotomized into those who had a low level of knowledge (scored less than 50%) and those who had a high level of knowledge (scored 50% or more). The study utilized various statistical methods to analyze the data. The Chi-square test of independence was used to examine the relationship between independent categorical variables and the dependent variable. For testing the association between a continuous variable and the categorical dependent variables, a t-test was used. Binary logistic regression analysis was employed to identify factors associated with foodborne illnesses while adjusting for confounders. The study also used Wilson's method to determine the 95% confidence interval Hald, (2008). The threshold of significant in hypothesis testing was set at a p-value <0.05. Qualitative data were transcribed and analyzed thematically using NVIVO v. 12 software.

3.10 Ethical Considerations

According to Saunders, Lewis, and Thornhill (2012), a scientific study needs to offer adequate relevance to ethical considerations to make the entire research activity more credible. For this study, the investigator handed out informed consent papers for the subjects to fill out. The MKU Institutional Research Ethics and Review Committee were contacted to receive ethical approval (IREC). It was requested that the National Committee for Science, Technology, and Innovation provide additional permission (NACOSTI). The study was discussed with the relevant local authorities who were in charge. Before the presentation of the questionnaires and collection of the samples, it was determined whether the respondents had provided their informed consent. The findings were kept a secret from everyone, and personnel in the food industry who tested positive for any pathogen were given the appropriate treatment.

CHAPTER FOUR

RESEARCH FINDINGS AND DISCUSSIONS

4.0 Introduction

This chapter comprises the statistical analysis, presentation, and interpretation of the findings resulting from this study. The data analysis and interpretation of data were carried out in two phases. The first phase was based on the analysis of quantitative data captured using questionnaires. The second phase involved the analysis of qualitative data (data from observational checklists, key informant interviews, and focus group discussions).

4.1 Response Rate

A total of 285 questionnaires were distributed to the study participants. Fifteen had missing data but the researcher was able to assess and include them in the analysis. Consequently, data analysis was done on all 285 questionnaires thus a response rate of 100%. The findings were presented in relationship to the research objectives stated in the study. In addition, the results were analyzed in the context of prior research and other relevant works of literature to highlight any parallels or discrepancies between the findings of this study and those of others.

4.2 Demographic Information

In the current study, 285 food handlers were included and their socio-demographic characteristics were presented in Table 2. More than half of the participants were females (52.6%).This mighty have impacted on the high prevalence of foodborne pathogens among the females. The age of the participants varied from 18 to 58 years, with a mean age and standard deviation of 40.0 ± 11.63 years. Those who were aged twenty years and below were 6.3% while those who were aged more than fifty years were 22.5%. Participants who were aged between 41 and 50 years were 29.8%. The rest were aged

between 21 and 30 years and between 31 and 40 years (17.5% and 23.9% respectively). Analysis of the highest level of education attained by the study participants indicated that those who had attained primary, secondary, and tertiary education were 24.6%, 45.3%, and 27.7% respectively. The minority had no formal education (2.5%). Further, the majority were Christians (92.3%) and had not undergone training on food safety (74.4%). The study enrolled cooks (15.8%), cashiers (14.0%), service personnel (15.1%), and cleaners (12.3%) among other cadres of staff.

Table 2: Sociodemographic characteristics of study participants

	Characteristic	**Frequency (n=285 (%))**
Gender	Male	135(47.4)
	Female	150(52.6)
Age (years)	≤20	18(6.3)
	21-30	50(17.5)
	31-40	68(23.9)
	41-50	85(29.8)
	>50	64(22.5)
Level of education	Primary	70(24.6)
	Secondary	129(45.3)
	Higher education	79(27.7)
	No formal education	7(2.5)
Religion	Christians	263(92.3)
	Muslim	22(7.7)
Location	Gatuanyaga	26(9.1)
	Hospital	65(22.8)
	Kamenu	61(21.4)
	Ngoliba	31(10.9)
	Township	102(35.8)
Work experience	< 1 month	20(7.0)
	1-6 months	76(26.7)
	>6 months - 1 year	80(28.1)
	> 1 year	109(38.2)
Work responsibility	Cook	45(15.8)
	Cashier	40(14.0)

	Service	43(15.1)
	Cleaner	35(12.3)
	All	98(34.4)
	Other	24(8.4)
Trained in food safety	Yes	73(25.6)
	No	212(74.4)

Source: Field Data (2022)

Figure 4 displays the work experience of the studied food handlers. The minority had worked for less than one month (7.0%). Those who had worked for more than one year were 38.2% while the rest had worked for a period of between one and six months (26.7%) and between 6 months and one year (28.1%).

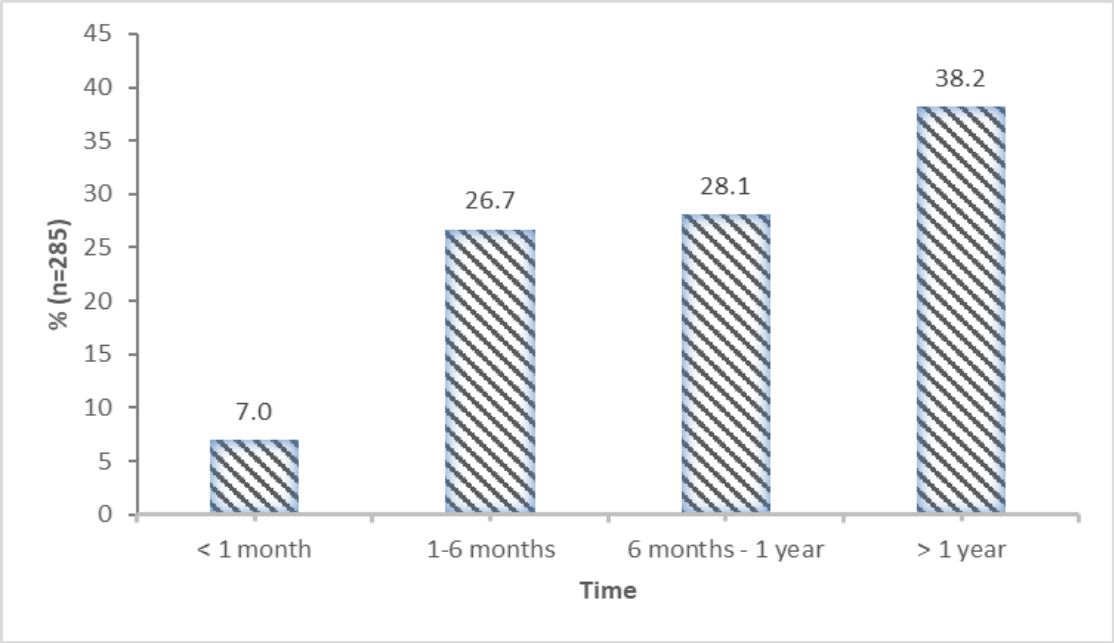

Figure 4: Food handling experience of the studied food handlers

4.3 Prevalence of selected foodborne pathogens

Laboratory analysis of stool samples from the enrolled food handlers revealed 8, 12, and 24 cases of *Campylobacter* spp., *S. typhi*, and *E. histolytica* infections respectively. The corresponding prevalence of infections was as follows 4.2% (95% CI 2.4% - 7.2%), 2.8% (95% CI 1.4% - 5.4%), and 8.4% (5.7% - 12.2%) respectively. Overall 44 out of the 285

food handlers who took part in the study had at least one food-transmitted pathogen (prevalence 15.4%, 95% CI 11.7% - 20.1%) as shown in figure 5.

Figure 5 illustrates the prevalence of selected foodborne pathogens isolated from the samples collected from the participating food handlers.

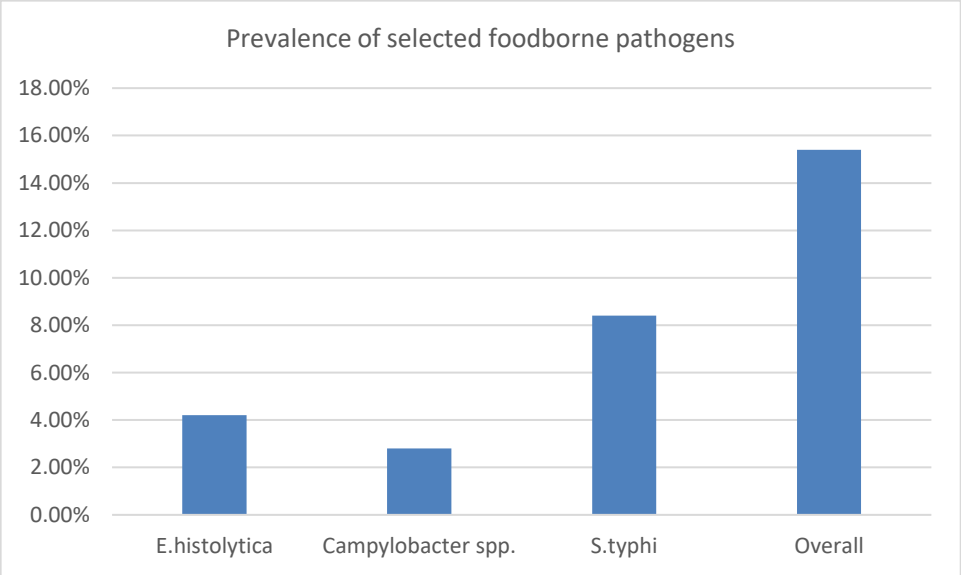

Figure 5: Prevalence of selected foodborne pathogens

Compared to the findings from our study, a similar survey done in Southwestern Nigeria showed a much similar prevalence of salmonellosis (7.0%) Olalekan (2018). The prevalence of foodborne pathogens documented in a study conducted among food handlers in catering establishments of public institutes in Dawuro Zone, South-Western Ethiopia was similar to the findings of the present study. In the Ethiopian study, the prevalence of salmonellosis was 6.4% Derso et al., (2017). However, another study conducted in the Conghua district of Guangzhou China revealed a higher prevalence of salmonellosis ranging at 20.39% Gong et al., (2022). Another study conducted in Gondar town in Ethiopia revealed a much lower prevalence of salmonellosis ranging to 5.5% Ejo et al., (2016). This was also consistent with another study conducted in Ambo and Holeta Towns in Ethiopia which recorded a prevalence of salmonella at 5.7% Gebremedhin et

al., (2021). Another study done in a chicken slaughterhouse in Jiangsu china recorded a higher prevalence of 57% Gu et al., (2020).

From this study, the prevalence of *Entamoeba histolytica* was 4.2%, these findings were similar to a study done in northeastern Brazil which recorded a prevalence of *Entamoeba histolytica* at 6.8%Silva et al., (2014). Another study conducted in Nishtar Hospital, Multan recorded a higher prevalence of entamoeba at 21.7% Alam et al., (2015), this was consistent with a study conducted on stool specimens at Muhondo Health Center, Rwanda recorded a prevalence of 16.8% regarding *Entamoeba histolytica/dispar* Gahamanyi et al., (2016).

The current study found a 2.8% prevalence of Campylobacter spp. However, other studies conducted in different settings have reported a higher prevalence of this pathogen. For instance, a study conducted in South Africa reported a higher prevalence of 14.7% (Samie et al., 2022). A similar study done in West Africa recorded a higher prevalence of Campylobacter spp standing at 34%(Paintsil et al., 2022). The most probable explanation for the discrepancy in the findings between the surveys is the study population variance.

4.4 Knowledge of food hygiene and safety practices.

Asked about their main source of knowledge on food hygiene and safety practices, the studied food handlers mentioned mass media (35.4%), health professionals (31.9%), and health centers (32.6%) as shown in Figure 6. These findings were similar to another study done in the metropolitan city of Nepal and among food handlers in Bahir Dar town, northwest Ethiopia Derso et al., 2017; Gautam et al., (2019)

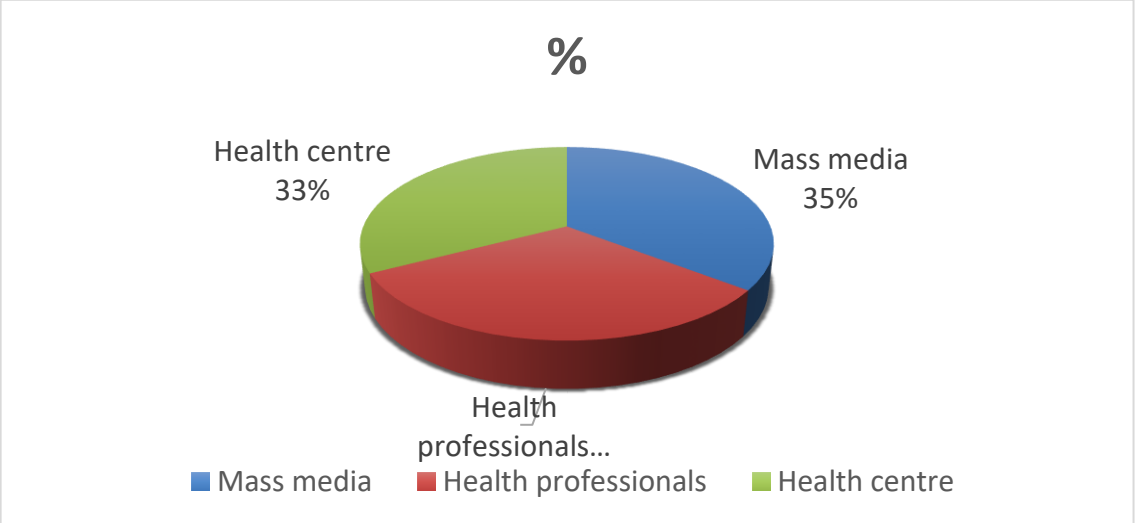

Figure 6: Source of information on food hygiene and safety practices among food handlers

Inquiries on the causes of foodborne pathogens yielded the responses displayed in Table 3. The majority of the interviewed food handlers mentioned germs as the causative agent of foodborne illness (64.6%). Those who responded in the affirmative on being asked if *Salmonella* spp. and *Campylobacter* spp. were causative agents of foodborne illness were 49.8% and 38.9% respectively. Similar findings were also reported in two similar studies done in the Desie region of Ethiopia and Northwest of Ethiopia Adane et al., 2018; Alemayehu et al., (2021).

Table 3: **Responses on the causes of infections with foodborne pathogens among food handlers**

	Response	Number (n=285(%))
Salmonella spp.	Agree	142(49.8)
	Disagree	143(50.2)
Campylobacter spp.	Agree	111(38.9)
	Disagree	174(61.1)
Causes of foodborne illnesses	Germs	184(64.6)
	Chemicals	75(26.3)
	Do not know	26(9.1)

Source: Field Data (2022)

Table 4 exhibits the findings on the assessment of the participant's knowledge of food hygiene practices, routes of transmission of foodborne pathogens, and symptoms of foodborne illnesses. The respondents reported that hand washing should be done at specific times, which include after using the restroom (41.9%), before and after preparing food (42.5%), after touching any object (33.3%), and after handling money (33.7%). The main routes of transmission of food-borne illnesses are contaminated food (42.5%), contaminated water (40.0%), and vectors (60.7%), as stated by the study participants. Symptoms of foodborne illnesses mentioned by the study participants included vomiting (31.9%), fever (36.5%), and diarrhea (32.6%).

Table 4: Assessment of knowledge on food hygiene practices, routes of transmission of foodborne pathogens, and symptoms of foodborne illnesses.

	Attribute	Number (n=285 (%))
Best time for handwashing	After using toilet	140(41.9)
	Before and after food preparation	121(42.5)
	After touching anything	95(33.3)
	After counting money	96(33.7)
Main routes of transmission of food-borne illnesses	Contaminated food	121(42.5)
	Contaminated water	114(40.0)
	Vectors	173(60.7)
	Do not know	35(12.3)
Symptoms of foodborne illnesses	Vomiting	91(31.9)
	Fever	104(36.5)
	Diarrhea	93(32.6)
	Do not know	30(10.5)

Source: Field Data (2022)

The majority of the respondents (52.6%) were in agreement with the statement that "*Poor hygiene causes cross contamination*" with those who agreed and strongly agreed to be 17.2% and 35.4%. Those who were in agreement and strong agreement with the statement that good hygiene practices prevent diarrhea were 17.9% and 33.3% respectively (Table 5).

Table 5: Assessment of knowledge of food hygiene

Response	Number (n=285 (%))
Poor hygiene causes cross contamination	
Strongly agree	101(35.4)
Agree	49(17.2)
Neutral	44(15.4)
Disagree	46(16.1)
Strongly disagree	45(15.8)
Good hygiene practices prevent diarrhea	
Strongly agree	95(33.3)
Agree	51(17.9)
Neutral	42(14.7)
Disagree	55(19.3)
Strongly disagree	42(14.7)

Source: Field Data (2022)

Table 5 shows the results of the assessment of knowledge on food contamination among the food handlers. Those who agreed the following statements; “When hands are cleansed before beginning work, the risk of food contamination is reduced”, “Preparing meals ahead of time lowers the likelihood of infection” and “When people eat and drink at their desks, the risk of food contamination rises” were 49.8%, 46.7% and 52.3% respectively. Asked if pregnant women who get a foodborne illness are more likely to have an abortion and that when one has a skin problem, it is vital to take time off from work 49.1% and 52.3% responded in the affirmative.

Table 6: Assessment of knowledge on food contamination

Characteristic	Response (n (%))		
	Agree	Uncertain	Disagree
When hands are cleansed before beginning work, the risk of food contamination is reduced.	142 (49.8)	70(24.6)	73(25.6)
Preparing meals ahead of time lowers the likelihood of infection.	133 (46.7)	76(26.7)	76(26.7)
When people eat and drink at their desks, the risk of food contamination rises.	149(52.3)	72(25.3)	64(22.5)
Pregnant women who get a foodborne illness are more likely to have an abortion.	140(49.1)	68(23.9)	77(27.0)
When you have a skin problem, it is vital to take time off from work.	149(52.3)	62(21.8)	74(26.0)

Source: Field Data (2022)

A summation of the scores derived from the nineteen knowledge assessment items revealed that the minimum and maximum scores were four and fifteen respectively. The mean ± sd score was 9.2 ± 1.77. Further analysis of the knowledge scores indicated that the respondents who were deemed to be highly knowledgeable on food hygiene and safety practices were 44.2% (95% confidence interval (CI): 38.6% - 50.0%). The majority were classified as having low knowledge on food hygiene and safety practices (55.8%, 95% CI: 50.0 - 61.4%) as shown in Table 7.

Table 7: Level of knowledge on food hygiene and safety practices

Knowledge level	Frequency (n=285(%))	95% Confidence interval	
		Lower	Upper
Low (<50%)	159(55.8)	50.0	61.4
High (≥50%)	126(44.2)	38.6	50.0

Source: Field Data (2022)

Data from KII indicated that lack of skills and knowledge of handling food safely is a major reason for inadequate food safety measures.

> *"In my opinion, the cause of incorrect food handling is due to a lack of understanding regarding what is considered safe and unsafe. When there is a shortage of knowledge and information, individuals may resort to relying on their own common sense and natural instincts. Unfortunately, this approach can lead to improper food handling practices and mistakes. …"* (KII 5, Male, 38 years)

4.5 Food handling practices

Table 8 presents the findings of the self-reported assessment of assorted food handling practices among the interviewed food handlers. Those who reported that they had a valid medical examination certificate, washed hands with soap and water before handling food, and always donned gloves and hairnets when handling food were the majority (62.8%, 67.4%, and 63.2% respectively). Half of the respondents refuted undertaking the following; Chewing/smoking while working, working when having a cold and handling food when having diarrhoea (34.7%, 34.0% and 35.1% respectively). Most of the respondents mentioned that they adhered to the following food handling practices; cleaning food contact surfaces before and after preparing food (70.9%), checking the expiry dates/shelf life of food (65.3%), boiling or treating water before serving the customers (71.9%) and drying hands, after washing them, with a towel (70.2%).

Table 8: Food handling practices

Practice	Response (n (%))	
	Yes	**No**
Valid medical examination certificate	179(62.8)	106(37.2)
Washes hands with soap and water before handling food	192(67.4)	93(32.6)
Wears gloves and hairnets when handling food	180(63.2)	105(36.8)
Chews/smokes while working	186(65.3)	99(34.7)
Works when having a cold	188(66.0)	97(34.0)
Handles food when having diarrhea	185(64.9)	100(35.1)
Cleans food contact surfaces before and after preparing food	202(70.9)	83(29.1)
Checks the expiry dates/shelf life of food	186(65.3)	99(34.7)
Boils or treats water before serving the customers	205(71.9)	80(28.1)
Dries hands after washing them with a towel	200(70.2)	85(29.8)

Source: Field Data (2022)

According to the participants in the focus group discussion, certain food safety measures cannot be put into practice due to a variety of limitations, such as time constraints and, most importantly, the absence of necessary resources like running water, freezers, and refrigerators. Despite having the correct understanding and awareness of the dangers of foodborne pathogens, they are also hampered by time constraints..

> *"The issue at hand is the absence of piped or running water, which is a prevalent problem in this region, not just specific to me. While acknowledging the hygienic and convenient benefits of having running water, there are no such facilities available in the vicinity, and the residents are accustomed to washing themselves in a basin.…*" (FGD 1).

The qualitative survey data indicated that pursuing quality of life affected risk perception and the adoption of measures to curb food-borne pathogens. Individuals who have a greater awareness and concern for their personal hygiene and health, as well as a desire for tasty food, were found to be more likely to practice safe food handling.

"Some individuals prioritize hygiene and take precautions such as washing their hands while cooking, while others may not consider it as important.. … (FGD 6)

It is important to prioritize hygiene to avoid getting sick from stomach problems or food poisoning. Neglecting hygiene can be harmful, so it is necessary to take it seriously. …" (KII 7, Female, 42 years).

Analysis of qualitative interview data showed that not adopting recommended food hygiene and safety standards was related to personality, including personal handling habits, laziness and past experiences.

"Don't bother with safe operations, hygiene, or cleanliness, and I don't even consider the risks of foodborne illnesses or food safety. However, it is essential to make safe behaviour a habit. If you believe a habit is safe, you can continue doing it. I feel lazy and can't do everything for safety, or I will become too tired….. "(FGD 8, Female 28 years)

In the local culture, being sparing, or frugal is emphasized and praised. Further, the frugal culture also moderates the paths from food safety knowledge to behaviors and practices.

"Despite being aware of the need to discard leftovers, I tend to keep them instead. This is because I feel it's wasteful to throw away food and money, and I would rather save and increase my earnings. …."(FGD 6,Male 44 years)

Additionally, many participants were highly pessimistic about the state of food safety; as a result, they either felt helpless or thought that adopting the recommended standards of food safety, maintaining hygiene and cleanliness would be rather costly and time-consuming.

"Proper food handling measures can be expensive to implement, and the monetary benefits may not be immediately apparent, making it seem like they don't exist. This

can make your business less competitive as the cost of food may be too high. …"

(FGD 3,Male 34 years)

4.6 Biviriate analysis on assessment of the association between sociodemographic characteristics and prevalence of foodborne pathogens.

Table 9 shows the outcomes of the evaluation of sociodemographic characteristics of food handlers associated with foodborne pathogens. The mean ± standard error (SE) age of the group that was found infected with at least one foodborne pathogen was 41.2 ± 1.77 years. The average age of the healthy volunteers was 39.8 0.75 years (mean SE). The age difference between the groups was not statistically significant (p=0.861). When the age of infected and uninfected food workers was a factor in the study, no significant differences were found. These findings agreed with a study conducted in the USA which found no association between age and having a foodborne pathogen Stratev et al., (2017). This could be attributed to age being reported in an aggregate manner whereby interaction between the two variables i.e age and presence of foodborne pathogens could not be meaningfully assessed. However, another study conducted in Bulgaria was contrary to the study findings as the study reported that older food handlers were more likely to report having a foodborne disease as compared to their fellow counterparts Strassle et al., (2019).

As indicated in table 9, male food handlers were 2 times less likely to be positive for foodborne pathogens as compared to their fellow counterparts who were females(odds ratio (COR) 2 (95% CI 0.234-0.916, p=0.031). According to a study of food handlers in Bahir Dar town, northwest Ethiopia, males were found to be four times more likely than females to get a foodborne disease Derso et al., (2017). This could be attributed to males being less likely to observe hygiene practices during food preparation, handling, and cooking thus increasing their exposure to foodborne diseases. These findings were

contrary to a study done in the USA which revealed that female partners were more likely to be involved in foodborne diseases. Sex distribution has predicted that women are more likely to engage in food preparation and cooking hence increased vulnerability to foodborne illnesses Strassle et al., (2019). Furthermore, owing to the difficulties of cleaning among female food workers, untrimmed fingernails may serve as a channel for the passage of intestinal parasites or enteric germs from source to food. In another two studies conducted in India and Nepal, they found no association between gender and having a food-borne pathogen Gautam et al., 2019; Sharma et al., (2022).

From the present study, training on food safety reduced the odds of having a foodborne disease by 3 times as compared to lack of training on food safety(odds ratio (COR)3 (95% CI 0.234-0.916, p=0.031). A study of food handlers in hospitals and hotels found that those who had received formal training in food safety were much less likely to get ill from handling contaminated food Al-Akash et al., (2022). Another research, this one in the town of Bahir Dar in northwest Ethiopia, came to a similar conclusion Derso et al., (2017). The possible reason for this could be associated with training providing sufficient knowledge on food safety this making aware the concerned food handlers take the necessary measures not to contaminate food through unhealthy practices that are likely to result in foodborne diseases. However, another study conducted in Malaysia among food handlers found no association between training on food safety practices and having a foodborne illness Zain & Naing, (2002).

The present study found no association between the level of education having a food-born pathogen as the P-value was greater than 0.05. The lack of association may be explained by the fact that some of the respondents may not have had any training on food handling-related issues as they pursued education. This data may support the argument that proper food safety training of food handlers is primarily responsible for ensuring that

workers have the necessary knowledge. Training programs on food safety have been advocated due to the necessity of SCFHs having this information and incorporating it into their hygiene procedures, as shown by research undertaken in Saudi Arabia, Ethiopia, and Ghana Lema et al., (2020). Foodborne pathogen infections have been linked to lower levels of education, according to research. Research conducted in Ethiopia found that those in the food service industry with no formal education were 2.142 times more likely to develop intestinal parasite and Salmonella typhi infections than those with secondary education or above Kumalo et al., (2021). Similar results were observed in earlier investigations done in other parts of Ethiopia Gezehegn et al., 2017; Marami et al., (2018). This might imply that food handlers are more susceptible to parasitic and enteric illnesses because they lack information about food safety and the spread of parasitic and enteric diseases owing to a lack of education. The contrasting results shown throughout these research are likely attributable to the various experimental designs used.

The present study found no association between work experience and having a food-borne illness as the P-value was greater than 0.05. Findings from this study were in agreement with another study conducted in Malaysia that found no association between work experience and having a food-borne disease Zain & Naing, (2002). Similar findings were also reported in another study conducted at the university of Nevada Hertzman et al., (2011). Anothet study conducted in Gondar town, northwest of Ethiopia reported similar findings Gizaw Z, (2014). This could be linked to having a similar or equal number of respondents in the work experience categories leading to the loss of the power of association. However, this finding was contrary to another study conducted in Bahir Dar town of Ethiopia which revealed that food handlers with less than two years of working experience were 5 times more likely to experience the food-borne pathogen as

compared to those who had a working experience of more than two years Derso et al., (2017).

The present study found no association between religion and having a food-borne pathogen as the P-value was greater than 0.05. This was in agreement with another study conducted among food handlers in Butwal sub-metropolitan city of Nepal which found no association between religion and foodborne illness Gautam et al., (2019). Similar findings were observed also in another study done in Germany which found no association Faour-Klingbeil & Todd, (2020). This was consistent with another study done in china which reported similar findings Zhou et al., (2020).

The present study found no association between household income and having a food-borne pathogen as the P-value was greater than 0.05.this was consistent with a study done in the USA which found no association between the level of household income and having a food-borne disease Whitney et al., (2015). This was contrary to another study done in Gondar town, northern Ethiopia which found an association between household income and foodborne illnessGizaw Z,(2014). From their study food handlers earning below the poverty line were 10 times more likely to get the foodborne disease as compared to their counterpart since they were not in a capacity to purchase the necessary PPEs used in food handling and preparation as well as own a valid medical certificate Gizaw Z, (2014). . Moreover, people with low socioeconomic status, as is the case for our study participants, have a higher probability of using less sanitary sewage disposal system (such as pit latrine) that may predispose them to free handling of faeces and contamination of water and surface soil with faeces and infective microorganisms Olalekan (2018). The rest of the sociodemographic factors work responsibility, and locality was not significantly associated with infection with foodborne pathogens as they had a p-value of greater than 0.05.

Table 9: Bivariate analysis on assessment of the association between sociodemographic characteristics and prevalence of foodborne pathogens.

Variable		Foodborne pathogen		χ^2	OR (95% CI)	P-value
		+ve(n=44)	-ve(n=241)			
Age (years)	**Mean ± se**	41.2± 1.77	39.8±0.75			0.861
	≤ 20	3(16.7)	15(83.3)	0.861	0.867(0.216-3.478)	0.840
	21-30	5(10.0)	45(90.0)	0.041	0.481(0.158-1.471)	0.193
	31-40	12(17.6)	56(82.4)	0.027	0.929(0.383-2.249)	0.870
	41-50	12(14.1)	73(85.9)	0.580	0.712(0.297-1.710)	0.446
	>50	12(18.8)	52(81.3)		Ref	
Gender	Male	14(10.4)	121(89.6)	5.047	0.463(0.234-0.916)	0.031
	Female	30(20.0)	120(80.0)		Ref	
Level of education	No formal education	1(14.3)	6(85.7)	0.001	1.030(0.113-9.399)	0.665
	Primary	10(14.3)	60(85.7)	0.004	1.271(0.580-2.787)	0.549
	Secondary	22(17.1)	107(82.9)	0.360	1.030(0.409-2.596)	0.950
	Higher education	11(13.9)	68(86.1)		Ref	
Religion	Christianity	42(16.0)	221(84.0)	0.736	1.900(0.428-8.437)	0.546
	Muslim	2(9.1)	20(90.9)		Ref	
Monthly Income (KSh.)	20000 and above	10(26.3)	38(86.4)	0.076	0.842(0.247-2.868)	0.783
	10000-2000	10(18.5)	44(81.5)	0.114	0.875(0.326-2.347)	0.734
	5000-10000	21(14.0)	128(85.9)	0.070	0.875(0.326-2.347)	0.791
	Below 5000	6(15.8)	32(84.2)		Ref	
Work experience	Less than one month	1(5.0)	19(95.0)	1.580	0.285(0.036-2.272)	0.304

	1 - 6 months	9(11.8)	67(88.2)	0.522	0.727(0.305-1.730)	0.470
	6 months - 1 year	17(21.3)	63(78.8)	1.000	1.460(0.693-3.075)	0.317
	More than 1 year	17(15.6)	92(84.4)		Ref	
Locality	Gatuanyaga	5(19.2)	21(80.8)	0.190	1.280(0.421-3.890)	0.663
	Hospital	10(15.4)	55(84.6)	0.003	0.977(0.414-2.308)	0.958
	Kamenu	8(13.1)	53(86.9)	0.201	0.811(0.325-2.026)	0.654
	Ngoliba	5(16.1)	26(83.9)	0.004	1.034(0.346-3.092)	0.953
	Township	16(15.7)	86(84.3)		Ref	
Work responsibility	Cashier	6(15.0)	34(85.0)	0.005	0.958(0.293-3.132)	0.943
	Service	6(14.0)	37(86.0)	0.045	0.880(0.270-2.867)	0.832
	Cleaner	5(14.3)	30(85.7)	0.025	0.905(0.261-3.137)	0.875
	All	16(16.3)	82(83.7)	0.014	1.059(0.402-2.788)	0.907
	Other	4(16.7)	20(83.3)	0.013	1.086(0.284-4.157)	0.904
	Cook	7(15.6)	38(84.4)		Ref	
Training on food safety	Yes	5(6.8)	68(93.2)	5.546	0.326(0.123-0.862)	0.023
	No	39(18.4)	173(81.6)		Ref	

Source: Field Data (2022)

4.7 Biviriate análysis on evaluation of the association between food handling practices and prevalence of foodborne pathogens.

The findings of the examination of the association between food handling practices and the prevalence of foodborne pathogen are outlined in Table 10 and table 11.

As provided in the same table, having a valid medical examination certificate reduced the odds of having a foodborne pathogen by 2.59 as compared to not having a valid medical examination certificate (95% CI 0.200 - 0.740), p=0.003). However, multivariate analysis, as shown in table 11, failed to detect the statistical association (p=0.319). This finding contradicted that of Barros et al (Barros et al., 2020). According to Wainaina et al study there was a lack of compliance with the current laws governing food safety, and relatively few food workers had a medical certificate Wainaina et al., (2020). The fact that so few food handlers have a medical certificate suggests that they lack training in food handling.

Wearing gloves and head nets was not associated with the presence of food-borne pathogens p=0.681 as shown in Table 10. These findings agreed with those of an earlier study in which more than half of the participants used personal protection equipment, compared to less than 25% who wore a hairnet or cap and 50% who wore an apron. Although it showed a statistically significant association with gender difference, the availability of these equipment did not show any statistical relevance with the occurrence of food-borne pathogens Gallad, (2020). Food handlers and establishment owners may not understand the importance of dressing appropriately when handling food, and owners may be tempted to avoid the expense of providing such clothing.

As demonstrated in table 10, washing hands with soap and water before handling food reduced the odds of food-borne pathogens by 4.2 (95% CI 0.122-0.464), p=<0.001). The initial statistical significance was not retained in multivariate analysis p=0.732 as manifested in table 11. In a prior study, none of the food managers washed their hands using the seven steps Dora-Liyana *et al.*, (2018). In contrast, a prior study in the Kibera slums found that washing hands with soap and water before handling food greatly lowered the risk of food handlers contracting the norovirus Wainaina et al.,(2020). Foods

preparers probably don't wash their hands as often when there aren't any hand washing facilities available, which could increase the risk of food borne infections.

As indicated in table 10, boiling or treating water before serving the customers was noted to reduce the odds of having a foodborne pathogens by 3.15 (95% CI 0.164 - 0.614), p<0.001). According to table 11, which is consistent with bivariate analysis, treating or boiling water before use reduces the risk of contracting a food-borne pathogen by three times when compared to not treating or boiling water (95% CI 1.2225 to 7.577, p=0.017). These results were in the same line with qualitative results as professed my majority of the participants.

The point is I do not have piped/running water, and that is a common problem in this area; not just my problem. I know that having running water would be hygienic and convenient. However, there are no such establishments around here, and people here wash in a basin… (FGD 1, Female 45 years).

These findings corroborated a case-control study where treated water was significantly associated to a decreased risk of typhoid whereas untreated water was strongly linked to a greater risk. Brockett et al., (2020). In a Zimbabwean study, boiling water was also statistically significantly associated to getting typhoid Muti et al., (2016).

Table 10 demonstrates that there was no correlation between knowledge level and the frequency of foodborne pathogen among food handlers in this recent research (p=0.418). While it was not significantly associated with the occurrence of food-borne illnesses, a study conducted in Saudi Arabia found that more than half of the participants had good knowledge scores of food poisoning, which is consistent with the current findings Shati et al., (2021). In contrast, the findings of the current study are different from those of a study carried out in Embu municipality, Kenya, where 28.9% of the food handlers had S.

typhi infection Kariuki and Orago, (2017). The disparity could be explained by variances in sociocultural surroundings and study settings.

The prevalence of food-borne pathogens and chewing/smoking were not found to be significantly associated p=0.432, as shown in table 10. These findings are consistent with those of an earlier study carried out in Ethiopia, which revealed that a statistically significant gender difference influenced the occurrence of a foodborne illness, with 22.6% of individuals using tobacco being men Gallad , (2020).Smoking causes the hands to get contaminated and exposed to smoke.

As demonstrated in table 10, there was no statistically significant relationship found between food handlers working while sick and food-borne pathogens p=0.482. The findings were in line with those of Gallad, where, despite the lack of statistical significance between the two variables, more than half of the respondents claimed to cough or sneeze while handling food Gallad , (2020).Poor adherence to the food handling policies is caused by insufficient food handling training.

As can be seen in table 10, there is no statistically significant correlation between the occurrence of food-borne pathogens and food handlers having an upset stomach in this current study p=0.402. The same findings were also found in Ethiopia, where a small proportion of participants said they avoided handling food when they had a runny stomach, although there was no evidence of a substantial relationship Gallad , (2020).

With regard to the prevalence of foodborne pathogens, Table 10 clearly shows that drying hands with a towel after washing has no statistical relevance (p=0.140). These findings are consistent with those of an earlier study in which the majority of participants stated that they dry their hands with a piece of cloth after washing them, even though no significant correlation was discovered Gallad , (2020)

Table 10: Biviriate analysis on the association between food handling practices and the prevalence of foodborne pathogens.

Variable	Foodborne pathogen		OR (95% CI)	χ^2	P-value
	+ve(n=44)	-ve(n=241)			
Valid medical examination certificate					
Yes	19(10.6)	160(89.4)	0.385(0.200-0.740)	8.579	0.003
No	25(23.6)	81(76.4)	Ref		
Washes hands with soap and water before handling food					
Yes	17(8.9)	175(91.1)	0.237(0.122-0.464)	9.540	<0.001
No	27(29.0)	66(71.0)	Ref		
Wears gloves and hairnets when handling food					
Yes	29(16.1)	151(83.9)	1.152(0.586-2.265)	0.169	0.681
No	15(14.3)	90(85.7)	Ref		
Chews/smokes while working					
Yes	31(16.7)	155(83.3)	1.323(0.658-2.662)	0.619	0.432
No	13(13.1)	86(86.9)	Ref		
Works when having a cold					
Yes	27(14.4)	161(85.6)	0.789(0.406-1.532)	0.491	0.482
No	17(17.5)	80(82.5)	Ref		
Handles food when having diarrhea					
Yes	31(16.8)	154(83.2)	1.347(0.670-2.710)	0.702	0.402
No	13(13.0)	87(87.0)	Ref		
Cleans food contact surfaces before and after preparing food					
Yes	24(11.9)	178(88.1)	0.425(0.220-0.821)	6.046	0.010
No	20(24.1)	63(75.9)	Ref		
Checks the expiry dates/shelf life of food			Ref		

			1.034(0.525-		
Yes	29(15.6)	157(84.4)	2.036)	0.010	0.922
No	15(15.2)	84(84.8)	Ref		
Boils or treats water before serving the customers					
			0.317(0.164-		
Yes	22(10.7)	183(89.3)	0.614)	12.394	<0.001
No	22(27.5)	58(72.5)	Ref		
Dries hands after washing them with a towel					
			1.791(0.820-		
Yes	35(17.5)	165(82.5)	3.913)	2.183	0.140
No	9(10.6)	76(89.4)			
Level of knowledge					
			1.311(0.679 -		
Low	27(61.4)	132 (54.8)	2.532)	0.655	0.418
High	17(38.6)	109(45.2)	Ref		

Source: Field Data (2022)

To determine factors predictive of foodborne pathogens or rather after adjusting for confounders, a binary logistic regression model was run and the outputs are presented in Table 11. Female food handlers were 10.2 less likely to have foodborne pathogens as compared to their male counterpart (aOR) 10.2 (95% CI 0.0304 to 0.315, p< 0.001). From this study, the presence of training on food safety practices reduced the odds of having a foodborne disease by 7 times as compared to the lack of training on food safety(aOR 7 (95% CI 0.141 to 1. 0.439, p=0.001)). Treating or boiling water before using it reduced the odds of having a food-borne disease by 3 times as compared to lack of treating or boiling water(aOR 3.043 (95% CI 1.2225 to 7.577, p= 0.017)).

Table 11: Multivariate analysis to determine factors predictive of foodborne pathogens.

Variable	β	Standard Error	adjusted Odds Ratio	95% Confidence interval		P-value
				Lower	Upper	
Gender (Ref.: Male)	-2.324	0.595	0.098	0.0304	0.315	<0.001
Training on food safety practices (Ref.: Male)	-1.956	0.577	0.141	0.439	0.046	0.001
Valid medical examination certificate (Ref.: No)	-0.363	0.413	0.696	0.3092	1.565	0.379
Washes hands with soap and water before handling food (Ref.: No)	-0.118	0.346	0.889	0.4510	1.751	0.732
Cleans food contact surfaces before and after preparing food (Ref.: No)	-0.008	0.361	0.992	0.4889	2.013	0.982
Boils or treats water before serving it to the customers (Ref.: Yes)	1.113	0.465	3.043	1.2225	7.577	0.017

Source: Field Data (2022)

4.8 Findings based on observations made on the studied food establishments

In total, 165 food premises were studied. The distribution of the food premises by locality were as follows; Gatuanyaga (9.1%), Hospital (19.4%), Kamenu (24.2%), Ngoliba (9.1%), and Township (38.2%). The distribution of the food premises by their sizes were

as follows; large hotel (14.5%), restaurant (23.0%), small hotel (23.6%), kiosk (18.2%), and fast foods premises (20.6%) (Table 12).

Table 12: Distribution of the food premises

Characteristic	Frequency (n=165(%))
Locality	
Gatuanyaga	15(9.1)
Hospital	32(19.4)
Kamenu	40(24.2)
Ngoliba	15(9.1)
Township	63(38.2)
Category of a food premise	
Large hotel	24(14.5)
Restaurant	38(23.0)
Small hotel	39(23.6)
Kiosk	30(18.2)
Fast food	34(20.6)

Source: Field Data (2022)

Table 13 shows the distribution of food handlers among the observed food premises. Most of the premises had two male food handlers (53.9%). The premises which had no female food handlers were 20.6%. Overall the number of food handlers in the food premises ranged from one to six.

Table 13: Distribution of food handlers

Food handlers		Number (n=165(%))
Male		
	1	76(46.1)
	2	89(53.9)
Female		
	0	34(20.6)
	1	27(16.4)
	2	31(18.8)
	3	32(19.4)

4	41(24.8)
Total number of food handlers in a premise	
1	15(9.1)
2	32(19.4)
3	26(15.8)
4	36(21.8)
5	34(20.6)
6	22(13.3)

Source: Field Data (2022)

Out of 137 food handlers (83.0%) who donned PPEs, 13.9% had PPEs that were classified as dirty. Majority of the food handlers had valid medical examination certificates (65.3%). Cooks who were observed to be covering their heads constituted the majority (72.1%) while minority of the cashiers were handling food after handling money without washing hands (17.0%).

Table 14 displays the observations made on assorted food handling practices, hygiene and cleanliness. The minority of food handlers were doing the following; licking their fingers to pick up wrapping papers (46.7%), smoked in the food preparation or serving areas (44.2%), scratched their bodies and touched foods without washing hands (47.3), and spit around while serving or preparing food (11.5%). Majority of the food handlers use towels for wiping and drying plates, knives, and spoons before serving (50.3%). Further, minority of the Food handlers utilize the chopping boards used for raw foods to chop cooked food without thorough washing (42.4%). Most of food premises had the Food Hygiene license (90.9%) and they had wash-hands basins provided in the kitchen and dining halls (55.8%).

Table 14: Observations on food handling practices and hygiene

Attribute	Observation (n=165) (n, %)	
	Yes	**No**
Food handlers lick their fingers to pick up wrapping papers	77(46.7)	88(53.3)
The food handlers smoke in any of the food preparation or serving areas	73(44.2)	92(55.8)
Food handlers scratch their bodies and touch foods without washing hands	78(47.3)	87(52.7)
Food handlers spit around while serving or preparing food	19(11.5)	146(88.5)
Food handlers use towels for wiping and drying plates, knives, and spoons before serving	83(50.3)	82(49.7)
Towels for wiping and drying plates, knives, and spoons clean	114(69.1)	51(30.9)
Food handlers utilize the chopping boards used for raw foods to chop cooked food without thorough washing	70(42.4)	95(57.6)
Food Hygiene license	150(90.9)	15(9.1)
Wash hands basins provided in the kitchen and dining halls	92(55.8)	73(44.2)

Source: Field Data (2022)

CHAPTER FIVE

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.0 Introduction

Chapter Five provides a brief overview of the research goal, objectives, and hypotheses, and summarizes the key findings of the study. Additionally, it presents conclusions and recommendations based on the results of the previous chapters. Implications for further study are discussed, and the chapter concludes with these suggestions. The following findings and suggestions from this study are qualified by the specifics of its historical setting and context. Therefore, these findings, when extrapolated to other contexts, may lead to erroneous inferences. Nonetheless, these findings and suggestions apply to the procedure of house evolution in forward-thinking development projects.

5.1 Summary of Findings

In summary, based on multivariate analysis the results from the present study demonstrated that the sociodemographic characteristic of food handlers that was significantly associated with food-borne illnesses was gender with female food handlers being more susceptible to food-borne pathogens than their male colleagues. Additionally, two food handling practices were significantly predictive of the prevalence of food-borne pathogens; having a valid medical certificate and boiling or treating water before serving the water to customers.

5.2 Conclusions

The relatively high prevalence of asymptomatic foodborne pathogens carriers among the food handlers in the study area highlights a significant public health concern in this setting. This shows that there's significant spread of food borne pathogens among the food handlers and the entire area of study highlight high spread of foodborne diseases and antimicrobial resistance of foodborne pathogens in the study area. The high prevalence

of pathogenic foodborne micro-organisms among the food handlers potentially highlights the important role of food handlers in the spread and transmission of foodborne infections in the study area.

The research also discovered several factors that can be changed to lower the risk of foodborne illnesses among food handlers. These factors include gender, receiving food safety training, having a valid medical examination certificate, cleaning food contact surfaces before and after food preparation, washing hands with soap and water before handling food, and boiling or treating water before serving to customers.

5.3 Recommendations

1. Coupled with poor compliance with food handling practices and health measures, there is an urgent need to put in place measures and strategies to raise awareness of food safety as well as enhance enforcement of the appropriate legal provisions.
2. Food handlers should be screened often, trained in safe food handling and hand washing procedures, and monitored frequently to ensure that these protocols are being followed. The period of acquiring medical examination certificates should be reduced from six months. All employees who come into contact with food should have up-to-date medical examination certificates, thus measures should be taken to make that a reality. Boiling or even other water treatment methods should be highly promoted and encouraged in the study area.
3. Besides addressing the risk factors, the study recommends intensification of surveillance of food-borne diseases in the study area. The high prevalence maybe as a result of antimicrobial résistance of foodborne pathogens which pose a greater health risk as a result of potential treatment failure.
4. Finally, it is recommended that food handlers be evaluated on their cleanliness and practices related to food safety on a regular basis as part of a food control

monitoring program. To further lessen the impact of foodborne infections, there is a pressing need to increase advocacy for personal cleanliness among food handlers in the research region, particularly female food handlers. In addition, the current research suggests routine food safety training for all staff members who come into contact with food.

5.4 Recommendation for Further Studies

Further research should be done on whether pre-employment training and interactive media may have influenced behavioural changes of food handlers. Additionally, more studies should be done to explore the antimicrobial resistance of foodborne pathogens. Study recommends further research on the influence of perceptions and attitudes on food handlers' knowledge, behaviours, and practices. It is also important that research be done to explore the health-seeking behaviours of food handlers who are infected with food-borne pathogens.

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APPENDICES

Appendix I: Introduction Letter

Joseph Maina Kimemia

342-01000.

THIKA

Dear Respondent;

My name is Joseph Maina Kimemia a postgraduate student at Mount Kenya University, undertaking a course in Public Health, carrying out a research study on "Factors Associated with Foodborne Illnesses Among Food Handlers in Thika Sub-County, Kiambu County, Kenya."

Kindly you are requested to answer the questions in each questionnaire to the best of your knowledge. The information provided will be treated with utmost privacy and confidentiality.

Your co-operation will be highly appreciated.

Thank you.

Regards;

Joseph Maina Kimemia

Appendix II: Informed Consent form.

Name of the researcher: Joseph Maina Kimemia

Research topic: Factors Associated with Foodborne Illnesses Among Food Handlers in Thika Sub-County, Kiambu County, Kenya.

Invitation to Participate in the study

It has been determined that you occupy a job that is suitable and will provide information that is necessary in order for the research to achieve its goals. Any assistance or information that is offered to me in order for me to complete this research will be kept in strict confidence, as its primary purpose will be to advance my academic standing.

Introduction and aim of the study

Dear Mr or Madam, My name is Joseph Maina Kimemia, and I am now attending Mount Kenya University to work toward earning a Master of Science degree in Public Health.I am conducting a study on **Factors Associated with Foodborne pathogens Among Food Handlers in Thika Sub-County, Kiambu County, Kenya.**

Research description

The purpose of the research is to interview 994 food handlers working in restaurants in order to learn about the socio-demographic factors, knowledge on food hygiene and safety practices, the prevalence of foodborne pathogens, and food safety practices associated with foodborne pathogens among food handlers in the sub-county.

Voluntary participation and withdrawal from the study.

It is entirely up to you whether or not you choose to take part in this research; if at any point you come to feel uneasy about taking part, you are free to stop doing so without incurring any sort of penalty.

Potential Benefits

There is a low probability that you will receive any direct benefit from this, but the findings will help to set steps to decrease foodborne disease and to improve habits in the community about food handling.

Possible risk or discomfort:

In case you feel offended by any sensitive question, you can decide to skip the question.

Privacy and confidentiality

According to the study's introduction and purpose, the information gathered will be utilized for that specific reason. Any information that might identify you such as your name will not be included in the findings, the questionnaires will be destroyed, and audio-recorded data will be removed soon after the results are presented and published.

Contact Information

If you have any inquiries regarding the investigation, please do not hesitate to ask them either now or at any time during the process of the experiment. To contact me, please use the following numbers or email address: jmakimem@gmail.com. Through jgkariuki@mku.ac.ke you may even reach out to the Dean of the School of Public Health, who is also a faculty advisor. You may contact the office of Mount Kenya University's Institutional Ethical Review Committee (IERC) at research@mku.ac.ke if you have any queries regarding how your information will be secured over the course of this project or if you feel as if you have been placed in danger.

Participant statement

A researcher has provided an explanation of the research's objectives, as well as its potential benefits and risks. You have my full authorization to leave at any time; my participation in this activity is purely voluntary.The researcher addressed all of my

questions and assured me that my personal information would be kept private..... I've decided to participate in the study because I want to help out.

Yes [ ]

No [ ]

Researcher statement

I made sure to explain the study's purpose to each participant in a language they could understand.

Participant's Signature

_____ Date _____

Interviewer Signature

_____ Date _____

Appendix III: Questionnaire

Date:……..

Unique No:…….

Dear Respondents,

My name is Joseph Kimemia, and I'm conducting research in Thika sub-county, which is located in Kiambu county, Kenya. I'm interested in determining the characteristics that are related with foodborne infections among food handlers there. Please respond to the following questions by either picking the option that best fits the description or by providing narrative responses in the spaces provided and marking the one that best applies with an asterisk (*). You may be certain that your response will be held with the highest regard of confidentiality and will solely be utilized for the sake of academic research.

SECTION A: Social Demographic Information

1. In the space provided, kindly indicate your gender.

   Male [ ] Female [ ]

2. How old are you……..……..

3. Level of education.

   Primary [ ]

   Secondary [ ]

   Higher education [ ]

   Do not read and write [ ]

4. Monthly Income

   Below 5000 [ ]

   5000-10000 [ ]

   10000-2000 [ ]

   20000 and above [ ]

5. For how long you have been working as a food handler

Less than one month	[ ]
1-6 months	[ ]
6months - 1 year	[ ]
More than 1 year	[ ]

6. What is your religion

Christianity	[ ]
Muslim	[ ]
Hinduism	[ ]
Others, specify _____	

7. Indicate your work responsibility

Cook	[ ]
Cashier	[ ]
Service	[ ]
Cleaner	[ ]
All the above	[ ]
Others, specify	[ ]

8. Have you attended/received any training on food safety practices?

Yes	[ ]
No	[ ]

SECTION B: Knowledge of food hygiene and safety practices.

The questions below regard knowledge of foodborne pathogens and safety practices. If you don't know the answer, please say that you don't know it or that you agree or disagree with each statement. Choose the correct statement.

9. What is your Source of information about food borne illnesses

Mass media [ ]

Health professionals during the inspection [ ]

Health center [ ]

10. The following pathogens are related to foodborne illnesses? Agree Disagree

a, Salmonella species [] []

b,Campylobacter spp [ ] [ ]

11. Below are the Cause of foodborne illnesses

Germs [ ] Chemicals [ ] Do not know [ ]

12. What is the best time for handwashing?

After using the toilet [ ]

Before and after food preparation [ ]

After touching anything [ ]

After counting money [ ]

13. From below what are the main routes of transmission of food-borne pathogens?

Contaminated food [ ]

Contaminated water [ ]

Vectors [ ]

Do not know [ ]

14. Symptoms of food borne illnesses (tick the correct)

Vomiting [ ]

Fever [ ]

Diaorrhea [ ]

Do not know [ ]

15. Poor hygiene Causes cross contamination

a). Strongly agree [ ] b) Agree [ ] c). Neutral [ ] d). Disagree [ ] e). Strongly disagree [ ]

16. Good hygiene practices prevent diarrhea

a). Strongly agree [ ] b) Agree [ ] c). Neutral [ ] d). Disagree [ ] e). Strongly disagree [ ]

The following are statements to ascertain knowledge on food safety. Please indicate your agreement by agreeing or disagreeing with the statement.

	Statement	**Agree**	**Disagree**	**Uncertain**
17.	When hands are cleansed before beginning work, the risk of food contamination is reduced.			
18.	Preparing meals ahead of time lowers the likelihood of infection.			
19.	When people eat and drink at their desks, the risk of food contamination rises.			
20.	Pregnant women who get a foodborne illness are more likely to have an abortion.			
21.	When you have a skin problem, it is vital to take time off from work.			

SECTION C: Food handling practices

Kindly respond to the following questions concerning the food handling practices. Indicate whether Yes or No.

	Question	**Yes**	**No**
	Do you have a valid medical examination certificate?		
	Do you wash your hands with soap and water before handling food?		
	Do you wear gloves and hairnets when handling food?		
	Do you chew/smoke while working?		
	Do you work when you have a cold?		
	Do you handle food when sick with diarrhea?		
	Do you clean food contact surfaces before and after preparing food?		
	Do you check the expiry dates/shelf life of food?		
	Do you boil or treat water before serving the customers?		
	Do you dry your hands after washing them with a towel?		

SECTION D: Effectiveness of regulatory bodies in food safety practices among food handlers.

Kindly respond to the following questions concerning the effectiveness of regulatory bodies in food safety practices. Indicate whether Yes or No.

	Question	**Yes**	**No**
	Do the Ministry of Public Health and Sanitation personnel regularly inspect your food selling outlet for food safety?		
	Does the Ministry of Health and Sanitation scrutinize your medical examination certificate to confirm that it is updated?		
	Do you encounter any difficulty to acquire a medical examination certificate?		
	Does the County Government regularly visit your workplace to confirm that it is a registered food eatery business that meets all the requirements?		

Appendix IV: Observation Checklist

Unique No……..

Category of a food premise

Large hotel [ ] Restaurant [ ] Small hotel [ ] kiosk [ ] Fast food [ ]

1. How many food handlers are there on the premises?

   Males [ ] Females [ ] Total [ ]

2. How many of the food handlers have a valid medical certificate……

   (Verify the certificates)

3. Those wearing pipes what is the general condition of the PPES

   Clean [ ] Dirty [ ]

4. Are the cooks covering their heads? Yes [ ] No [ ] If yes how many?.....

5. Do cashiers in the premises touch food after handling money without washing hands (tick app) yes [ ] no [ ] If yes how many……

6. Do the food handler's lick their fingers to pick up wrapping papers: (Tick as appropriate)

   Yes [ ] No [ ] If yes, how many?.....

7. Do the food handlers smoke in any of the food preparation or serving areas: (Tick an appropriate) Yes [ ] No [ ] If yes, how many?.....

8. Do the food handlers scratch their bodies and touch foods without washing hands. (Tick as appropriate) Yes [ ] If yes, how many?..... No [ ]

9. Do the food handlers spit around while serving or preparing food? (Tick as appropriate) 'Yes [ ] No. [ ] If yes, how many?.....

10. Do the food handlers use towels for wiping and drying plates, knives, and spoons before serving? (Tick as appropriate) Yes [ ] No [ ]

If yes in No. 16, What is the condition? (Tick as appropriate)

Dirty [ ] Clean [ ]

11. Do the food handlers utilize the chopping boards used for raw foods to chop cooked

foods without thorough washing? (Tick as appropriate) Yes [ ] No [ ]

12. Crockery and Utensils

a) Clean [ ] b). Fairly Clean [ ] c). Dirty [ ]

13. Health and Safety License (2015)

a). Issued [ ] b). Not Issued [ ]

14. Are wash hands basins provided in the kitchen and dining halls? (Tick as appropriate)

Provided [ ] Not provided [ ]

Note:

A dirty protective garment refers to a garment that is greasy, spotted with food marks and any other spots or marks spread in most parts of the garment, that may be repugnant to, the eyes and might be a source of food contamination while a clean protective garment refers to a protective garment without any food mark or spot or only with a few food marks and spots that are not spread in most parts of the garment.

Appendix V: Introduction Letter

Mount Kenya University

DIRECTORATE OF GRADUATE STUDIES

MPH/2020/63325

17th March, 2022

The Director, Research Coordination Division
National Commission for Science, Technology & Innovation
Utalii House, 8th & 9th Floor
P.O Box 30623- 00100
NAIROBI

Dear Sir/Madam,

RE: JOSEPH MAINA KIMEMIA - REGISTRATION NO. MPH/2020/63325

The purpose of this letter is to introduce the above named student who is pursuing Master of Public Health in the Department of Epidemiology and Biostatistics in the School of Public Health.

The title of his research is *"Factors Associated with Foodborne Illnesses Among Food Handlers in Thika Sub-County, Kiambu County, Kenya."*

He has been cleared by the University's Ethics Review Committee (Certificate attached) and now has to proceed to the field to collect data for his research between March, 2022 and May, 2022.

Any assistance accorded to him will be highly appreciated.

Thank you.

Mount Kenya University
P.O. Box 342-01000, THIKA
Office of the Director
Graduate Studies

Dr. Samuel M. Karonga, Ph.D
Director, Graduate Studies
Enc.

Appendix VI: ERC Certificate

Mount Kenya University

REF: MKU/ERC/2077
TO: JOSEPH MAINA KIMEMIA

Date: 26 January 2022

REG: MPH/2020/63325

Dear Sir/Madam,

RE: FACTORS ASSOCIATED WITH FOODBORNE ILLNESSES AMONG FOOD HANDLERS IN THIKA SUB-COUNTY, KIAMBU COUNTY, KENYA.

This is to inform you that **Mount Kenya University** has reviewed and approved your above research proposal. Your application approval number is **1150.** The approval period is **26/01/2022 - 25/01/2023.**

This approval is subject to compliance with the following requirements:

i. Only approved documents including informed consents, study instruments, MTA will be used
ii. All changes including amendments, deviations and violations are submitted for review and approval by **Mount Kenya University**
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to **Mount Kenya University** within 72 hours of notification
iv. Any changes, anticipated or otherwise that may increase the risks or affect the safety or welfare of study participants and others or affect the integrity of the research must be reported to **Mount Kenya University** within 72 hours
v. Clearance for export of biological specimens must be obtained from relevant institutions
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal
vii. Submission of an executive summary report within 90 days upon completion of the study to **Mount Kenya University**

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://research-portal.nacosti.go.ke and also obtain other clearances needed.

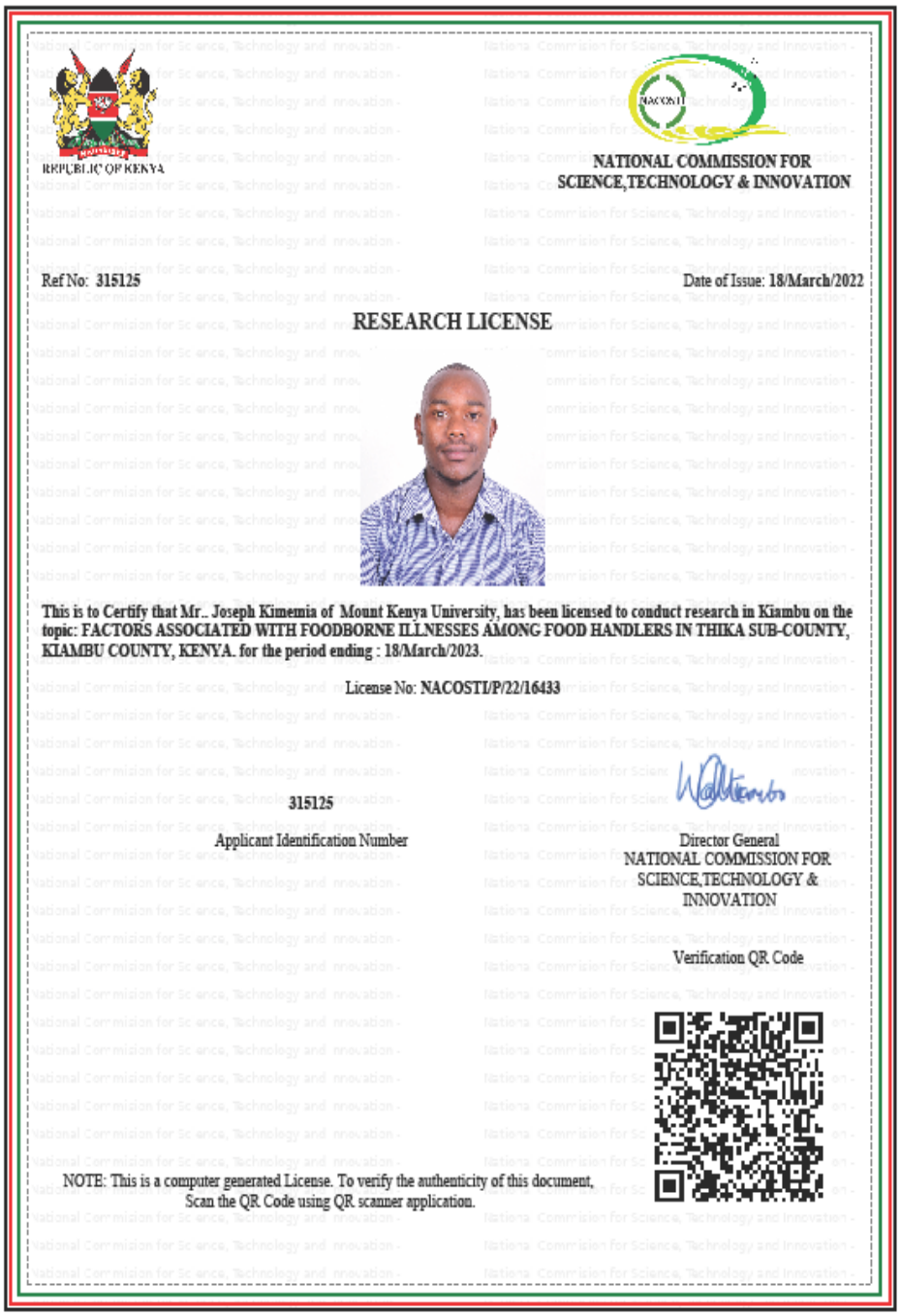
Yours sincerely,

The Chairman
Mount Kenya University
Ethics Review Committee
P. O. Box 342 - 0100, Thika

Dr. Peter G. Kirira
Chairman, Mount Kenya University IERC

Main Campus, General Kago Road. P.O. Box 342-01000 Thika. Tel: +254 67 2820 000,
Cell: +254 722 700 706, 0730 153 000

Appendix VII: Research Permit Nacosti



REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: 315125

Date of Issue: 18/March/2022

RESEARCH LICENSE

This is to Certify that Mr.. Joseph Kimemia of Mount Kenya University, has been licensed to conduct research in Kiambu on the topic: FACTORS ASSOCIATED WITH FOODBORNE ILLNESSES AMONG FOOD HANDLERS IN THIKA SUB-COUNTY, KIAMBU COUNTY, KENYA. for the period ending : 18/March/2023.

License No: NACOSTI/P/22/16433

315125

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

Appendix VIII: Clearance To Conduct Research In Kiambu County

COUNTY GOVERNMENT OF KIAMBU
DEPARTMENT OF HEALTH SERVICES

All correspondence should be addressed to HEAD
HRDU – HEALTH DEPARTMENT
Email address: mndiritu@email.com
mkwasa@live.com
Tel. Nos: 0721641516
0721974633

HEALTH RESEARCH AND DEVELOPMENT
UNIT
P. O. BOX 2344 – 00900
KIAMBU

Ref. No.: KIAMBU/HRDU/22/03/18/RA_KIMEMIA Date: 18th Mar 2022

TO WHOM IT MAY CONCERN

RE: CLEARANCE TO CONDUCT RESEARCH IN KIAMBU COUNTY

Kindly note that we have received a request by Mr. Joseph Maina Kimemia of Mount Kenya University to carry out research in Kiambu County, the research topic being on **"factors associated with foodborne illnesses among food handlers in thika sub-county, Kiambu county, Kenya"**

We have duly inspected his documents and found that he has been cleared by Mount Kenya University Ethics Review Committee to carry out the research for a period ending **25th January 2023.** As he has received approval from a NACOSTI licenced ERC, we hereby give him a provisional clearance to begin collecting his data immediately to avoid any delays in the research process. However, he is required to submit the license within 2 months of receiving this letter.

It is incumbent upon the institution where he is carrying out research to ensure that he receives adequate supervision during the process of conducting the research. This note also accords him the duty to provide a feedback on his research to the county at the conclusion of his research.

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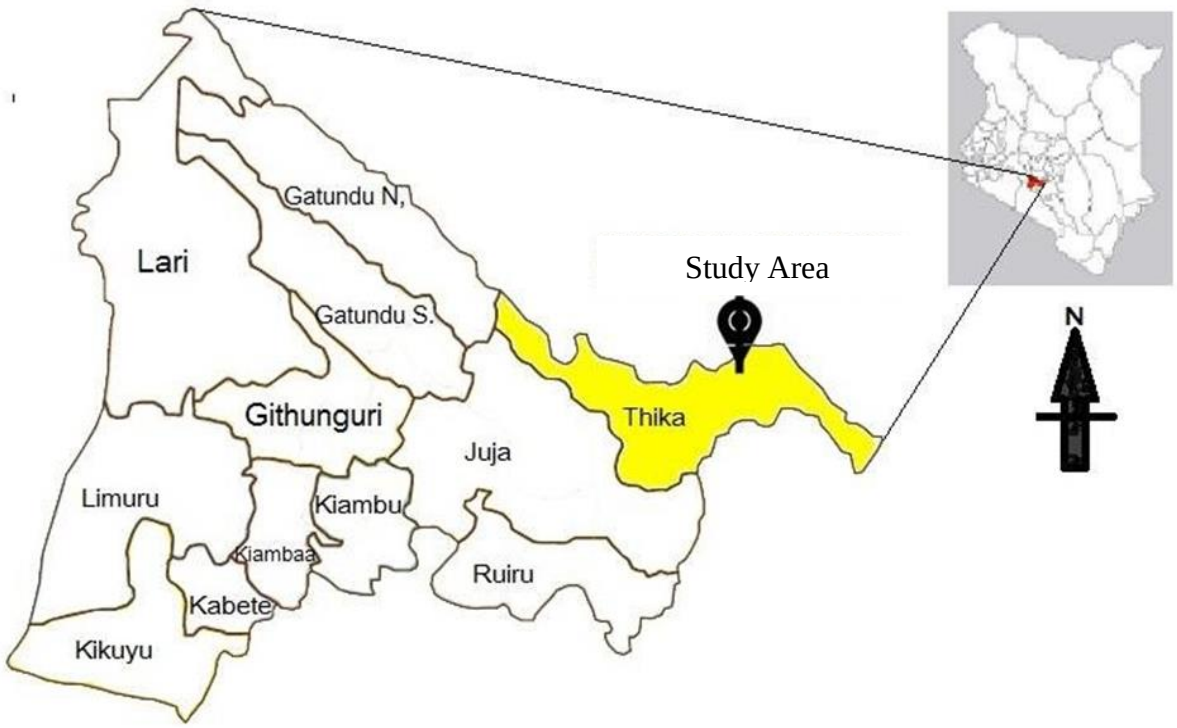
DR. MWANCHA KWASA
COUNTY CLINICAL RESEARCH OFFICER
KIAMBU COUNTY

Appendix IX:Map of Kiambu County



Source: (google maps)

Appendix X: Similarity Index

FACTORS ASSOCIATED WITH FOODBORNE PATHOGENS AMONG FOOD HANDLERS IN THIKA, KIAMBU COUNTY, KENYA.

by Joseph Maina Kimemia

Submission date: 20-Jun-2023 05:21PM (UTC+0300)
Submission ID: 2119716427
File name: current_updated_thesis_at_as_17_6_23_final.docx (7.42M)
Word count: 20136
Character count: 111880

FACTORS ASSOCIATED WITH FOODBORNE PATHOGENS AMONG FOOD HANDLERS IN THIKA, KIAMBU COUNTY, KENYA.

ORIGINALITY REPORT

20%	15%	10%	7%
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PRIMARY SOURCES

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5	erepository.uonbi.ac.ke Internet Source	<1%
6	Kingsley E Amegah, Henry O Addo, Mary E Ashinyo, Loveland Fiagbe, Serene Akpanya, Samuel K Akoriyea, S Dajan Dubik. "Determinants of Hand Hygiene Practice at Critical Times among Food Handlers in Educational Institutions of the Sagnarigu Municipality of Ghana: A Cross-Sectional Study", Environmental Health Insights, 2020 Publication	<1%

Students' Cafeteria of Woldia University, North Eastern Ethiopia", International Journal of Food Science, 2022
Publication

Exclude quotes	Off	Exclude matches	Off
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