HYGIENE KNOWLEDGE, PRACTICES AND MICROBIAL SAFETY OF MIXED VEGETABLE SALADS SOLD IN THE STREETS OF PIPELINE WARD, NAIROBI COUNTY, KENYA

DAVID OBINDA KAVUNJA

A56/7531/2017

A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN FOOD SAFETY AND QUALITY

DEPARTMENT OF FOOD SCIENCE, NUTRITION AND TECHNOLOGY

COLLEGE OF AGRICULTURE AND VETERINARY SCIENCES (CAVS)

UNIVERSITY OF NAIROBI

2020

DECLARATION

I DAVID OBINDA KAVUNJA declare that "This dissertation is my original work and has not been submitted for award of a degree in any other University".

DAVID OBINDA KAVUNJA

Signature:  Date: 18/08/2020

This dissertation has been submitted with our approval as University supervisors.

Dr. LUCY NJUE

Department of Food science, Nutrition and Technology

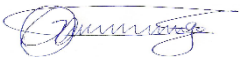
University of Nairobi

Signature:  Date: 18/08/2020

Dr. GEORGE O. ABONG'

Department of Food science, Nutrition and Technology

University of Nairobi

Signature:  Date: August 18, 2020

PLAGIARISM DECLARATION

Name of Student:	DAVID OBINDA KAVUNJA
Registration Number:	A56/7531/2017
College:	UNIVERSITY OF NAIROBI
Faculty/School/Institute:	COLLEGE OF AGRICULTURE AND VETERINARY SCIENCES
Department:	DEPARTMENT OF FOOD SCIENCE NUTRITION AND TECHNOLOGY (DFSNT**)**
Course: MSc.	FOOD SAFETY AND QUALITY
Title of the work:	HYGIENE KNOWLEDGE, PRACTICES AND MICROBIAL SAFETY OF MIXED VEGETABLE SALADS SOLD IN THE STREETS OF PIPELINE WARD, NAIROBI COUNTY, KENYA

DECLARATION

1. I understand what Plagiarism is and I am aware of the University's policy in this regard
2. I declare that this dissertation is my original work and has not been submitted elsewhere for examination, award of a degree or publication. Where other people's work or my own work has been used, this has properly been acknowledged and referenced in accordance with the University of Nairobi's requirements.
3. I have not sought or used the services of any professional agencies to produce this work
4. I have not allowed, and shall not allow anyone to copy my work with the intention of passing it off as his/her own work
5. I understand that any false claim in respect of this work shall result in disciplinary action, in accordance with University Plagiarism Policy.

Signature 

Date: 18/08/2020

ACKNOWLEDGEMENT

I wish to extend my sincere gratitude and appreciation to my supervisors starting with the lead supervisor Dr. Lucy Njue and her counterpart Dr. George Ooko Abong for giving precious contributions towards the completion of this research. For their patience, motivation, enthusiasm, and immense knowledge. Their guidance helped me in all the time of research and writing of this dissertation.

I would like to thank my family: My Wife Victoria Obinda and my Son Ivan Obinda for their moral and financial support and providing the space to work with.

To the University of Nairobi, food microbiology laboratory team for allowing me to make use of the available equipments while conducting my laboratory work.

Moreover, most especially to God, for giving me the guidance and knowledge as well as good health in constructing this research work.

To God be the Glory.

ACRONYMS AND ABBREVIATIONS

BPW	Buffered peptone water
CDC	Center for Disease Control
CFU	Colony Forming Units
FAO	Food and Agriculture Organization
FBD	Food Borne Disease
MRD	Maximum recovery diluent
PCA	Plate Count Agar
RTE	Ready To Eat food
VRBA	Violet Red Bile Agar
WHO	World Health Organization
TSA	Tryptone Salt agar
USDA	United States Department of Agriculture

TABLES OF CONTENT

LIST OF TABLE

LIST OF FIGURES

GENERAL ABSTRACT

Street foods are those sold outside in the public place without a permanent structure and are most often ready to eat. However, ready-to-eat foods are a source of contamination and can transmit foodborne diseases. This study assessed hygienic knowledge and practices, status of microbiological contamination of mixed vegetable salads sold in pipeline ward of Nairobi County in Kenya and to determine the exposure to pathogenic microorganisms through consumption. Questionnaires and personal observations were the two main instruments used for gathering the data. Vegetable salad samples were collected from the vendors and were transported to the laboratory and analyzed for *Staphylococcus aureus, Escherichia coli, Salmonella SPP* following recommended standard procedures. Consumption and contamination were then combined to estimate exposure of consumers. The average bacterial intake and the 95th percentile (P95) intake levels estimations were obtained using Monte Carlo simulation models. Out of …venders, majority (60%) of the respondents were males and in the age category of 26-35 (53%) and most of them had up to secondary level of education (73%). Majority of the vendors (59%) had been trained on food handling practices and therefore had good knowledge of food hygiene, and practiced good hygiene. The results indicate that a few (percent?) of the respondents did not practice food handling hygienic practices predisposing salads to contamination. Majority of the consumers (64%) had estimated body weight above 60 kgs and heights ranging from 1.7-2.0 meters. About 91 % of respondents purchased mixed salads on weekly basis and consumed it directly without additives. Majority (67 %) of respondents reported an increase in consumption trend, which was linked to increased number of vendors along the streets. The salad consumption was characterized by triangular distribution and ranged from 0.53 to 4.01 g/kgbwt/day with an average consumption of 1.88 g/kgbwt/day. *Staphylococcus aureus* was present in 98 % of the samples while *Escherichia coli* tested positive for about 73 % of the samples. Only 18 % of the analyzed samples were

contaminated with *Salmonella spp*. The *S. aureus* concentrations ranged between 2.01 log CFU/g and 3.77 log CFU/g while that of *E. coli* ranged between 2.63 log CFU/g to 3.49 log CFU/g. The average intake of *Staphylococcus aureus* was 5.83-log cfu/kgbwt/day, *E.coli* was 5.50 log cfu/kgbwt/day while *Salmonella spp* was 0.19 log cfu/kgbwt/day. The 95th percentile (P95) intake of *Staphylococcus aureus* was 10.92 log cfu/kgbwt/day, *E.coli* was 10.15 log cfu/kgbwt/day while *Salmonella spp* was 0.58 log cfu/kgbwt/day. All the vegetable salads sampled from different zones, in Pipeline Nairobi had a high contamination levels. The high contamination levels of these pathogens could be as a results poor handling of the vegetables right from the farm up to consumption point. This calls for awareness of the possible hazardous effect of consuming street sold vegetable salads. It is therefore important that policies that regulate microbial quality of street vended foods are put in place and are practiced by vendors. Street food vendors and consumers should be cognizant of both personal and environmental hygiene since street foods are literally prepared and served on the street with the preparation area exposed to the natural elements should be taken care

CHAPTER ONE: INTRODUCTION

1.1 Background information

Street foods have been in existence for a long time and are common in many countries as a source of food and income (Ryza *et al*., 2015; WHO, 2011). Street foods are those sold outside in the public place without a permanent structure and are ready to eat (WHO, 2011). Most of these food items are prepared and consumed on site, while others are prepared at home and transported to streets for vending (Rene, 2011; FDA, 2014). This is mainly due to culture diversity, food preferences and availability of the foods in different parts of the world. Foods sold in the streets are readily available, inexpensive and with good nutritional values to those who consume them (Rene, 2011). Occurrence of food borne illnesses is majorly dependent on how food is handled. Over 97% of all food borne illnesses associated with catering outlets have been tagged to improper food handling (Pratima and Daisy, 2016). Food safety and hygiene is a public health area that protects consumers from the risks of food poisoning and foodborne diseases. Food safety was made as a theme for WHO world health day in 2015 to enhance the relevance of food safety to all people on the planet including government, civil society, the private sector, and intergovernmental agencies (WHO, 2015). Consumption of street foods in many African countries where there is high unemployment, low salaries, poor social programs and few work opportunities is high (WHO, 2017).

According to (FAO/ WHO, 2010) food safety is the assurance that food will not cause harm to the consumer when it is prepared and consumed according to its intended use. Foods that are not safe can lead to a range of health problems diarrheal disease, viral diseases among others. Food borne illnesses are normally infectious or toxic and are caused by bacteria, viruses, parasites or chemical substances that enter the body through contaminated food or water (WHO, 2017). Food that is unsafe, containing harmful microorganisms or chemicals cause over

200 diseases (WHO, 2017). Estimated 600 million (around 1 in every 10 people) in the world become sick after consuming unsafe food or water annually where around 420,000 die (WHO, 2017). Food borne diseases affect socio economic growth and development by straining healthcare systems, and hurt national economics, trade and tourists (FAO, 2011). There is a big risk of serious food poisoning outbreak linked to street foods especially salads and this has been a threat in many parts of the world (FAO, 2011).

In Kenya, especially in the urban areas, the most common and popular foods vended in the streets include eggs, sausages, smokies, mandazi among others. They are served along with mixed vegetable salads. The common ingredients of the vegetable salads are tomatoes, onions, coriander and occasionally fresh chillies. Consumption of the mixed vegetable salad is very common and wide spread in the country (Mbae *et al*., 2018). Raw food especially ready to eat vegetable salads have been linked to occurrence of food borne diseases all over the world (Pratima and Daisy, 2016).

Majority of these vegetables consumed in the city come from small-scale farmers in or near the city where they use unclean water for growth (Kariuki and Orago, 2017). Therefore, there is a likelihood of the vegetables becoming contaminated with the untreated water used for irrigation.

The hygiene status where the foods sold is often questionable. This is evident by accumulated rubbish, blocked drainages and flying insects. This makes the safety of the mixed vegetable salads to be questionable. Different factors can lead to outbreak of food borne diseases. They may include use of dirty untreated water to clean food and food surfaces, improper storage, poor transportation of food, lack of hygienic practices during handling and preparation, infected food handlers among others (Mbae *et al*., 2018, Gitahi 2012, Kariuki and Orago, 2017). The population of Kenyans relying on the street foods served with salads has increased

tremendously (Mbae *et al*., 2018). The level of unemployment has further pushed many people to eating street foods. Street food vending is seen by many as a way of creating employment and this has led to increase in street food vending (CDC, 2017).

Street food samples in India were reported to be contaminated with Escherichia coli (37.5%), Salmonella spp (5.6%), Shigella (17.6%) (Tambekar *et al*., 2011). In some African countries, Kenya included, tests on street foods have revealed contamination with bacteria that include *Escherichia coli, Staphylococcus aureus, Salmonella spp, fecal coli forms among others* (Gitahi, 2012). The study on vegetable salads vended in pipeline is important, as it will give information on the safety of these products and will show the intake levels of pathogenic microorganisms consumed in the salads.

1.2 Statement of the problem

According to Kariuki (2017), there is an increase in the number of vendors of street foods in Kenya and over 40% of Nairobi residents consume them. Increase in food vending has been instigated by rapidly growing and changing food demands alongside the need to diversify and/or employ more income sources in the face of declining incomes. Studies done by FAO revealed that street food vendors are often unlicensed, untrained in food hygiene and sanitation, and work under crude unsanitary conditions. Estimated 600 million (around 1 in every 10 people) in the world become sick after consuming unsafe food or water annually where around 420,000 die (WHO, 2017). Food borne diseases affect socio economic growth and development by straining healthcare systems, and hurt national economics, trade and tourists (FAO, 2011). There is a big risk of serious food poisoning outbreak linked to street foods especially salads and this has been a threat in many parts of the world (FAO, 2011).

A number of studies have been conducted on the microbiological quality of many street foods. However, there is little information on the microbial quality and safety of mixed vegetable salads served along with eggs, smokies, and sausages in Nairobi and more so Pipeline Ward.

There is therefore a potential risk of food borne disease outbreaks to consumers. Street food vending is a growing business in Pipeline area of Nairobi County in Kenya, which have most of its inhabitants being low-income earners who mostly depend on the low priced street foods served with mixed vegetable salads. This therefore implies that in case of any food contamination, majority of the inhabitants may be affected. There is also need to study the intake levels of food pathogens and the relationship to occurrence and the hygiene practices of the mixed vegetable salad vendors in Pipeline Nairobi. This could reveal potential of food poisoning outbreaks relating to the salad consumption. Results from this study will be very benefits to policy makers, research scientists, academicians, households and consumers, farmers. Knowledge of the pathogenic microorganisms in vegetable salads and the intake levels of pathogens will help to develop intervention methods to reduce the risk of contamination and outbreak of food borne illness resulting from consumption of the vegetable salads.

1.3 Justification

According to Gitahi (2012), the foods sold in the streets are of a major hygiene concern to the food control officers. The stands and other tools used such as trolleys where the food is sold are usually crude structures. Clean water and toilet facilities are a challenge. Unlike other street foods that are served hot, minimally processed mixed vegetable salads faces a higher risk of food contamination and spreading of food borne illnesses. However, there were limited studies on specific intake levels of biological hazards of public health concern in mixed vegetable salads sold in street. There is need to study the intake level of harmful pathogen via consumption of mixed vegetable street salads and the hygiene practices coupled with food safety knowledge of the salad vendors in Nairobi. This could reveal potential of food poisoning outbreaks relating to mixed vegetable salad consumption and relate to practices and food safety knowledge of the salad vendors.

1.4 Study aim

The aim of the study is to contribute towards improved safety of mixed vegetable salads sold by street food vendors in Kenya.

1.5 Purpose of the study

The purpose of the study is to determine the potential microbiological hazards and intake associated with the consumption of vegetable salads vended in streets.

1.6 Objectives

1.6.1 Overall objective

To evaluate hygienic practices, knowledge and status of microbiological contamination of mixed vegetable salads sold in pipeline ward of Nairobi County in Kenya and to determine the exposure to pathogenic microorganisms by the salad consumers.

1.6.2 Specific objectives

1. To determine the hygienic practices and safety knowledge among the vendors of vegetable salads in Pipeline ward of Nairobi County
2. To assess the exposure to pathogenic microorganisms through consumption of mixed vegetable salads in pipeline Nairobi, Kenya

1.7 Research questions

1. What is the hygiene awareness level and practices among the vegetable venders in pipeline ward of Nairobi County?
2. What is the exposure level to pathogenic microorganisms by the consumers of mixed vegetable salads sold in pipeline ward of Nairobi County?

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

According to Abibio and Loavatt 2014, Salads are fresh vegetables, which require minimal washing and processing, cut into desired shapes and sizes with knives or other shredding utensils, and usually serve as along with other foods. A ready-to-eat raw vegetable salad is widely prepared at home and in food outlets around Kenya. Its common fresh ingredients include tomatoes and onions. The ingredients could vary to include capsicum, coriander, and hot green/red chilies. Occasionally, freshly squeezed lemon juice or vinegar is added to enhance the flavor. The vegetables ingredients are washed, chopped or sliced into small pieces, and mixed to produce the salad. Serving the salad as an accompaniment to boiled eggs, smokies, sausages and even nyama choma (roast meat) is a common practice in Kenya (Kakonge and Omiti, 2018)

The food combination is offered in a cross section of top-class to low-end to street vended food eateries that are common in urban centers and the countryside and is popular among locals and tourists visiting the country. Street vended salads are cheap compared to those in the restaurants and supermarkets (FAO, 2017). The foods are labeled street foods by those who consume them (WHO, 2011). Selling of ready to eat street vended mixed salads is very controversial from public health perspective because they have been implicated with outbreak of food borne diseases (Kibret and Tedese, 2013). Due to lack of basic infrastructure and services and difficulty in putting the huge number of street food venders under control, these foods served on the streets are perceived to be of public health risk (Rene, 2011).

2.2 Importance of salads served on the streets along with other foods

2.2.1 Nutritional benefit of the mixed salads

Ramteke *et al* 2016 observed that, vegetable salads are considered a major source of nutrients for people and particularly as sources of cancer fighting agents for the skin world over. Recent

studies done by Coulibaly-Kalpy *et al*., 2017 have established that consumption of salad vegetables can prevent heart diseases and skin cancers. Mixed vegetable salads are served raw and termed as ready to eat (RTE), are heterogeneous in nature which provide important components of nutritional fulfillment, source of minerals, phytonutrients and vitamins (Taban and Halkaman, 2011). Choudhury *et al*., 2011 noted that the vegetable salads are mostly consumed due to their nutritious components as well as their gustatory attributes when consumed in combination with other foods, which is sometimes as result of the culinary prowess of the food vendors. Salads are also sources of vitamins, minerals, proteins and relevant nutritional components for the proper functioning of the human body (Amoah, 2014).

A lot of vegetable salads are consumed in many parts of the world (Nostou *et al*., 2012). According to FAO/ WHO 2011, many countries in the recent past have started to encourage their citizens to eat fresh fruits and vegetables that include all variety of salad leaves, leafy green vegetables such as spinach, cabbage, lettuce. These categories of foods have demonstrated high concern from microbiological safety point of view (WHO, 2011). According to Alimi *et al*., 2016, diets based on fruits and vegetables have high concentration of antioxidants and contribute to reduced mortality from cardiovascular and cerebrovascular diseases; however, their protection against cancer is not conclusive and is considered to be safe to eat by those who consume them. Consumers who look for healthy and convenient foods are normally attracted to RTE products (WHO, 2017). Due to absence of heat treatment of the salads, microbiological safety becomes a great concern (WHO, 2011)

2.2.2 Economic benefits and global status of mixed vegetables salads

Due to changes in the socioeconomics in many countries, the vending of foods in the streets have grown significantly in the past few years (WHO, 2011). Kenya bureau of statistics anticipates urbanization and population growth; this is expected to continue into the coming century; street vending of foods which are largely seen as urban phenomenon will grow

accordingly (KNBS, 2017). Vending of foods in the streets offers business opportunities for upcoming entrepreneurs (WHO, 2011). Foods vended on the streets affirm food security for the large population in the urban dwelling of low income (WHO, 2012). Large population of urban workers who cannot afford expensive restaurant foods rely on these street vended foods (Mbae, 2017). Globally, street vended foods are a significant part of urban food supply (FAO, 2011).

Ready to eat food vendors in many developing countries are an important component of the food supply chain as they satisfy the need of the urban population due to them being reasonable in terms of price and are readily available for large part of global population who depend on them in entirety for survival (Kisembi, 2013). Vendors of the mixed vegetable salads after receiving the raw materials should be in a position to handle them in a sanitary condition so as not to enhance chances of contamination by microbial hazards which may get attached to the surface of the products or penetrate the salads and multiply in the tissues mostly during peeling, washing, slicing and mixing, surfaces of food may also act as reservoirs for microbial contamination (Gitahi, 2012)

2.3 Preparation of mixed vegetable salads before selling

Vendors of mixed vegetable salads sold in the streets buy their raw materials from open markets where products are usually kept on or near the ground and not adequately covered (Mwadime, 2011). The products are then transported to the sites where they are vended using carts, public transports mean, while others carry them in gunny bags on their backs (Mwadime, 2011). Transportation increases the risk of contamination as dirty carriers are used many a times (Hannan *et al*., 2014). The sites where the salads are prepared and sold are near the roadsides in open or stalls (Abakari *et al*., 2018). Vending surfaces are mostly made of wooden boards and are not adequately cleaned (Kariuki, 2017). Preparation of salad ingredients involves washing, slicing, and then holding the salads in open bowls (Kariuki, 2017, Abakari *et al*.,

2018, Hannan *et al*., 2014). The water used to clean the salads is sourced from city council tap waters, bought in water kiosks or water trucks or sometimes borehole water is used (Gitahi, 2012). The water mostly is never enough to clean the salad ingredients and work surfaces adequately and this further increases risk of contamination as it is recycled (Gitahi, 2012). Sanitization of the raw materials is mostly never done due to lack of enough water and sanitizers being unaffordable by the vendors (Mbae *et al*., 2017). Prepared salads are left exposed posing increasing risk of contamination from dust and insects (Mwadime, 2011). Many of the vendors with little formal education lack food safety appreciation and these leads them to improperly handling the foods which may play a role in pathogen transmission and multiplication in salads (Mbae *et al*., 2017, Mwadime *et al*.,2011, Kariuki 2017).

2.4 Food borne diseases

Global incidences of food borne diseases are difficult to estimate due to many cases going unreported (WHO, 2011). More than 250 diseases have been identified to be food borne (CDC, 2017). Majority of the diseases are infections caused by different bacteria, viruses and parasites (CDC, 2017). Harmful chemicals and toxins which can contaminate food (CDC, 2017) may also cause food borne illnesses. According to CDC 2017, over 40 million people get sick from food borne diseases annually where approximately 120,000 are hospitalized and 3000 die in the USA. The symptoms of food borne diseases include the following; nausea, vomiting, stomach cramps and diarrhea (CDC, 2017). The symptoms can be severe and sometimes can even be life threatening (WHO, 2017).

Globally, food borne diseases have been responsible for approximately 2.2 million deaths and majority being children (WHO, 2011). According to WHO 2005, food borne microbial hazards is major health concerns associated with street vended foods. In Kenya in 2017, incidences of food borne diseases outbreak occurred that resulted to closure of several restaurants (MOH, 2017).

2.4.1 Types of microbial food borne diseases

Food borne diseases result from consumption of food or water contaminated with pathogenic microorganisms (bacteria, viruses, parasites) or their spores for the case of bacteria or food containing toxins produces by toxigenic bacteria or molds. (WHO, 2017). The illness can be categorized into three groups; Intoxication; toxicoinfection and infection (WHO, 2017). Toxicoinfection occurs after ingestion of viable cells of pathogenic bacteria through contaminated food or water. The bacteria then either grow or die in the body releasing toxins that causes symptoms. An example is Clostridium perfringens gastroenteritis. Intoxication illness occurs after ingestion of preformed toxins produced by bacteria or molds in foods. The microorganism grows and multiplies in food producing toxins and there is no need of viable cells during consumption of the food for illness to occur. Example is Staphylococcus aureus food poisoning. Infection illness occurs due to consumption of food and water contaminated with pathogenic bacteria or viruses. The pathogenic microorganism must be present and remain alive in the food at the time of consumption. The cells then multiply in the digestive tract causing illness. Example is salmonellosis type of food borne illness.

2.4.2 Microbial safety of mixed vegetable salads.

Vegetable salads have been implicated with outbreak of food borne diseases in many countries and organisms involved includes bacteria, fungi, viruses and parasites (FAO/WHO, 2011). Outbreaks of norovirus have been associated with salads in the USA (CDC, 2017). Bacteria like salmonella, E. coli, Shigella spp, campylobacter can contaminate salads via contact with unclean water (Muinde and Kuria, 2002, Gitahi, 2012,). Staphylococcus aureus can contaminate the salads through poor personal hygiene of the food handlers (WHO, 2011). Majority of food vendors on the street lack knowledge and appreciation of food safety, which further increases the risk factor of street foods to contamination (FAO, 2011). Lack of adequate supply of clean water; poor hygiene and unsanitary work environment such as garbage dumps and sewerage increases public health risks related with street vended foods like salads (FAO,

2011). Mbae *et al*., 2017 reported that preparation surfaces for street vended foods may be reservoir for microbial hazards. Holding salads at danger zone (inappropriate temperature) and traditional processing methods such as not using gloves and not failure to sanitize hands may cause contamination of street vended salads and enhance multiplication of pathogens (Kariuki *et al*,. 2017). In many African countries, street vended foods have tested positive of various microorganisms of public health concern (FAO/ WHO, 2017) Bacteria isolates of Staphylococcus aureus, E. coli, Bacillus cereus and fungal isolates of Aspergillus spp, and Penicillium spp were isolated from fruits salads in Kaduna Nigeria (Anta *et al*., 2017). E. coli and Enterobacteriaceae were isolated from food samples in Kenya (Gitahi, 2012). According to Mbae *et al*., 2017, street foods can be a source of several groups of entropathogens.

2.5 Contributing factors to microbial contamination of street vended salads

Cross contamination during production and transportation; poor personal hygiene; inappropriate holding temperatures are among the main contributing factors to microbial contamination of street vended foods including salads (Rayza *et al*., 2016).

2.5.1 Cross contamination

Cross contamination is the transfer of microbial hazards from raw foods, dirty surfaces and equipment's to ready to eat foods. (FDA, 2014). Cross contamination can occur when food is put on surfaces that are not cleaned or sanitized (Kendall, 2012). Cross contamination can occur when food is transported on dirty surfaces, unclean trucks (Chukuezi, 2010). Cross contamination can be prevented by washing hands with soap and warm water before handling and preparing salads and after visiting washroom (FDA, 2014). Dirty and unclean salads should not be put together with clean ones and coughing and sneezing on exposed foods should be avoided (FDA, 2014).

2.5.2 Poor personal hygiene

Studies have discussed that poor personal hygiene can lead to food contamination, for instance failure to wash hands after visiting washrooms can lead to fecal contamination (Gitahi, 2012, WHO, 2011). Healthy humans harbor bacteria on the skin, mouth and various other body parts such as the scalp and therefore food handlers can contaminate food and cause food borne illness (WHO, 2011). Food handlers may cause cross contamination from dirty surfaces, from one food handler to another or from hands contaminated with microorganisms from gastrointestinal tract (Mbae, 2017).

2.5.3 Inappropriate holding temperatures

Majority of microbial hazards grow at temperature range of between 5 to 63 degrees Celsius known as danger zone (Kendall, 2012). Time temperature relationship is a factor that can cause food contamination that may result in food borne illness (WHO, 2011). Leaving ready to eat food such as salads for more than two hours at danger zone may allow growth and multiplication of microbial hazards to levels capable of causing food borne illness (FDA, 2014). Hot foods should be kept above 63 degrees Celsius while cold serves should be stored below 5 degrees Celsius (Kendall, 2012).

2.5.4 Use of unclean water

Unclean water may contain harmful microbial hazards such as fecal E. coli and such water when used to clean and prepare food may cause transfer of pathogens to foods (WHO, 2017). In Nairobi for instance, observation by Nairobi water and Sewerage Company have shown that water pipes are vandalized and water diverted for unintended use. Such habit risks contamination water with microbial, chemical and even physical hazards. Such water when used to clean salads may lead to contamination. Use of unclean, untreated water for irrigation may transfer microbial contamination to the leaves and surfaces of fruits and vegetables

2.6 Food hygiene practice and knowledge of the salad vendors

Studies have shown that peoples who work in the industries and other institutions are more likely to be trained on hygiene and food safety than the vendors on the street (Monica, 2011). In Ghana, studies revealed that 0ver 94% of women street vendors had no or minimal formal education (Monica, 2011). Food safety and hygiene education can be used to reduce food borne diseases among vendors of salads sold on the streets by learning various proper methods of handling them and maintenance of hygienic environment (Chukuezi, 2010). In Nigeria, survey revealed that salad vendors have undergone hygiene training but only less than half are implementing the knowledge (Nurudeen *et al*., 2014). Personal hygiene and grooming, medical checkups and washing hands are an important control measure to outbreak of food borne illness (Monica, 2011). In Kenya, all food handlers are required to have food handlers' medical certificate which is valid for six months (Kenya food, drugs and substance act 2011). WHO/ FAO 2011 recommends food preparation areas, premises to be clean and free from accumulated garbage, should not be congested and the surfaces should be made of material that are easy to clean and free from crevices that can harbor pathogenic microbes.

2.7 Assessment of exposure to pathogenic microorganisms through food consumption.

Exposure assessment is defined as the qualitative and/or quantitative evaluation of the likely intake of biological, chemical or physical agents via food, as well as exposure from other sources if relevant (FAO/WHO, 2011). Microbiological hazards are present in the food supply chain and the risk of illness from consuming food varies considerably depending on different types of hazards and food matrices as well as the susceptibility of individual consumers (Magnusson *et al* 2012). The exposure assessment provides an estimate of the level of a hazard the consumers may be exposed to through food consumption. The exposure assessment integrates information about the hazard (such as prevalence and concentration, growth, and survival characteristics for microbial hazards), the food product (such as production methods, presence, ability to support growth of microbes, and food chain handling), and the consumer (such as the quantity and frequency of consumption, and handling practices) to produce the required estimates of the exposure in units that vary from per serving or per population for

microbial hazards, to average daily intakes and lifetime exposures for chemical hazards. (Magnusson *et al* 2012).

2.8 Gaps in knowledge

Research on microbial quality of street foods served hot such as rice, beef and chicken has been carried out in Kenya and specifically Nairobi (Gitahi, 2012). Food safety knowledge, practices of food vendors who sell these hot meals have also be done in Kenya (Gitahi, 2012). However, very little is known on the microbial quality and intake levels of pathogens in vegetable salads sold on the street hence the need to carry out this research.

CHAPTER THREE

FOOD SAFETY KNOWLEDGE AND HYGIENIC PRACTICES AMONG VENDORS OF VEGETABLE SALADS IN PIPELINE WARD OF NAIROBI COUNTY, KENYA

3.1 Abstract

Street vended foods are a source of inexpensive, nutritious food for many people living both in the urban and rural areas. It is also a major source of income for many people, particularly women by providing self-employment and the opportunity to develop business skills with low capital investment. However, ready-to-eat foods are a source of contamination and can transmit food-borne diseases through those handling the salads. Therefore, this study was carried out to assess food safety knowledge and hygienic practices among vendors of vegetable salads in Pipeline Ward of Nairobi. The study sample included trained and untrained salad vendors within the ward. Questionnaires and personal observations were the two main instruments used for gathering the data. Data was coded and analyzed using SPSS to obtain percentages and frequencies. Majority (60 %) of the respondents was males aged between 26-35 (53 %) and most of them had up to secondary level of education (73 %). Majority of the vendors (59 %) had been trained on food handling practices and therefore had good knowledge of food hygiene, and practiced good hygiene. The results indicate that even though most respondents used gloves and aprons, some did not practice food handling hygienic practices and this could predispose the salads to contamination. The study indicates that majority of the respondents had formal education and were trained on food handling practices, and this may have had an effect on their perception towards hygiene. However, some of the vendors exhibited poor food handling practices and therefore there is need to enhance training and law enforcement governing street food vending business.

3.2 Introduction

Salads are fresh vegetables which require minimal washing and processing and are cut into desired shapes and sizes with knives and is usually served along with other foods (Mbae *et al*., 2018). Vegetable salads are ready to eat widely prepared at home and in food outlets around Kenya and its common fresh ingredients include tomatoes and onion (Mbae *et al*., 2018). The ingredients may also include capsicum, coriander, and hot green/red chilies. Occasionally, freshly squeezed lemon juice or vinegar is added to enhance the flavor. To prepare the salads, the vegetables ingredients are washed, chopped or sliced into small pieces, and mixed to produce the salad. Serving the salad as an accompaniment to street food such as boiled eggs, smokies, sausages and even *nyama choma* (roasted meat) is a common practice in Kenya (Reang and Bhattacharjya, 2013)

The food combination is offered in a cross section of top-class to low-end street vended food eateries that are common in urban centers and the countryside and is popular among locals and tourists visiting the country. Street vended salads are cheap compared to those in the restaurants and supermarkets. These foods are important for many people living in the cities in developing countries both economically and in terms of meeting food demands (Campbell, 2011). They also contribute to economic growth of households headed by female. It is estimated that street foods contribute up to 40 % of the daily diet of urban consumers in developing countries. Salads nutritionally provide vitamins, minerals, proteins for the proper functioning of the human body (Amoah, 2014). However, they could be potential sources of enteropathogens and food borne diseases (Mensah *et al*., 2002). These foods are prepared in informal settings since they are exposed to unsafe water, dump sites and pests.

Street food sector is, however, confronted by a myriad of challenges such as inadequate supervision, lack of enforcement of hygiene regulations, lack of training for the vendors on areas of food safety and lack of good hygienic practices (Okojie and Isah, 2014). The foods

are prepared in dirty places with waste garbage disposed close (Barro *et al*., 2006). In most cases washing of hands are done in bowls and sometimes without soap since running water is not available at vending sites (Abdalla *et al*., 2008). These foods have high chances of contamination at all stages of handling with foodborne pathogens.

Poor personal and environmental hygiene contribute significantly to food contaminations and street food are seen as a major contributor to food borne diseases since they are prepared under filthy environmental conditions (Campbell., 2011). Mishandling of food has been reported to play a significant role in the occurrence of food borne diseases (Grappasonni *et al*., 2018). These diseases may cause serious problem and cause significant health issues to the communities. When food is mishandled there is risk of spread and food poisoning since they may be source pathogens during food preparation and processing. Understanding hygienic and safety standards when handling food is imperative as this will ensure safety of street food. Therefore, proper food handling and good knowledge of food safety is important as it will reduce contamination. This study was therefore undertaken to determine hygienic practices and safety knowledge among vendors of vegetable salads in Pipeline Ward of Nairobi County

3.3. Materials and Methods

3.3.1 Study area

The study was conducted in Pipeline Ward of Embakasi South constituency in Nairobi County. There are five wards in Embakasi south constituency namely Kwa Reuben, Kware, Kwa Njenga, Imara daima and Pipeline ward. Pipeline ward was purposively selected because of its affordable housing project for low earning city dwellers and has improved road networks, which provide ideal sites for street food vending. The vendors situated along outer ring road, Taj mall area, stage Mpya and Pipeline who consent to take part in the research were involved.

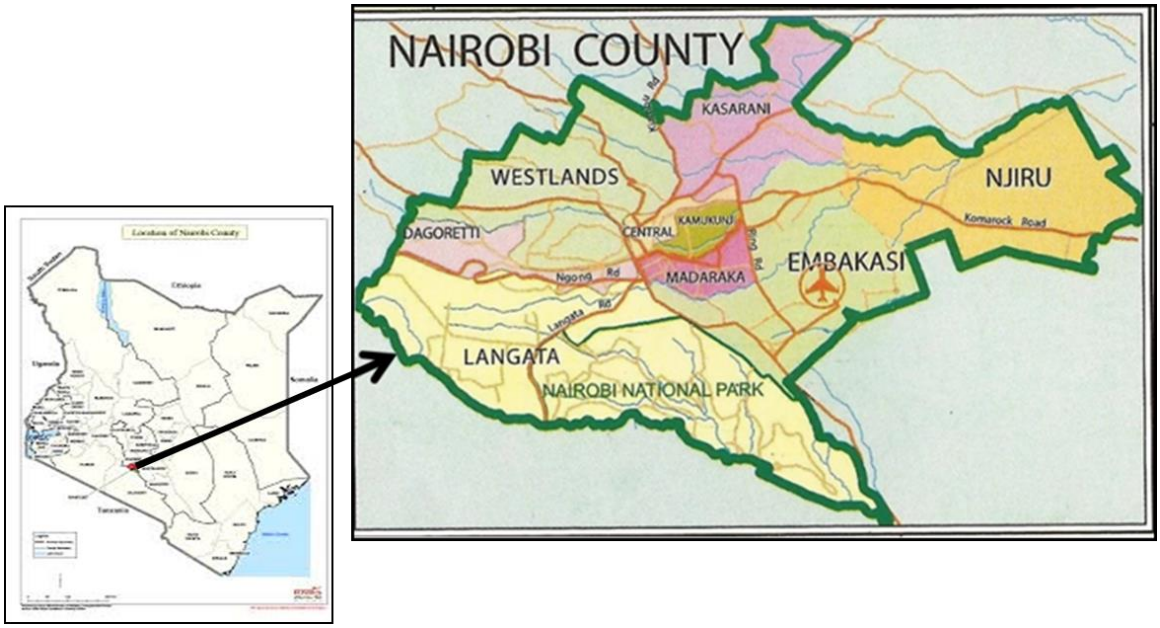


Figure 3. 1: A map of Nairobi showing Embakasi Sub County in Nairobi County, Kenya. Source: SoftKenya.com 2018.

3.3.2 Study Population

The study population consisted of street food vendors selling ready to eat food along with mixed vegetable salads in pipeline Ward, Nairobi. The sampling population consisted of both trained and untrained vendors in Food Hygiene and safety.

3.3.3 Sampling

Pipeline ward was purposively selected because of availability of mixed vegetable salads sold along its streets. Approximately 120 vendors sell mixed vegetable salads along with egg, smokies and sausages in the study area. Exhaustive sampling technique was employed for data collection. All vendors who volunteered to participate in the research were interviewed.

3.3.4 Data collection methods and tools

The knowledge and practices of street food vendors regarding food safety was determined by means of a face to face interview using a semi-structured questionnaire. Data collected included general information such as demographic information, training and related information, knowledge to regulatory measures, knowledge, and practice to the tenants of food safety such clean, temperature control, cross contamination, and safe ingredients. Possible answers were

listed as either “True”, “False” or “Don’t know” for food safety knowledge questions. Knowledge was scored as “1” for every correct answer and “0” for a wrong answers and the reply of don’t know. Knowledge scores were transformed into percent scores whereby scores below 50% were considered poor knowledge, between 50 and 75% were considered as moderate and above 75% was considered sufficient.

The practices were scored using four point Likert scale as explained by Coban and Bilgin (2015). The scores were given as “4” for always, “3” for sometimes, “2” for rarely and “1” for never for positive practices and the scoring was reversed in the case of negative practices. The scores were transformed into percentages with scores below 50% was unsatisfactory and whereas 50% and above was considered satisfactory.

3.3.5 Data analysis

The data collected was coded to facilitate statistical analysis. All statistical analyses were performed using the Statistical Package for the Social Sciences, Version 20.0 (SPSS, Inc., Chicago, IL, USA) and R programming software (R Core Team, 2019). Multivariate analysis was done on the dependent variables separately being food safety knowledge and hygiene practices, whereas the independent variables were socio-demographic characteristics. Linear regression model of socio-demographic predictors of food safety practices was obtained using the equation 1. Linear modelling was further done for practices scores against knowledge to establish the effect of knowledge on practices. Association of socio-demographics and knowledge was done using chi-square test. Significance was tested at p-value of 0.05.

$\boldsymbol{y = a + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_n x_n}$ Equation 1

Whereby *y* is the dependent variable food safety practices scores and β and *x* ranges from 1 to n with n being the total number of independent variables, with *a* as the intercept, β as the slope and *x* as the socio- demographic factors being evaluated.

3.4 Results

3.4.1 Socio-demographic characteristics of the Street Food Vendors

The demographic characteristics of participants are presented in table 3.1. Majority (60 %) of the street salad vendors were males. Many of the interviewed street salad vendors (53 %) were in the age category of 26-35 years followed closely by those in the category of 36-55. Only a few (7 %) were in the category of 18-25 years. The level of education was spread across all the variables with close to 73 % having attained secondary education. Approximately 3% of the participants had no formal education while 4 % had tertiary level of education. The years of business operations was spread across all the variables with a majority of the interviewed respondents (67%) having been in the business for about 1-5 years, others had only joined while a few had been in the business for more than 10 years. Interestingly, many of the respondents (57 %) had at least been trained on food safety and hygienic practices

Table 3. 1: Demographic characteristics of salad vendors in pipeline ward, Nairobi

Characteristics (n-73)	Category	Percentage
Gender	Male	60.3
	Female	39.7
Age (years)	18-25	6.9
	26-35	52.8
	36-55	40.3
Education level	None	2.9
	Primary	20.3
	Secondary	72.5
	Tertiary	4.3
Length in Business (Years)	Less than 1	1.4
	1-5	66.7
	6-10	26.1
	11 -20	5.8
Training	Yes	56.9
	No	43.1

3.4.2 Food safety knowledge

Table 3.2 shows results of the participants' awareness on food safety knowledge. Results show that all the interviewed participants agreed that poor hygienic practices resulted in food-borne

diseases; while about 98 % of the respondents indicated that food borne diseases are transmitted by food contamination. Majority of the interviewed vendors (97 %) also agreed that water contamination may also result in foodborne diseases. When they were asked about heating food, majority of the respondents (81 %) categorically stated that improper heating of food caused diseases while around 10 % indicated this as false and the rest had no idea. On skin infection, majority agreed that when one is infected he/she should not be involved in day-to-day affair of running the business and therefore should take leave, however, a few thought that taking leave was incorrect. At the same time, when the respondents were asked about whether it's only sick people who carry bacteria, many of the respondents (96 %) did not agree while around 3 % considered this to be true. Again majority of the respondent (81 %) rejected the notion that microbes are mainly found on the skin, nose and mouth, a few (8%) agreed while around 11 % of the respondents did not know. Majority of the respondent agreed that children, adults, pregnant women, and older people are at risk of being contaminated; also typhoid fever can be transmitted by food.

Over half (53.4%) of the vendors had moderate level of knowledge with those having satisfactory and unsatisfactory level of knowledge being 42.5%% and 4.1%, respectively (Table 3.3). Tests of association between socio-demographic and the level of knowledge revealed that the level of education significantly influenced the level of knowledge ($p<0.05$, $\chi^2= 6$). Those who attained tertiary level of education had significantly ($p<0.05$) more satisfactory level of knowledge compared to those who only attained primary level of education.

Table 3. 2: Knowledge assessment among street food vendors on food hygiene and safety

Statement	% of respondents		
	TRUE	FALSE	Don't know
Disregarding hygiene rules causes food borne illness	100.0	0.0	0.0

Foodborne diseases transmitted by food contamination	98.6	1.4	0.0
Foodborne diseases from water contamination	97.3	1.4	1.4
Improper heating food causes diseases	80.8	9.6	9.6
Skin infection take leave from work	78.1	17.8	4.1
Only sick people carry bacteria causing food contamination	2.7	95.9	1.4
Microbes are in the skin, nose and mouth of food handlers	8.2	80.8	11.0
Children, healthy, adults, pregnant women, older people at risk	93.2	5.5	1.4
Typhoid fever can be transmitted by food	97.3	1.4	1.4

Table 3. 3: Association between level of food safety knowledge and socio-demographic characteristics

Socio-demographic characteristics		**Level of knowledge**			**p-value (χ^2, df)**
		Unsatisfactory (<50%)	**Moderate (50-75%)**	**Satisfactory (>75%)**	
Gender	Male	4.5	52.3	43.2	0.954
	Female	3.4	55.2	41.4	(0.093, 2)
Age (years)	18-25	0	60.0	40.0	0.854
	26-35	2.6	55.3	42.1	(1.34,4)
	36-55	6.9	48.3	44.8	
Level of education of education	Illiterate	0.0	100.0	0.0	15.6
	Primary	64.3	35.70	0.0	(0.016, 6)
	Secondary	2.0	56.0	42.0	
	Tertiary	0.0	66.7	33.3	
Years in business	Less than 1	0.0	100.0	0.0	0.891
	1-5	4.3	54.3	41.3	(2.3, 6)
	6-10	5.6	50.0	44.4	
	11-20	0.0	75.0	25.0	
Undergone food safety training	Yes	4.9	63.4	31.7	5.0
	No	3.2	38.7	58.1	(0.081, 2)

3.4.3 Personal hygiene and sanitary knowledge of salad vendors

Majority of the vendors (90 %) reported that those handling food should have health check regularly, however, a few thought that regular health check was not important (Table 3.4). Majority (75 %) of the respondents disagreed that contaminated food could be detected by taste. However, majority of the vendors reported that washing hands, use of gloves, and use of detergents reduces food contamination. Many of the vendors reported that eating and drinking while preparing food increases chances of contamination, however, more than 80 % of the

vendors rejected the notion that cleaning and sanitation of equipment increased risk of food contamination, chemicals and food ingredients should be stored in store, raw food should be mixed with processed food and salads can be prepared on dirty surfaces. Majority (97%) of the vendors reported that cleaning equipment should be done at the end of processing, cross contamination with microorganisms is possible and contaminated food have a change in colour. However, more than 90 % of the vendors reported that temperature control is important in storage and processing of food. The mean of the percentage scores for the knowledge on food hygiene among the vendors was above average

Table 3. 4: The level of knowledge of good sanitary practices among street food vendors

Statement	% of the respondents		
	True	False	Don't know
Food production staff should have health check	90.4	9.6	0
Contaminated food can be detected by taste	15.1	75.3	9.6
Washing hands reduces risk of food contamination	94.5	5.5	0
Working without protective clothing is allowed	11	89	0
Using gloves reduces risk of food contamination	98.6	1.4	0
Eating and drinking while handling food increase contamination	84.9	8.2	6.8
Cleaning and sanitation of equipment increase risk of food contamination	2.8	97.2	0
Working with jewelry is allowed when handling food	2.7	95.9	1.4
Detergents remove contaminations	95.9	2.7	1.4
Clean is the same with sanitized	82.2	6.8	11
Chemicals and food ingredients should be stored in store	1.4	98.6	0
Salads can be prepared on dirty surfaces	8.2	91.8	0
Cleaning equipment should be done at the end of processing	97.2	2.8	0
Cross contamination of microorganisms can occur when dirty and sanitized food are kept together	89	11	0
Contaminated food have change in color	79.5	20.5	0
Raw food can be mixed with processed food	2.7	97.3	0
Temperature control is important in storage and processing of food	95.9	4.1	0

3.4.4 Food hygiene practices

Majority of the respondents (48 %) do not wear jewelry, do not rub their hands on the face and hair (44 %) and over 90 % of the respondents would sometimes smoke or chew gum while working and serving food to the customers (Table 3.5). All the respondents washed their hands after visiting toilets, more than 90 % of the respondents used detergents whenever they washed their hands and wore hand gloves when handling and distributing food. However, those who used gloves while handling food, only 10 % washed their hands after using gloves while 68 % only washed sometimes and not often. Many of the respondents (49 %) rarely wore nail polish while handling food while 36 % never wore nail polish. However, majority of the respondents wore protective clothing while handing food. Majority of the vendors (96 %) washed their hands after touching raw food, cleaned their working area (93%), checked shelf life of the products they bought and they cleaned food storage area before storage (94 %). However, a few of the respondents (14 %) agreed to be wiping their hands on the apron while majority of the respondents (68 %) sometimes did that. Only around 3% never tried to wipe their hands using the apron. Majority of the respondents (64 %) also rarely treated water for preparing food, 31 % of the respondents sometimes treated while only 6 % ensured water for food preparation was treated

Table 3. 5: The level of hygiene practices among street food vendors

	Percent Response			
Parameter (n-73)	Always	Sometimes	Rarely	Never
Do you wear jewelry and watch while working	25.0	48.6	15.3	11.1
Do you rub your hands on face, hair while working	11.1	44.4	31.9	12.5
Do you smoke or chew gum while working	8.3	91.7	0.0	0.0
Do you use detergent whenever you wash your hands	98.6	1.4	0.0	0.0
Washing hands after visiting toilet	100.0	0.0	0.0	0.0
Do you use gloves when touching or distributing food	91.7	6.9	1.4	0.0
Do you wash your hands before wearing gloves	73.6	22.2	4.2	0.0
Do you wash your hands after using gloves	9.7	68.1	22.2	0.0
Wear nail polish while handling food	4.2	11.1	48.6	36.1
Apron/ ppe while working	52.8	30.6	9.7	6.9
Use protective clothing	81.9	12.5	5.6	0.0
Do you wash your hands after touching raw food	95.8	2.8	1.4	0.0
Do you wipe your hands with apron	13.9	68.1	15.3	2.8
Do you treat water for cleaning food	5.6	30.6	63.9	0.0
Do you clean working area	93.1	1.4	5.6	0.0
Do you check shelf life of food at delivery	95.8	2.8	1.4	0.0
Do you clean the food storage area before storage	94.4	5.6	0.0	0.0

The linear regression model of socio-demographic characteristics significantly ($p<0.001$, $R^2 = 0.422$) predicted the safety and hygiene practices scores (Table 3.6). Vendors who had been in business for over 10 years were three times (3.36) more likely to have more satisfactory food safety and hygiene practices than those than had been in business for less than a year ($p<0.05$). The linear predictor model of food safety knowledge on food safety practices scores was significant ($p<0.001$), Figure 3.2. Variation in knowledge scores accounted for 38.4% variation in food safety and hygiene practices scores.

Table 3. 6: Linear regression model for socio-demographic characteristics determinants of food safety and hygiene practices scores

Socio-demographic characteristics		Beta	Std. Error	t value	odds ratio	p-value
Intercept		75.41	2.99	25.22		<0.001
Gender	Female [R]				1.00	
	Male	-0.39	1.08	-0.36	0.68	0.719
Age (years)	18-25 [R]				1.00	
	26-35	3.37	1.95	1.73	29.13	0.089
	36-55	3.58	2.08	1.72	35.75	0.092
Level of education	Illiterate [R]				1.00	
	Primary	-2.69	3.16	-0.85	0.07	0.398
	Secondary	-2.64	2.92	-0.90	0.07	0.371
	Tertiary	-7.44	3.78	-1.97	0.00	0.054
Years in business	Less than 1 [R]				1.00	
	1 to 5	-9.04	4.00	-2.26	0.00	0.334
	6 to 10	-0.83	2.88	-0.29	0.44	0.775
	>10 years	1.22	1.25	0.97	3.39	0.028
Has food safety training	No [R]				1.00	
	Yes	1.45	1.13	1.29	4.26	0.204

[R] denotes the reference category for a specific variable. R^2 is 0.422

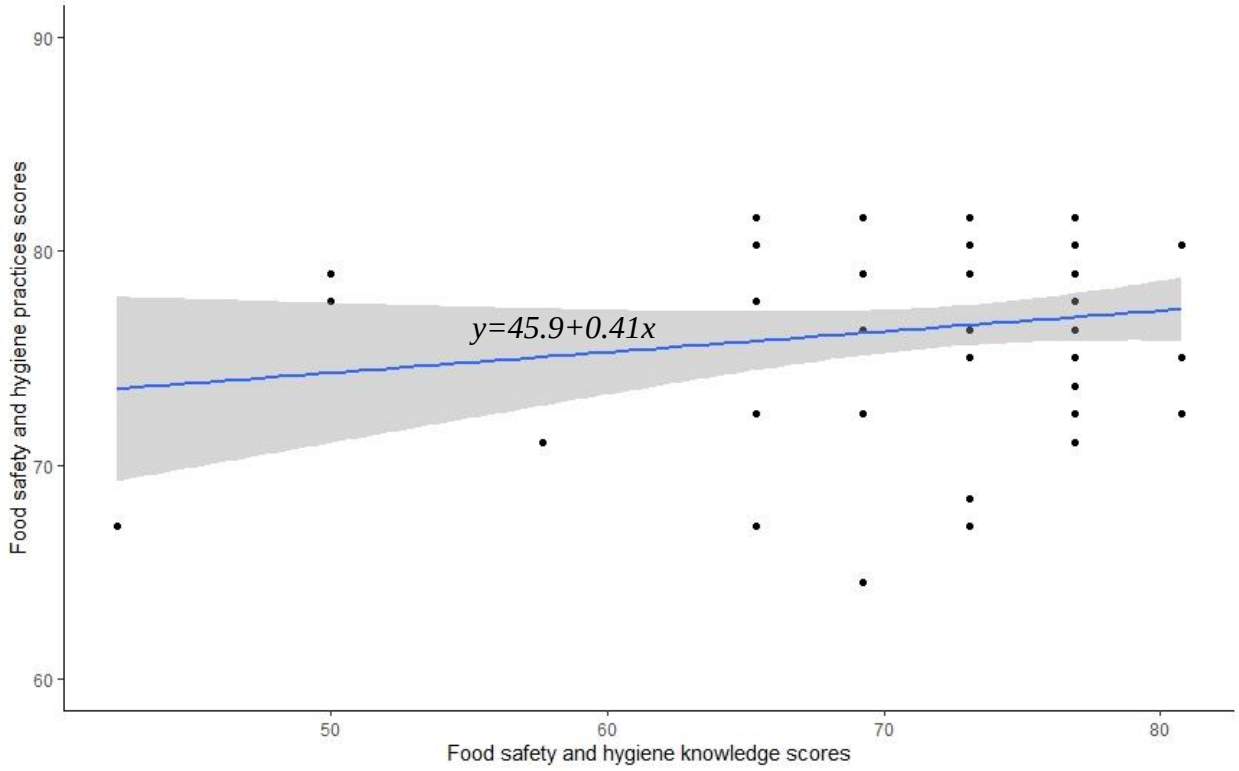


Figure 3. 2: Linear regression predictor model of food safety and hygiene practices scores by knowledge scores. R^2=0.384

3.5 Discussion

During the survey, it was found that majority of the vendors were males and most were in the age category of 26- 35 years. There has been an increase in number of men selling street vended food which for a long time has been a preserve of women and this is because of lack of employment. These results are in accordance with those reported in Kenya and South Africa by Duse *et al*. (2003) and Muindi and Kuria (2005) where majority of the vendors were reported to be males. The results, however, contradict many of the research findings where many of the vendors have predominantly been women as they use it to supplement family income (Okojie and Isah, 2014; Nurudeen *et al*., 2014) as well as contributing significantly to the informal sector of the economies (Abakari *et al*., 2018). Majority of the vendors also have been in the food vending trade for about 5 years. More experience in street vending business gives one edge over the others however, according to Parajuli, (2013) street vending business is one of the most vulnerable business due to pollution, natural calamities and health. These findings are

consistent with those reported by Nurudeen *et al*., (2014). In their findings, they reported that over 70 % of the interviewed vendors had been in the business for about to five years and according to Muzaffar and Malik (2009) there has been clear increase in the number of people vending foods in the streets.

The vendors had various levels of education, with majority having the basic level of education in Kenya. This is because street vending of food is seen as belonging to those who are economically disadvantaged and the people engaged in this business lack opportunity to further their education (Okojie and Isah, 2014). Low educational levels and lack of employment contributes to increase in number of vendors in street food entrepreneurship (Muzaffar and Malik 2009). A study done in South Africa by Martins, (2006) documented similar findings where majority of the vendors had attained a secondary education, however, the results contradicts other studies where many of the respondents had only a primary level of education (Georges, 2000). The level of education had effects on food handling practices, as majority understood the need for hygiene while handling foods. More than half of the respondents had some training on food safety handling practices. These results, however, contradicts findings by Okojie and Isah (2014) who reported lesser number of people as having been trained on food handling practices. The Kenyan bylaws advocate that food handlers should have training on food handling practices.

All those interviewed agreed that poor hygienic practices resulted in food-borne diseases, while majority of the respondents indicated that contamination through water and food may result in foodborne diseases. Poor hygienic practices promote contamination and introduction of pathogenic microbes in foods (Velero et al., 2016). Therefore, routine hygiene is important as it reduces risks associated with food poisoning (Czarniecka-Skubina *et al*., 2018). These results are in agreement with those reported by Nurudeen *et al*. (2014). In their results they

pointed that poor hygienic practices or lack of it results in food borne diseases. These results also confirm that because the vendors understood poor hygienic practices are source of food borne diseases, an improvement in hygiene within the surrounding where the food are sold may lead to relatively safe food which are less contaminated with pathogenic microbes (Leus *et al*., 2006). Food safety also depends on both personal and environmental hygiene; many vendors agreed that skin infections may not force one to take leave from work while only a few respondents reported that only sick carry pathogens causing foodborne diseases and they are mostly found on the skin, nose and mouth. According to Nurudeen *et al*. (2014) vendors with undressed skins that discharge are important risk factors in food contamination that may result in food poisoning. The occurrence of these pathogens within the sites is a health risk to children, adults and even older people, an aspect that more than 90 % of respondents agreed with.

About 53 of the vendors had moderate level of knowledge with those having satisfactory and unsatisfactory level of knowledge being 43% and 4.1%, respectively. The level of education significantly influenced the level of knowledge ($p<0.05$, $\chi 2= 6$) and is consistent with other studies which reported a significant association between education and knowledge score (Zyoud et al., 2019). Respondents with a high level of education reported higher knowledge scores than those with a lower level. According to Johnson et al. (2003) there is a direct relationship between education level and experience on food safety knowledge. Education level, residential area, age, gender, socio-economic status and employment status have been shown to affect food safety knowledge, attitude, behaviors, perception and practice (Soon et al., 2012; Zyoud et al., 2019). Food safety knowledge has been found to increase with increase in length of practice and training. Food safety improvement is imperative and can be realized when those involved in handling it acquire safety knowledge through education. According to Roberts et al., (2008) when food handlers have training they are better placed to respond to questions on food safety and knowledge than those without training.

Majority of the respondents agreed that various sanitary practices are important in ensuring safety of the food vended in the street and those handling food should occasionally have health check, wash their hands using detergents to reduce food contamination. Also it is important that equipment is washed at the end of every process. Hand washing is effective way in preventing the spread of foodborne diseases. Good hand washing technique is significant in reducing spread of infectious food borne diseases (Boshell, 2013). However, these results contradicts those reported by Lubos, (2014) where majority of the respondents had little knowledge on the importance of hand washing when handling foods and very few (24 %) were aware that it is necessary to wash hands after using handkerchief. In fact high risk areas such as where vendors prepare and sale their food require the highest level of food hygiene and safety compliance

Many of the respondents agreed that cross contamination of the pathogens is possible and this may occur when harmful microorganisms are spread between food, surfaces and equipment. Cross contamination is possible through mixing raw and cooked food during storage; however, this practiced was not common among the interviewed vendors. This result agrees with those reported by Campbell, (2011) where it was possible that cross contamination was due to use of same chopping board for cutting salads and raw meats as well. For instance, salad is prepared on a chopping board and the board is not washed well before preparing or chopping other salads. The cross contamination by the pathogens is a concern since major disease outbreaks are associated with cross contamination (Park *et al*., 2010; Grappasoni *et al*., 2018). However, according to Campbell, (2011) the risk of posed by cross contamination when food is prepared may not be very high since very few salads accompaniments. Therefore cleaning using detergents to wipe out places of work and to clean the boards for chopping salads can prevent cross contamination.

Many of the respondents reported that sometimes they wore jewelry, rubbed their hands on the face and hair while working, however, many did not smoke or chew gum while working. This implies that the chances of cross contamination with various pathogens are high since many if not all of the jewelry worn are neither washed or sanitized or even removed during food preparation. This contradicts the results reported by Czarniecka-Skubina *et al*. (2018) where majority of the respondents did not wear any jewelry on their heads or hands, hand clean and safe hands and did not have any skin problem. Majority of the respondents wore aprons to cover their clothes. The results agree with those reported by Czarniecka-Skubina *et al*. (2018) and Tiisekwa, (2013) where vendors used aprons either with long or short sleeves. This action is taken to help in preventing contaminants in their clothes from being transferred into the salads. The results are in agreement with a similar one where 69 % of respondents wore aprons to reduce contamination of cut fruits (Cuprasitrut *et al.,* 2011). It is important that any one preparing food should wear protective clothing such as apron, and head covering. Many respondents complied with certain aspects directly related to personal hygiene. In all cases, the vendors washed their hands after visiting toilets, nearly all the vendors used gloves while handling food, and washed their hands before putting on a glove. The findings are in agreement with those reported by Reang and Bhattacharjya (2013). Many of the respondents agreed that temperature control is important in storage and processing food. According to Campbell (2013) temperature abuse may occur when food is stored at wrong temperatures for long time. Again when food is not adequately cooked in the correct temperature they may enhance contamination of food by pathogens and therefore cross contamination may easily occur. Education level of the vendors was found not to be significantly related to food safety and hygiene practices. This is probably because majority of the respondents had at least basic education of the Kenyan system. This contradicts findings by Faremi et al., (2018) where education level of food vendors was significant related to food safety and hygiene. Water contamination was found to

be related to food contamination, contaminated water contains pathogenic microbes which can contaminate food prepared for consumption. The linear regression model of socio-demographic characteristics significantly ($p<0.001$, $R2 = 0.422$) predicted the food safety practices scores. Vendors who had been in business for long had satisfactory food safety practices than those than had been in business for less than a year. Being long in business, level of education and training was a strong predictor for food safety practices level

3.5.1 Conclusion

This study shows that majority of the respondents had formal education and were trained on food handling practices, and this may have had an effect on their perception towards hygiene. Most of them practiced good hygiene especially during food handling and serving. However, some of the vendors exhibited poor food handling practices therefore likely to affect the quality of the salads they handle. These poor handling practices poses a great risk to the consumers of the salads.

3.5.2 Recommendations

The county government of Nairobi under the departments of food, agriculture and forestry and sanitation and the public health department of the Ministry of Health should conduct awareness among street vendors and consumers through regular trainings on food safety and hygiene.

There is a need by the National government to provide basic infrastructures and establishment of adequate working conditions of street vendors as well as their code of practice.

CHAPTER FOUR
EXPOSURE TO PATHOGENIC MICROORGANISMS THROUGH CONSUMPTION OF MIXED VEGETABLE SALADS IN PIPELINE NAIROB, KENYA

4.1 Abstract

Street-vended food including vegetable salads is gaining importance in Kenya due to its economic contributions through job creation as well as reducing food insecurity. However, they serve as potential contaminants responsible for various diseases. This study was conducted to determine exposure to pathogenic microorganisms through consumption of street vended mixed vegetable salads sold in Pipeline Nairobi, Kenya. A survey was conducted using questionnaires targeting 80 consumers who were selected randomly and interviewed on different aspects such as consumer characteristics and consumption trends. A total of 38 different mixed vegetable salads were sampled from different street vendors during the survey. The samples were transported to the laboratory and analyzed for *Staphylococcus aureus, Escherichia coli, Salmonella SPP* following recommended standard procedures. Consumption and contamination were then combined to estimate exposure of consumers. Majority of the consumers (64 %) were men within the age bracket of 26-35 and most of them had an estimated body weight of above 60 kgs. About 91 % of respondents purchased mixed salads on weekly basis and consumed it directly without additives. From the survey, majority (67 %) of respondents reported an increase in consumption trend, which was linked to increased number of vendors along the streets. The salad consumption was characterized by triangular distribution and ranged from 0.53 to 4.01 g/kgbwt/day with an average consumption of 1.88 g/kgbwt/day. *Staphylococcus aureus* was present in 98 % the samples while *Escherichia coli* tested positive for about 73 % of the samples. Only 18 % of the analyzed samples were contaminated with *Salmonella spp*. The *S. aureus* concentrations ranged between 2.01 log CFU/g and 3.77 log CFU/g while that of *E. coli* ranged between 2.63 log CFU/g to 3.49log CFU/g. The average exposure for *Staphylococcus aureus* was 5.83-log cfu/kgbwt/day, *E.coli*

was 5.50-log cfu/kgbwt/day while *Salmonella spp* was 0.19 log cfu/kgbwt/day. The 95th percentile (P95) exposure for *Staphylococcus aureus* was 10.92 log cfu/kgbwt/day, *E.coli* was 10.15 log cfu/kgbwt/day while *Salmonella spp* was 0.58 log cfu/kgbwt/day. Mixed vegetable salads sampled from different areas had high microbial contamination levels and the presence and growth of these pathogens is a true reflection of poor hygienic practices by the street food vendors. Concerted effort by public health officers is required to train and monitor street vendors on hygiene and handling practices.

4.2 Introduction

Fresh and locally prepared mixed vegetable salads are common in Kenya at either various homes and or a long several streets (Mbae *et al*., 2018). Mixed vegetable salads production is gaining popularity in Kenya because the sector has become an alternative source of employment to various people in the country coupled with their health and nutritional benefits (Gitahi *et al.,* 2012). Mixed salads, which are foods primarily made from raw vegetables mixed together is gaining prominence due to their health and nutritional benefits (Kibitok and Nduko, 2016). They are rich in vitamins, minerals, dietary fiber, and phyto nutrients; however, they are also potential sources of pathogenic microorganisms. However, they are usually not subjected to any form of heat treatment or may be partially cooked before consumption (Harris et al., 2003). Furthermore, the ingredients used are often not adequately washed and peeled making consumption of the commodity a potential source for food borne diseases.

There has been a tremendous increase in street food consumption with more than 40 % of Kenyan population both in the rural and urban areas reported to consume street foods either as salads or in any other form (Muhonja and Kimathi, 2014). However, the quality of raw materials, food handling and storage practices has affected the safety of street foods. Even though street vended foods are of economic benefits to vendors, most of the vendors are often

poor, uneducated, and lack knowledge in safe food handling practices, environment sanitation and hygiene (Khairuzzaman *et al*., 2014). Improper handling and preparation of street foods by vendors has resulted to food poisoning in different outlets (Fukuda 2015). In most cases, street food vendors use contaminated protective clothing and are not certain on water source used in cleaning raw products, utensils as well as consumer hands. Also some of the street vended foods are sold under terrible environmental conditions such as near sewer lines and in open air markets which predispose consumers to health risks from myriad of foodborne pathogens especially those of bacterial origin (Todd *et al*., 2009). Similarly, some vendors may by raw materials from dubious sources, which are already contaminated with foodborne pathogens (Islam *et al*., 2015).

Several studies have reported contamination in cooked foods, and on food-handling personnel with various pathogenic enteric microorganisms, and documented poor food-handling practices in food joints (Githaiga *et al*., 2012; Kariuki *et al.,* 2017). Again, various diseases have been associated with fresh fruits and vegetables. The most important pathogenic microorganisms of fresh cut produce include *Campylobacter* spp., *E. coli, Salmonella* spp., *Shigella* spp. Other bacteria of concern are *Listeria monocytogenes, Staphylococcus aureus, Yersinia enterocolitica* (Mbae *et al*., 2018). Therefore, contaminations by microbes have negative effect on the product including spoilage, decreased sensory appeal and decreased shelf life. Ensuring food safety and hygienic practice among vendors is a challenge that has occurred for many years, and therefore there is need for vendors to adhere to food safety regulations and hygiene practices that will ensure no contamination of foods with microbes. In view of the above risks, the current study was intended at evaluating the consumption pattern and microbial quality of vegetable salads vended in the streets of Nairobi County, Pipeline ward by examining the salads for microorganisms and food-borne pathogens that are commonly found in fresh cut vegetables

4.3 Materials and method

4.3.1 Study area

The study area is described in section 3.3.1 of this dissertation

4.3.2 Sampling

Pipeline ward was purposively selected because of availability of mixed vegetable salads sold along its streets. Approximately over 120 vendors sell mixed vegetable salads along with egg, smokies and sausages in the study area. Simple random sampling was used select vendors and consumers who took part in the research.

4.3.2 Sample size

The sample size required in the research was larger than 5 % of the population size (n/N>0.05). Nassiuma's formula (Nassiuma, 2000) was used to determine the sample size n=

$$n = \frac{\mathrm{N}(C\mathrm{V}^2)}{CV^2 + (N-1)e^2}$$

Where; n is the Sample size, N is the population Size, CV is Coefficient of Variation and e is the margin of error. For this study, N =60 for sample population while the number of consumers were 396. Since Nassiuma (2000) recommends a Coefficient of variation (CV) ranging between 20%-30% and a margin of error (e) of between 2%-5%, this study will use a CV of 20% and a margin of error of 2%. The sample size will be calculated as shown below; Sample population for microbial analysis N=60, CV=20% and e=0.02

$$n = \frac{60(0.2^2)}{0.2^2 + (60-1)0.02^2}$$

n=38

Sample population for consumers N=396, CV=20% and e=0.02

$$n = \frac{396(0.2^2)}{0.2^2+(396-1)0.02^2}$$ n=80

This gave a sample population of 38 samples for microbial analysis. 80 consumers of the vegetable salad participated in the research. These consumers were interviewed on demographic characteristics, consumer characteristics as well as consumption trends. Samples with tomatoes, onions and coriander were selected randomly. The ward was divided proportionally into four clusters namely, Taj mall, Stage Mpya, Pipeline and Outer ring road. For each identified cluster, the sample size for the salads vendors was determined and the proportionate of the required samples randomly picked. Forty vendors were sampled from all the clusters. Upon selection of the food vendor, 50g salads were purchased in duplicate. The food samples were transferred into sterile bags aseptically and then placed into sanitized cooler box containing dry ice. The samples were transported to the University of Nairobi and stored in the refrigerator at $4^{o}C$.

4.3.3 Preparation of samples

Homogenization of salad samples was done by sterilized motor and pestle after taking 25 g of the samples. The homogenized samples were inserted aseptically into sterile cotton plugged conical flask containing 0.9 % sterile sodium chloride solution. After that, these were mixed thoroughly by shaking for 20 times. The mixture was allowed to stand for 5-10 minutes.

4.3.4 Microbial Analysis of the vegetable salad samples

4.3.4.1 Determination of total viable counts

Total viable bacterial count of the samples was determined according to Maturin and Peele (2001). About 25 grams of the salad samples was aseptically transferred to sterile stomacher bags and 225 ml of buffered peptone water (Oxoid) added to the sample. The samples were homogenized using a stomacher for 2 to 3 minutes and then transferred into a sterile bottle. The samples were further diluted by transferring 1ml of the food homogenate in to test tube containing 9 ml of sterile maximum recovery diluent (MRD) to prepare 10-2 dilution. One ml of the dilutions 10-2 was dispensed into sterile Petri plate in triplicate. The pour plate method

was done aseptically using sterile molten plate count agar (HI Media). The plates were then incubated at 37 ºC for 48 h. The colonies were counted using STUART SCIENTIFIC, UK which allows viewing of individual colonies. All plates showing colony counts between 30 and 300 were selected and their colony-forming unit per gram of food calculated by multiplying by the dilution factor.

4.3.4.2 Determination of *E. coli* population

The population of *E. coli* was determined according to ISO 16649-2:2001:2001-04. About 25 g of the sample were weighed in sterile stomacher bags. Approximately 225 ml of buffered peptone water added to the sample. The sample was homogenized using a stomacher for about 2- 3 minutes and dispensed in a sterile bottle. 1ml of the sample was diluted in 9 ml of the diluent. The same was repeated until a dilution of 10-2 was arrived. One ml of the diluent was dispensed into sterile petri dishes in triplicate then approximately 15 ml of molten violet red bile agar (VRBA) (OXOID CM 0107) was dispensed to each plate and mixed by swaying to allow even distribution of the inoculum with the medium. The media was allowed to solidify at room temperature then incubated at inverted positions at 37 ºC for 18 to 24 hours. Red colonies growing above or inside the media were observed. After the specified period of incubation the typical CFU of VRBA positive Escherichia coli in each dish containing typical CFUs were counted using a colony counter. The average numbers of colonies were computed at every dilution level and the final figure was computed by factoring in the dilution factor.

4.3.4.3 Determination of *Staphylococcus aureus*

The population of *Staphylococcus aureus* was determined according to ISO 6888-1 (E). About 25 grams of the sample was weighed in sterile stomacher bags. 225 ml of buffered peptone

water (BPW) added to the sample. The sample was homogenized using a stomacher for about 2- 3 minutes and dispensed in a sterile bottle. 1 ml of the sample was diluted in 9 ml of the diluent (MRD). Approximately 15 ml of molten baird parker agar (BP) was dispensed to each plate and mixed with 1 ml of the sample by swaying to allow even distribution inoculum with the medium. The plates were incubated at 37 ^{o}C for 48 hours after which colonies were observed. Staphylococcus was identified based on characteristic hallow zones around. Confirmatory tests were done using coagulase test, catalase test and sugar fermentation test. A sample of the colony in plasma was prepared and incubated for 2-6 hours at 37^{o}C. Where there was no clot formed, incubation was continued up to 24 hours. Clotting occurred for coagulase positive samples.

4.3.4.4 Determination of *Salmonella* spp

The population of Salmonella spp was determined according to ISO 6579:2002(E). About 25 grams of the sample was weighed in sterile stomacher bags. 225 ml of buffered peptone water (BPW) then added to the sample. The sample was homogenized using a stomacher for about 2- 3 minutes and dispensed in a sterile bottle. Buffered peptone water containing the sample was incubated for 24 hours at 37 ^{o}C. The sample was sub cultured in Rappaport-Vassiliadis medium with soya (RVS) broth (0.1 ml of the sample was added to 10 ml RVS) and incubated at 42oC for 24 hours. The sample was sub cultured on Xylose lysine deoxycholate (XLD) agar in a petri dish using streak plate method. Streaked Xylose lysine deoxycholate plate was incubated at 37 ^{0}C for 24 hours. The colonies were identified based on colony characteristics and were then sub cultured on Triple sugar/iron agar (TSI) agar and Urea broth by stubbing into the agar. Triple sugar/iron agar was then incubated for 24 hours at 37 ^{o}C while urea broth was incubated at 37 ^{o}C for 6 to 24 hours. For TSI agar, pink surface/ colonies with black coloration on the slant section were expected while on urea broth, negative result was expected for positive salmonella test. The colonies on TSI agar were sub-cultured on Nutrient agar and

incubated at 37 ^{o}C for 24 hours. Antibody antigen agglutination test using latex agglutination Kit from HI media was used where agglutination was evidence of *Salmonella*.

4.3.5 Estimation of the quantitative intake of microorganisms through salad consumption

The consumption data obtained based on daily consumption of salads was calculated by dividing the weekly intake of salads (grams/person) by respondents' body weights and dividing again by 7 days JECFA (2011) so as to obtain the amount consumed per kg body weight per day. The microbial distribution in the salads was obtained by dividing the levels of the respective microorganism per gram of vegetables salads with the levels of intake being calculated by multiplying the microbial loads and the salad consumption to obtain the estimated intake per kg body weight per day. The average bacterial intake and the 95th percentile (P95) intake levels estimations were obtained using Monte Carlo simulation models. The intake variability was determined by performing 1,000, 000 iterations for the consumption data

4.3.6 Data collection methods and tools

The consumption level of street food was determined by means of a face-to-face interview using a semi-structured questionnaire (Appendix 1). Data collected included general information such as demographic information, training and related information, Consumption trends, and consumption levels. Microbiological counts for *Staphylococcus aureus*, *E. coli* and *Salmonella* spp counts were converted to base-10 logarithm of colony forming units (CFU) per gram of each sample and entered into excel.

4.3.7 Data analysis

The data collected was coded to facilitate statistical analysis. All statistical analyses were performed using the Statistical Package for the Social Sciences, Version 20.0 (SPSS, Inc., Chicago, IL, USA) and descriptive statistics were calculated for all variables. The quantitative data on microbial counts was subjected to analysis of variance (ANOVA) using Genstat version 15th edition, VSN International. Differences among the results were compared using Fishers

protected LSD test at 5 % probability level. The salad consumption was characterized by triangular distribution.

4.4 Results

4.4.1 Demographic characteristics of consumers of street vended mixed vegetable salads sold in pipeline

The result showed that majority of consumers of street vended mixed vegetable salads sold in various streets of pipeline are men at 64 % while women only constituted 36 % (Table 4.1). Most of the surveyed consumers were of age bracket 26-35 followed by 18-25, 36-55 and above 55 years respectively. About 40 % of consumers attained collage/university education, 47 % secondary education, 9 % primary education, 1 % adult education while 4 % were illiterate. It was also observed that most of the interviewed consumers had estimated body weight above 60kgs and heights ranging from 1.7-2.0 meters. Majority of them were married and salaried employees.

Table 4. 1: Demographic characteristics of interviewees at pipeline

Characteristics	Category	Percentage of N
Gender	Male	64.4
	Female	35.6
Age (Years)	18-25	34.5
	26-35	43.7
	36-55	19.5
	Above 55	2.3
Education	Collage/university	39.5
	Secondary	46.5

	Primary	9.3
	Adult education	1.2
	Did not attend	3.5
Estimated body weight (Kgs)	30-40	0.0
	41-50	5.7
	51-60	41.4
	Above 60	52.9
Estimated heights (M)	1-1.3	1.1
	1.4-1.6	44.8
	1.7-2.0	54.0
Marital status	Married	47.1
	Separated	6.9
	Widowed	1.1
	Single	41.4
	Divorced	2.3
	Not applicable	1.1
Occupation	Salaried employee	31.0
	Farmer	1.1
	Self employed	23.0
	Casual labour	24.1
	Student	9.2
	House wife	3.4
	Unemployed	6.9
	Other	0.0
	Not applicable	1.1

Key: N – number of interviewees

4.4.2 Mixed vegetable salad consumption preference in pipeline area Nairobi County, Kenya

The study revealed that about 91 % of interviewed consumers' consumed mixed vegetable salads sold in the streets (Table 4.2). Majority of the consumers purchased less than 50 grams of mixed vegetable salad directly without additional treatments mainly once a week. Most of the consumers (94 %) consumed mixed vegetable salads a lone without sharing and with the largest percentage purchasing from preferred vendors. It was also realized that the majority (38 %) of consumers interviewed could not explain their reason of preference, 32 % level of preference was influenced by service delivery of various vendors, 29 % hygiene and 1 % ingredients.

Table 4. 2: Consumption of vegetable salads in pipeline

Consumption	Category	Percentage (%) N

Mixed vegetable salads sold in the street	Yes	90.8
	No	9.2
Frequency	Once daily	17.4
	Twice daily	12.8
	Once a week	43.0
	Twice a week	23.3
	Other (specify)	3.5
Unit package purchased weekly	20 grams	20.9
	30 grams	26.7
	50 grams	41.9
	70 grams	9.3
	Other	1.2
Mode of consumption	Direct consumption	95.3
	Treated before consumption	4.7
Shared salad consumption	No	94.0
	Yes	6.0
Preferred place of purchase	Preferred vendor	62.8
	Any street vendor	37.2
Reason for preference	Hygiene	29.4
	High service delivery	31.8
	Ingredients	1.2
	Don’t know	37.6

4.4.3 Consumption trends of street vended mixed vegetable salads in pipeline Nairobi, Kenya in the past 2 years

From the survey, about 67 % of the interviewed consumers reported an increase in consumption trend, while 19 % reported a decreasing trend (Figure 4.2). About 14 % of the respondents reported that consumption neither increased nor decreased. About 43 % of the interviewed consumers linked the observed trends to increased number of vendors along the streets, 42 % could not explain while 15 % linked it to Hygiene.

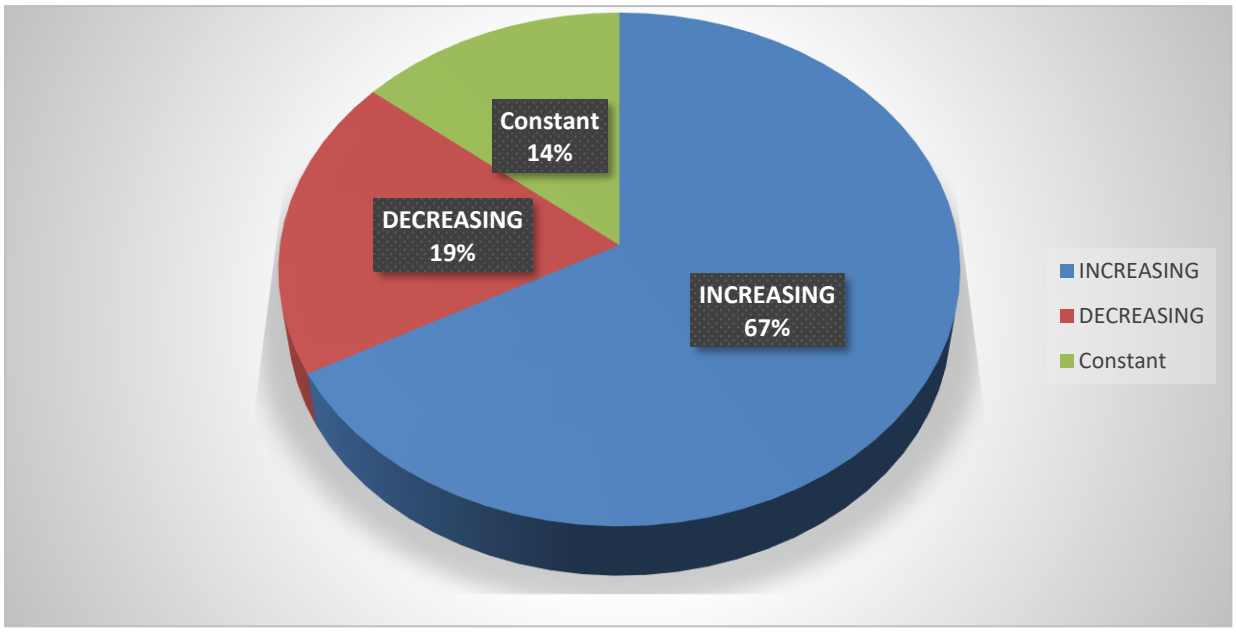


Figure 4. 1: Consumption trend of street vended salads in pipeline in the past 2 years

4.4.4 Total viable counts and different pathogens contaminating mixed vegetable salads sold in the streets

The microbial analysis of the salad samples collected from different locations in Pipeline ward indicate that the vegetable salads were contaminated with various pathogens. There were significant differences ($p \leq 0.05$) in the number of pathogens with regards to vendor locations (Table 4.3). The total viable counts of all the pathogens isolated from the samples ranged from 4.16 log CFU/g to 4.46 log CFU/g and indicate that samples collected from Stage Mpya had the highest level of contamination while the least contamination of samples was observed in Outering ring road. There were significant differences ($p \leq 0.05$) in the population of pathogens isolated in different sites with Taj Mall area consistently having lower contamination levels compared with other sites. The pathogens isolated include *Staphylococcus aureus*, *Escherichia coli and Salmonella* spp. *Staphylococcus* was present in 98 % of the analyzed samples, *Escherichia coli* tested positive for about 73 % of the samples while only 18 % of the analyzed samples were contaminated with *Salmonella* spp. The *Staphylococcus aureus* load was between $\log_{10}$ of 2.01 CFU/g in vegetable salads collected from Taj Mall area and 3.77 log

CFU/g in samples that were collected from Outering road vendors. The concentrations of *Escherichia coli* load ranged between 2.63 log CFU/g in vegetable salads collected from Taj Mall area and 3.49 log CFU/g in samples that were collected from Outering road vendors while the concentrations of *Salmonella* spp ranged between 0.34 log CFU/g in vegetable salads collected from Outering road and 0.59 log CFU/g in samples that were collected from Stage Mpya vendors.

Table 4. 3: Contamination by various microorganisms in raw vegetables salads sold in various vendor locations at Embakasi, Nairobi Kenya

Vendor Location	**TVC**	**Microbial Contaminants (logCFU/g)**			**Mean**
		S. aureus	*E. coli*	*Salmonella*	
Outer ring road	4.16±0.053^{b}	3.77±0.203^{a}	3.46±0.434^{a}	0.34±0.345^{a}	2.52±0.19^{a}
Pipeline	4.28±0.053^{ab}	3.43±0.203^{a}	2.72±0.434^{ab}	0.46±0.345^{a}	2.20±0.19^{a}
Stage mpya	4.46±0.053^{a}	3.41±0.203^{a}	3.49±0.434^{a}	0.59±0.345^{a}	2.49±0.19^{a}
Taj Mall Area	4.35±0.053^{ab}	2.01±0.203^{b}	2.63±0.434^{b}	0.45±0.345^{a}	1.69±0.19^{b}
Mean	4.31	3.13	3.08	0.46	2.23
LSD (P≤0.05)	0.15	0.52	0.87	0.69	0.61
P Value	0.003	<0.001	0.049	0.001	0.001
CV (%)	5.5	28.9	44.6	29.0	48.3

Results are means ± standard deviations of triplicate samples. CFU: Colony forming units, TVC: Total viable counts. Values followed by the same letter within the same column are not significantly different at p≤0.05.

4.4.5 Salad Consumption and Microbial intake levels

The salad consumption was characterized by triangular distribution (Figure 4.3) and ranged from a minimum of 0.53 g/kgbwt/day to 4.01 g/kgbwt/day with an average consumption of 1.88 g/kgbwt/day (Figure 4.3). The Total viable count (TVC), *Staphylococcus aureus* and *E. coli* also had triangular distributions while the *Salmonella SPP* levels were exponentially distributed. The Total viable count (TVC) had the highest load at 3.50-4.48 cfu/g while the least loads were found for salmonella at -0.01 – 0.45 cfu/g. The E coli and staphylococcus levels were almost equal at -0.05-4.48 and -0.78 – 4.72 cfu/g (Figure 4.4)

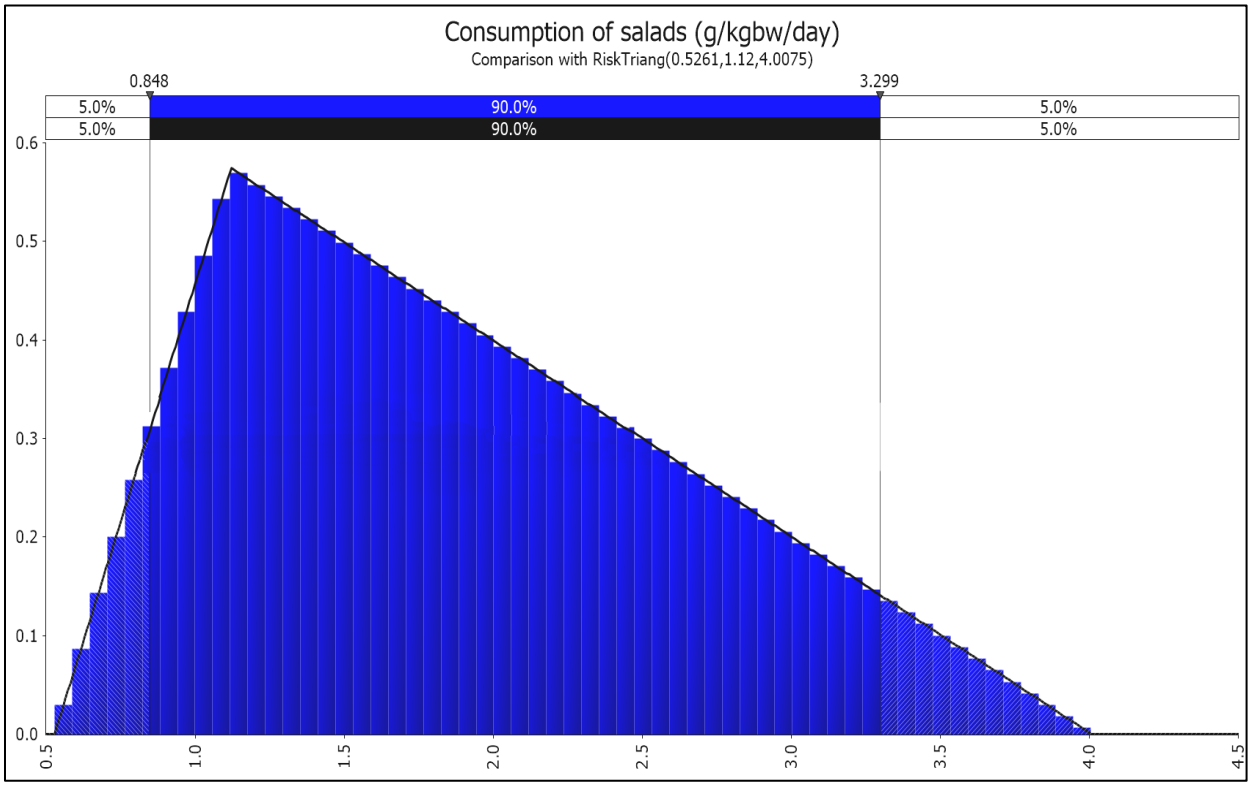


Figure 4. 2: Triangular distribution for consumption of mixed vegetables (g/kgbwt/day)

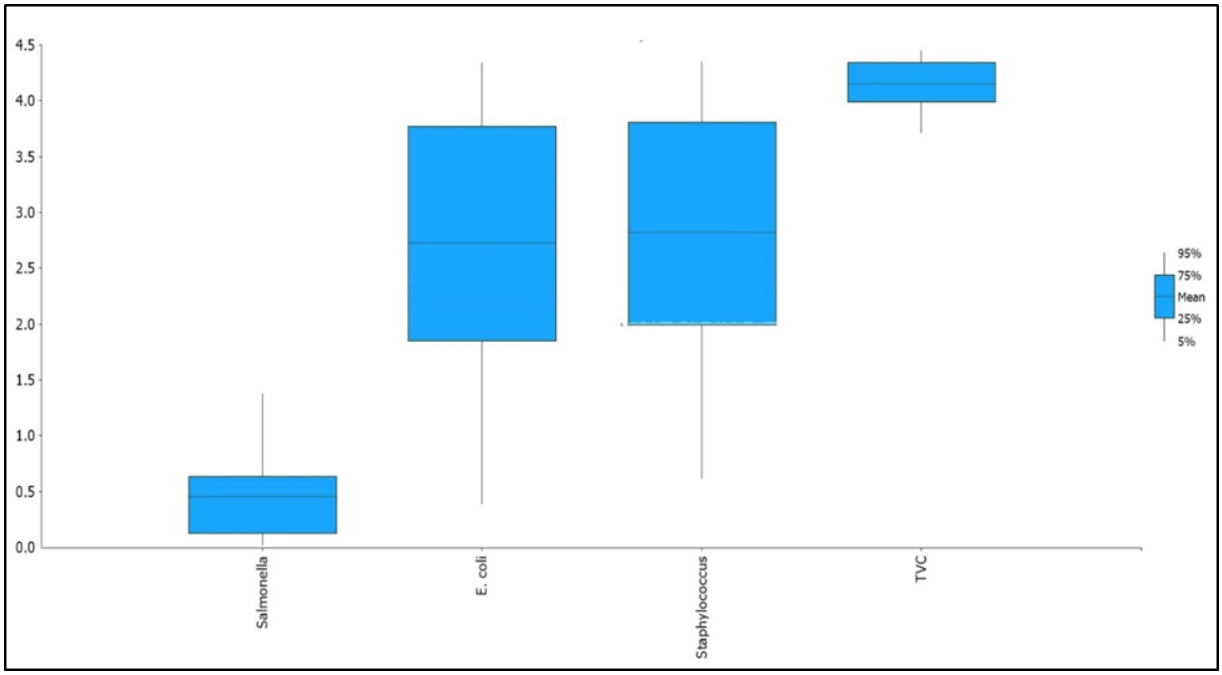


Figure 4. 3: Distribution of bacteria in mixed vegetables (log cfu/g)

The microbial intake was least for *Salmonella* and highest for the Total viable count TVC for the means and 95th percentile respectively (Table 4.4). However, the intakes from *E coli* and *staphylococcus* were almost similar for both the mean and the 95th percentile. The current findings also showed that the intake from *Salmonella* would be as much as (∞) as the bacterial load would be in the food or none at all in case the food was not contaminated with the bacteria.

Table 4. 4: Estimated intake levels for quantitative microbial distributions through salad consumption

Measurement	**Intake estimates**			
	Range (95% CI)		**Mean**	**95th percentile**
	Min	**Max**		
TVC intake (log cfu/kgbwt/day)	2.27	17.29	8.13	14.23
Staphylococcus intake(log cfu/kgbwt/day)	1.63	12.39	5.83	10.92
Salmonellae intake (logcfu/kgbwt/day)	0.00	∞	0.19	0.58
E coli intake (log cfu/kgbwt/day)	1.62	12.33	5.80	10.15

CI-Confidence interval, Bwt-body weight, Min-minimum intake, Max-Maximum, CI-Confidence interval, Bwt-body weight, Min-minimum intake, Max-Maximum, Bwt – Body weight

4.5 Discussion

The demographic profile of the respondents revealed that the majority of consumers of street vended mixed vegetable salads sold in various streets of pipeline were men. These results concur with findings by Hill *et al*., (2006) who reported men as the majority of the street vended food consumers. This can be attributed to the fact that most African men find it difficult to cook their own food hence they prefer readily available and affordable foods like street vended foods (Hill *et al.,* 2016). Most of the interviewed consumers had high school education, others attained collage/university education while the remaining had primary education and below. These results are in accordance with those reported by Martins (2006). Majority of the consumers were youths of age bracket 18 to 35 years with estimated body weights above 60 kgs and heights ranging between 1.7-2.0 meters. This is an indication that mixed vegetable salads may be rich in nutrients which results into increased heights and body weight of consumers (Steyn *et al.,* 2011). However, a clear study should be done to a certain whether the increase in weight is as a result of consumer becoming obese. Most of them were married and salaried employees. These findings were in agreement with that of (Mathye and Maliwichi 2015) who reported that most street vended food consumers are youths who are married and have regular source of income. In addition, the nature of employment of various consumers can influence their decision of preference to street vended mixed vegetable salads over homemade food.

Majority of consumers preferred mixed vegetable salads sold in the streets compared to franchised ones. This can be attributed to various factors such as low prices, time convenience and other social factors (Mathye and Maliwichi 2015). Most of the consumers purchased less than 50 grams of mixed vegetable salad once a week and consumed it directly without adding any additional treatments. In most cases, the interviewed consumers consumed mixed vegetable salads a lone without sharing. This could be due to financial constraints and or

differences in eating habits of specific consumers. The largest percentage of consumers purchased mixed vegetable salads from preferred vendors. Most of the consumers could not explain their reasons for preference while other consumer's preferences were influenced by service delivery of various vendors, hygiene and the ingredients used. Consumer preference can also be attributed to several factors predicting consumer patronage behavior such as attitude, subjective norm, food quality and cultural influence among others (Ayodele and Panama 2016). From the study, majority of the interviewed consumers (67 %) believed that consumption trend of mixed vegetable salads has been increasing in the past two years, 17 % believed on a decreasing trend while 14 % thought it was constant. Most consumers linked the observed trends to increased number of vendors, others could not explain while others linked it to hygiene. The increased consumption trend can be attributed to high population growth, increased labor force and the demand for ready to eat foods (Rane 2011). Similarly, consumption trend might have increased due to their cheap costs, taste, the convenience they offer to the consumer and easy access since most of the street vended foods are sold along streets and footpaths (Rahaman *et al.*, 2014).

The microbial intake was the least for *Salmonella* and highest is for the TVC for the means and 95^{th} percentile respectively. However, the intakes for *E coli* and *staphylococcus* were almost similar for both the mean and the 95^{th} percentile. The findings also showed that the intake from *Salmonella* would be as much (∞) as the bacterial load would be in the food or none at all in case the food was not contaminated with the bacteria. The findings reinforces the fact that human exposure to food related pathogens is mainly through diet that we consume and the pathogens are transmitted by food handlers in a food chain commencing at the point of production (Skovgaard, 2004). Pathogens from fecal, nose or throat, and skin are likely to be transmitted by the hands, emphasizing the need for effective hand hygiene (Lang et al., 2014).

Taking into consideration the effects of these pathogens, the estimated high exposure to *E coli*, *staphylococcus, Salmonella,* is of great significant to health.

The presents study also aimed at evaluating the contamination levels of various pathogenic microbes in most consumed mixed vegetables salads vended in the streets of Pipeline ward in Nairobi County. The results show that highest total viable counts were observed in vegetable salads at $\log_{10}$ 4.46 CFU/g in Stage Mpya among the four sampling zones. Nearly all the samples analyzed were contaminated with *Staphylococcus,* while more that 75% of the samples were contaminated with *E. coli* and some samples were contaminated with *Salmonella* spp. The results show that vegetable salads pose public health concern, indicating the need to improve hygiene practices in preparation and handling of the street fruits to avoid contamination. These results compare with those reported by Muganga (2001) where *Escherichia coli* was detected in samples collected from Korogocho slums of Nairobi. These results also concur by those reported by Kibitok and Nduko, (2016) and Mbae *et al*., (2018). However, in their results *E. coli* was more predominant than *Salmonella* spp.

The presence of *E. coli* in the analyzed vegetable salads could be an indication that raw materials were contaminated from sewage, faeces, soil, water, as result of the water used during the growing processes of the vegetables (Pesewu *et al*., 2014). This may be responsible for food borne illnesses that enter the body through contaminated food or water (WHO, 2017). The presence of these pathogens in vegetables salads points to the poor sanitary practices by the vendors (Mbae *et al*., 2018) and also confirms that the entire process of vegetable salad preparations such as transportation, storage, and processing of the salad is of poor sanitary quality (Beuchat *et al*., 1996).

The presence of these pathogens in the final product of mixed vegetable salad could be because of carry over effect due to poor field sanitation, unhygienic practices at harvesting, transport,

and marketing stages, absence of surface decontamination, and cross-contamination at eateries (Mbae *et al*., 2018). Because most of these vegetables are served raw or when partially cooked, they can be a source of contamination (Wango *et al*., 2012). The high frequency of bacterial pathogens found contaminating mixed vegetable salads may also be attributed to the high population of bacteria in the environment of human beings and therefore can contaminate salads when hygiene is not prioritized (Pesewu *et al*., 2014).

Again it has been reported that during processing of raw vegetables into making salads, an environment that is conducive to the pathogens is created that ensures faster multiplications (Muhonja *et al*., 2014). This is because the salads have a lot of moisture that promotes the proliferation of these pathogens (Muhonja *et al*., 2014). However, according to Rane. (2011), fermentation of the vegetable salads increases acidity that may promote the growth of some microbes such as *Salmonella spp* which is known to grow at 4.2 – 8.2 pH levels. *Salmonella spp* was not the predominant pathogen in this study however, its occurrence in the vegetable salads remain a concern

Among the sampling zones, Taj Mall consistently had low levels of contamination. This may be because Taj Mall is considered of high class compared to the other three sampling zones and the environment appears clean without dirty wastes and garbage. The hygiene status of the other sites is often questionable. Rubbish, blocked drainages and flying insects always accompany them. Factors such as dirty untreated water, improper storage, poor transportation of food, lack of hygienic practices during handling and preparation, infected food handlers among others are also common in these sites and these may lead to outbreak of food borne diseases (Mbae *et al*., 2018).

The number of pathogens increased with the amount purchased in all the enumerated and analyzed samples. In this study, we estimated the total numbers and kinds of microorganisms

consumed by the consumers. These results corresponds to those reported by Lang *et al*., (2014) where respondents were found to consume microbes in the range of 10^6–10^9 CFUs. Majority of the respondents weighed more than 60Kg and averagely consumed 5.83-log cfu/kgbwt/day of *Staphylococcus* spp, 5.80-log cfu/kgbwt/day of *E. coli*, and 0.19-log cfu/kgbwt/day of *Salmonella* spp. A study conducted by USDA (2010) revealed that the infectious doses for Staphylococcus aureus was 500 to 800 CFUs, E.coli 10^6–10^8 CFUs while Salmonella was $<10^1$ to 10^9 CFU. The pathogens were at unacceptable high levels in street vended vegetable salads and only a few samples were confirmed to be contaminated with *Salmonella spp*. The identified pathogens have been implicated in food poisoning and as such are very harmful to human beings. For instance the mean average for *E. coli* was of 3.08 log CFU/g, while that of *Staphylococcus aureus* log cfu/ g was 3.13, which is very high, compared to the Kenya Bureau Standards recommended value of < 10 CFU/g. As for *Salmonella* spp Kenya Bureau Standards recommends no contamination in 25 g of sample, therefore the results surpassed the recommended value. The WHO recommends that the bacterial load $<10^4$ cfu/g is satisfactory, 10^4 < 10^5 is acceptable, and $>10^5$ unsatisfactory (WHO/FAO, 2012). The counts at unacceptable levels may be as results of inadequate handling and poor sanitary knowledge amongst the different food handling chains from the farms and through transportation which may have been a source of contamination to the vendors. The study findings can be compared with those of Tambaker *et al*., (2009) who found severe contamination of food through handing process, which is a worrying concern.

4.5.1 Conclusion

This study confirms the high pathogenic population of bacteria especially *S. aureus* and *E. coli* in mixed vegetable salad samples sold in Pipeline Ward, Nairobi County due to poor handling of the vegetables right from the farm up to consumption point. This calls for awareness of the possible hazardous effect of consuming street sold vegetable salads.

4.5.2 Recommendation

It is important that policies that regulate microbial quality of street vended foods are put in place and are practiced by vendors. Food hygiene and safety training among the vendors may also help in alleviating risks that may be associated with these foods.

CHAPTER FIVE

GENERAL DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 General discussion

Majority of the street salad vendors (60%) were male and many (53%) were in the age category of 26-35 years with majority (73%) having attained secondary education. The results confirm those reported by Muindi and Kiru (2005) and Cortese *et al*., (2015) where majority of the vendors were reported to be males. However, according to Nurudeen *et al*., (2014); Alves da Silva, *et al*., 2014; Samapundo *et al*., 2015; Low *et al*., (2016) many of the street food vendors are reportedly female because they this type of business to supplement their family income and therefore there has been increase in the number of women venturing into the business (WHO, 2016). Many of the interviewed vendors had attained basic level of education. The reason many ventured into street food vending business is because of lack of employment and low education levels (Okojie and Isah, 2014). However, majority of the respondents in this study had trained in food handling and hygienic practices which is inconsistent with other findings (Okojie and Isah, 2014). According to Okojie and Isah, (2014) lesser number of people as having been trained on food handling practices.

Results reveal that many of the respondents had agreed that poor hygienic conditions while preparing food causes food borne diseases. The results agree with those reported by Nurudeen *et al*. (2014) where poor hygienic practices promote contamination and introduction of pathogenic microbes in foods. Poor hygienic practices are source of food borne contamination with food borne pathogens. Therefore routine hygiene is important as it cuts risks associated with food poisoning (Skubina *et al*., 2018). However, the occurrence of these pathogens within the sites where food is prepared is a health risk, an aspect that more than 90% of respondents agreed with. Sanitary practices such as washing hands using detergents, regular visits to the doctor for health check are important in reducing contamination. Hand washing is an effective

way to the spread of foodborne diseases; therefore, good hand washing practices are important in decreasing spread of infectious food borne diseases (Boshell, 2013). Food contamination is possible with food borne pathogens through surfaces of equipment, chipping boards for cutting salads, mixed foods. This contamination is therefore a concern as it may result in an outbreak of food borne disease (Grappasoni *et al*., 2018). In order to avoid cross contamination, cleaning places of work and the chopping boards using detergents is important. Majority of the respondents wore aprons while working in order to preventing contaminants in their clothes from being transferred into the salads. It is important that any one preparing food should wear protective clothing such as apron, and head covering.

Linear regression analysis reveals that education level has significant influence on food safety knowledge and this supported by other studies where a significant association between education and knowledge score was noted (Zyoud et al., 2019). Respondents with a high level of education have high knowledge scores than those with a lower level. According to Johnson et al. (2003) there is a direct relationship between education level and experience on food safety knowledge. Education level, residential area, age, gender, socio-economic status and employment status have been shown to affect food safety knowledge, attitude, behaviors, perception and practice (Soon et al., 2012; Zyoud et al., 2019).

The microbiological analysis of the vegetable salads indicated that majority had been contaminated with *Staphylococcus, Escherichia coli and Salmonella* spp. The *E. coli* was present in in nearly all the samples The *E. coli* concentrations in the samples and ranged between of 2.63 log CFU/g and of 3.49 log CFU/g. The mean average for E. coli was 3.047 log CFU/g, was higher than the recommended value by the Kenya Bureau Standards recommended value of < 10 CFU/g. These results concur with those reported by Kibitok and Nduko, (2016) and Mbae *et al*. (2018). *E. coli* was more predominant than *Salmonella* spp. According to Pesewu *et al*., (2014) the presence of *E. coli* in the vegetable salads could be from

sewage, faeces, soil, water, as result of the water used during the growing processes of the vegetables. The presence of these pathogens in vegetables salads points to the poor sanitary practices by the vendors (Mbae *et al*., 2018) and also confirms that the entire process of vegetable salad preparations such as transportation, storage, and processing of the salad is of poor sanitary quality (Beuchat *et al*., 1996).

Many consumers of the vegetable salads were aged between 18 to 35 year old with estimated body weights above 60kgs and heights ranging between 1.7-2.0 meters. These findings were in agreement with that of (Mathye and Maliwichi 2015) who reported that most street vended food consumers are youths who are married and have regular source of income. Majority of the consumers preferred salads prepared from the streets and from their preferred vendors and this may be because of factors such as low prices, time convenience and other social factors. Some of the consumer's preferences of vendors' salads could have been influenced by service delivery of various vendors, hygiene and the ingredients used. Consumer preference can also be attributed to several factors predicting consumer patronage behavior such as attitude, subjective norm, food quality and cultural influence among others. However, increased consumption of street vended foods may endanger the lives of many consumers because of foodborne pathogens. This situation calls for sensitization of both consumers and street food vendors on health risks accompanied by consumption of street vended food.

5.2 Conclusion

The study indicates that many of the respondents had basic education, had training on food handling practices, and had adequate information with regard to food safety and hygiene which may have had an effect on their perception towards food safety and hygiene. However, some of the vendors exhibited poor food handling practices therefore there is need for training and law enforcement governing street food vending business.

This study also confirmed the high population of pathogenic bacteria *Staphylococcus* and *E. coli* in vegetable salad samples. This high contamination levels could be attributed to poor handling practices of the vegetables right from the farm up to the vendors. This calls for awareness campaign by The Nairobi county food department and the Ministry of health public health department about the possible health hazards due to poor handling of these vegetables.

Street foods may endanger the lives of the consumer because of the harmful foodborne pathogens, which can cause serious foodborne diseases. This was evident based on the high intake levels of pathogenic microorganisms via street vended salads. .

5.3 Recommendations

i. The county government of Nairobi under the departments of food, agriculture and forestry and sanitation and the public health department of the Ministry of Health should conduct awareness among street vendors and consumers through regular trainings on food safety and hygiene.

ii. There is a need by the National government to provide basic infrastructures and establishment of adequate working conditions of street vendors as well as their code of practice.

iii. Street food vendors and consumers should be cognizant of both personal and environmental hygiene since street foods are literally prepared and served on the street with the preparation area exposed to the natural elements should be taken care of.

iv. Creation of policies that regulate microbial quality of street vended foods such as mixed vegetable salads and ensure they are put in place and are practiced by vendors

v. Food safety study should be carried out in this area to assess health risks that may arise from increased consumption of street vended mixed vegetable salads and other street

foods. The results will then be used to sensitize both consumers and vendors on health risk accompanied by street vended foods and recommended remedies.

REFERENCES

Abakari, G., Cobbina, S. J., Yeleliere, E. (2018). Microbial quality of ready-to-eat vegetable salads vended in the central business district of Tamale, Ghana. International Journal of Food Contamination. 5:3 https://doi.org/10.1186/s40550-018-0065-2

Abdalla, M.A., Suleiman, S. E., Alien, Y. Y. H. A., and Bakheit, O. (2008). Food safety knowledge and practices of street food vendors in Khartoum City. Sudanese Journal of Veterinary Science & Animal Husbandry. 47: 123–136.

Akusu, O.M., Kiin-Kabari, D.B., and Wemedo, S.A. (2016). Microbiological quality of selected street vended foods in Port Harcourt metropolis, Rivers State, Nigeria. *Sky* Journal of Food Science, 5(2): 008-11.

Alves da Silva, S., Cardoso, R. C. V., Góes, J. Â. W., Santos, J. N., Ramos, F. P., Bispo de Jesus, R., Sabá do Vale, R., and Teles da Silva, P. S. (2014). Street food on the coast of Salvador, Bahia, Brazil: A study from the socioeconomic and food safety perspectives. Food Control, 40: 78-84.

Amoah, D. (2014). Microbial risk assessment of mixed vegetable salads from selected canteens in the Kumasi metropolis, Ghana. Pp 41-56.

Ayodele, A. A., and Panama, A. E. (2016). Predictors of Consumer Patronage of Street Food Vendors in a Typical Developing Economy Context. *Developing Country Studies*, *6*(11): 105-119

Barro, N., Bello, A. R., Salvadogo, A., Ouattara, C. A., IIboudu, A. J., and Traore, A. S. (2006). Hygienic status assessments of dish washing waters, utensils, hands and pieces of monies from street food processing sites in Ouagadougou (Burkina Faso). African Journal of Biotechnology. 5: 1107–1117.

Bempah, C.K., Donkor, A.K.(2013). Pesticide residues in fruits at the market level in Accra Metropolis,Ghana, a preliminary study. *Environmental Monitoring and Assessment*, 175: 551–561.

Boshell, P. (2013). Hand Hygiene and Food Safety. https://info.debgroup.com/blog/bid/226858/hand-hygiene-and-food-safety. Accessed on 21 April 2019.

Campbell, P. T. (2011). Assessing the knowledge, attitudes and practices of street food vendors in the city of Johannesburg regarding food hygiene and safety (Doctoral dissertation, University of the Western Cape).

Campbell, P. T. (2013). Assessing the knowledge, attitudes and practices of street food vendors in the City of Johannesburg regarding food hygiene and safety. Master's Thesis, School of Public Health, University of the Western Cape.

Centers for Disease Control and Prevention (CDC) (2017). Multistate outbreak of Shiga toxin-producing Escherichia coli O157:H7 infections linked to ready-to-eat salads (final update)," 2017, https://www.cdc.gov/ecoli/2013/O157H7-11-13/index.html.

Coban, G. I& Bilgin, S. (2015). Development of the scale of hygıene behavıors for nursıng students. BMC Medical Research Methodology, 15(1), 69: DOI 10.1186/s12874-015-0064-4

Comfort O. C. (2010). Food safety and hygienic practices of street food vendors in Owerri, Nigeria at Owerri, Nigeria. *Studies in Sociology of Science*, 1(1): 50-57.

Cortese, R.D.M., Veiros, M.B., Feldman, C. and Cavalli, S.B. (2016). Food safety and hygiene practices of vendors during the chain of street food production in Florianopolis, Brazil: A cross-sectional study. *Food Control*, 62:178-186.

Cuprasitrut, T., Srisorrachatr, S., and Malai, D. (2011). Food safety knowledge, attitude and practice of food handlers and microbiological and chemical food quality assessment of food for making merit for monks in Ratchathewi District, Bangkok. *Asia Journal of Public Health*, 2 (1): 27-34.

Czarniecka-skubina, E., Trafiałek, J., Wiatrowski, M and Głuchowski, A. (2018). An evaluation of the hygiene practices of European street food vendors and a preliminary estimation of food safety for consumers, conducted in Paris. *Journal of Food Protection*, 81: 1614–1621

Duse, G. A., da Silva, M. P. and Zietsman, I. (2003). Coping with hygiene in South Africa, a water scarce country. *International Journal of Environmental Health Research,* 13: S95– S105.

FAO, (2011). Food consumption food group accessed on http://www.fao.org/fileadmin/templates/ess/documents/food_security_statistics/FoodConsumptionFoodGroups_en.xls

Faremi, F. A., Olatubi, M. I., and Nnabuife1, G. C. (2018). Food safety and hygiene practices among food vendors in a tertiary educational institution in South Western Nigeria. European Journal of Nutrition & Food Safety 8(2): 59-70.

Food Safety in China: A Mapping of Problems, Governance and Research; Forum on Health, Environment and Development: Guangzhou, China, (2014).

Fukuda, K. (2015). Food safety in a globalized world. https://www.scielosp.org/pdf/bwho/2015.v93n4/212-212/en

Georges, C. (2000). FAO technical support for improvement within the street food sector, Pretoria, South Africa.

Gitahi, M., G., Wangoh, J., and Njage, P. M. K. (2012). Microbial safety of street foods in industrial area, Nairobi. *Research Journal of Microbiology 7*: 297-308.

Githaiga, G. M. (2012). Microbial quality, strain distribution and enterotoxigenicity of selected food borne pathogens in relation to the hygienic practices in industrial area, Nairobi, Kenya, M.Sc thesis, University of Nairobi, Nairobi, Kenya, http://www.uonbi.ac.ke/openscholar/john.wangoh/files/2012_gitahi_msc_thesis.pdf

Grappasonni, I., Marconi, D., Mazzucchi, F., Petrelli, F., Scuri, S., Amenta, F. (2013). Survey on food hygiene knowledge on board ships. International Maritime Health. 64 (3): 160-7.

Grappasonni, I., Marconi, D., Mazzucchi, F., Petrelli, F., Scuri. S., Amenta, F. (2013). Survey on food hygiene knowledge on board ships. *International Maritime Health*, 64, 3: 160-7.

Grappasonni, I., Petrelli, F., Scuri, S., Mahdi, S. S., Sibilio, F., and Amenta, F. (2018). Knowledge and attitudes on food hygiene among food services staff on board ships. Ann Ig, 30(2): 162-172.

Hannan, A., Rehman, R., Saleem, S., Khan, M.U., Qamar, M.U. and Azhar, H., (2014). Microbiological analysis of ready-to-eat salads available at different outlets in Lahore, Pakistan. *International Food Research Journal*, 21(5):123-136

Hanson, L.A., Zahn, E.A., Wild, S. R., Döpfer, D., Scott, J. and Stein, C. (2012). Estimating global mortality from potentially foodborne diseases: an analysis using vital registration data. *Population Health Metrics*, 10(1): 5-15

Harris, L. J., Farber, J. N., Beuchat, L. R. *et al. (*2003). Outbreaks associated with fresh produce: incidence, growth, and survival of pathogens in fresh and fresh-cut produce,Comprehensive. *Reviews in Food Science and Food Safety,* 2: 78–141.

Henson, S. (2013). The economics of food safety in developing countries. In ESA Working Paper No. 03–09; Food and Agriculture Organization: Rome, Italy, 2003.

Hill, J., Mchiza, Z., Fourie, J., Puoane, T., and Steyn, N. (2016). Consumption patterns of street food consumers in Cape Town. *Journal of Family Ecology and Consumer Sciences*, 2006: 25 - 35

Islam, S., Nasrin, N., Rizwan, F., Nahar, L., Bhowmik, A., Esha, S. A., and Ahmed, M. (2015). Microbial contamination of street vended foods from a university campus in

Bangladesh. *Southeast Asian Journal of Tropical Medicine Public Health*, *46*(3), 480-485.

Johnson, L., Shin, J. H., Feinstein, A. H., & Mayer, K. J. (2003), Validating a food safety instrument: Measuring food safety knowledge and attitudes of restaurant employees. Journal of Foodservice Business Research, 6, 49–65.

Kakonge, J and Omiti, J (2018, November 08). Challenges, prospects from operating street food sector. Daily Nation. Retrieved from https://www.nation.co.ke/kenya/blogs-opinion/opinion/challenges-prospects-from-operating-street-food-sector-107042

Kariuki, E. N., Ng'ang'a, Z. W., and Wanzala, P. (2017). Bacteriological contamination of street foods among street food vendors in githurai and gikomba markets-Nairobi county, Kenya. *International Journal of Innovative Research and Advanced Studies*, 4(1): 337-346.

Kenya National Bureau of Statistics. (2010). http://www.knbs.or.ke. Accessed 12/03/2018

Khairuzzaman, M., Chowdhury, F. M., Zaman, S., Al Mamun, A., and Bari, M. (2014). Food safety challenges towards safe, healthy, and nutritious street foods in Bangladesh. *International Journal of Food Science*, 2014: 121-134.

Lang, J. M., Eisen, J. A., and Zivkovic, A. M. (2014). The microbes we eat: Abundance and taxonomy of microbes consumed in a day's worth of meals for three diet types', PeerJ, 2014(2), pp. 1–39. doi: 10.7717/peerj.659.

Leech, N.L., Barret, K.C., and Morgan, G, A. (2005). SPSS for intermediate statistics: Use and Interpretation.

Leus, F.R., Mpeli, R.R., Venter, P. and Theron, M. M. (2006). Assessing food safety and associated food handling practices in street food vending. *International Journal of Environmental Health Research*, 16(5): 319-328.

Low, W. Y., Jani, R., Halim, H. A., Alias, A. A., and Moy, F. M. (2016). Determinants of food hygiene knowledge among youths: A cross-sectional online study. *Food Control*, 59: 88-93.

Lubos, L. C. (2014). Food safety knowledge and handling practices of street vendors. *Asian Journal of Health*, 4: 1-14.

Magnússon S.H., Gunnlaugsdóttir H., van Loveren H., Holm F., Kalogeras N., Leino O.(2012). State of the art in benefit–risk analysis: food microbiology. Food and Chemical Toxicology.50:33–39.

Margaret, G., Paul, O., and Judith, K. (2010). Hygienic practices and occurrence of coliforms and Staphylococcus on food at a public hospital in Kenya. *Journal of Applied Biosciences*, 27(27): 1727-231.

Martins, J. H. (2006). Socio-economic and hygiene features of street food vending in Gauteng. *South African Journal of Clinical Nutrition*, 19(1), 18-25.

Mathye, R., and Maliwichi, L., L. (2015). An investigation into factors contributing to the consumption of street foods and franchise foods in Vhembe District, Limpopo Province. *Journal of Human Ecology*, *49*(3), 281-284.

Mbae, K. M., Ndwiga, M. K., and Kiruki, F. G. (2018). Microbiological quality of kachumbari, a raw vegetable salad popularly served alongside roast meat in Kenya. Journal of Food Quality, Article ID 8539029, 7 pages https://doi.org/10.1155/2018/8539029

Mensah, P., Manu, D.Y., Darko,K.O., Ablordey, A. (2001). Streets foods in Accra, Ghana: how safe are they? Bull World Health Organization, 80(7):546–54

Muganga, M. E. N. (2001). Nutritional and safety quality of street foods in Korogocho and Industrial Area of Nairobi, Kenya. M.Sc Thesis, University of Nairobi

Muhonja, F., and Kimathi, G. K. (2014). Assessment of hygienic and food handling practices among street food vendors in Nakuru Town in Kenya. *Science Journal of Public Health*, *2*(6), 554-559.

Muindi, O. K., and Kuri, E. (2005). Hygiene and sanitary practices of vendors of street foods in Nairobi, Kenya. *African Journal of Food and Nutritional Development*, 5: 1–15.

Muzaffar, A. T., Huq, I., & Mallik, B. A. (2009). Entrepreneurs of the streets: An analytical work on the street food vendors of Dhaka City. International journal of Business and Management, 4(2), 80-88.

Nurudeen, A. A., Lawal, A. O., and Ajayi, S. A. (2014). A survey of hygiene and sanitary practices of street food vendors in the Central State of Northern Nigeria. *Journal of Public Health and Epidemiology,* 6(5), 174-181.

Odonkor, S.T., Adom, T., Boatin, R., Bansa, D., Odonkor, C. J. (2011). Evaluation of hygiene practices among street food vendors in Accra metropolis, Ghana. *Food Science - Elixir International Journal,* 41:5807-5811.

Okojie, P. W., and Isah, E. C. (2014). Sanitary conditions of food vending sites and food handling practices of street food vendors in Benin City, Nigeria: implication for food hygiene and safety. *Journal of Environmental and Public Health, Volume* 2014, Article ID 701316. http://dx.doi.org/10.1155/2014/701316

Parajuli, A. (2013). Livelihood opportunities of street vendors: Study of Ason, Indrachowk and Khullamunch of Kathmandu Metropolitan City.

Park, S., Kwak, T., and Chang, H. (2010). Evaluation of the food safety training for food handlers in restaurant operations. *Nutrition Research and Practice*, 4(1):58- 68

Pesewu, G. A., Gyimah, I. K., Agyei, J. N. Y. K., Adjei, D. N., Olu-Taiwo, M. A., Asmah, R. H., and Ayeh-Kumi, P. F. 2014. Bacteriological assessment of the quality of brassica

oleracea var. capitata grown in the Accra Metropolis, Ghana. Africa Journal Microbiology Research. 8 (22): 2223-2228

Pokhrel, P., and Sharma, D. (2016). Study on assessment of food safety knowledge and practices among the street food vendor of urban and semi urban areas of Guwahati, Assam. *International Journal of Home Science*, 2(2): 85-89.

Pulliam, J.R., Epstein, J.H., Dushoff, J., Rahman, S.A., Bunning, M., Jamaluddin, A.A., Hyatt, A.D., Field, H.E., Dobson, A.P. and Daszak, P. (2011). Agricultural intensification, priming for persistence and the emergence of Nipah virus: a lethal bat-borne zoonosis. *Journal of the Royal Society Interface*, 9(66): 89-101.

Rahman, M. M., Rahman, M. H., & Ansary, N. P. (2014). Safety issues of street foods in Bangladesh. *Time Journals of Biological Sciences and Technology*, *2*(1), 21-32.

Rane S. (2011). Street vended food in developing world: Hazard analyses. *Indian Journal of Microbiology*, 51: 100-106.

Rayza D. M., Cortesea, M. Veirosa, B., Charles F., Suzi B. C. (2016). Food safety and hygiene practices of vendors during the chain of street food production in Florianopolis, Brazil: A cross-sectional study (2016)

Reang, T., Himadri Bhattacharjya, H. (2013). Knowledge of hand washing and food handling practices of the street food vendors of Agartala, a North Eastern city of India. *Journal of Evolution of Medical and Dental Sciences*, 2 (43): 8318-8323.

Richter, C.H., Custer, B., Steele, J.A., Wilcox, B.A., and Xu, J. (2015). Intensified food production and correlated risks to human health in the Greater Mekong Subregion: a systematic review. *Environmental Health*, 14(1):.43-57

Roberts, K. R., Barrett, B. B., Howells, A. D., Shanklin, C. W., Pilling, V. K., & Brannon, L. A. (2008). Food safety training and foodservice employees' knowledge and behavior. Food protection trends, 28(4), 252-260.

Roesel, K.; Grace, D., Toyomaki, H., Mwai, C., Desissa, F. (2014). Informal markets are not necessarily dangerous and formal markets are not necessarily safe, 1st ed. In Food Safety and Informal Markets: Animal Products in Sub-Saharan Africa; Roesel, K., Grace, D., Eds.; Routledge: Oxford, UK.

Samapundo, S., Climat, R., Xhaferi R., Devlieghere, F. (2015). Food safety knowledge, attitudes and practices of street food vendors and consumers in Port-au-Prince, Haiti. *Food Control*, 50: 457-466

Schreinemachers, P., Tipraqsa, P.(2012). Agricultural pesticides and land use intensification in high, middle and low income countries. Food Policy 2012, 37, 616–626.

Skovgaard, N. (2004). Risk assessments of *Salmonella* in eggs and broiler chickens. Interpretative summary-Microbiological Risk Assessment Series 1, WHO/FAO 2002, xxii+ 44 pages, soft cover; ISBN 92 9 156230 7 (WHO); Sw. fr. 14.00/US $12.60. In developing countries: Sw. fr. 9.80. Order no. 1150537; E-mail: bookordersωho. int; in US: qcorpγompuserve. com. International Journal of Food Microbiology, 2(91), 223.

Soon, J.M., Baines, R., and Seaman, P. (2012). Meta-analysis of food safety training on hand hygiene knowledge and attitudes among food handlers. *Journal of food protection*, 75(4): 793-804.

Steyn, N. P., Labadarios, D., and Nel, J., H. (2011). Factors, which influence the consumption of street foods and fast foods in South Africa-a national survey. *Nutrition Journal*, 10(1), 104.

Tiisekwa, A, B. (2013). Compliance by street salad and juice vendors with national food safety and quality requirements a case of Morogoro Municipality, Tanzania. Master Thesis, Sokoine University of Agriculture.

Todd, E. C., Greig, J. D., Bartleson, C. A., and Michaels, B. S. (2009). Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 6. Transmission

and survival of pathogens in the food processing and preparation environment. *Journal of Food Protection*, *72*(1), 202-219.

USDA 2010. Effective doses and pathogen carriage. 2010 food safety education conference. https://www.fsis.usda.gov/shared/PDF/Atlanta2010/Slides_FSEC_JGreig_Doses.pdf

Valero, A., Rodríguez, M. Y., Posada-Izquierdo, G. D., Pérez-Rodríguez, F., Carrasco, E., & García-Gimeno, R. M. (2016). Risk factors influencing microbial contamination in food service centers. Significance, Prevention and Control of Food Related Diseases, 27-58.

Wango, J., Gitahi, M.G., Njage, P. M. K. (2012). Microbial safety of street foods in Industrial Area, Nairobi. *Research Journal of Microbiology*, 7: 297-308.

WHO/FAO 2010. Seventy second report of the joint FAO/WHO expert committee of food additives. Rome 2010.

WHO/FAO Joint organization (2012). Codex Alimentarius Commission on Food Hygiene

Xue, J. and Zhang, W., (2013). Understanding China's food safety problem: An analysis of 2387 incidents of acute foodborne illness. Food Control, 30(1):311-317.

Zanin, L.M., Da Cunha, D.T., De Rosso, V.V., Capriles, V.D., Stedefeldt, E.(2017). Knowledge, attitudes and practices of food handlers in food safety: an integrative review. Food Res Int. 100(Pt 1:53–62.

Zyoud, S. E., Shalabi, J., Imran, K., Ayaseh, L., Radwany, N., Salameh, R., Al-Jabi, S. (2019). Knowledge, attitude and practices among parents regarding food poisoning: a cross-sectional study from Palestine. BMC public health, 19(1), 586.

APPENDICES

Appendix 1: Consumer questionnaire

Survey on consumption patterns of mixed vegetable salads Sold in Pipeline Nairobi, Kenya

The aim of this study is to measure the current consumption pattern of mixed vegetable salads to form a basis for determination of intake and exposure levels of Salmonella SPP, Staphylococcus aureus, Escherichia coli in the salad. Your honest responses will be used for this research purpose only and shall be treated with utmost confidentiality. Your cooperation and participation is highly appreciated.

Thank you for accepting to take part in this study.

Enumerator's Name_____ Start time _____End time _____

Background information

1. **General information**

Date of interview	
Location of interview	
Date checked	
Date of data entry	

2. **Respondent and general household information**

2.1 Name of Respondent	
2.2 Respondent gender	Sex M=1 { } F=2 { }
2.3 Educational level	1=college/university 2=completed secondary 3=completed primary 4=Dropped from primary 5 =dropped from secondary 6 =in primary 7 =in secondary 8 =adult education 9=Did not attend { }
2.4 Age (years)	
2.5 Estimated body weight (Kg)	
2.6 Estimated height (metres)	
2.7 Marital status	1=married 2=separated 3=widowed 4=single 5=divorced 6=N/A { }
2.8 Main occupation	1=salaried employee 2=farmer 3=self-employment/business 4=casual laborer 5=student 6=housewife 7 =unemployed 8= other (specify) 9= N/A { }

3. Consumer study

3.1 Do you consume mixed vegetable salads sold in street 1=Yes { } 2=No { }

3.2 If no above, why _____

3.3. If yes, how often do you consume them per week? Once a daily { } Twice daily {} Once a week { } Twice a week { } other {specify} _____

3.4 What unit package do u buy? 20g {} 30g {} 50g {} 70g{} others [specify].

3.5 Do you consume all the salads alone? 1 = Yes [ ] 2= No [ ]

3.6 If not how much of the product do you, consume? _____
Who else consumes the salads?_____

3.7 Where do you buy your salads? 1= Preferred vendor [ ] 2=Any street vendor

3.8 Why do you buy from your preferred retailer?_____

4.1 Describe trend in consumption of street vended salads in Pipeline in the past 2 years

	Trend (Increasing/decreasing)	Reasons
Consumption		

4.3 Any comments you would like to share

1. _____

2. _____

Thanks

Appendix 2: Food safety knowledge and hygiene practices questionnaires

The aim of this study is to investigate food safety knowledge and practices among vendors of mixed vegetable salads sold along with street foods in Pipeline Nairobi County. Your honest responses will be used for this research purpose only and shall be treated with utmost confidentiality. Your cooperation and participation is highly appreciated.

Thank you for accepting to take part in this study.

Enumerator's Name_____ Start time _____End time _____

Background information

4. **General information**

Date of interview	
Location of interview	
Date checked	
Date of data entry	

5. **Respondent and general salad vendors information**

2.1 Name and age of Respondent	
2.2 Length in business	
2.3 Respondent gender	Sex M=1 { } F=2 { }
2.4 Educational level	1=college/university 2=completed secondary 3=completed primary 4=Dropped from primary 5 =dropped from secondary 6 =in primary 7 =in secondary 8 =adult education 9=Did not attend { }
2.5 Food safety training	1=Yes 2=No
2.6 Marital status	1=married 2=separated 3=widowed 4=single 5=divorced 6=N/A { } **[**

FOOD SAFETY KNOWLEDGE AND SANITARY PRACTICES	TRUE	FALSE	DON'T KNOW
Proper cleaning and sanitization of utensils increase the risk of food contamination.			
Using gloves while handling food reduces the risk of food contamination.			
Eating and drinking in the work place increase the risk of food contamination.			
Foodborne diseases can be result from water contamination			
Washing hands before work reduces the risk of food contamination			
Improper heating of food causes food borne diseases			
Washing utensils with detergent leaves them free of contamination.			
Children, healthy adults, pregnant women and older individuals are at equal risk for food poisoning.			
Typhoid fever can be transmitted by food.			
Disregarding hygiene rules causes food borne illness			
Foodborne diseases transmitted by food contamination			
Only sick people carry bacteria causing food contamination			
Staphylococcus aureus is among the food-borne pathogens			
During infectious disease of the skin, it is necessary to take leave from work.			
Microorganisms are in the skin, nose and mouth of healthy handlers			
Food production staff should have health check			
Working without protective clothing is allowed			
Cleaning and sanitation of equipment increase risk of food contamination			
Working with jewelry is allowed when handling food			
Clean is the same with sanitized			

Chemicals and food ingredients should be stored together			
Salads can be prepared on dirty surfaces			
Cleaning equipment should be done at the end of processing			
Contaminated food have change in color			
Raw or unclean food can be mixed with processed food			
Temperature control is important in storage and processing of food			

FOOD HYGIENE PRACTICES	**Always**	**Sometimes**	**Rarely**	**Never**
Do you wear jewelry and watch while working				
Do you rub your hands on face, hair while working				
Do you smoke or chew gum while working				
Do you use detergent whenever you wash your hands				
Washing hands after visiting toilet				
Do you use gloves when touching or distributing food				
Do you wash your hands before wearing gloves				
Wear nail polish while handling food				
Apron/ PPE while working				
Use protective clothing				
Do you wash your hands after touching raw food				
Do you clean working area				
Do you treat water for cleaning food				
Do you clean the food storage area before storage				
Do you clean working area				
Do you wipe your hands with apron				

Do you check shelf life and quality of food at delivery				

THANKS

ANNEXES

Consent form

Volunteer agreement form

Project title: Hygiene knowledge, practices and microbial quality and exposure levels of mixed vegetable salads served a long with street foods in pipeline ward of Embakasi South constituency Nairobi County.

Principal Researcher: David Obinda Kavunja.

Address: University of Nairobi, P.O Box 30197 -00100 Nairobi Kenya

General Information about the study: This study will investigate the microbial quality of mixed vegetable salads served a long with street foods determine the food safety knowledge, attitudes and practices of the vendors. Possible Benefits, Risks and Discomforts: There are no direct benefits to be gained from this study immediately, neither are there any risks associated with it. The inconvenience from the study might come from the time spend completing the questionnaire. The data obtained from the study will be used only for the purpose of the study, which is master's thesis. Confidentiality: Your participation and identity will be treated confidential. The study investigator will only use the information that is obtained from you. Your identity remains secret since a unique participant number will only designate your personal information. Your name will not appear in any reports or publications resulting from this study. After the study is completed, you may request information about the study results. Voluntary Participation and Right to Leave the Research. You participate entirely voluntarily in this study. You have the right to refuse to participate in the study. You also have the right to stop your participation in the study at any time, even after you have signed this informed consent form. The withdrawal of your consent will not cause any disadvantage or loss of advantages/privileges. Contacts for Additional Information; Any questions or any further clarifications concerning the study can be directed to: Contact of the Supervisor: Doctor Lucy Njue, University of Nairobi P.O BOX 30197-00100 Nairobi Kenya.