Evaluation of food safety knowledge and practices among consumers of foods of animal origin in the Mafikeng Local Municipality, North West Province

By

Munyai Emmanuel Khathutshelo

Student number: 18023967

Dissertation submitted in fulfillment of the requirements for the degree of Master of Science in Animal Health, School of Agriculture, Faculty of Science and Technology, North West University, Mafikeng campus

Supervisor: Dr Mulunda Mwanza

March 2015

DECLARATION

I, Munyai Emmanuel Khathutshelo, declare that the dissertation entitled "Evaluation of food safety knowledge and practices among consumers of foods of animal origin in Mafikeng Local Municipality, North West Province", hereby submitted for the degree of Master of Science in Agriculture (Animal Health), has not previously been submitted by me for a degree at this or any other university. I further declare that this is my work in design and execution and that all materials contained herein have been duly acknowledged.

Signed _____this _____ day of _____2015

DEDICATION

This study is dedicated to the following people:

To God the Father, the Son and the Holy Spirit;

To my family, for their financial assistance throughout my studies.

ACKNOWLEDGEMENTS

I thank the Almighty God for His protection, guidance and for providing me with the necessary resources during my studies.

My deep gratitude goes to my supervisor, Dr Mulunda Mwanza and co- supervisor, Dr Rendani Ndou for their support and encouragement towards the successful completion of this study. May God bless you all.

I appreciate the contributions of Dr Lebo Motsei and U. Marume (Department of Animal Health, North-West University, Mafikeng Campus) afterwards the success of this study. Sincere thanks go to Tshenolo and Katlego, Animal Health students who helped me a lot with the distribution of the questionnaires, officers from the Department of Agriculture, Health and Education, Social Workers, buyers and sellers of street-vended food, people in the shopping centres, University/schools such as Letsatsing, Matlou, Mmabatho and the North West University (NWU), primary and secondary health facilities and Hospitals.

I thank my parents, Mr and Mrs Munyai for putting me in the right track in life. God bless you.

My sincere appreciation also goes to the Postgraduate bursary Unit of the North West University, for making available the research funds to undertake this study.

ABSTRACT

Knowledge and attitudes on food safety differ from one location to another and it is always important to assess these in order to have an idea on the community's level of knowledge and attitude and their needs in terms of training and awareness in order to close the gaps.

The aim of this study was to survey and determine knowledge, attitudes and practices on food safety among consumers with regard to food of animal origin such as meat, meat products, milk and dairy products in Mafikeng Local Municipality, North West Province, South Africa.

Unsafe food is the most source of ill-health among 2 billion people worldwide and the cause of one third of deaths each year (National Institute for Allergies and Infectious Diseases, 2007b). In Africa alone, it has been estimated that, each year, 800 000 children die from food-borne related illnesses such as diarrhoea and dehydration (UN, 2004b). Immune compromised people and children are more susceptible as they fall sick and eventually die even from mild food-borne infections. Therefore, the study on the evaluation of knowledge on food safety and practices among consumers will assist and provide insights on implementation of food safety measures by consumers in the Mafikeng Local Municipality, North West Province.

The designed questionnaire was subjected to a preliminary validation to measure its clarity, the suitability of wording, and the average time needed for its completion and distributed to taxi ranks, administrative offices, buyers and sellers of street-vended food, people in shopping centres, schools such as Letsatsing Science Secondary School, Matlou High School, Mmabatho High School, colleges, the North West University, primary, secondary health facilities and hospitals. A total of 698 questionnaires were issued to respondents and targeted issues of demographics, knowledge on food safety, attitudes and practices of consumers.

The results in this study revealed that in general, majority (65.02% ± 16.64) of respondents answered correctly all questions relating to knowledge on food safety. In addition, a significant relationship ($P<0.05$) was found between gender, race and education on food safety knowledge by respondents. With regard to attitude and practices, 83.3% of questions were answered correctly by respondents. A significant correlation ($P<0.05$) was found between gender, race, education of respondents and food safety practices as well as attitude. The correlation obtained between race, knowledge and attitude might be explained by the fact

there was no equal number based on race. African respondents were in the majority (80%) while Indians, Coloured and Whites represented the remaining portion of respondents. Although level of education was associated with food knowledge and attitude, 39% of respondents neither had food safety knowledge nor passed the correct attitude towards food safety. Women showed a better understanding, knowledge and practised better in terms of food safety compared to men.

This study also revealed that there is a need for consumers to be informed about knowledge on food safety hence, the need for food manufacturing companies, State agencies and consumers to be involved. Creating awareness in terms of safe food handling practices to promote it to consumers should be cherished in order to accept several food safety measures. Educational efforts among senior managers, regardless of gender, should include the most current, research-based scientific facts related to food safety, the link between inappropriate practices and threats to health and preferred delivery methods.

With regard to the results obtained, inhabitants of the Mafikeng Municipality are knowledgeable about food safety but there is a need for all stakeholders such as the department of health, education, communication and social and rural development to join efforts in order to improve the consumers' knowledge.

Table of contents

LIST OF TABLES

LIST OF FIGURES

1. DEFINITION OF CONCEPTS

1.1. Food safety-an assurance that food will not cause any harm to consumers when it is consumed.

1.2. Food- Refer to any substance, whether processed, semi-processed or raw, which is intended for human consumption, and includes drink, chewing gum and any substance which has been used in the manufacture, preparation or treatment of "food" but does not include cosmetics or tobacco or substances used only as drugs.

1.3. Attitudes-comprised of evaluative perceptions associated with how people think, feel and behave.

1.4. Food-borne-A disease caused by consuming contaminated food or drink.

1.5. Pathogens-Any disease producing agent or microorganism.

1.6. HACCP-Food safety management plan that operates assessment of hazards, analysis, identification and implementation of critical control points.

1.7 Hazard- A biological, chemical or physical agent in, or condition of, food with the potential to cause an adverse health effect.

1.8 Food control- A mandatory, regulatory activity of enforcement by the competent health authority to provide consumer protection and ensure that all food during production, handling, storage, processing and distribution is safe, wholesome and fit for human consumption; conform to safety requirements and is honestly and accurately labelled as prescribed by law.

1.9 Risk -Refers to a function of the probability of an adverse health effect and the severity of that effect, consequential to a hazard(s) in food.

CHAPTER ONE

INTRODUCTION

Every year, worldwide, millions of people suffer from food-borne diseases and illnesses due to consumption of contaminated food, which has become one of the major public health concerns in the whole world. Knowledge of food safety is one of the biggest problem that affects people worldwide and it is a fact that some foods purchased by consumers, especially meat products, are contaminated during processing, in abattoirs, production, storage, management, handling, transportation and in butcheries. Incidents of bacterial contamination of food are occasional but their consequences have huge effects health, production, public confidence and death (Harris, 1997). Consumers' concerns about food safety are not only based on worries or health but about agriculture, ecology and food culture (Holm and Kildevang, 1996). Consumers' attitudes and practices related to food safety are themes of interest to food producers, public authorities and health educators, and have been discussed as to how food safety should be defined and how consumers should perceive and choose food (Rozin*et al.*, 1999).

Therefore, common mistakes identified include serving contaminated raw food, cooking/heating food inadequately, allowing infected persons to handle implicated food and poor hygiene. However, it is known that part of food-borne illnesses in the home results from eating raw foods of animal origin or engaging in unsafe food preparation practices in the home. Mishandling of food plays an important role in the occurrence of food-borne illnesses and is implicated in 97% of all food-borne illnesses happening in the kitchen (Howes*et al.*, 1996). Improper practices and lack of knowledge by consumers are among factors that contribute to the spread of food-borne out-breaks. Poor handling practices were the primary causes of outbreaks of infection-intestinal diseases (IID) that occurred in Wales and England (Evans *et al.*, 1998). Improper practices responsible for microbial food-borne illnesses have been documented and involve cross-contamination of raw and cooked foodstuffs, inadequate cooking and inappropriate temperature during storage (Bryan, 1988).

Consumers carry human specific pathogens such as Hepatitis A, noroviruses, *typhoidal Salmonella*, *Staphylococcus aureus* and *Shigella spp* in their hands, cuts or sores, mouth, skin and hair. They may also shed food-borne pathogens such as *E. coli* O157:H7 and non-

typhoidal Salmonella during the infectious period or less important during recovery periods of a gastrointestinal sickness if they do not wash their hands during food preparation (Adams and Moss, 2008).

Food-borne diseases commonly occur in developing countries, especially in Africa due to poor food handling and sanitation practices, inadequate food safety laws, weak regulatory systems, lack of financial resources to invest in safer equipment and lack of education for food-handlers (WHO, 2004). Foods of animal origin proposed for humans tend to be most hazardous unless the principles of food hygiene are implemented. Animal products such as meat, fish and their products are regarded as high-risk commodities with respect to pathogen contents, natural toxins as well as other possible contaminants (Yousuf *et al.*, 2008). Bacterial contamination of meat products is a major concern to meat processing companies (Jones, 2008).

Reduced interest in food safety may be due to lack of awareness on the part of consumers. It is therefore important to educate consumers and make them understand that food safety is an important global issue. It is also important to understand the diversity of food safety issues relevant to consumers before educating them and to know that food safety education is the only strategy to improve food safety (Smith, 1994).

Food safety is a dynamic issue both in developed and developing countries because food-borne diseases contribute to millions of illnesses and thousands of deaths annually (Pilling *et al.*, 2008). It is becoming a key public health concern, because a large number of people do not practice food safety measures in their homes for various reasons. As a result, they are exposed to food-borne illnesses. The World Health Organisation (WHO) has established five main keys to safer food, which include keeping clean, separating raw food from cooked food, cooking thoroughly, keeping food at safe temperatures, and using safe water and raw materials (WHO, 2007). These five keys to safer food are of enormous importance in developing countries, and equipping consumers globally with such information could have a considerable influence on knowledge of food safety.

The overall cost of food-borne diseases includes the cost of medical treatment, loss in productivity, pain and suffering of affected people and losses within the public health sector. The reason for studying food safety and practices among consumers of animal food products in Mafikeng local municipality in the North West province of South Africa is to evaluate if consumers have sufficient knowledge on the safety of the food they eat in their everyday life

and also to improve the effectiveness and quality of the food they eat and provide insights on food safety and its standards.

1.1 AIM AND OBJECTIVES OF THE STUDY

1.1.1 Aim of the study

The aim of the study was to assess knowledge of food safety and practices among consumers in Mafikeng, North West Province, South Africa on food of animal origin focusing on primary food. In addition, it assessed the level of education provided to consumers regarding food safety from government and stakeholders and to evaluate possible risks due to lack of knowledge among consumers.

1.1.2Objectives of the study

The objectives of this study were to:

- Evaluate consumers' knowledge on food safety;
- Determine attitudes of consumers towards food safety and hygiene;
- Determine the risks of food-borne diseases in consumers in the North West province, Mafikeng;
- Evaluate health risks based on level of practices towards food safety; and
- Evaluate health risks based on attitudes towards food safety.

1.2HYPOTHESIS

Unsafe food is the cause of ill-health among 2 billion people worldwide and the cause of one third of deaths each year (National Institute for Allergies and Infectious Diseases, 2007b). In Africa alone, it has been estimated that, each year, 800 000 children die from food-borne related illnesses such as diarrhoea and dehydration (UN, 2004b). Immune compromised people and children are more susceptible as they fall sick and eventually die even from mild food-borne infections.

There are more than 250 known food-borne diseases caused by bacteria, viruses, or parasites (National Institute for Allergies and Infectious Diseases, 2007a). According to Mohamed (2005:1), consumption of food contaminated with microorganisms and their toxins leads to food-borne diseases. The following are the most common food-borne pathogens: *Campylobacter spp*, *Salmonella spp* and *Escherichia coli*. These pathogens rendered 6 million people sick and the death of 9000 people in 1999 whole world (Koohmaraie *et al.*, 2005). These organisms are mostly found in the intestinal tract of animals. Contamination occurs during processing, in abattoirs, during production, storage, management, handling and transportation (Hilton, 2002).

The utmost influence on carcass contamination of meat occurs during the removal of internal organs such as the intestines and the hide (Mead, 1994).

These pathogens can survive inadequate cooking and cause human food poisoning (Hilton, 2002). According to studies conducted by Holt and Henson (2000a), there is a relationship between consumption of meat and outbreaks of food-borne diseases in many countries and this condition is also true for South Africa. In South Africa alone, food-borne diseases have been reported since 1989 and statistics on food-borne illnesses remain poor. There is very little data currently to create trends in food-borne diseases (Agricultural Research Council, 2000).

Education has proven to be the most important weapon that can be used to provide valuable knowledge to everyone. A study on the evaluation of knowledge on food safety and practices among consumers will assist and provide insights on implementation of food safety measures by consumers in the Mafikeng Local Municipality, North West Province.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The degree to which food will not cause any sickness or harm to consumers when prepared, served and eaten according to its intended use is called food safety (FAO/WHO, 2003). There are a lot of possible and unwanted compounds in foods ranging from natural (mycotoxins) and environmental contaminants (dioxins) to agrochemicals (pesticides, and veterinary drug residues) and many more (Henson and Traill, 1993). Despite this, many cases of food-borne illnesses are preventable if food protection principles are followed from production to consumption.

Worldwide millions of people suffer from food-borne diseases and illnesses due to the consumption of contaminated food every year, and this has become one of the most important public health problems in the world (Notermans *et al.*, 1995; WHO, 2000). Lack of knowledge on food safety is one of the biggest problems affecting people worldwide. It is true that some foods purchased by consumers, especially meat products, are contaminated during processing (abattoirs to butcheries). Considering the fact that it is currently impossible for food producers to ensure a pathogen free food supply, the home food preparer is a critical link in the chain in order to prevent food-borne illnesses. Therefore, home-cooked food should be properly prepared in order to minimise the risk and presence of pathogens or their toxins in food. Food can be mishandled during preparation, handling and storage. Studies have shown that consumers in Turkey have inadequate knowledge on measures needed to prevent food-borne illnesses at home (Mederios *et al.,* 2001). Factors most commonly associated with reported outbreaks of food-borne illnesses at home include contaminated raw foods, inadequate cooking and consumption of food from unsafe sources (Mederios *et al.*, 2001).

There are more than 250 types of food-borne diseases. Most of them can be prevented if certain precautions are taken such as using good personal hygiene, cooking food thoroughly, and keeping food at correct temperatures during serving and storage (WHO, 2000). Food-borne illnesses can affect everyone, but there are certain individuals who are at a greater risk than others. Pregnant women, children, the elderly, and those with compromised immune systems are at an increased risk to illnesses associated with food (Mederios *et al.*, 2001). Therefore, making the kitchen the last point of defence against food-borne diseases will be

important to prevent cross contamination. Most pathogens die when food is cooked but the main problems are cross contamination, improper storage and handling. Food-borne pathogens in humans cause gastroenteritis characterised by nausea, vomiting, diarrhoea, abdominal pain and sometimes death (Dewall *et al.*, 1999). This is common in children, older people and immuno compromised individuals. The association of the outbreaks of food poisoning and consumption of contaminated food are important in many countries (Sockett, 1995). Food that stored under hygienic conditions, the demand for cheap food and failure to provide the required care while preparing food results in food poisoning in developed countries as well (Eves and Kipps,1995; Soner and Ozgen, 2002; Medeiros *et al.*, 2004).

The aim of this study is to improve consumers' knowledge of food safety and standards, and the effectiveness and quality of the food they consume.

Many people get poisoned because they consume foods produced under unhygienic conditions, lack of hygiene education; use of contaminated waters; inappropriate food storage conditions, lack of cleaning, and presence pesticide residues in food. However, food poisoning is not a problem specific only to less developed countries. It can also occur in developed countries such as the United States of America and other European countries. Considering the fact that South Africa is a developing country, this study provides insights and educates the public of the North West province on food safety and hygienic practices. This can be achieved by going back to the community and give the feedback of the questionnaires.

2.2 OVERVIEW OF GLOBAL FOOD SAFETY

Food safety is the opposite of food risk - the probability of not being exposed to any form of hazard after consuming a specific food (Henson and Trail, 1993). Regardless of a constant increase in the prevalence of food-borne illnesses, the global importance of food safety is not fully respected by public health consultants. Epidemiological surveillance has shown a constant increase in the prevalence of food-borne diseases though devastating outbreaks of salmonellosis, cholera, enterohaemorrhagic *Escherichia coli* infections, hepatitis A and other diseases which have occurred in both industrialised and developing countries (WHO, 1988). Traditionally, the spread of this food-borne diseases was considered to be caused by water or person-to-person contact, but it is in fact, found to be a largely food-borne disease. Up to 10% of the population have been reported to suffer annually from food-borne diseases in industrialised countries (WHO, 1988).

There has been considerable public interest in transgenic foods, toxic chemicals in food, the irradiation of foodstuffs, and the possible risk of transmission of the` `mad cow" disease through the consumption of beef (WHO, 1998). Food safety is likely to receive increasing attention, especially as some global changes, already in progress, are likely to have contrary effects in this field. Urbanisation, alterations in microbial and other ecological systems and diminishing supplies of food and fresh water are among the factors in question (WHO, 1997). In addition, many of the re-emerging or newly recognised pathogens are food-borne or have the potential of being transmitted by food and/or drinking water (WHO, 1988).

Several food-borne pathogens are to be expected because of changing production methods, processes, practices and habits and can be expected to increase, especially in developing countries because of environmental and demographic changes (Tent, 1999).

These differ from climatic changes, changes in microbial and other ecological systems, to decreasing fresh-water supplies. However, a greater challenge to food safety will come from changes resulting directly in degradation of sanitation and the immediate human environment that includes the increased age of human populations, unplanned urbanisation, migration and mass production of food due to population growth and changes in food habits (Tent, 1999). Mass tourism and international trade in food and feed are causing food and food-borne pathogens to spread transnationally.

As new toxic agents are identified and new toxic effects recognised, the health and trade consequences of toxic chemicals in food will also have global implications. Meeting the huge challenges of food safety will require the application of new methods of identifying, monitoring and assessing food-borne hazards. This can be done using new technologies to ensure food safety and needs to be done through legislative measures where suitable, but with much greater reliance on voluntary compliance and education of consumers and professional food handlers. This will be an important task for the primary health care system aiming at "health for all" (WHO, 1997).

Greater challenges to food safety have huge impacts on microbiological considerations because harmful microorganisms have the ability to grow from low numbers in food to multiply in the human body once ingested (Tent, 1999). Vital actions have thus been taken in various countries to improve the safety of food supplied to consumers. In Great Britain, for example, the 1990 Food Safety Act and the 1995 General Hygiene Act have affected food safety risk management practices in the food sector (Sockett, 1995).

In April 1997, the United Kingdom approved a communication on "consumer health and safety". One of the highlights of this communication was the increased role to be played by independent scientific research in the evaluation of potential hazards for the preparation of community legislation (Tent, 1999). A new food standard agency was created in the United Kingdom in April 2000. Its mandate includes the surveillance of food in retail stores and coordination of research activities in the area of food safety (Tent, 1999). Even with these measures, majority of consumers do not understand the important role of food safety regulations. In order to provide support to vulnerable consumers, it is important to first examine consumer' attitudes towards food safety.

2.2.1 Changing influences that pose a challenge to food safety

a) Demographic changes

The human population is predicted to reach 8.5 billion people within two decades, 80% of which is expected to be in developing countries (WHO, 1997), compared to the 5.8 billion people in 1996. This tremendous increase and irregular distribution could cause serious problems in terms of food security and safety, environmental degradation, large-scale migration from rural to urban areas and from poor to richer countries, as well as significant changes in ecosystems. In industrialised countries, the proportion of people aged over 60 years is predicted to rise from 17% to 25% by 2025. A similar phenomenon is occurring in developing countries (WHO, 1998).

b) Environmental hazards

Hazards caused by food-borne diseases are aggravated by biological and chemical contamination of areas where food is produced, processed and consumed. Population growth, unplanned migration from rural to urban areas, and consequent slum formation are bound to increase pollution. The supply of drinking water and waste disposal systems come under intensified pressure in such situations, particularly in developing countries, and the risk of the spread of food-borne pathogens is thereby aggravated.

The occurrence of food-borne infections and intoxications is significantly influenced by temperature because most people are still not sure or aware of the appropriate temperature in their fridges (Bentham and Lanford, 1995). Substantial increases in such infections have been reported in temperate regions experiencing long and hot summers (Hollingworth, 1996). The United Nations Intergovernmental Panel on Climate Change has forecast that the average temperature will rise in 2030 and 2090, respectively. The global effect on food-borne diseases and other aspects of human health is unpredictable because the relationships involved are complex and multifactorial (WHO, 1997). However, an association has been

established between the prevalence of cholera and dysentery. This underlines the need for correct predictions and other phenomena so that preventive measures could be taken against these diseases.

Toxic chemicals released into the environment through industrial processes and agricultural practices may enter the human food chain (Bentham and Lanfor, 1995).

c) Social and behavioural factors

Primary factors that contribute to poor health are poverty and inequity. Poverty has been referred to as the world's deadliest disease (WHO, 1995). With regard to food safety, the gap between privileged and underprivileged groups may seem less marked than in other areas because food-borne diseases are quite prevalent in rich societies as well as in poor ones (Repetto and Baliga, 1996). However, people in rich societies generally suffer from mild diseases that persist because of hazardous lifestyles (preference for raw foods, mishandling of foods, etc.), whereas in poor communities, serious life-threatening diseases such as infant diarrhoea, cholera, typhoid fever and fluke infections are still quite prevalent and cause high levels of mortality (Hollingworth, 1996). Between one fifth and a quarter of the world's population live in absolute poverty; the proportion is increasing and is likely to continue. Poverty can be expected to be the primary encounter to equity in health care, including the control of food-borne diseases (WHO, 1998).

Behaviour and lifestyle have a strong impact on food-borne diseases (Abdussalam *et al.*, 1989). The risky practice of eating shellfish and other foods in the raw state is increasingly common with rich people, where consumers are demanding minimally processed foods with long shelf-lives, no preservatives, and low salt and sugar contents (Hollingworth, 1996). Pathogens are likely to multiply to dangerous levels, even at refrigerator temperatures, and the probability of infection and intoxication increase under such conditions. Consumer concerns about food irradiation, an affordable means of rendering food safe, even in the raw state, are likely to decline in the next century because of the intrinsic merits of technology and efforts of health educators (Repetto and Baliga, 1996).

There is a likelihood of severe husbandry being used to grow transgenic plants and animals that are resistant to pests and diseases, thus reducing the need for chemical control. The increasing use of aquaculture for the production of fish makes it possible to apply safety measures more effectively now that reliable food safety advice is available for this area of production (WHO, 1997).

The increase in international and interregional trade in human and animal foodstuffs could increase the risks of carrying contaminants for long distances. Simple and rapid screening

methods should be developed for the detection of pathogens in such products, together with innovative approaches to their application in the interest of food safety.

During the 20th century, the tried and tested methods of preventing food contamination and rendering contaminated foods safe (cooking, pasteurization, sterilization and fermentation), have been improved. Newer methods such as irradiation, microwave cooking and high-pressure treatment have been developed. Further progress in this area will undoubtedly be made in the future. Information technology offers the prospects of revolutionising health education, the exchange of epidemiological data and the training of health professionals (WHO, 1997). Finally, the large-scale use of solar power as a non-polluting, low-cost renewable energy policy and practice would also go a long way in revolutionising the sector.

2.2.2 Evaluation of knowledge on food safety

Poor personal and environmental hygiene contribute to food contamination leading to food-borne diseases. According to a study conducted by Unusan (2007), on adults in Peru, knowledge on food safety tends to increase with age and practice. Females had higher scores than males, and younger respondents showed the greatest need for additional food safety education (Bruhn and Schutz, 1999; Byrd-Bredbenner *et al.*, 2007; Rimal *et al.*, 2001). Studies suggest that children and adults are usually unaware of basic methods of food handling and preparation (Williams *et al.*, 1992), although a substantial proportion of food-borne illnesses can be attributed to improper preparation (Redmond and Griffith, 2003).

Due to inappropriate food preparation methods by consumers in Peru, an outbreak of cholera was reported in 1991. The disease spread across the country and sanitary measures were taken to reinforce consumers' food control programmes (Codjia, 2000). It is very vital that such programmes be initiated, managed and encouraged in order to emphasise the need for safety among consumers. The proportion of cases arising from food preparation practices in households is under-represented in outbreak statistics (Day, 2001). According to Redmond and Griffith (2002), studies have estimated that between 50% and 87% of reported cases of the outbreak of food-borne diseases have been associated with preparation of food at home. Common mistakes identified include serving contaminated raw food, cooking/heating food inadequately, having infected persons to handle implicated food and poor hygiene (WHO, 1999). However, it is known that part of food-borne illnesses in the house results from eating raw foods of animal origin or engaging in unsafe food preparation practices at home (Klontz *et al.*, 1995). The cost of food-borne illnesses include cost of medical treatment, loss in productivity, pain and suffering of affected people and losses within the public health sector

(Harris, 1997). A total of 84,340 and 77,515 cases of food-borne diseases were notified in Turkey in 1999 and 2000, respectively. In both years, salmonellosis was the most frequently notified disease, present in 34% of all cases, followed by amoebiasis, comprising 27% and 32% of reported cases in 1999 and 2000, respectively. Since notification is not obligatory, data on food-borne infections and intoxications do not reflect the real situation (WHO, 2004). There are no regulations for the preparation, handling and storage of food at home. Home food safety is measured through the educational level of the consumer. There are a number of studies that have recommended the need for continued efforts towards educating consumers on the hazards of improper food handling (Bruhn and Schutz, 1999; Finch and Daniel, 2005; Li-Cohen and Bruhn, 2002; Mitakakis *et al.*, 2004; WHO, 2000).

The need for improved food safety education is well known in developed countries with the introduction of national initiatives to find ways to excellently educate consumers, especially the young, who prepare food. Changing demographics and lifestyles, as well as the emergence of resistant and exceptionally hazardous strains of food-borne micro-organisms, create a situation that could lead to major outbreaks of life-threatening food-borne illnesses (Haapala and Probart, 2004). People of all ages seem to believe that they know how to handle food safely, but their self-reported food-handling behaviours do not support this confidence (Bruhn and Schutz, 1999; Gettings and Kiernan, 2003; Li-Cohen and Bruhn, 2002).

2.2.3 Role and responsibility of consumers in terms of food safety

An effective, efficient control and management of food safety involves the determined efforts of industry, government regulators, academia as well as consumers. A lot of emphasis, initially, was placed on what governments had to do to ensure food safety. Recent changes also acknowledge the role of consumers and the private sector as well (Hanak *et al.*, 2000). Handling, using food in an appropriate manner, being at the receiving end of potential health risks in value chains and playing an advocacy and watchdog role in the regulatory process could be considered the role of consumers in controlling food safety. Through the third role, consumers provide information to regulators on food safety (Hanak *et al.*, 2000). Consumers' representation in decision-making and policy is particularly significant. There are specialist consumer organisations which focus exclusively on both general consumers and sectoral interests, which may be formed by government, with specific statutory status. Others should be established by non-governmental organisations (Hanak *et al.*, 2000). Consumer bodies should be involved in the meetings of national or international technical committees, during

the standards development process, to ensure that regulations developed conform to standards that address issues of concern for consumers (WHO, 2003).

2.2.4 Food safety in South Africa

The implementation of laws on food safety in South Africa has been described as 'depressing'. *E. coli, salmonella* and *listeria* have been described as the leading threats to food safety (WHO., 2007). They cause brain damage, paralysis and deaths in severe cases. This might be because there is no political will in South Africa to implement and enforce food safety laws (Farm to Fork Symposium, Johannesburg 2013).

Five percent of deaths in 2010 were caused by intestinal infectious diseases, including food poisoning (Statistical release South Africa 2010). Thousands of cases went unreported as medical practitioners failed to report outbreaks (as required by law) and the health department keeps no records as it should".

In understanding the relationship between the IFSC and the South African Food Safety Regulatory Framework, this study focused on the concept of participation. Normative correspondence in the structure and legislation of the South African food safety system with the IFSC were the two aspects used by South African and IFSC institutions to determine food safety to which officials share and advocate South Africa's position in institutional meetings of the IFSC.

South Africa has the foremost market within the SADC region and accounts for 50% of all intra SADC trade (SADC). As a result, it plays a management role in the development of food safety standards. South Africa's food safety legislation is the primary responsibility of the health and agricultural sectors. Food control is defined as "a mandatory regulatory activity of enforcement by national, provincial or local authorities to provide consumer protection and ensure that all foods during production, handling, storage, processing and distribution are safe, wholesome and fit for human consumption, conform to quality and safety requirements, and are honestly and accurately labelled as prescribed by law (SADC). Due to the fact that the food industry is the primary manufacturing sector within the South African economy, food safety has socio-economic consequences on trade, public health, food security and poverty. The domain of food safety is controlled by three governmental departments – the Department of Health (DoH), Department of Agriculture, Forestry and Fisheries (DAFF) and the Department of Trade and Industry (DTI), provinces, municipalities, industry and consumers (see Figure 4). Provincial or district health authorities who exercise

food safety controls at ports of entry are expected to understand developments regarding Sanitary and phytosanitary measures (SPS) measures within Southern African Development Community SADC.

In South Africa, food control is controlled by several authorities and various components, within the health sector, at national, provincial and local levels. A brief outline of the roles and responsibilities of the different authorities is presented below:

a) The National Department of Health

The Directorate: Food control - administers food legislation on behalf of the Minister of Health. It is thus responsible for:

- Directing events such as the recall of food product within the country;
- Setting national norms and standards;
- Supporting provinces and local authorities; and
- Assuming the role of the National Codex Contact Point.

b) Provincial Department of Health

It is responsible for food control at provincial level and is referred to as the Environmental Health Services. It is responsible for:

- Managing activities within the province;
- Providing support to local authorities;
- Rendering specialised services (import control, which is done on behalf of the national Department of Health); and
- Setting protocols and strategies for health within the province.

c) District/local authorities (municipalities)

At district/local level, Environmental Health Services are also responsible for, among others, food control in their areas of jurisdiction. They are involved in the following activities:

- Health promotion;
- Connecting community participation in health-related issues; and
- Hygiene control (within the environment).

d) National Department of Agriculture

At the National Department of Agriculture, the Directorate for Food Safety and Quality Assurance is responsible for:

- Regulating and promoting the safety of animals and animal products;
- Regulating and promoting the quality of agricultural products;
- Ensuring the safety, quality and efficiency of production enhancement agents; and
- Promoting the safety of food of plant and animal origin.

2.3 Food safety in South Africa's abattoirs

Food-borne diseases resulting from the consumption of food contaminated with microorganisms or their toxins constitute a serious public health problem in South Africa (Hugas and Tsigarida, 2008). These diseases are not due to a single pathogen, but are caused by various pathogenic organisms that have diverse ways of behaving in foods, resulting in human illnesses (Hilton, 2002).

The microbiological quality of carcass meat depends mainly on hygienic slaughter and dressing processes in the meat industry (Shale *et al.*, 2006). Carcass contamination increases when animals are dirty during the slaughtering process (Hilton, 2002). South Africa's abattoirs have no policy for clean livestock that could lead to the rejection of dirty animals during the slaughtering process.

The link between meat consumption and the outbreak of food-borne diseases in the United Kingdom is higher than in any other country in Europe (Holt and Henson., 2000a). This condition is comparable to other countries, including South Africa (Hilton, 2002).

According to the terms of the Animal Slaughter, Meat and Animal Products Hygiene Act No. 87 of 1967 (SA, 1967a), abattoirs that were under the direct control of the State, had to ensure the safe production of processed meat in abattoirs for both local and export markets. The State allowed the introduction of private abattoirs after the declaration of the Abattoir Hygiene Act No. 121 of 1992 (SA, 1992a) in 1992, and this led to competition between abattoirs, which saw the end of State-operated abattoirs. There are no State-operated abattoirs in South Africa to this date. Meat inspection was privatised after the announcement of the Abattoir Hygiene Act. South Africa's provincial government examination of hygiene practices in the processing of meat in abattoirs slowly reduced to the point where government today, only monitors privately-owned abattoirs. This is done in terms of evaluating hygienic practices and certifying compliance with government legislation. Because of pressure from European countries that import South African meat, the Department of Agriculture (DoA), has in its service, meat inspectors placed nationally in order to check and monitor the conditions of private abattoirs in the country. These foreign abattoirs are privately-owned and

have contracted the facilities of government inspectors from the Department of Agriculture (DoA) to carry out meat inspection as per international requirements requiring government control over abattoir hygiene management and meat inspection.

The Meat Safety Act No. 40 of 2000 was publicised due to increasing pressure from both local and export communities for acceptable food safety management at local export and non-export abattoirs (SA, 2000). According to the standing regulations under this Act, the owner of an abattoir is responsible for the implementation and management of a Hygiene Management System (HMS). The HMS was envisaged by veterinarians from the DoA as a pre-requisite for the food safety management system (Ehiri *et al.*, 1997).

The Hygiene Assessment System (HAS) is an instrument used to evaluate the overall hygiene performance of abattoirs. It was also amended in South Africa by local veterinarians from the Department of Agriculture and the Red Meat Abattoir Association adopted from the United Kingdom. This instrument is a scoring system for observing the hygienic conditions at abattoirs. HAS is a management tool and is not projected as a legislative health mark required to show that meat has been produced according to statutory hygiene standards under veterinary supervision and has been declared fit for human consumption (Van Zyl, 1998). The meat inspector at the abattoir is obliged to use the HAS to level the hygiene status of abattoirs according to the Red Meat Regulations (No. 1072 of 2004) (SA, 2004c).

2.4 SOUTH AFRICA'S FOOD SAFETY LEGISLATION

2.4.1 Food safety control legislation in South Africa

Legislation and other regulatory measures aimed at ensuring that the food we eat is safe and handled hygienically are probably one of the oldest legal arrangements to be found in society. Throughout the years, there has always been the need to control activities of people whose actions are aimed at producing, processing, manufacturing, or preparing food intended for consumption by others, by means of what is referred to as food laws. Initially, these measures were religion-based but also aimed at protecting people from harmful as well as potential risks to their health and general wellbeing which could be from contaminated or unsafe food; the National Health Act (Act 61 of 2003), Regulation R918. To ensure effective food control, it is important that South Africa's Food Safety Control Programmes introduce food control regulatory activities that are enforced by local authorities in order to provide consumer protection, ensuring that foodstuffs are safe and suitable for consumption. Food legislation in

South Africa is the sole responsibility of the health and agricultural sectors and the following legislation is currently the responsibility of the health sector in this regard.

2.4.2 The Foodstuffs, Cosmetics and Disinfectants Act, 1972 (Act 54 of 1972)

This Act manages the manufacture, sale and importation of all foodstuffs from a food safety control perspective. The Act is accompanied by a complete set of regulations published by the Department of Health aimed at setting the minimum standards and requirements that all foodstuffs should comply with, including correct labelling.

2.4.3 The Health Act, 1977 (Act 63 of 1977)

The Department of Health published the Act on 30 July 1999 to control hygiene requirements for food premises and transport because consumers were becoming sick through cross-contamination in the kitchen during food preparation. Studies conducted by Harris (1997) show that it is a fact that some foods purchased by consumers are contaminated during processing, in the abattoir, during production, storage, management, handling, transportation and in butcheries. It was thus important for authorities to pass this law in order to protect both consumers and production industries.

2.4.4 Food safety policy and regulations

The general food safety plan of action constitutes the standard and the vision of the food safety system of a country. It explains the national strategy, goals and objectives of the food safety system. The policy also defines training activities and makes necessary provisions for educational information for consumers. The policy shall also identify measures believed to control a range of biological agents as well as ease the risk associated with physical and chemical hazards in the food chain. Quality and safety of food products have to be certain at each stage of the value chain i.e. production in the farm, storage, transportation, processing and distribution. Provision should also be made for the control of imports and sub-Saharan countries need to assess their policies. The key questions to take into consideration are how to design a uniform, consistent and comprehensive approach to safety standards in the food value chain based on the farm-to-table approach. The first step is to integrate the various pieces of legislation that regulate food safety issues into one with the view of simplifying and making them more user-friendly for both the regulatory board and the industry. It is also advisable to continuously update the standards and refer to them in the regulation. Conditions and guidelines should be developed separately as national standards so that in the regulation, reference could be made to them. This is important because laws are not easy to amend or review, the process usually takes long to be completed. Standards are very easy to review and

this will assist in their update and include for instance, new requirements (Jaykus *et al.*, 2004). The mere reference to standards in the law makes them legal documents and mandatory.

2.5 Food safety management

The food industry is responsible for producing not only safe foods but also for demonstrating in a transparent manner, how food safety has been planned and implemented. These can be done through the development of a food safety management system (FSMS) (Motarjemi and Mortimore, 2005). Major financial, technological and managerial investments have been conducted in the last 10 years in order to implement FSMS along the Agri-food chain (Jacxsens *et al.*, 2010). Hazard Analysis and Critical Control Point (HACCP) is a food safety management system (Al-Kandari and Jukes, 2011) widely acknowledged as the best method of ensuring product safety while becoming internationally recognised as a tool for controlling food-borne safety hazards (Khandke and Mayes, 1998). HACCP is a systematic approach to the identification, evaluation, and control of hazards in food manufacturing that are critical to food safety (Ropkins and Beck, 2000). There are currently intensive attempts to develop principles and guidelines for risk analysis in order to ensure sound application of science, transparency and consistency on how food safety is managed (Anonymous, 1995 and Hathaway, 1997). This will hopefully lead to greater management of policies on risk analysis and methodologies.

2.5.1 Hazard Analysis and Critical Control Point (HACCP)

It is the systematic preventative approach to food safety that addresses physical, chemical and biological hazards as a means of prevention rather than finished product inspection. HACCP was originally invented by Pillsbury and NASA in the early 1960s, but became an effective hygiene management system based on the principles of Hazard Analysis and Critical Control Point (HACCP) on 2nd February 2006. In South Africa, it is now a legal requirement in every industrial operation involving the manufacture, preparation, treatment, processing, transportation and storage of food (Regulation (EC) No. 852, 2004). Implementation of HACCP systems is now an important component of safety assurances for food in international trade. In pursuing a preventative approach, the new Codex general principles of food hygiene highlight that food control should not rely on end-product testing and "in deciding whether a requirement is necessary or appropriate, an assessment of the risk should be made, preferably within the framework of a HACCP approach" (Anonymous, 1997). Some countries have introduced HACCP requirements into their national legislation, and are

specific in their HACCP requirements for particular sectors of their domestic food industries. There is an obvious expectation that exporting countries will meet the same requirements for internationally-traded foods, or pursue acceptance of food control systems with equivalent public health outcomes. Given that global experience with HACCP across all food sectors (especially raw) is relatively new, both importing and exporting countries have much to learn in ensuring that the safety of food in international trade is supported by HACCP systems that are scientifically-derived, risk-based and equitable.

2.5.2 Developing HACCP trends in internationally/nationally food trade

HACCP development registered in international food trade are:

a. Trust on well-documented prerequisite programmes;

b. The need for more narrowly-focused, scientifically-justified and pragmatic HACCP systems that do not only represent a "translation" of good hygienic practice (GHP) requirements;

c. Creation of food safety objectives (FSOs) that provide a "target" for the achievement of expected food safety goals; and

d. Approval of HACCP plans as achieving FSOs.

2.6.1 Transferring knowledge on food safety into food practice

Training on activities relating to food hygiene need to target behaviours that are most likely to result in food-borne illnesses to change consumer's knowledge into practice. Most training courses on food hygiene depend heavily on the provision of information. It is understood that such training leads to changes in behaviour, based on the Knowledge, Attitudes and Practices (KAP) model. This model has been criticised for its limitations (Ehiri *et al.,* 1997b; Griffith, 2000). It is understood that knowledge alone is inadequate to activate preventive practices and that some mechanism is needed to motivate action and generate positive attitudes (Tones and Tilford, 1994). In an evaluation of education on food hygiene, it was concluded that knowledge alone does not result in changes in food handling practices. Various studies have shown that the efficacy of training in terms of changing behaviour and attitudes to food safety is questionable (Mortlock *et al.*, 1999). Consumer education and awareness in terms of food safety in South Africa is very inadequate (Mortlock *et al.*, 1999). Just as is the case with many other things in life, no one cares until it is too late. If there is no public scare, if people do not die because of food-borne diseases that could have been avoided with proper food safety checks in place, no one will pay attention. Many food-related health alerts go unnoticed to a certain extent. South African consumers are content and do not complain, but

this has to do with limited public knowledge in the field of food safety (Mortlock *et al.*, 1999).

Consumers need education, especially those in lower income groups as there is a risk that these people will be taken advantage of since they have a low level of understanding about food safety issues. Until consumers become better educated and more aware, they need to be protected immediately as they are reliant on effective policing.

2.6.2 Knowledge gaps and research needs on food safety, knowledge and attitude

Food-handling behaviour must change in order to influence the incidence of food-borne illnesses and not just be self-reported. Relationships between self-reported and actual behaviour do not properly agree. Self-reported behaviour in most cases, is the only data at the disposal of food safety educators. There is a need to institute validity of self-reported evaluation instruments with observational studies (Worsfold and Griffith, 1997). There is also a need to assess whether food safety educational programmes teach the most relevant food safety behaviour to communities by defining the most vital concepts that affect food safety behaviour and lead to food-borne diseases if not practised. Therefore, such assessment should be on-going because new pathogens may arise and potentially change relevant food safety behaviours necessary to prevent illnesses. Once serious food safety behaviours are recognised, educational programmes must be intended to address them. If food safety education only focuses on thawing and cooling errors, food-handling inaccuracies that lead to the most costly causes of foodborne illness would be ignored. Similarly, if a food safety questionnaire measures whether participants thaw meat on the counter as crucial food safety behaviour indicator question, yet this behaviour hardly causes food-borne illnesses, the device is to measure what has been taught but may not be a measure of the effectiveness of the programme in decreasing the risk of food-borne illnesses.

2.7. Common food-borne diseases

2.7.1. Campylobacter

a) Introduction

Campylobacter jejuni is the most common cause of diarrhoea and abdominal cramps. Fever, chills, and headaches are also common symptoms. Unpasteurized milk, contaminated water and poultry are common carriers of this pathogen. Symptoms start within 2-11 hours of exposure and can last 7-14 days (Dewall *et al.*, 1999). Campylobacter can lead to the life-threatening Gullian-Barre syndrome (Nachamkin *et al.*, 1999). This is a genus of bacteria that is Gram negative, spiral and microaerophilicmontle, with either bacterial food-borne disease

in many developed countries. *Campylobacter* organisms are a leading cause of gastroenteritis in man and animals throughout the world (Lior, 1994). In sheep, campylobacteriosis is characterised by abortion, still births, and birth of weak lambs during late pregnancy (Kimberling, 1988). *Campylobacter jejuni* and *Campylobacter* foetus are the main causative agents of this disease. Several epidemiological studies in developed countries have identified sources of *Campylobacter enteritis* in man as follows: animals, food, water and milk products (Khan, 1982). Although there are sporadic reports of *Campylobacter* enteritis in developing countries (Nigeria), very little is known regarding its mode of spread. A proper understanding of the epidemiology of *Campylobacter* infections is necessary for the planning of effective prevention and control measures (Adegbola *et al.*, 1990).

b) Recent outbreaks

One feature of *Campylobacter* infection is that general outbreaks (affecting members of more than one household) are rarely recognised (Pebody *et al.*, 1997 and Frost *et al.*, 2002). Between 1995 and 1999, 374 general outbreaks of infectious intestinal diseases in England and Wales were reported to the Health Protection Agency (HPA) centre for infection. Where an agent was identified, campylobacters accounted for 50 (2%) of them (Frost *et al.*, 2002). Cross-contamination was the most reported food-handling fault (18% outbreaks) (Frost *et al.*, 2002). Thirty-five of 50 outbreaks reported to HPA CFi between1995 and 1999 were food-borne. In a study of gastroenteritis outbreaks in the Netherlands, campylobacters were identified in 1% of 281 (Van Duynhoven *et al.*, 2005). The symptoms of this disease are abdominal pain, vomiting, tiredness and fever (Wheeler *et al.*, 1999).

Treatment with antibiotics for uncomplicated campylobacter infection is rarely indicated (Frost *et al.*, 2002). Antimicrobial resistance to clinically important drugs used for treatment is increasingly reported for campylobacter. There is evidence that patients infected with antibiotic resistant strains suffer worse outcomes than those infected with sensitive strains (Helms *et al*, 2005).

2.7.2 *Salmonella* infection

a) Introduction

Salmonella contaminates eggs, poultry, unpasteurized milk, fruits and vegetables. The symptoms range from mild diarrhoea to severe and painful diarrhoea. The symptoms can occur 12 hours to 3 days after ingestion of infected food (Dewall *et al.*, 1999). Salmonella are members of the family Enterobacteriaceae. They are facultative anaerobic Gram-negative bacteria, oxidase positive and possess peritrichous flagella (Janda and Abbott, 1998). The nomenclature of Salmonella is quite complex and is based on both serotype and subspecies

names. For example, Salmonella enterica subspecies enterica serotype *enteritidis* is shortened to Salmonella serotype enteritidis or *S. enteritidis* (Brenner *et al.*, 2000). Salmonella can be further subdivided into biotype and phase type with biotype being a biochemical variation between two microorganisms of the same serotype, whereas the phase type is based on the differences in susceptibilities of two microorganisms of the same serotypes to a lytic bacteriophage (Ward *et al.,* 1987). Salmonella are also classified by three distinct types of antigens including somatic O, flagella H and capsular Vi antigens. Antigens have been used to isolate and identify more than 2500 serotypes of Salmonella (Popoff *et al.*, 2003). There are two species of Salmonella namely: *S. bongori* and *S. enterica. S. enterica* is divided into six subspecies as follows: *enterica; salamae; arizonae; diarizonae; houtenae;* and *indica.* The most common O-antigen serogroup within *S. enterica* subspecies are A, B, C1, C2, D and E strains. This serogroup is numerically the most significant and causes approximately 99% of Salmonella infections in humans and warm-blooded animals (Uzzau *et al.*, 2000). They are also the most frequent pathogens causing bacteria-borne gastroenteritis worldwide. Most of them are associated with the consumption of contaminated food from animal origin (eggs, meat and sliced sausage) (Uzzau *et al.*, 2000). Its complex chains of infection with a lot of potential hosts and ways of transfer are difficult to control. Modern intensive livestock farming and feeding, huge slaughterhouses, industrialised food production, global distribution as well as changing habits in preparation and consumption are important factors favouring extensive epidemics due to local contamination (Brenner *et al.*, 2000; WHO, 2000). All bacteria colonising human beings which belong to the genus Salmonella in the family of Enterobacteriaceae are obligatorily pathogenous and regularly cause diseases if the dose is sufficient.

b) Classification

Salmonella can be classified into two groups according to the pathogenicity: Enteric fevers group and the Gastro enteric fevers group (Brenner *et al*, 2000). The Enteric fever group includes S. Typhi and S. Paratyphi A, B and C. They are human pathogens although S. Paratyphi B has been isolated from animals (Greenwood *et al.*, 1997). The gastro enteric fever group includes all the other salmonellae which are mainly animal pathogens.

The most important clinical signs in many neonatal cows and pigs are diarrhoea and respiratory diseases due to suboptimal immune functions. Thus, neonatal animals are more susceptible to infections by various pathogens such as viruses and bacteria. It causes typhoid in rodents, and septicaemia and gastroenteritis in young kids, lambs, calves, goats and piglets

(Das *et al.*, 1990). Clinical signs in humans and animals of acute Salmonella enteritis include: fever, severe watery diarrhoea with subsequent onset of dehydration (D'Aoust, 1997). If sufficient damage occurs to the intestinal lining, the bacteria may enter the bloodstream, resulting in systemic infection. Adult cattle may be asymptomatic or latent carriers that harbour the bacteria in lymph nodes or tonsils and excrete the organism in their faeces, milk, genital discharges and urine, particularly in the case of cows when stressed during parturition (Steffen, 1984).

c) Transmission

Enteric fevers and gastroenteritis have different modes of transmission. Enteric fevers are transmitted from person-to-person through faecal-oral routes (Greenwood *et al.*, 1997). Gastroenteritis is also transmitted through contaminated animal food and food products with chicken, turkey, pigs and cows being the most common animal reservoirs (Baron and Jennings, 1991).

d) Treatment

Enteric fever requires antibiotic treatment since mortality of 20% has been reported when untreated (Greenwood *et al.*, 1997). Ciprofloxacin is not recommended for children because of its potential joint toxicity. Cephalosporin such as cefataxime is used in paediatric population (Baron and Jenning, 1991, Greenwood *et al.,* 1997; Konemman *et al.,* 1997; Janda and Abbott 1998). Cephalosporin is also used in cases where salmonella with decreased fluroquinolone susceptibility are responsible for treatment failure (Threlfall and Ward, 2001). Azithromycin has also been used in life-threatening systematic Salmonellosis (Stoychevaand, 2006).

e) **Recent outbreaks of Salmonella**

The transmission routes of *Salmonella enterica* are of particular interest in preventing outbreaks of human salmonellosis. In the case of a large-scale outbreak, there is a need for reliable, rapid identification at the strain level in order to trace the source of infection. Human outbreaks of Salmonella Livingstone are relatively uncommon, but this particular serotype was one of those most commonly isolated from farm animals in England and Wales in 1999 (Liebana *et al.*, 2001). It has been identified as a source of human infection, possibly related to ingestion of eggs or other poultry-related products (Steffen 1984; Old *et al.*, 1995). During the final weeks of 2000 and the first weeks of 2001, a serious outbreak of salmonellosis occurred in Norway and Sweden, caused by Salmonella Livingstone (Grundling *et al.*, 2004).

2.7.3 Escherichia coli

a) Introduction

Escherichia coli is one of the common causes of food-borne illnesses. This pathogen is responsible for an estimated 73,000 cases of infections and 60 deaths each year. Escherichia coli is an important causative agent of haemorrhagic colitis and haemorrhagic uremic syndrome in humans (Rangel *et al.*, 2005). Escherichia coli is also a Gram-negative bacterium of the family Enterobacteriaceae. The species is a normal part of the intestinal flora of humans, domesticated and free-living animals, though pathogenic E. coli strains have been recognised since the early 1900s. Although the number of human infections in the United States has declined over the past several years (402 human infections in the United States in 2004) (Food Net Surveillance Annual Reports, 1997-2004), the outbreaks in 2006 (CDC, Health and Safety Topics, 2006) led to a better understanding of the importance of this human food-borne pathogen. The main reservoir for E. coli is the intestinal tract of healthy cattle. Individual cattle are transiently colonised and shed E. coli in their faeces (Bach *et al.*, 2002).

One of the potential means of spread of this pathogen in the environment is by insects that develop in animal faeces/manure (primarily house flies, *Muscadomestica* L). House flies (HF) commonly build up very large populations on cattle farms and other animal facilities. Previously, a laboratory-based study demonstrated that E. coli O157 ingested by HF remains viable in the excreta of the fly and the fly is able to carry and disseminate E. coli for several days (Kobayashi *et al.*, 1999). In Japan, HF was implicated in the transmission of E. coli O157:H7 from reservoir animals to other animals and humans (Moriya *et al.*, 1999). Common carriers of this pathogen are unpasteurized milk and undercooked meat. E. coli is more likely to contaminate ground beef than steaks or other cuts of meat because bacteria on the surface can end up inside the patty when the meat is ground. Current research reveals that unpasteurized apple ciders can also harbour *E. coli*.

b) Transmission

Infection with E. coli O157:H7 occurs after ingestion of contaminated food or water, or oral contact with contaminated surfaces. It is highly virulent, with a low infectious dose: an inoculation of fewer than 10 to 100 CFU of E. coli O157:H7 is sufficient to cause infection, compared to over one-million CFU for other pathogenic E. coli strains (Greig *et al.*, 2010). A foremost cause of infection is undercooked ground beef. Other sources include consumption of unpasteurized milk and juice, and contact with infected live animals. Water-borne

transmission occurs through swimming in contaminated lakes and pools. The organism is easily transmitted from person-to-person and has been difficult to control in children. E. coli O157:H7 is also found in cattle farms and can live in the intestines of healthy cattle. The toxin requires highly specific receptors on the surface of cells in order to attach and enter the cell. Species such as cattle and swine, which do not carry these receptors may harbour toxigenic bacteria without any ill effect, shedding them in their faeces, from which they may be spread to humans. Some cattle may also be so-called 'super-shedders' of the bacterium. Super-shedders may be defined as cattle exhibiting recto-anal junction colonisation and excreting $>10^{3-4}$ CFU g^{-1} faeces. Super-shedders have been found to constitute a small proportion of the cattle in a feedlot (<10%) but they may interpret>90% of all E. coli O157:H7 excreted (Chase *et al.,* 2008). Carcasses and other animal products can be contaminated during slaughter and butchering, and organisms can be thoroughly mixed into beef when ground into hamburger. Bacteria present on the cow's udders or on equipment may get into raw milk. Foods contaminated with E.coli taste the same as normal. Another potential vector of E. coli O157:H7 is filth flies (which includes house flies, *Musca domestica*). Filth flies have shown that they are vectors of E. coli O157:H7 using PCR (Brazil *et al.*, 2007). United States food advocates have unsuccessfully attempted to control the spread of this illness by promoting the so-called "Kevin's Law". This law would give the United States Department of Agriculture power to shut down food processing plants that fail multiple inspections. The food processing industry vigorously opposes this proposal (Food Inc, 2009).

c) Clinical signs

Symptoms of E. coli infection include watery diarrhoea within 1-8 days of exposure, then progressing to bloody diarrhoea. Nausea, vomiting and fever also occur as the infection progresses. E. coli infection can lead to kidney damage and can be life-threatening in children (Dewall *et al.,* 1999). Diarrhoea in young children is one of the biggest problems. Other problems include acute renal failure, thrombocytopenia and microangiopathic haemolytic anaemia (Tarr *et al.*, 2005). Escherichia coli are recognised as a cause of diarrhoea and dysentery in young calves, mainly from two to eight weeks old (China *et al.,* 1998). EPEC causes diarrhoea in various animal species and in humans, whereas EHEC is associated with diarrhoea and dysentery in ruminants and humans. In the latter, EHEC also causes the haemolytic-uraemic syndrome (HUS) (China *et al.,* 1997).

d) Treatment

Cooking treatments of foods such as milk and meat would be desirable. Lime-treatment has been implemented to kill a range of enteric pathogens, including E. coli O157:H7, in sewage (Bean *et al.*, 2007) and animal wastes (Duffy, 2003). Other methods include treatment of abattoir-derived wastes, including management through wastewater treatment plants, rendering and composting. It is now illegal to spread untreated ruminant blood or waste containing ruminant blood onto agricultural land in Europe. Such waste must now be rendered or incinerated (Duffy, 2003).

e) Recent outbreaks of *E.coli*

A well-publicised case was the E. coli outbreak in the Jack in the Box restaurants in 1992. Until the illnesses were traced to E. coli, for several weeks, people across four states continued to eat infected hamburger meat. The incident resulted in 4 deaths and over 700 illnesses (Dewall *et al.*, 1999). Escherichia coli were first recognised as a pathogen in 1982 during an outbreak investigation of hemorrhagic colitis (Riley *et al.*, 1983). E. coli infection can lead to hemolytic uremic syndrome (HUS), characterised by hemolyticanemia, thrombocytopenia and renal injury (Banatvala *et al.*, 2001). E. coli became broadly recognised as an important and threatening pathogen. In 1994, E. coli became a nationally notifiable infection, and by 2000, reporting was mandatory in 48 states. An estimated 73,480 illnesses due to E. coli infection occur each year in the United States, leading to hospitalisation of about 2,168 people and 61 deaths annually (Mead *et al.*, 1999). It is an important cause of acute renal failure in children (Neill *et al.*, 1987). Even though reported outbreaks account for only small cases of E. coli, outbreak investigations contribute greatly to understanding E. coli epidemiology by identifying transmission routes, vehicle, and mechanisms of contamination (Keene, 1999). Findings of outbreaks of the disease force regulatory and public health agencies and industry to increase prevention and control measures in order to prevent similar outbreaks. Knowledge of transmission routes and vehicles allow consumers to be educated on reducing risky behaviour that can decrease their risk of infection. Recent outbreaks of E.coli was reported in the North West province called Bloemhofs were it was reported that it killed 3 and 177 being hospitalised.

2.7.4 *Shigella* infection

a) Introduction

Shigella is a small, unencapsulated, non-motile and Gram-negative rod. It causes acute inflammatory rectocolitis characterised by fever, intestinal cramps and bloody stool. It has an

estimated global annual incidence of 164.7 million cases, among which 163.2 million occur in developing countries, leading to 1.1 million deaths. Moreover, 69% of all episodes and 61% of all *Shigella*-related deaths involve children younger than 5 years (WHO, 2003). Members of the Enterobacteriaceae family, *Shigella* spp. may be classified into four major subtypes based on biochemical and serological characteistics namely, *Shigella dysenteriae, Shigella flexneri*, *Shigella* boydii and *Shigellas onnei. Shigella* infection can result in a variety of symptoms ranging from mild, self-limiting diarrhoea to severe dysentery with frequent passage of blood and mucus, high fever, cramps and tenesmus.

b) Recent outbreaks

Among *Shigella* species, *Shigella dysenteriae* type 1 (Sd1) is of particular importance (Aragon *et al.*, 1995) because it produces the Shiga toxin and causes severe infections (Bogaerts *et al.*, 1997). It is associated with large dysentery epidemics in developing countries, and Sd1 strains isolated worldwide are often multidrug resistant (MDR). In 1979, a major epidemic caused by MDR Sd1 started in North East Zaire (now Democratic Republic of Congo) and spread rapidly through Zaire, Rwanda, Burundi and Tanzania between 1981-1982 (Bogaerts *et al.*, 1997). Afterwards, other MDR Sd1 outbreaks were reported in Central, East, South and West African countries between 1983 and 2004 (Aragon *et al.*, 1995). Between 2003 and 2004, two large outbreaks of dysentery occurred in two *Prefectures* (administrative subdivisions) of the Central African Republic (CAR) (WHO, 2003). CAR is a 623 000 km^2 Central African country with an estimated population of 3 285 000 inhabitants. An outbreak occurred between July 2003 and February 2004 in the *Prefecture* of Ouaham-Pende in northwest CAR, about 450km from the capital, Bangui (WHO, 2003). In total, 2013 cases of bloody diarrhoea were reported in the towns of Bozoum and Paoua and in villages along the 140-km-long road between these towns. Forty-one deaths attributed to dysentery were recorded during the period of the outbreak, giving an overall case fatality rate (CFR) of 2.04%. Outbreak B occurred between August and December 2004 in the Kaga-Bandoroarea in the *Prefecture* of Nana-Grebizi in northern CAR, about 350km from Bangui. Outbreak B involved 445 cases of bloody diarrhoea. A total of 34 deaths (overall CFR 7.6%) attributed to dysentery were reported.

Bloody diarrhoea in young children is usually a sign of invasive enteric infection that carries substantial risks of serious morbidity and death (Victora *et al.*, 1993). *Shigella* is the most frequently isolated pathogen from the stools of young children with bloody diarrhoea in developing countries (Keusch and Bennish, 1989). It causes abdominal cramps, fever,

headache and watery or bloody diarrhoea. Shigelladysenteriae type 1 is associated with the highest fatality rates, the majority of deaths from shigellosis worldwide results from endemic diseases caused by *S.Flexneri* (Bennis and Wojtyniak, 1991). Shigella infection can result in a variety of symptoms ranging from mild, self-limiting diarrhoea to severe dysentery with frequent passage of blood and mucus, high fever, cramps and tenesmus.

Appropriate antimicrobials therapy reduces the duration of symptoms and prevents life-threatening complications. Ciproflaxin, a 3rd generation Fluroquinolone, has been recommended by the World Health Organisation (WHO) as the 1st line choice for patients with bloody diarrhoea, irrespective of their age, on the basis of its efficacy, safety and low cost (Christopher *et al.*, 2010). Although the use of Ciproflaxacin in paediatric patients is limited, concerns about the potential risk of damage to growing cartilage, Fluroquinolones are generally safe for the treatment of shigellosis in children. Several reports have documented that short-term treatment of children with fluroquinolones has no effect, (Vihn *et al.,* 2000; WHO; 2003; Ramaswamy *et al.,* 2007).

9.8. Listeria infection

a) Introduction

Listeria monocytogenes is the bacterium that causes listeriosis. It is a facultative anaerobic bacterium, able to survive in the presence of oxygen. It can grow and reproduce inside the host's cells and is one of the most virulent food-borne pathogens, with 20 to 30 percent of clinical infections resulting in death (Ramaswamy *et al.,* 2007). It is responsible for an estimated 1,600 illnesses and 260 deaths in developing countries annually. Listeriosis is the leading cause of death among food-borne bacterial pathogens, with fatality rates exceeding even Salmonella and Clostridium botulinum (Ramaswamy *et al.,* 2007). *L. monocytogenes* is a Gram-positive bacterium, in the division of Firmicutes, named after Joseph Lister. Motile through flagella is at 30°C and below, but usually not at 37°C (Gründling *et al,* 2004). *L. monocytogenes* can instead move within eukaryotic cells by explosive polymerization of actin filaments (known as comet tails or actin rockets). Because of its recurrent pathogenicity that causes meningitis in new-born babies, pregnant mothers are often advised not to eat soft cheese such as Brie, Camembert, which may be contaminated with growth of *L. monocytogenes* (Genigeorgis *et al.*, 1991). It is the third-most-common cause of meningitis in new-borns. The genus *Listeria* belongs to the class, *Bacilli*, and the order, *Bacillales*, which also includes *Bacillus* and *Staphylococcus*. The genus Listeria includes six different species (*L. monocytogenes*, *L. ivanovii*, *L. innocua, L. welshimeri*, *L. seeligeri*, *and L. grayi*). *Both L.*

ivanovii and *L. monocytogenes* are pathogenic in mice, but only *L. monocytogenes* is dependably associated with human illness (Seafood HACCP Alliance, 2007). There are 13 serotypes of *L. monocytogenes* that cause disease, but more than 90 percent of human isolates belong to only three serotypes: 1/2a, 1/2b, and 4b. *L. monocytogenes* serotype 4b strains are responsible for 33 to 50 percent of sporadic human cases worldwide and for all major food-borne outbreaks in Europe and North America since the 1980s (Ward *et al*, 2011).

b) Recent outbreaks

Listeriosis is an infection caused by the bacterium *Listeria monocytogenes*. The outbreak was determined to originate from Jensen Farms in Holly in 2011. Twenty-five states, including Arkansas, Arizona, California, Colorado, Idaho, Illinois, Kansas, Minnesota, Missouri, Montana, Nebraska, New Jersey, New Mexico, New York, North Dakota, Ohio, Oklahoma, Pennsylvania, South Dakota, Tennessee, Texas, Utah, Virginia and Wyoming were confirmed to have experienced *Listeriosis* outbreaks in 2011 by the Centres for Disease Control (CDC) (Staff writer, 2011). In total, 133 cases were confirmed, and among the number, 33 deaths. The incubation period could exceed one month (Mary Clare Jalonick, 2011). The CDC report also stated that Listeria mainly sickens the elderly, pregnant women and others with compromised immune systems and that the median age of all the people infected was 78 years (Staff writer, 2011). Among the people who died, ages ranged from 48 to 96 years, with a median age of 82.5 years (Elizabeth, 2011; JoNel, 2011).

Listeria infections can cause miscarriages in pregnant women. The first case of miscarriage attributed to the 2011 outbreak was reported in early October, in a woman living in Iowa (JoNel, 2011).

On the mild end of the spectrum, *listeriosis* usually consists of the sudden onset of fever, chills, severe headaches, vomiting and other influenza-type symptoms (Lorber and Bennett, 2000). Along these same lines, the CDC notes that infected individuals may develop fever, muscle aches, and sometimes gastrointestinal symptoms such as nausea or diarrhea (CDC, 2011). When present, the diarrhea usually lasts 1-4 days (with 42 hours being average), with 12 bowel movements per day at its worst (Lorber and Bennett, 2000). As already mentioned, when pregnant, women have a mildly impaired immune system that makes them susceptible to Listeria infection (Mayo Clinic, 2009). If infected, the illness causes acute fever, muscle pain, backache and headache (Bortolussi, 2008). Illness usually occurs in the third trimester, which is when immunity is at its lowest (Lorber and Bennett, 2000). Infection during

pregnancy can lead to premature labour, miscarriage, infection of the new-born baby or even stillbirth (Silver, 1998). Twenty-two percent of such infections result in stillbirths or neonatal deaths (Lorberand Bennett, 2000).

Listeriosis is a self-limited illness whereby the majority of sick individuals will recover without the need for medical care (Bortolussi, 2008). For patients with high fever, a stool culture and antibiotic-treatment may be justified for otherwise healthy individuals (Bortolussi, 2008). Although there have been no studies to determine what drugs or treatment duration is best, Ampicillin is generally considered the "preferred agent," (Lorber and Bennett, 2000). There is no consensus on the best approach for patients who are allergic to Penicillins (Lorber and Bennett, 2000).

9.9 *Staphylococcus aureus* infection

Commonly referred to as staph, it is found on the hands and in the nose, intestines, open cuts and sores of humans. Staph bacteria are one of the most common causes of skin infections in the U.S. (Centre for Disease, 2006). The symptoms occur 1-6 hours after ingestion and include nausea, vomiting, abdominal pain, and diarrhoea, but not fever. The common carriers are salads with protein-containing ingredients, meat, poultry, eggs and milk products.

Table 2.10: Five of the usual causes of food-borne infections presented in descending order of occurrence

Pathogen	Sources	Symptoms
Campylobacter jejuni	Raw or undercooked meat, raw milk, raw vegetables	Abdominal pain, bloody diarrhoea, fever, chills, headache; within 2-11 hours, can last 7-14 days
Escherichia coli 0157H7	Raw or undercooked ground beef, uncooked fruits and vegetables, raw milk, unpasteurized apple juice	Diarrhoea, severe cramping, nausea, vomiting, fever, kidney damage in children; within 1-8 days of exposure
Salmonella enteritidis	Eggs, poultry, unpasteurized milk, fruits, vegetables, seafood	Fever, nausea, vomiting, diarrhoea, severe abdominal pain; within 12 hours to 3 days
Listeria monocytogenes	Unwashed fruits and vegetables, soil, water,	Flu-like symptoms, encephalitis, meningitis
Shigella	Under cooked food, water and in a stool.	Mild diarrhoea to severe dysentery with blood and mucus, high fever, cramps, tenesmus

Table 2.11.Examples of bacteria that produce toxins which could cause food-borne illnesses include the following: Staphylococcus aureus, Clostridium botulinum and Clostridium perfrigens

Pathogen	Sources	Symptoms
Staphylococcus aureus	Meat, poultry, eggs, milk Products	Nausea, vomiting, abdominal pain; 1-6 hours after ingestion
Clostridium botulinum	Soil, water, home-canned Vegetables	Weakness, double vision, fatigue, diarrhoea, paralysis; within 4-36 hours after ingestion
Clostridium perfringens	Surfaces of meat and Poultry	Nausea, vomiting, abdominal pain, diarrhoea; within 8-48 hours after ingestion

9.10 *Clostridium botulinum infection*

It is a rare, anaerobic bacterium that produces a toxin that is unusually heat resistant. Symptoms occur within 4-36 hours after ingestion of the harmful toxin and include weakness, double vision, fatigue and diarrhoea. The *Clostridium botulinum* toxin impairs the central

nervous system and can be fatal if not treated properly within 3-10 days (Dewall *et al.*, 1999). Although this type of severe food poisoning is rare, the mortality rate is high. Of the 2,320 cases reported in the U.S. from 1899-1990, 1036 deaths have been attributed to Clostridium botulinum (Solomon and Lilly, 2001). Sources of Clostridium botulinum include soil, water, and home-canned vegetables (Dewall *et al.*, 1999).

9.10 *Clostridium perfrigens*

It is caused by an anaerobic toxin found on the surfaces of meat and poultry. However, it is not as serious as *Clostridium botulinum*. It is often called the "cafeteria bug" because the usual sources include food that is improperly cooked or reheated, cooled slowly, or not kept at the correct temperature, such as when food is left out on the cafeteria line (Dewall *et al.*, 1999). Symptoms occur within 8-15 hours after ingestion and include intense abdominal pain, gas and diarrhoea (CDC, 2011).

CHAPTER THREE
MATERIALS AND METHODS

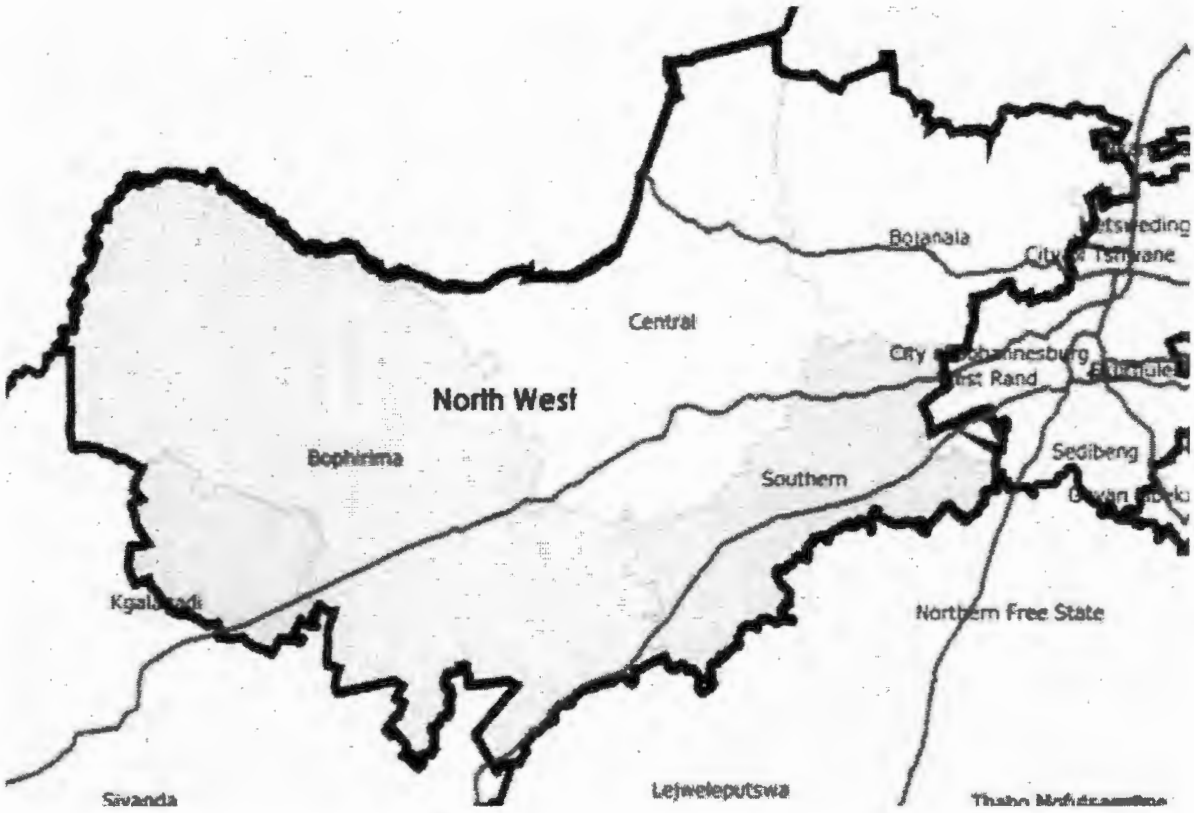
3.1 Research/study area

This study was conducted in the North West Province of South Africa. The province is located towards the western boundaries of Gauteng and the Free State. It shares borders on the south of Limpopo and Botswana and lies to the north of the Northern Cape. The North West Province forms part of the border between South Africa and Botswana. In the southeast of the province, there is a commercial concentration around the towns of Klerksdorp and Potchefstroom, while large urban concentrations are also found towards the eastern parts of the province (Rustenburg-Brits area) and Mafikeng/Mmabatho.

The province is divided into four district municipalities, one cross-border municipality and 21 local municipalities. The province covers a surface area of 116180 square kilometres. The district municipalities are as follows (refer to Map 1):

- Bojanala-Platinum District;
- Central District;
- Southern District;
- Bophirima District; and
- Kgalagadi Cross Border Municipality.

Mafikeng Local Municipality (Map 2) falls within the Central District Municipality with a total population of 291,527(Census 2011). On 18 October 1994, the town was declared the capital of the North West Province. In 1996, Mafikeng once again, became the capital city but this time with Mmabatho as part of Mafikeng. The town is presently faced with the challenge of uniting Mmabatho (the Bophuthatswana heritage), Mahikeng (the Barolong heritage) and Mafikeng (the colonial heritage), into one greater capital for all people of the North West Province.



Mafikeng map/South Africa Google satellite mapsAfriGIS 2014 (pty) Ltd

Figure 3.1: Map of district municipalities in the North West Province

Mafikeng map/South Africa Google satellite maps AfriGIS 2014 (pty) Ltd

Figure 3.2: Map of Mafikeng local municipality

Table 3.1: Types of dwellings in Mafikeng local municipality

TYPES OF DWELLINGS	NUMBER OF DWELLINGS
House or brick structure on a separate stand or yard	51 136
Traditional dwelling/hut/structure made of traditional materials	2298
Flat in block of flats	527
Town/cluster/semi-detached house	149
House/flat/room in back yard	1895
Informal dwelling/shack in the back yard	1895

Source: Statistics South Africa, 2007 Community Survey. SuperCROSS. Copyright © 1993-2009 Space Time Research Pty Ltd. All rights reserved

3.2 Data collection

A total of 670-1000 (Raosoft) people in Mafikeng (291527000/2011 census) local municipality were interviewed. Above 20 trained university students visited each household selected and briefly explained the purpose and nature of the study to people concerned with accountability for food preparation in the household. Permission to participate in the study was obtained from participants. The names, cell phone numbers or identification numbers of respondents were not requested. This was to guarantee secrecy of responses and to prevent the easy identification of questionnaires by individuals. Items in the questionnaire were explained where necessary and administered at one sitting as far as possible.

3.3 Method of data collection

A questionnaire was designed with the help of a statistician using a modified version of Bruhn and Schutz (1999). The questionnaire was subjected to a preliminary validation in order to assess its clarity, the suitability of wording and the average time needed for its completion. Based on the pilot study, necessary modifications were identified and corrected, but the results not included in the final survey. The questionnaire took approximately 15 minutes to complete. The questionnaire was piloted and distributed in the respective areas between June and October 2013. The level of knowledge was determined based on results obtained after analysing the questionnaires. The revised questionnaire was divided into 4 sections as follows:

(a) Demographic;
(b) Knowledge on food safety;
(c) Food handling practice; and
(d) Source of information.

It was issued out to participants on weekends in their neighbourhoods, villages and on weekdays at their respective work places if a member of the particular target group was not at home.

3.4 Target groups

Data was randomly collected among different population groups; educated and uneducated, employed and unemployed, young and elderly people. Samples were collected during the day at taxi ranks, streets, administrative offices such as the Department of Agriculture, Health and Education, social workers, buyers and sellers of street-vended food, people in shopping centres, secondary schools such as Letsatsing Science Secondary School, Matlou Secondary School, Mmabatho High School and the North West University. Data were also collected from primary and secondary health facilities, hospitals and primary health centres.

3.5 Data analysis

The data collected were analysed using SPSS software (Statistical Package for the Social Sciences, version 22.0 (2013) SPSS Inc, III, USA). Mean responses and percentages of responses in each category were calculated and presented in tabular form. Frequency, percentage, mean and standard deviation were also calculated and tabulated. In addition, tables, graphs and percentages were presented where necessary.

Cronbach α coefficient of internal consistency was used to estimate the reliability of the questionnaire (0.83). Statistical differences were set at $p<0.05$. Analysis using independent t-test was conducted to investigate gender differences and concerns regarding food handling practice, food safety attitude and knowledge. ANOVA was conducted to investigate educational differences and correlation carried out to measure the strength of the linear relationship between food handling practice, food safety attitude and knowledge on food safety. Results obtained from this study are described and presented according to the items in the questionnaire (see appendix 1).

CHAPTERFOUR
RESULTS AND DISCUSSION

4.1 PROFILE OF RESPONDENTS DERIVED FROM SECTION A

A total of 704 people in Mafikeng (291527000/2011 census) Local Municipality were interviewed using a questionnaire. The majority of respondents were females (56.3%) compared to 43.8% males. In addition, 20.5% of respondents were married, with 489 (69.5%) single, 6.7% divorced and only 3.4% widowed. 317 (45.0%) were below the age of 20, 33.1% were between 21-30, 11.5% aged between 31-40 and 10.4% above 40 years. 81% were black while 11.8% were white, 0.6% were Indians and 6.6% coloureds. 340 (48.0%) had primary level of education, 14.8% of respondents had no qualification at all and 28.1% had only secondary level of education while only 9.2% had tertiary qualification. 478 (67.9%) were unemployed, 67.9% unemployed and only 3.3% were pensioners (Table 4.1).

Only selected questions are discussed in the presentation section and in the discussion due to their impact on knowledge on food and food practices of respondents.

4.2 KNOWLEDGE ON FOOD SAFETY

Section B of the questionnaire focused on consumers' knowledge on food safety and in particular, food of animal origin. Respondents were presented with a list of multiple choice questions to tick the correct answer. Respondents had the choice not to answer if they did not feel like doing so or ask for clarity (see Appendix 1). Results obtained in this section are summarised in Table 4.2.

Table 4.1: Demographic characteristics of respondents

Demographic characteristics	N=704	%
Gender (n=704)		
Male	308	43.8
Female	396	56.3
Age (n=704)		
Below 20	317	45.0
21 to 30	233	33.1
31 to 40	81	11.5
Above 41	73	10.4
Race (n=704)		
Blacks	571	81.1
Whites	83	11.8
Coloured	46	6.5
Indians	4	0.6
Marital status (n=704)		
Married	144	20.5
Single	489	69.5
Divorced	47	6.7
Widowed	24	3.4
Education (n=704)		
No qualification	104	14.3
Primary level	340	48.0
Secondary level	196	27.8
Tertiary level	64	9.2
Employment status (n=704)		
Employed	200	28.4
Unemployed	479	68.1
Pensioner	23	3.3

Table 4.2: Overall responses on knowledge on food safety by consumers

Questions	Responses	n	%
5. Leftovers should be boiled until hot to prevent food poisoning.	True	396	**56.3**
	False	308	43.7
6. Putting a stew in a shallow pan and refrigerate it same time is the best way to cool it.	True	298	42.3
	False	406	57.7
7. Chilling/freezing eliminates harmful germs in milk/meat.	True	476	**67.6**
	False	228	32.4
8. All types of bacteria cause food poisoning.	True	381	54.1
	False	323	**45.9**
9. Freezing will only make food last longer by killing bacteria.	True	509	**72.3**
	False	195	27.7
10. Taking out meat from the refrigerator and putting it back after it has defrosted will increase the level of bacterial growth.	True	446	63.4
	False	258	**36.6**
11. One obtains protein, vitamin and calcium by drinking milk.	True	558	**79.3**
	False	146	**20.7**
12. Drinking unpasteurised milk will increase the level of food poisoning.	True	494	70.2
	False	210	29.8
13. Milk must always be covered to prevent food poisoning when consumed.	True	523	74.3
	False	181	25.7
14. Milk that has turned sour must be disposed of.	True	463	65.7
	False	241	34.2
15. All abattoirs in the country should comply with government regulations regarding safety standards.	True	548	77.8
	False	156	22.2
16. Freezing meat will increase its quality and last longer.	True	546	**77.6**
	False	158	22.4
17. Everyone has the right to consume food that is hygienic and nutritious.	True	582	82.7
	False	122	17.3
18. Government has to ensure that citizens consume food that is free from food-borne diseases.	True	539	76.6
	False	165	23.4
19. Refrigerating meat will reduce the growth of bacteria and other microbes.	True	547	**77.7**
	False	157	22.3
20. Proper handling of equipment in the kitchen reduces risks of food poisoning.	True	529	**75.1**
	False	175	24.9

* The bold figures are the correct responses to the items in the questionnaire

Respondents showed different knowledge of food safety depending on the questions. This study also reveals that age, race and educational level or qualification play a major role in terms of people understanding of food safety. Questions such as "Leftovers should be boiled until hot to prevent food positioning" (question SB5) illustrates respondents' knowledge. 56.3%of respondents answered in the affirmative while based on gender, no significant correlations (P>0.05) were observed between male and female regarding this item of the questionnaire. In addition, there was no significant relationship (P > 0.05) between education, age, race, employment status or marital status of respondents and their response to this question.

These results are in line with the study conducted by Goulet *et al.* (2001). In their study, they found that just over 58% of respondents heated leftovers to prevent food poisoning. Microbiological studies have shown that it is very important to cook food thoroughly before consuming it, especially poultry and pork Goulet *et al.* (2001). This will kill any harmful bacteria that may be present, such as listeria and salmonella. In addition, though keeping food cold enough (fridge or freezer) is one of the methods which consumers can use to prevent food poisoning, steaming or boiling is regarded as the best way to prevent food poisoning as it guards against bacterial growth because some of the bacteria such as *Listeria* can grow in refrigerators (Goulet *et al.*,2001). However, results obtained were not in line with findings obtained by Buccheri *et al.* (2007) who, in their study in New York, found age, gender, educational level and length of service to be inconsistently associated with knowledge on food.

Respondents were asked if chilling/freezing eliminates harmful germs in milk/meat (Question SB7). 67.6% of respondents answered in the affirmative. Among this number, 58% were adults and educated while 42% were below 20 years of age. Statistical studies based on gender, education, marital status, employment status or educational level revealed no correlation (P >0.05) between their status and knowledge on food safety. However, it was observed that there was a significant correlation (P >0.05) between age of respondents and their knowledge on food safety regarding question SB7. The results obtained correlate with the study conducted in New York by Gill (2002). A similar question asked to consumers saw 69% of them responding in the affirmative. In this study, 54.1% of consumers responded correctly to question SB8 (knowing if all types of bacteria cause food poisoning). The majority (72.3%) of respondents failed to answer correctly to this question while only 27.7% answered correctly. There is no significant association (P>0.05) between gender, age, educational level and marital status to the question asked. However, there is a significant link

($P<0.05$) between race, marital status of respondents and their knowledge on food safety relating to the question asked. It was observed that most respondents with tertiary level of education responded in the affirmative to the question compared to respondents with primary level of education who provided negative responses. The absence of correlation between education and responses obtained for this question is worrying because most respondents had primary level of education and knowledge of food poisoning is normally acquired in Life Sciences in primary school. According to Craig (2013) and Schiller *et al.* (2010), several studies have demonstrated that bacteria such as *E. coli* live in the intestines of humans and animals and that most of the time, it does not cause any problems, though certain strains such as *E. coli* O157:H7 can cause a severe case of food poisoning (Sodha *et al.*, 2009).

Question SB9 requested respondents to indicate whether freezing of food makes it last longer or not. Here, too, neither age, education nor sex influenced responses to the question. It is known that freezing foods render bacteria inactive but does not actually kill anything (Mead *et al.*, 1999). This means freezing of contaminated food does not kill bacteria and once thawed, it will still harbour the same harmful bacteria (Mead *et al.*, 1999). However, cooking of food at recommended temperature is the only way to ensure that food is safe (Jay, 1996). Da-Wen Sun (2001) also confirmed that freezing food preserves it from the period it is prepared to the time it is eaten. It also helps in slowing down decomposition, preventing the growth of most bacterial species. In the 20th and 21st centuries, conserving food in domestic kitchens is accomplished by household freezers (Tressler, 2001). Recognised ways of freezing food in households was to freeze food on the day of purchase. Tressler (2001) reports that some supermarkets promote the freezing of food immediately until the food is used. Several bacteria exist around us that are generally not troublemakers but can become dangerous if they are given the ideal breeding climate, between 60°C and 125°C in which they quickly multiply to dangerous levels and can cause food poisoning. Food must not be left in this danger zone for more than 2 hours (Centre for Disease, 2006).

In contrast to the two previous questions (SB8 and 9), 63.4% of respondents answered correctly to question 10: if meat refrigeration, defrosting and refrigeration would increase the level of bacteria growth. Statistical analysis showed that there was no significant relationship ($P>0.05$) between gender, age, race, educational level and marital status of respondents and knowledge of question SB10. This shows once more, that, there is a problem of basic knowledge on food safety among people in the Ngaka Modiri Molema District.

Milk is considered "nature's wellness drink" and is full of calcium, vitamin D, phosphorous and a steadiness of other nutrients that have been confirmed to build bones and teeth. It also promotes the healthy functioning of body muscles and blood vessels (WHO, 2000). (79.3%) of respondents confirmed that milk contains nutrients such as proteins, calcium and vitamins (SB11). It was observed that most blacks responded in the affirmative to this question and the majority of female respondents responded correctly to the question. This study revealed that there was no significant relationship ($P>0.05$) between educational level of respondents and their knowledge of the questionnaire item.

When asked if drinking of unpasteurised milk would expose consumers to the risks of food poisoning (question SB12), 70.2% of respondents agreed. Neither gender, age, nor marital status influenced the response to this question. However, there was significant relationship ($P<0.05$) between race, educational level and knowledge to question SB12. Among the respondents, 55.3% were Blacks, 15.2% Whites and 23.6% Coloured and 5.9% percentage of Indians. 14.7% of respondents had no qualification, 47.9% had primary level qualification with 24.2% having secondary level of education. Only 9.6% of respondents had tertiary level of education.

Based on education, it was revealed that the majority of respondents who responded in the affirmative to the question were educated (90%) and among them, 99% had at least a high school certificates.

Studies published by CDC (2011) highlight the potential dangers of unpasteurised milk. According to the agency, between 1998 and 2011, 148 outbreaks due to consumption of unpasteurised milk were reported. During the outbreaks, 2,384 illnesses, 284 hospitalisations and 2 deaths were reported (CDC, 2011). Even though drinking unpasteurised milk affects everyone, more concern is on infants, children, elderly people, pregnant women and people with a compromised immune system (Oliver *et al.*, 2005). Nowadays, with modern knowledge on food safety, it is not considered safe to drink sour milk, but it was commonly used in cooking which would have killed any bacteria present (Nakamura *et al.,* 1995).

Furthermore, responses to the questionnaire item showed that (SB14) 65.6% of respondents responded in the affirmative to the question asked while 34.2% of consumers indicated provided negative responses. Results obtained in this study correlate in a way with the findings of Nakamura *et al.,* (1995). In their study, a similar question asked to respondents in Taiwan obtained 60% response rate that sour milk must be disposed of.

Analysis of data showed that there is no significant relationship (P>0.05) between gender, age, marital status, educational level or knowledge of food safety to the questionnaire item. However, the analysis showed that there was significant correlation (P<0.05) between race and the response to the questionnaire item. 80.9% of respondents to the question asked above were Africans, 52.7% provided positive responses while 28.2% provided negative responses. The total number of whites stood at 11.8%. Among them, 7.0% answered in the affirmative while 4.8% of responses were negative. 6.5% of Coloured respondents provided negative responses while 5.3% provided positive responses. 1.4%

77.6% of respondents answered in the affirmative to question (SB16): "freezing the meat will increase its quality and last longer." Responses to this question showed that there was no significant association (P>0.05) between the questionnaire and responses given by respondents (P>0.05) based on gender and age. Significant statistical correlations (P<0.05) were observed between race of respondents, educational level, marital status of respondents and knowledge to the question. Based on educational level, it was found that the majority (95%) of respondents with primary school certificate responded compared to respondents with no primary school qualification. While the majority of African respondents (80.9%) responded to the questionnaire item, 64.1% of them answered in the affirmative with 16.7% providing negative responses. Out of the 11.8% of white respondents, 7.1% answered in the affirmative compared to 4.7% who provided negative responses. Coloured respondents (6.3%) responded to the question with 5.5% them giving the right answer while only 1.00% answered wrongly. The total number of Indians (0.57%) answered with 0.42% answering correctly while 0.14% of them gave the wrong answer.

It is important to mention that frozen foods have an exceptional safety record and it is extremely unusual for a food-borne illnesses to be traced back to frozen food. Freezing preserves food by either stopping microbes from multiplying or uncertain the food's own enzyme activity that would otherwise cause the food to rot (WHO, 1998).

All utensils that will have direct or indirect contact with food and kitchen surfaces should be disinfected/sanitised. These include work surfaces, chopping boards and knives. 75.1% of respondents responded in the affirmative and indicated that it is true that "Proper handling of equipment in the kitchen reduces the risk of food poisoning" (question 20). Statistical significant (P<0.05) relationships were observed in terms of age, race, marital status and the response to question asked. It was revealed that most respondents aged below 20 years knew the answer to the question and it was also found there was correlation between race at 62.6%, the response to this question with 62% of black respondents answering. In addition, it was

revealed in this study that marital status had influenced somehow the response to this question (SB20). Single respondents provided a positive response rate of 54.15%.

It is important to mention that kitchen utensils can act as a bacterial superhighway shipping bacteria around a kitchen. Therefore, it is important to clean all kitchen materials (Griffiths, 2003). In addition, a study carried out by the Global Hygiene Council found *E.coli* in high numbers in many utensils in the kitchens of participants. Similar findings were also obtained in commercial kitchens on BBC1 programmes Watchdog and Rogue Restaurants (Griffiths, 2003). The trouble with utensils such as clothes is that while the aim is to clean, the opposite possibly happens. The clothes should thus be disinfected daily and stored in regularly changed bleach (Griffiths, 2003).

Results from the overall survey of knowledge on food safety revealed that most participants "already had" proper food safety knowledge because among the 15 questions asked in this section, 12(80%) were answered by more than 50 % of respondents. It was found that in total, a mean of 65.02% ± 16.64 of all respondents answered correctly to all 15 questions asked in this section (Table 4.3). Only 34.96% ± 16.93 of respondents answered negatively or did not have knowledge on food to all the questions asked. It is important to mention that there is a significant difference ($P \leq 0.05$) between the two groups of people, among men and woman in their knowledge. It was also observed from the responses obtained to questions asked in this section that most important questions relating to food knowledge, there was significant correlation between race and answers by respondents to different questions. This might be explained by the fact that most respondents were black (81.1%), while others were white (11.8%), coloured (6.5%) and Indians (0.6%) were in the minority. They could all easily respond to the majority of questions in the affirmative or negatively. Education is also one of the factors that contributes to knowledge to many questions (20%). This clearly indicates that education is important in developing and fighting against diseases through food hygiene. Important information on food safety is acquired through education, especially in primary schools.

These findings differ from those of Samapundo *et al.*, (2015) who, in their study in Haiti, found that neither educational level, nor the length of employment in the food service industry had a significant impact on knowledge on food safety.

4.3 FOOD SAFETY ATTITUDES AND PRACTICES BY CONSUMERS DERIVED FROM SECTION C

Knowledge without practice is of no use and this applies also to food safety attitudes and practices. Therefore, a population that has knowledge of food safety but does not put the knowledge into practice, will always be affected by food-borne diseases. Any direct evaluation of results is difficult because of the inequality measures used in different reported studies. The resources used to assess attitudes and practices fall into two categories: examinations of premises; and structured questionnaires (Cook and Casey, 1979). In this study, however, only one way of assessment was done (through the questionnaire).

Responses obtained in section C are also summarised in Table 4.2. Among the 18 questions asked to respondents in this section, one of the questions (question 5) sought to find out how long respondents usually keep purchased food (meat, milk and other perishable products) in the kitchen before putting them in the fridge. Among the interviewed participants, 57.5% responded in the affirmative by indicating that they immediately put their food in the fridge after purchase while 32.1% of respondents indicated that they did so after about 2 hours and 10.4% did not care. A study conducted by Dietician, Zeratsky in 2004 in Minnesota confirmed that most cases of food poisoning can be prevented with proper food handling, and in particular, by respecting the time perishable food is kept at correct temperatures. Therefore, to practise food safety, one has to quickly refrigerate perishable foods such as meat, poultry, fish, dairy and eggs as soon as purchased and not let them stay for more than two hours at typical room temperature or more than one hour at temperatures above 32°C. In addition, only 59.1% of respondents checked regularly the expiry date of food before buying or cooking, 32.2% did not bother to check while 8.5% did not even know that an expiry date existed for perishable foods such as meat, milk and eggs. In this study, 23.9% of respondents affirmed to have experienced food poisoning while 21.7% did know or did not remember having experienced it in their life. The truth is that some respondents, even among those who indicated that they have never experienced it, did not know what food poisoning was about. Food poisoning is characterised by symptoms which usually include abdominal cramps, nausea, vomiting and diarrhoea. Kennedy (2011) affirmed that the most common causes of food poisoning are bacteria, followed by viruses, parasites, chemicals and toxins.

Table 4.3: A summary of overall responses of respondents on food safety attitudes and practices

Questions and responses %			
5. For how long do you keep your food (meat, milk, and other products) in the kitchen before putting it in the fridge?	a) Immediately b) After 2 hours c) Do not care	404 225 73	57.5 32.1 10.4
6. For how long do you keep your food in the fridge before cooking it?	a) Immediately b) After 2 hours c) Do not know	358 274 73	50.9 38.9 10.2
11. Have you ever experienced food poisoning?	a) Yes b) No c) Do not remember	168 383 153	23.9 54.4 21.7
12. Do you control the quality, smell, colour of food eaten in your household?	a) Yes b) No c) Do not know	372 192 138	52.8 27.3 19.6
13. Do you check the expiry date of food eaten in your household?	a) Yes b) No c) Do not know	416 227 60	59.1 32.2 8.5
14. Have you ever taken educational courses on food safety?	a) Yes b) No c) Do not remember	188 437 75	26.7 62.1 10.7
15. Do you want to learn more about food safety?	a) Yes b) No c) Do not know	499 160 44	70.9 22.7 6.3
16. What would you do if there was a black-out and the chicken in your freezer thawed and get warm to prevent food poisoning?	a) Throw it away b) Cook it immediately c) See how they smell/look d) Do not know	122 259 298 25	17.3 36.8 42.3 3.6
17. Which one is considered the best way to prevent food poisoning?	a) Spray for pets in the kitchen for every week b) Never serve leftover. c) Keep food refrigerated until it is time to cook/serve it. d) Do not know	122 84 436 62	17.3 11.9 61.9 8.8
18. How do you keep food safe if one of the family members is going to be late for dinner?	a) Store it in the refrigerator and reheat it when the person is ready to eat. b) Store it on the kitchen counter. c) Store it in a cool oven. d) Do not know.	315 96 260 33	44.7 13.6 36.9 4.7
19. After you have cracked open eggs, do you wash your hands with soap?	a) Yes b) No c) Do not cook eggs d) Do not know	288 301 94 21	40.9 42.8 13.4 3.0
20. What do you do with a knife after cutting raw material?	a) Use it as it is b) Wipe it with a cloth c) Rinse in clean water d) Rinse with soap	90 173 324 117	12.8 24.6 46.0 16.6
21. What do you do with your expired milk/meat?	a) Keep it b) Throw it away	88 611	12.5 86.8
22. After you have used a cutting board to slice raw beef and need to use it to cut chicken, what do you do?	a) Use it as it is b) Clean the cutting board with a paper towel c) Rinse it under running water d) Wash with soap and rinse under hot water	89 116 269 230	12.6 16.5 38.2 32.7

23. If you have a sore in your hand, do you prepare food for other people?	a) Yes, if I put on a bandage	128	18.2
	b) Yes, with gloves on	142	20.2
	c) Yes, if I put on a bandage and wear gloves	157	22.3
	d) No, I do not prepare food until the sore is healed	277	39.3
24. How do you wash your hands before preparing food or eating?	a) Ordinary soap and water	404	57.4
	b) Water only	205	29.1
	c) Wipe with a dish cloth	61	8.7
	d) I do not clean them at all	34	4.8
25. How often is the kitchen sink drain in your home sanitised?	a) Daily	386	54.8
	b) Weekly	122	17.3
	c) Monthly	93	13.2
	d) Other	103	14.6
26. When preparing food, do you wash or clean your hands after touching the following:	a) Your face	353	50.1
	b) Clean pots and pans	101	14.3
	c) Clean countertop	72	10.2
	d) None of the above	178	25.3

Table 4.2: A summary of overall responses of respondents on food safety attitudes and practices (continuation)

It is important to mention that several bacteria, such as certain strains of *E. coli, Salmonella, Shigella* and *Campylobacter* cause food poisoning due to inadequate cooking. Unhygienic handling and storage of foods give bacteria an ideal opportunity to get into the food and to multiply. Bacteria are responsible for the vast majority of food poisoning cases (Kennedy, 2011). Hot temperatures (25-35°C) recorded in the Ngaka Modiri Molema can contribute to food poisoning risks encountered by consumers as well as to food deterioration because these temperatures favour the growth and multiplication of some bacteria, especially when the food is kept out long without being stored in a fridge or freezer (Food Safety Education, 2004).

Respondents were asked if they check the temperature in the fridge. The majority of respondents (55.6%) responded in the affirmative that they always check the temperature in shops when buying foods compared to 44.4% of respondents who did not bother to check the temperature. These results concur with other findings by Abdul *et al.,* (2012). In their study, the same questions were asked to food handlers in Lebanon and it was found that most of them often reflected their inability to comprehend the temperature values and its relevance to the degree of heat. The results of this study are lower than those of Buccheri *et al.* (2010) and Abdul *et al.,* (2012) who both reported that 82% of food handlers did not know the critical temperature for storing hot food. In addition, in their study, the proportion of responses varied greatly when respondents were asked for the correct temperature of cooler and freezer units; 77.5% and 55% of food handlers knew the correct operating temperature of the refrigerator and freezer, respectively.

In addition to this question, respondents were asked if they regularly check the expiry date of foods. The majority of respondents (59.1%) answered in the affirmative while only 40.9% of them provided negative responses. The most operative tools to protect the family from food-borne diseases is to be aware of the refrigerator if it is working or not, either in the shops or at homes (Food Safety Education, 2004). Consumers were also asked if they regularly checked the quality (colour, smell, texture) of food before buying in the shops or before cooking at homes. Most participants (77.5%) responded in the affirmative to this question compared to 22.3% who did not check when buying foods in the shops. The majority of respondents (78.9%) provided a positive response with only 20.9% who indicated that they did not check. According to Mead *et al.* (1999), the USDA advises that food storage is at its best if properly packaged and stored in a refrigerator or freezer. This extends the shelf life of the food and protects it from damage, contamination, and deterioration. Measures such as the use of foil, plastic wraps, plastic bags, or airtight containers designed for refrigerating or freezing food should be used and moisture- and vapour-proof materials are the best. In addition, regular cleaning of the refrigerator to reduce food odours and cross contamination, the removal of spoiled foods immediately to prevent decay and the regular monitoring of the refrigerator and the temperature between 1 to 4°C are recommended. Perishable foods stored at temperatures above 4°C get damaged rapidly and would speed the growth of pathogens. It is important also to keep the freezer clean and at -18°C or lower and food needs to be used as fast as possible and not to wait for the maximum storage time (Mead *et al.*, 1999).

It is known that the storage of food in the fridge is a way of keeping the quality and nutritional value of the food longer. Microorganisms cause over 76 million food-borne illnesses each year; *Salmonella* and *Compylobacter* are some of the microorganisms that cause illnesses (Food Safety Education, 2004). Most of the growth of bacteria will happen if food is kept in the danger zone of 4°C to 60°C(Food Safety Education, 2004). Consumable foods that are kept in these temperatures for more than 2 hours have high chances of multiplying microorganisms that can cause food-borne illnesses (Food Safety Education, 2004). The length of time to store food safely in the fridge depends on the freshness of the food, whether it is packaged or unpackaged and also if the package has been opened or if the food has been cooked (Mead *et al.*, 1999).

One of the items on the questionnaire also sought to know how long participants kept perishable food outside before putting it in the fridge after its purchase" (question SC5).

Results obtained revealed that the majority of respondents (50.9%) indicated that they did so immediately, 38.9% said after 2 hours and only 10.2% did not know the answer to the question. There was no significant (P>0.05) relationship between gender, race, marital status or educational level of respondents and their practices towards the question. These findings show once again the food safety risk encountered by consumers who do not store their food immediately in the fridge. A study conducted by Gill (2007) revealed that refrigerators are the most important tool to slow down the growth of bacteria that cause food poisoning. Refrigerators that are set at 4°C or below will protect most foods, however, this practice does not keep the foods forever. Cool temperatures slow down bacterial growth but do not stop their growth completely. In addition, it is important to use food on time to maintain its freshness and quality (Gill, 2007).

Food quality has been defined as the quality appearances of food that is in a standard for consumers to use (size, shape, colour, consistency) as enforced by the Food Safety Act 1990 (Heldman, 2006). In this study, one of the items on the questionnaire sought to know if respondents regularly checked the quality, smell, colour of food before buying the food (SC12). Results obtained revealed that only 52.8% responded in the affirmative, 27.3% said they did not do it while only 19.6% had no idea. Analysis showed that the gender, age, or educational level influenced responses given by participants to the question (SC12). While significant correlation (P<0.05) was found between race and the answer to the question mentioned above in that, the majority of respondents who answered in the affirmative to this question were Africans (59.3%) followed by White respondents (20.1%), Coloured (15.3%) and only 53.3 of them were Indians.

With regard to the question on whether respondents had ever taken educational courses on food safety, only 26.7% responded in the affirmative with 62.1% providing negative responses. Only 10.7% could not remember. On SC14, statistical analysis based on gender revealed that there was no significant relationship between (P>0.05) gender, food safety attitudes and practices with responses given by respondents to the question asked. Based on age, statistical analysis revealed that there was no significant relationship (P>0.05) based on age food safety attitudes and practices with responses given by respondents regarding SC14. Concerning SC14, statistical analysis showed that there was no statistical significant relationship (P>0.05) between race, food safety attitudes and practices with how consumers responded to the question asked. Statistical analysis based on marital status showed that there was no significant relationship (P>0.05) between marital food safety practices and attitudes

with responses provided by consumers to SC14. However, results obtained in this study revealed that there was a statistical significant relationship ($P<0.05$) between educational level, working status and food safety attitudes and practices with how respondents responded to the question asked in SC14. In addition, results obtained in this study revealed that respondents with tertiary education (65.3%) had better knowledge on food safety attitudes and practices compared to those with only secondary (15.2%) and primary (11.9%) school education. Respondents with no qualification (7.6%) did not have any knowledge on practices and attitudes. These results correlate with those obtained by Morrone and Rathburn (2003). In their study, they found that many participants did not have any educational training on food safety attitudes. In addition, these results are in line with the affirmation of Morrone and Rathburn (2003) who reported that only few studies on food safety have been conducted to discover knowledge on food safety and behaviours among consumers in developed countries. There is a need for improved education on food safety in developed countries with the introduction of national initiatives to find ways to successfully educate consumers, especially the young, who prepare food. Hence, the need for all stakeholders (education institutions, government department in charge of health and food safety) to develop and get involved in food safety campaigns with as target, education and awareness of all categories of the population and in particular, people with no education.

When asked if they have ever participated in a food safety course (SC 14), 26.7% of respondents confirmed to have had one training while 60% had never attended. These results might be explained by the fact the majority of people are not aware that in South Africa, there is a month (September) dedicated to food safety education for all. September has been designated as national food safety month education since 1994 by the National Restaurant Association in order to intensify awareness on the importance of safety education whereby experts promote food safety to food services and consumers. These results are in line with the findings obtained through a survey conducted by the International Food Information Council Foundation (2014) which revealed that the majority of consumers are aware of their own food safety action; although the same data reveal that there is room for improvement. This study emphasises that people should be sensitised on organisations such as the International Food Information Council Foundation (IFICF), in order to learn more basic food safety practices.

One of the questionnaire items also sought to find out if respondents had ever suffered from a food-borne disease. Results obtained are summarised in the Table 4.3. Among those who reported having had a food-borne illness, 33.4% reported to have had diarrhoea after consuming food, followed by food-poisoning (7.7%), cholera (3.3%), allergy (2.7%) and

salmonella (1.7%). It is important to mention also that from the data obtained in this study, 28.6% of respondents confirmed to have suffered from food-borne illnesses but did not identify what could have been the causes of the diseases. The data is confirmed by studies conducted in South Africa and elsewhere in which food-borne diseases have been identified in the past years (Motarjemi *et al.,* 2005). It is estimated that the reported incidence of food-borne diseases represents less than 10%, and maybe less than 1% of the real incidence (Motarjemi and Käferstein, 1997).

South Africa is currently facing serious electricity shortage with unannounced power cuts all over the country. In this study, respondents were also asked on what they would do to prevent food poisoning if there was a black out and the food (meat) in the freezer was thawed. 17.3% of respondents indicated that they could "throw it away"36.8% maintained they could cook it immediately, 42.3% said they could check the smell/look before deciding, and only 3.6% did not know. Statistical analysis revealed that there was a significant correlation ($P<0.05$) between age of respondents and knowledge to the question. Age of respondents <20 (52.3%) responded in the affirmative compared to respondents aged between 21-30 (20.6%), consumers between 31-40 (15.9%) and respondents above 40 years old (11.2%). Any food that is thawed above 4°C must be discarded and remain there for 2 hours or more (WHO, 1998). A concern would be with the 42.3% of respondents who indicated that they would check the smell and texture before taking the decision on what to do with the food because such practice is in contradiction with the findings of Mead *et al.* (1999). In their study on food control, they reported that the best way to control quality is by checking the smell of food and by purchasing fresh foods packaged in good conditions. Other researchers such as Mead *et al,* (1999) and Katherine (2004) maintain that the best way to conclude quality and safety cannot be based on smell and texture as the presence of pathogens cannot be detected by appearance. However, food should be thrown away if it is slimy (Jay, 1996). Katherine (2004) also found that since bacteria do not change the taste, smell or look of food, one cannot tell whether the food is dangerous to eat or not. Therefore, it is best to throw it away if one is in doubt. It is also advisable to discard any food that has strange colour or odour immediately if it is difficult to tell exactly if the food is spoiled. Without power, the refrigerator keeps food cool for 4-6 hours depending on the kitchen temperature and the freezer should keep food frozen for about two days. Therefore, any food that have strange odour should be thrown away to prevent illnesses caused by eating contaminated food.

When asked on the best way to prevent food poisoning (QuestionSC17), 17.3% of respondents said they spray for pests in the kitchen every week, 11.9% mentioned that they

never serve leftovers. The majority of respondents (61.9%) responded in the affirmative by indicating that keeping foods refrigerated until it is time to cook/serve them, while only 8.8% of respondents did not have knowledge of what to do. The study also revealed significant correlations ($P<0.05$) between race, marital status and knowledge to the question asked. 52.3% of African respondents answered in the affirmative compared to Whites (25.1%), followed by Coloured (13.9%) and only 8.7% Indians. In addition, majority (63.8 %) of respondents who gave the correct answer were married compared to 22.6% single, 8.5% divorced (8.5%) and 5.1% widowed. Here, also, there is a concern over the 38.1% of respondents who have no knowledge to the question. These results indicate the need for public education and awareness on basic food safety. Control and prevention of food-borne diseases depends on 5 pillars: identification of contaminated ingredients; temperature control; personal hygiene; cross contamination; and sanitation (Food Protection Report, 1996).

Respondents were asked what they do with a knife after cutting raw material before using for another food (question SC20). Among respondents, 12.8% indicated that they use it as it is, 24.6% declared they clean it with a cloth; 46.0% rinse in clean water while 16.6% indicated that they clean it with soap and rinse with water. There was significant relationship ($P<0.05$) between gender and educational level of respondents and food safety attitudes and practices regarding the question. In addition, regarding this question, it was revealed in the study that majority (73.2%) of respondents who answered in the affirmative were females and a showed better understanding of food safety attitudes compared to male respondents (26.8%). In addition, 55.3% of respondents who answered in the affirmative had tertiary qualification and showed better understanding of the topic compared to respondents with secondary school education (25.0%), primary school education (10.5%) and those who did not have any qualification (9.2%).

Washing the knives (kitchen utensils) at all times with warm water and soap is an appropriate way of preventing any cross contamination and also, keeping the kitchen clean is essential in controlling bacterial pathogens (Disease Control and Prevention (CDC), 2011). This can help to control bacteria such as *E.coli* that can be transmitted through foods, including undercooked ground beef. Results obtained in this study are in line with the observation by Abdullah *et al.,* (2012) that 95% of respondents knew the response to the question. On the contrary, this finding is not in line with results obtained by Samapundo *et al.,* (2015) who found in a study in Malaysia that only 19% of respondents responded in the affirmative to the question. It is important to emphasise that poor handling of kitchen utensils such as knives

and pots has been identified as one of the causes of cross contamination of food during food preparation (CDC, 2011).

Milk and meat being essential and perishable foods, respondents in this study were asked what they do with their expired milk/meat (question 21). Results obtained revealed that 12.5% of respondents kept it until it got finished while the majority (86.8%) threw it away. Hence, a significant difference ($P<0.05$) between those who knew the answer and those who did not know the correct practice. A significant correlation ($P<0.05$) was also found between gender, educational level and food safety attitudes and practices of respondents towards this question. 50.14% of female respondents answered in the affirmative showing a better understanding and provided the correct answer compared to males. It was also noted that respondents with tertiary educational level (69.5%) had a better understanding and action towards the question compared to respondents without any qualification (8.8%), primary School level (10.2%) and secondary school level (11.5%).

It is also important to mention that although 86.8% of respondents threw away damaged milk, 12% still consumed it as it was and this becomes a food safety issue. Milk has been identified as a good medium for bacterial growth and can also be affected by many things in the environment such as lights that contribute to its bad smell. Milkloses vitamins within 36 hours if left unrefrigerated (WHO 1998). Storage at 37°C for pasteurised milk will remain fresh for two to five days after its sell-by date (Frank, 2014). Therefore, it is important to keep milk refrigerated in order to keep its value.

When asked on what respondents do after using a cutting board to slice raw beef and the need to use it to cut chicken, 12.6% of respondents indicated that will used it as it was, 16.5% cleaned the cutting board with paper towel and rinse it under running water, 38.2% washed it with soap and only 32.7% rinsed with hot water. Here also, a significant relationship ($P<0.05$) was found between educational level of respondents and their knowledge to the question. 93% of respondents who answered in the affirmative had primary education while 89% provided negative responses on food safety attitudes and practices to the question asked in SC22.

With regard to self-sanitation, respondents were asked what they would do if they had a sore in their hands and had to prepare food for other people. The data revealed that 18.2% of respondents would bandage the wound, 22.3% said they would put on gloves while 39.3% said they would not prepare food until the sore was completely healed. It has been reported that due to lack of sanitation, several infectious diseases can easily be spread from one person to another by contaminated hands, mostly gastrointestinal infections (FAO, 2006). Sanitising

the hands remains one of the most important ways of preventing the spread of bacteria or viruses. Respondents were also asked if they washed their hands before handling or eating food (Question24). It was revealed that 57.4% of respondents did it by using ordinary soap and water, 29.1% used water only, 8.7% cleaned their hands with a dish cloth and 4.8 % did not clean them at all. Although the majority of interviewees (57.4%) cleaned their hands properly, the remaining 42.6% did not and therefore remain at risk of contracting food-borne diseases. Gastroenteritis can cause severe complications, and as a result, young children, the elderly, or those with weak immune systems could be in danger of contracting diseases (FAO, 2006). Statistical analysis showed that there was a significant correlation ($P<0.05$) between race, marital status, educational level, working condition and food safety. Majority of African respondents (50.1%) responded in the affirmative compared to whites (33.2%), Indians (2.5%) and coloured (14.2%). In addition, the majority of respondents (43.55%) who gave the correct answer to the question were unmarried and showed a better understanding compared to married (10.9%), divorced (3.2%) and widowed (2.3%) respondents. In addition, it was observed that among those who responded in the affirmative, 58.3% had attained at least tertiary education compared to 28.9 with secondary education, 6.5% primary education and 6.3% who had no qualification..

It is important to mention that as much as the majority of respondents (57.4%) understood the need to wash hands using soap, this study also reveals that there are a number of respondents (29.1%) who did not know they needed to use soap when washing hands. Soap contains ingredients that assists in loosening dirt on the hands; therefore, it is vital to use soap when washing hands (FAO, 2006). Drying hands properly is as important as washing them before or after food preparation. The data confirms the findings by Verbeke (2007) that in general, lay people are deficient in terms of understanding the hazards and risks associated with poor food safety.

Keeping the kitchen clean every day is one of the most important practices to food safety and helps control bacteria. There was a need to assess the practice of respondents regarding the kitchen, sink and drain in their homes (SC 25). Results obtained revealed that 54.8% of respondents did it daily, 17.3% did it weekly, 13.2% did it monthly and 14.6% indicated that they did not have regular schedules for cleaning. Analysis of the data showed a relationship ($P<0.05$) between race, marital status and educational level food safety attitudes and practices, while in terms of employment, statistical analysis revealed that no significant relationship between working status food safety attitudes and practices and how consumers responded to the question asked ($P>0.05$). Furthermore, this study has shown that there is no

connection between knowledge test scores and hygiene inspection scores. This confirms the studies conducted by Kirby and Gardiner (1997); Powell *et al.* (1997) and Samapundo *et al.* (2015). In their respective studies, they found the same trends. More studies using inspections have reported that there are no significant improvements.

Table 4.3: Summary of diseases identified by respondents for which they suspected to have been exposed to as a result of bad or not practising food safety attitudes

Diseases	Frequency	Percentage	Valid percentage	Cumulative %
Allergy	19	2.7	2.7	2.7
Anorexia	1	0.1	0.1	2.8
Bugs	2	0.3	0.3	6.0
Cancer	1	0.1	0.1	6.1
Cholera	23	3.3	3.3	9.4
Cramps	5	0.7	0.7	10.1
Diarrhoea	235	33.4	33.4	43.5
Ecoli	8	1.1	1.1	44.7
Fever	3	0.4	0.4	45.2
Flu	2	0.3	0.3	45.5
Germs	12	1.7	1.7	47.3
GIT	4	0.6	0.6	47.9
Infection	2	0.0	0.3	48.4
Malaria	4	0.6	0.6	49.0
N/A	201	28.6	28.6	77.6
NO IDEA	38	5.4	5.4	83.0
Pain	16	2.3	2.3	85.2
Pimples	2	0.3	0.3	86.6
Poison	53	7.5	7.5	94.2
Rush	2	0.3	0.3	94.5
Salmonella	11	1.6	1.6	96.0
Shigella	1	0.1	0.1	96.2
TB	6	0.9	0.9	97.0
Thrush	10	1.4	1.4	98.4
Vomition	1	0.1	0.1	98.6
Worms	2	0.3	0.3	100.0

4.4. Summary of respondents' attitudes and practices based on demographics

4.4.1 Gender, food safety attitude and practices

The study revealed that the attitudes of consumers towards food safety in general differed according to demographics and socio-economic factors such as gender, age, educational level and economic status. In this section, the study reviewed correlations between socio-economic factors and their influence on food safety. Previous studies have shown the impact of demographics with regard to food safety practices and the huge role they play in the food industry (Christensen *et al.*, 2005; Kennedy *et al.*, 2005b). When food is being prepared, the level of hygiene differs from one individual to another because of demographic factors such as gender and race.

Results obtained in this study revealed that 23.3% (males) and 34% (females) put food immediately after cooking or purchasing in the fridge while 15% (males) and 17% (females) would wait for up to 2 hours. 5.4% (males) and 5% (females) did not care and did it later. These results are in line with the conclusions of Lin (1995) who also observed in his study that gender has a huge impact on how people perceive food safety. A significant correlation was found between race and the response to the item mentioned above. Finucane *et al.*, (2000) in their study, observed that females tend to judge health risks as having a higher potential of danger compared to males due to the fact that females are regarded as primary food preparers which is also the case in this study. The results obtained in this study are similar to those of studies conducted by (Bruhn and Schutz, 1999; Byrd-Bredbenner *et al.*, 2007 and Unusan, 2007) who found that females scored better than males when it came to knowledge on food safety knowledge (Figure 4.1). This might be explained by the fact that women deal with food regularly than men and that they tend to know all the basics regarding food safety and take care of their members of the family by providing safe food.

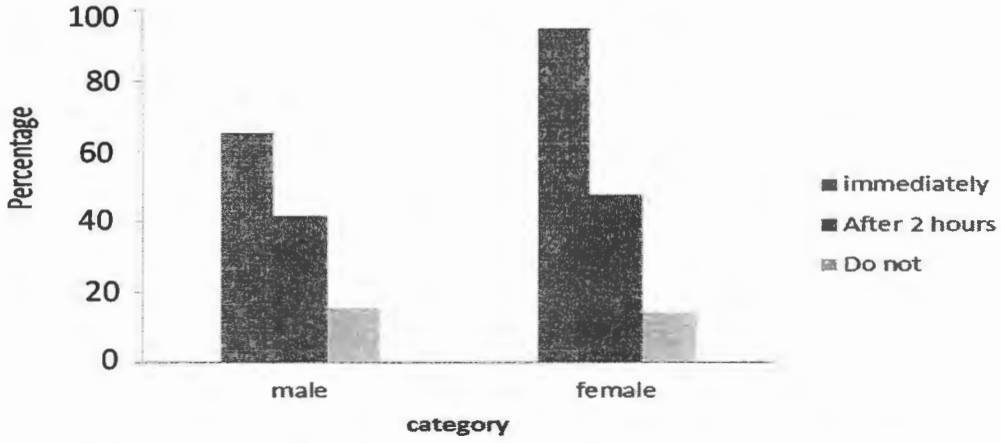


Figure 4.1: Summary of responses based on gender on the time taken by respondents to put cooked or purchased food in the fridge

The questionnaire item on whether respondents have ever taken educational courses on food safety revealed that 10.3 % (males) and 22.3% (females) had taken such courses and 22.4% (males) and 14.1 % (females) had not done so. Statistical bonds were observed between educational level, employment status and food safety attitudes and practices with how respondents responded (Figure 4.2).

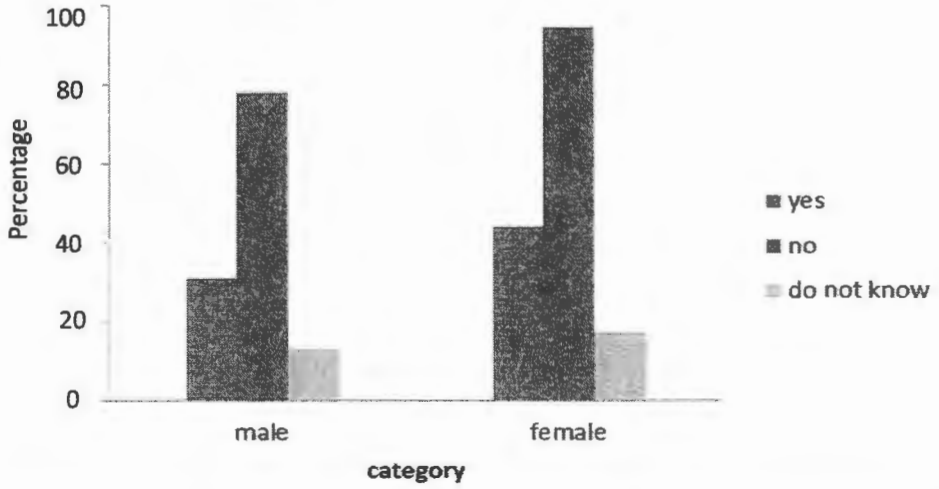


Figure 4.2: Summary of responses based on gender on whether respondents haver ever taken a course on food safety

In this study, 8.1 and 9.3% (male)s and (females) respondents respectively indicated that they sprayed for pests in the kitchen every week; 4.8 % (males) and 7.2% (females) said they never served leftovers while 26.6% (males) and 35.2% (females) indicated that they kept foods refrigerated until it was time to cook/serve them. Only 4.1% (males) and 4.4% (females) had no idea.

When asked on the best methods for preserving food after cooking, in order to prevent food poisoning, results obtained in this study showed that 21 % and 23.9% of male and female respectively indicated that they preserved food in the refrigerator and re-hearted it when the person was ready to eat", while 6.5% and 7 % males and females respectively, indicated that they preserved it on the kitchen counter. 14 % and 22.6 % males and females preferred to store it in the cool oven. Only 2.1% males and 2.5 % females had no idea on what to do (Figure 4.3).

Responses for both questions discussed above showed that female respondents had a better knowledge and practices compared to male respondents. This might be explained by the fact that female respondents deal more with food preparation in houses compared to males. In addition, in this same study, results showed that more female respondents at least went through a food safety course compared to males. In addition, significant statistical correlations (P>0.05) between gender and knowledge and practice were fund for these questions.

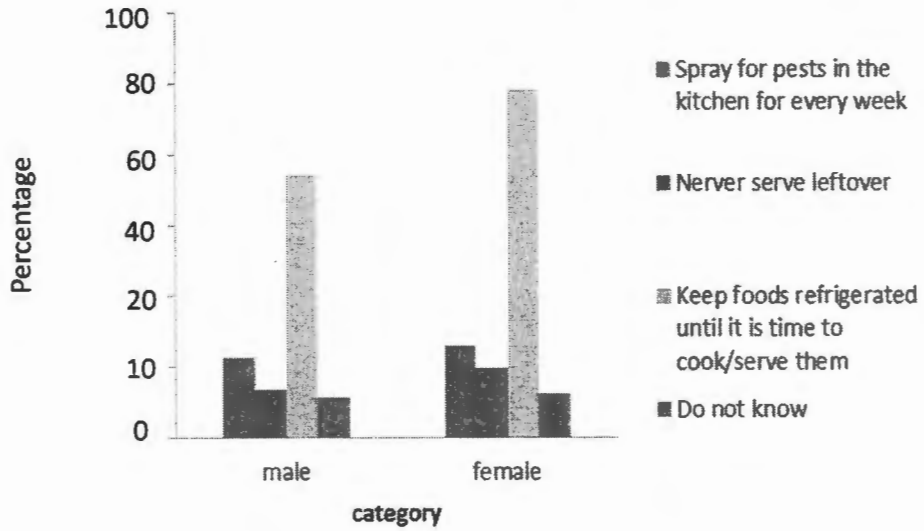


Figure 4.3: Gender responses to question 17 on the best way to prevent food poisoning

This study assessed the practices of respondents towards the cleaning of kitchen utensils such as knives when cooking and the cleaning between two foods (question 20). Based on gender, 7.1% and 5.7% respectively of male and female respondents revealed that they used it as it was, while 12.3% and 12.1% of males and females, respectively, wiped it with a cloth.17.7% males and 28.2% females rinsed in clean water. Finally 6.5% male and 10% female respondents maintained that they rinsed with soap. Statistical analysis based on gender

showed that there was a significant relationship (P>0.05) between gender and educational level of respondents and food safety attitudes and practices regarding the question.

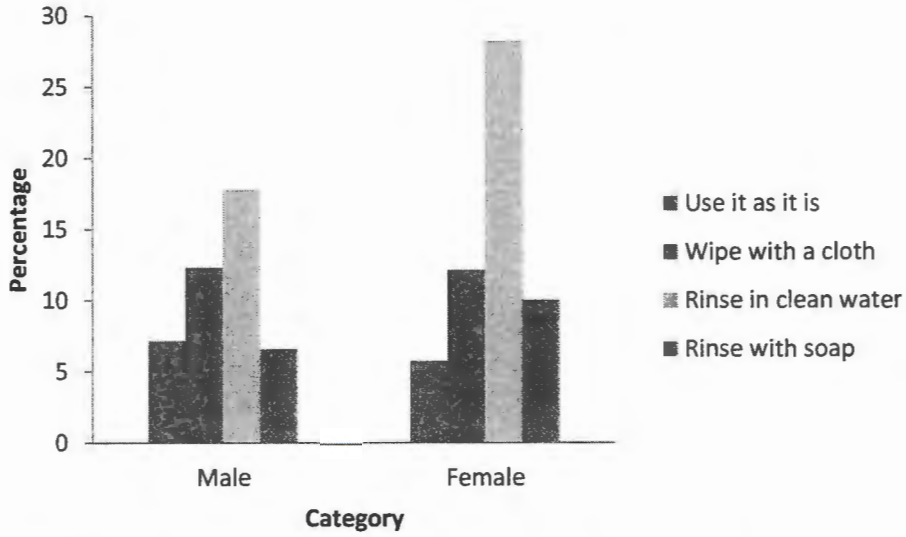


Figure 4.4: Gender responses on what respondents did with a knife after cutting raw meat (question 23)

One of the questionnaire items also sought to find out the hygienic practices of respondents when cooking food with a sore in the hand (question 23). The following responses were obtained based on gender. It was revealed that 8.3 and 9.8% of males and females respectively indicated that they would put on a bandage"; 8.8% males and 11.4% females said "yes with gloves on". 8.7% males and 13.6% females said "yes if I bandage the sore and wear gloves" while 17.9% and 21.2 males and females respectively said that they would not prepare food until the sore was healed". Here also, female respondents have better practical knowledge than their male counterparts. It is important to mention that personal hygiene practices by food handlers are essential to control food-borne diseases.

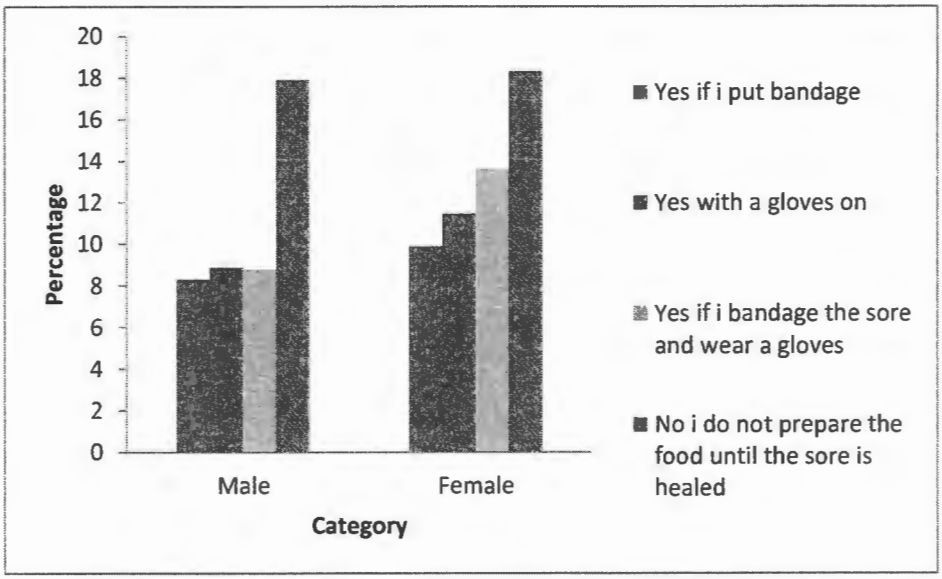


Figure4.5: Summary of gender responses on people's attitude when cooking food with a sore in the hand

Participants in this study were also asked how often they sanitised the kitchen sink and drain in their homes. Results based on gender revealed that 24.2 and 31% respectively of males and females did it on a daily basis; 7.3% males and 10% females did it on a weekly basis; 6.5% and 6.7% of males and females did it monthly. However, 5.7% males and 8.4% females did not care. Analysis of the data revealed that there was a significant relationship (P>0.05) between respondents' attitudes and practices towards the questionnaire item as more women knew and followed the correct way by cleaning on a daily basis.

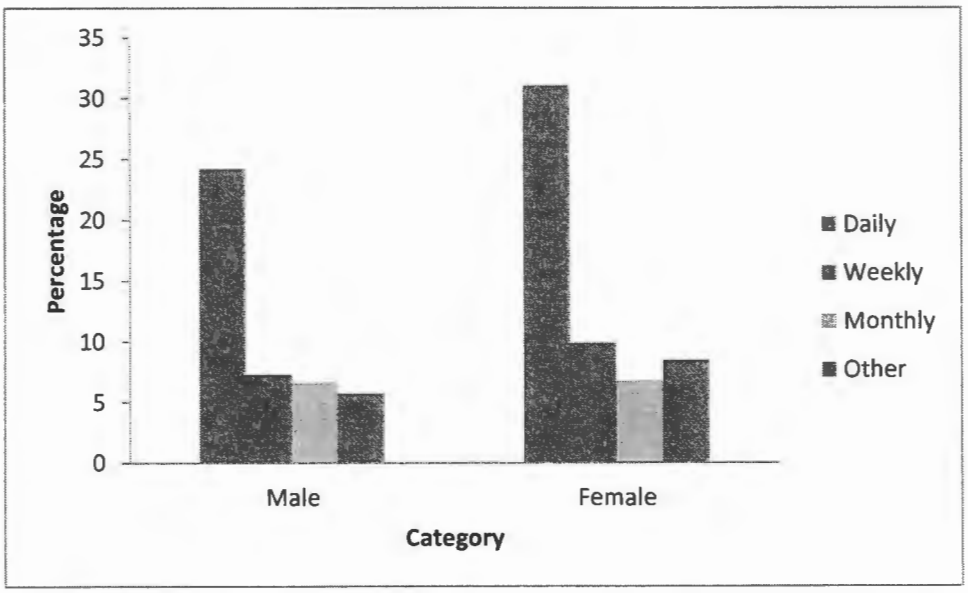


Figure4.6: Summary of responses based on gender on how often respondents sanitised their kitchens and sinks

The results obtained in this study revealed that females (56.3%) displayed better food safety attitudes than men (43.8%). Statistically, the difference based on gender and age, was significant ($P<0.05$) between men and women on food safety attitude.

These results are in line with other studies which also confirmed that gender influenced food safety attitude (Gender in Agriculture, 2009; Bredbenner *et al.*, 2007). This might be explained by the fact that women are frequently involved in food activities such as cooking, learning and improving their knowledge on food (Bredbenner *et al.*, 2007). Women tend to be responsible for food preparation and childcare within the family and are more likely to spend their income on food and the needs of children (Gender in Agriculture, 2009). Also, the data gathered in this study confirms Lin's (1995) perception that gender plays a significant role in risk perception. In addition, results obtained in this study are in line with the findings of Bruhn and Schutz (1999); Dosman *et al.* (2001); Brennan *et al.* (2007); Byrd-Bredbenner *et al.,* (2007); Unusan, 2007; Nesbitt *et al.* (2009). They reported in their studies that females had better knowledge on food safety than males.

The better score obtained for females compared to males might be explained by the fact that women tend to consider health risks as having a higher potential of danger than men. Furthermore, women are considered to be mothers and nurturers (Ninucane *et al.*, 2000; Dosmon *et al.*, 2001; Al-Sakkaf, 2013). Gender aspects of food security are visible along the four pillars of food security: availability, access, utilisation and stability as defined by the Food and Agriculture Organisation (FAO, 2006). Women's access to food is closely connected to households' food access because they are responsible for food supply in households in most cases (Gender in Agriculture Sourcebook, 2009).

4.4.1 Age and consumers' attitudes and practice on food safety

One of the objectives of this study was to assess the attitude of consumers towards food safety. In this section, the impact of age on the attitude of respondents towards food safety is analysed. Age can be a huge contributor in terms of knowledge of food safety and attitudes (WHO, 1998). People, who are at tertiary level, are believed to be the ones who possess the highest level of knowledge on food safety and attitudes. This is because when young adults leave their homes to the university, they become food preparers and also take modules related to food safety. It has been reported that age plays a huge role in determining the knowledge the public has on food safety practices (Kennedy *et al.,* 2005b). The following responses were provided by different respondents according to their age:

Respondents in this study were requested to indicate how long they keep their food in the fridge before cooking it. Data collected revealed that based on age, 26.5% of respondents below 20 indicated "immediately", 14.1% said "after 2 hours" while only 3.8% of the same age group said "do not know". In addition, 17.6% of respondents aged between 21 and 30 said "immediately", 11.8% said "after 2 hours" and only 3.5% of the same age group said "do not know". Respondents aged between 31 and 40 provided the following responses: 6.1% said "immediately", 3.4% said "after 2 hours" while only 2% of the same age group said "do not know". Respondents aged above 41 (7%) years said immediately, 2.4% said "after 2 hours", while only 1% said "do not know" (Figure 4.8).

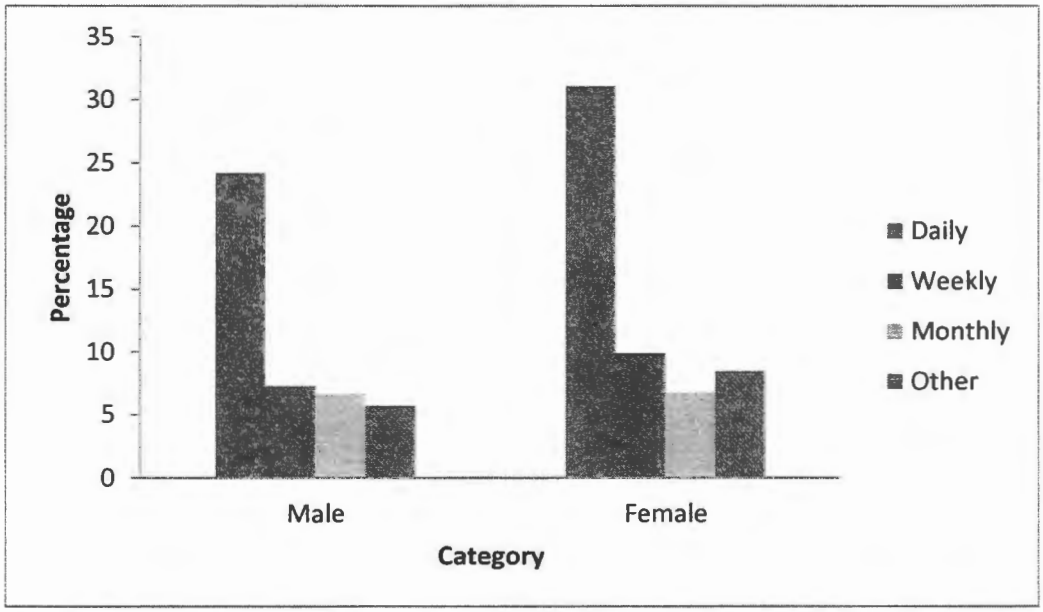


Figure 4.7: Responses based on age on "after how long do you keep food in the fridge before cooking it?"

When asked if they had ever experienced food poisoning, 8% of respondents aged below 20 years confirmed to have experienced it; 28.6% of respondents had never experienced it, while 9% of them said they could not remember. Among the 21-30 years age group, 8.1% responded in the affirmative; 17.9% said "no" while 7.3% of respondents said they did not remember. For respondents aged between 31 and 40, 4.4% of participants provided positive responses; 4.2% said "no" while 2.8% of respondents said they did not know the correct answer. In this study, 3.2% of respondents aged above 41 years responded in the affirmative to the questionnaire item, 4.1% provided negative responses while 3% of them indicated they could not remember (Figure 4.9).

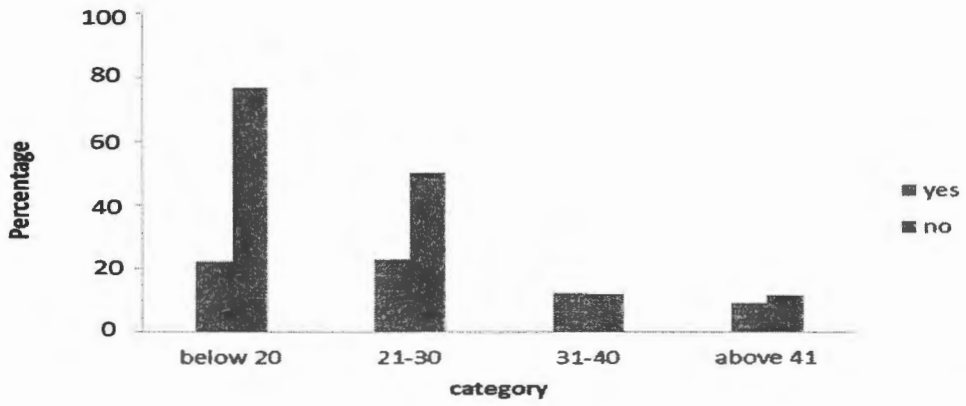


Figure 4.8: Summary of the age of respondents who experienced food poisoning based on age

One of the items in the questionnaires also sought to know if respondents had ever taken educational courses on food safety. Among respondents who participated in the study, 10.4% of those aged below 20 confirmed to have gone through a food safety course; 28.2% never attended a course and 5.5% of respondents could not remember. Among respondents aged between 21-30 years, 9.1% responded in the affirmative, 21.0% provided negative responses while 3% could not remember. Among respondents aged between 31-40 years, 4.0% said "yes", 7.0% said "no" while 0.57% could not remember. Among those aged above 41 years, 3.2% responded in the affirmative, 5.4% provided negative responses while 1.5% indicated they did not remember (Figure 4.10). These results show that the younger generation (20-30 years old) have had more chances of exposure to knowledge on food safety compared to the older generation (31 years old and above). There was a significant correlation between the age of respondents and exposure to knowledge on food safety and practice. These results are in line with those obtained by previous researchers (Samapundo *et al.*, 2015). In their study, they observed that the younger generation was more exposed to knowledge on food safety than adults. This could be explained by the fact that the younger generation is also taught food safety in classes compared to the old curriculum in which food safety and hygiene were not taught.

In addition, this revealed that that very few participants (27%) have had access to the food safety courses. These findings are also in line with the study conducted by Samapundo *et al.*, (2015). They found a similar value of 30% in their study conducted in Haiti for training on food safety among participants.

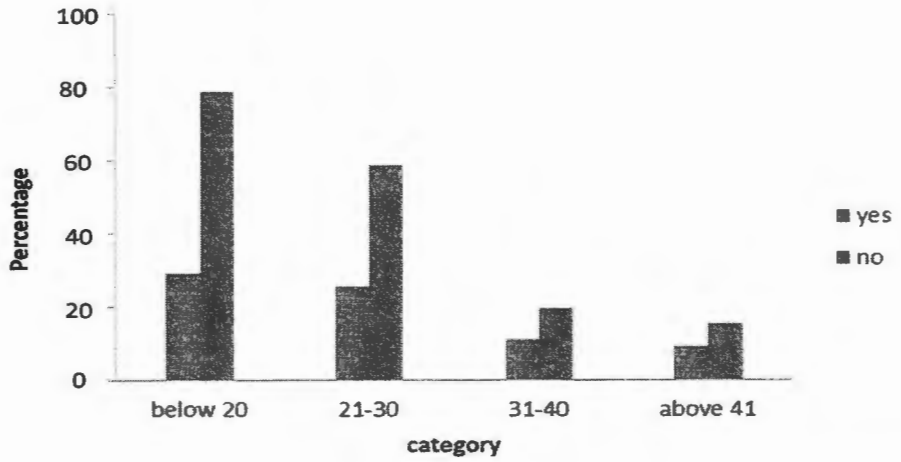


Figure 4.9: Age responses regarding educational courses on food safety

Keeping the kitchen and all equipment clean at all times is considered as one of the methods of controlling and preventing food poisoning. In this study, 8.2% of respondents aged below 20 years old indicated that they sprayed for pests in the kitchen, 5.1% never serve leftover food, and 26.7% of them kept foods refrigerated while 4.4% had no idea of what to do. 5.7% of participants aged 21-30 years sprayed for pests in the kitchen, 4% never serve leftover food, and 20.7% kept foods refrigerated and 2.8% had no idea of what to do. Among the 31-40 years age group, only 1% indicated that they sprayed for pests in the kitchen, 1.5% never served leftover food, 8.2% kept foods refrigerated while only 0.85% indicated that they had no idea of what to do. Among respondents aged above 40 years, 2.5% indicated that they sprayed for pests in the kitchen, 1.2% never serve leftover food, 6.1% rather kept foods refrigerated and only 0.4% had no idea of what to do (Figure 4.11).

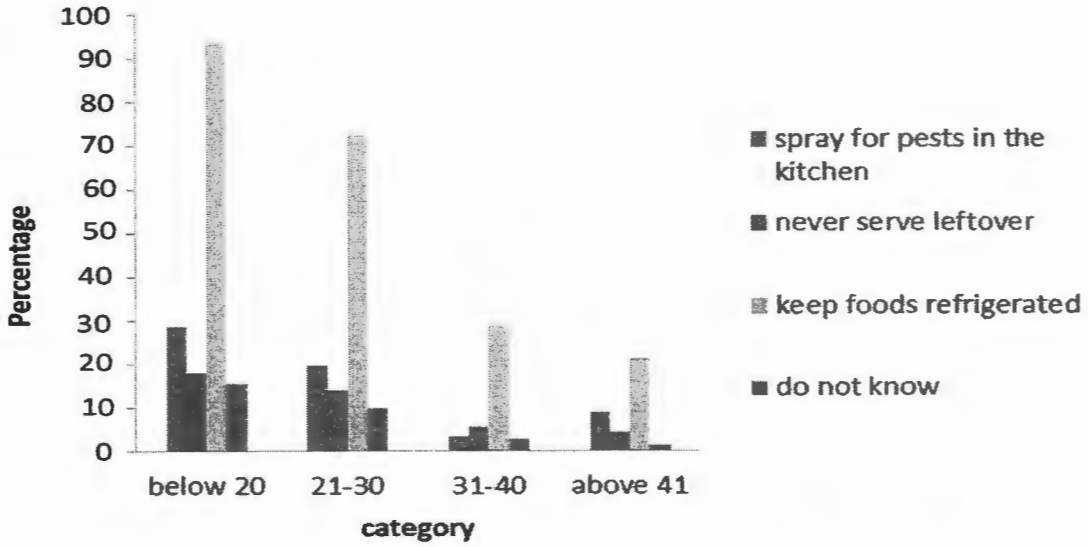


Figure 4.10: Summary of responses on the best way to prevent food poisoning by age group of respondents

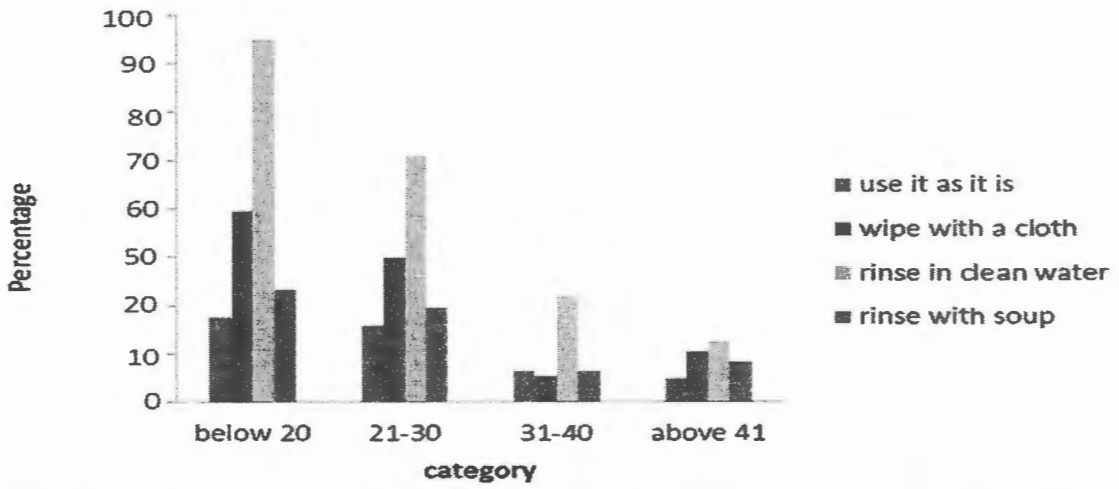


Figure 4.11: Summary of respondents' responses based on age group on what they do with a knife after cutting raw meat

In order to eliminate bacteria in the kitchen, every utensil used in the kitchen to prepare food and all the counters should always be cleaned at all times even when one is not preparing food. The questionnaire item on what respondents do with knives after cutting raw meat revealed that 5% of respondents aged group below 20 years indicated that they use the knife as it is, 11.3% indicated that they clean it with a dish cloth, 21.4% rinse the knife clean water while 6.7% of respondents maintained they rinse with soap and water. Among those aged 21-30, 4.5 and 8.5% of respondents, respectively, use it as it was and cleaned the knife with a dish cloth", 14.6% maintained they rinsed with clean water while only 5.5% rinsed with soap and water. Among respondents aged 31-40, 1.8% indicated that they used it as it was, 1.5% cleaned it with a dish cloth, 6.3% rinsed with cleaned water while 1.8% only rinsed it with soap and water. It is important to mention that among respondents aged above 41 years, 1.4% indicated that they use it as it was and 3% maintained they cleand it with a dish cloth, 3.5% rinsed the knife with cleaned water and 2.4% rinse with soap and water (Figure 4.12).

Item 23 of the questionnaire was directed to respondents aged below 20 years of age. 5.7%, 8.7%, 8.1% and 21.9% respectively said they would cook if they tied a bandage around the wound, if they put on gloves, if they bandaged the sore and put on gloves and they do not prepare food until the sore is completely healed. It was discovered that among respondents aged 21-30 years, 7.7% indicated that they would cook after bandaging the sore, 6.1% said they would cook with gloves on, while 8.5% said they would do it if the sore is bandaged and put on gloves. 10.8% of respondents said "no I do not prepare food until sore is healed". Participants aged 31-40 were also interviewed and yielded the following responses: 2% said

they will cook if they put on a bandage, 3% said "yes" if they put on gloves, 3% said "yes" if they bandage the sore and wear gloves, while 3.5% said "no" until the sore is completely healed. Finally, respondents above 41 years provided the following responses to questions 2.7, 2.4 and 2.5. They said yes if they put a bandage with gloves on, if the sore is bandaged and they put on gloves and 2.7% said no I do not prepare food until the sore is completely healed (Figure 4.14).

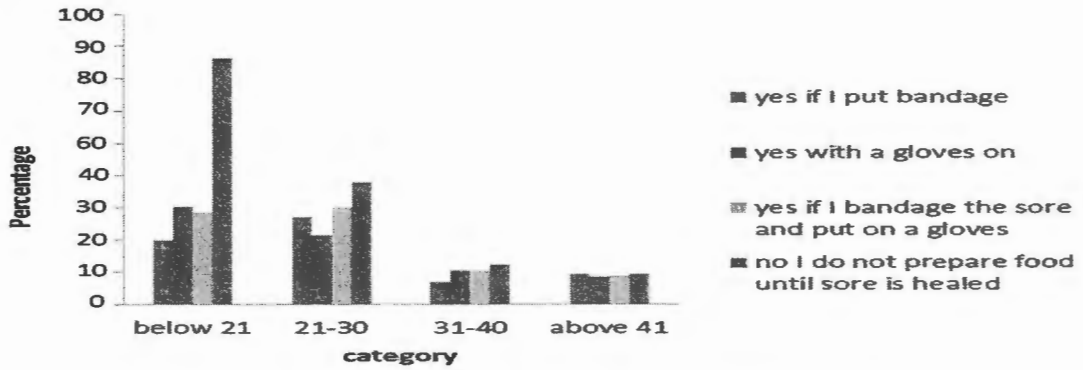


Figure 4.12: Age responses on "if participants prepare food for other people with a sore on the hand"

Results on the influence of respondents' age in terms of cleaning and sanitising the kitchen sink drain (Figure 4.15) yielded the following results: 21.9% of respondents aged below 20 years said at least daily, 8.5% weekly; 6% monthly while 8% did not know. 17.6, 6.1 and 5.1% of respondents aged 21-30 years said they cleaned it daily, weekly, and monthly. 4.4% of them did not know precisely when they clean their sinks and sanitised the kitchen. Respondents aged 31-40 years old said they do it daily (8.5%), (1.1%) do it weekly and 1% monthly. Only 0.85% said they did not know the correct answer. Among respondents aged above 41 years, 7.1% said daily, 1.2% weekly, 1.1% said monthly and 0.8% did not know. Results obtained in this study revealed that age influences attitude towards cleaning and sanitising the kitchen. Respondents aged below 20 years have the greatest positive attitude in cleaning the kitchen on a daily basis (21.9%) while those aged above 41 years were the least in terms of cleaning the kitchen on a daily basis with only 7.1%.

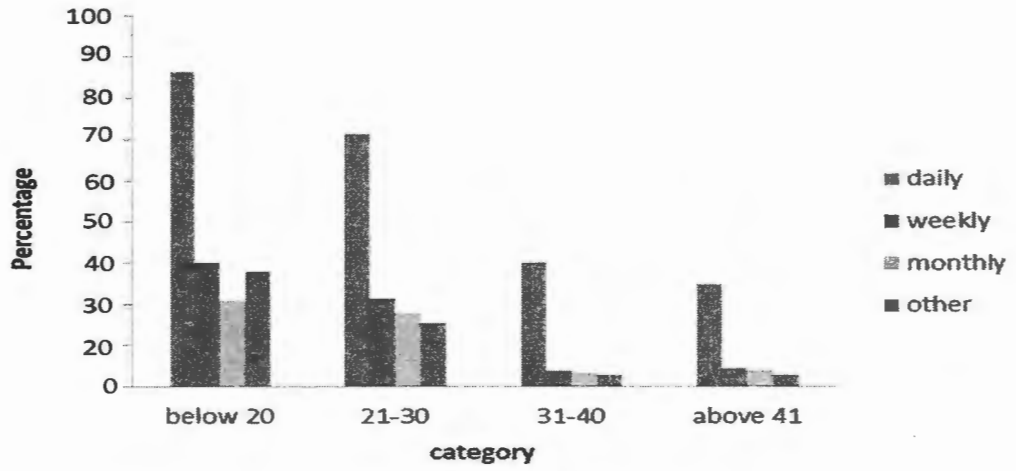


Figure 4.13: Summary of participants' responses based their age group on how often they cleaned and sanitised the kitchen sink drain in their homes

Race, attitudes and practice towards food safety

In this study, one of the items also sought to know how long respondents kept food in the fridge after cooking. Based on race, 45.9% of African respondents said "immediately", 25.7% said "after 2 hours", 8.8% indicated "do not know". With White respondents, 6.5% said "immediately", 4.7% said "after 2 hours" while only 0.5% said "do not know". Among Coloured respondents, 4.2%, 1.4%, 0.8% said immediately, after 2 hours" and did not know respectively. All Indian respondents said they stored food immediately (Figure 4.15).

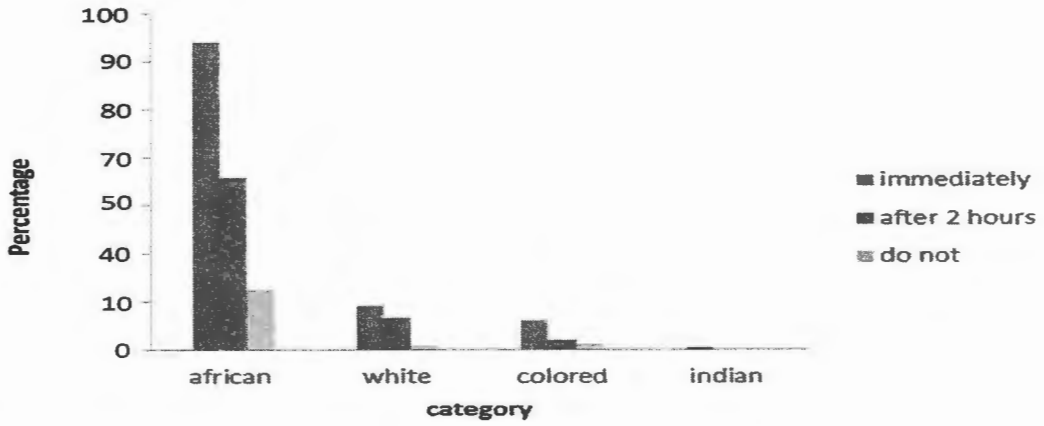


Figure4.14: Summary of participants' responses based on race groups on how long they kept food in the fridge before cooking it

Question 11of the questionnaire sought to find out if respondents had ever experienced food poisoning. The results revealed that 18.4% of African respondents had experienced food poisoning while 46.7% have never experienced any disease, while 15.7% of them did not remember. Among White respondents, 2.4% responded in the affirmative to the question, 4%

of them said they had never experienced any disease and 5.4% of them did not remember anything. 2.4% of coloured respondents said "yes", 3.1% said "no" and "do not remember" respectively. Only 0.5% of Indians interviewed confirmed to have suffered from food poisoning at least once within a period of a year (Figure 4.17).

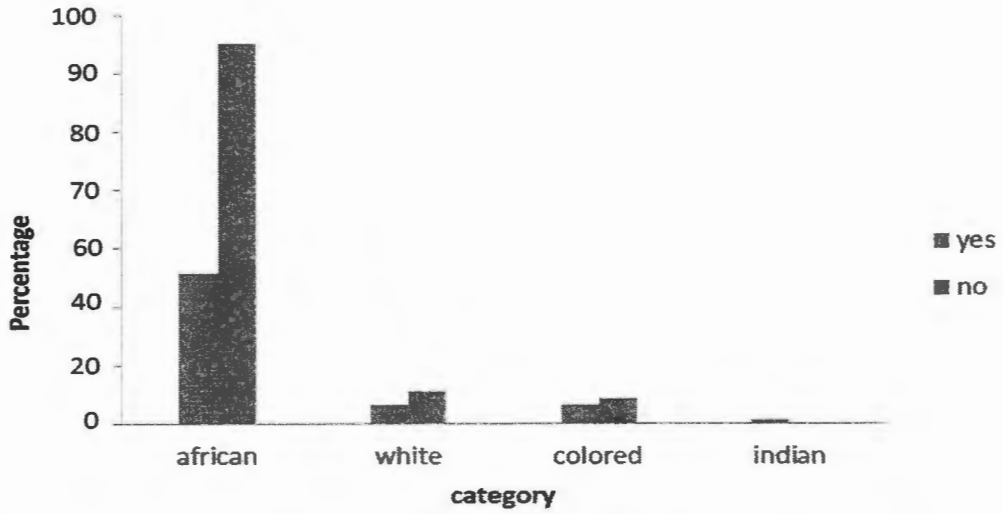


Figure 4.15: Summary of participants' responses based on race groups on "if respondents have ever experienced food poisoning before"

Regarding the questionnaire item 14 if respondents had ever taken any educational courses on food safety, based on race, 19% of Africans agreed, 52.8% said "no" while 8.7% of them said they did not remember. Among white respondents, 6.1% said "yes", 4.4% of them said "no" and 1.2% said they "do not know". 1.5% of Coloured respondents said "yes" while 4% said "no". Only 0.7% did not remember anything. All Indian respondents confirmed they had taken an educational course on food safety (Figure 4.18).

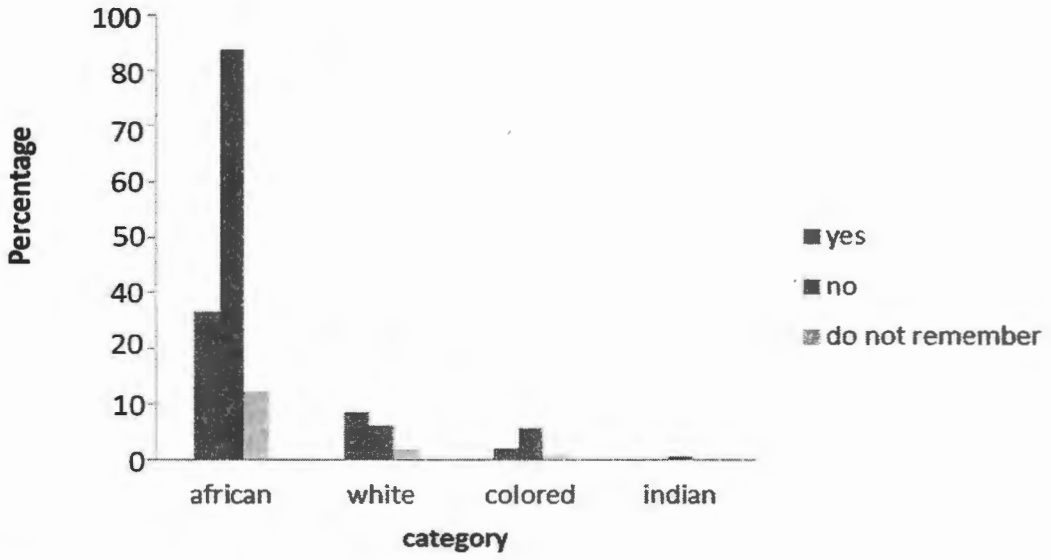


Figure 4.16: Summary of participants' responses based on race groups on "if respondents have ever taken an educational course on food safety"

Respondents were asked to choose the best way to prevent food poisoning (question 17). Based on race, 14.3; 2 and 1% of Africans, Whites and Coloured, respectively, said through spraying pests in the kitchen every week, 7.5, 3.2 and 1% of Africans, Whites and Coloured respondents said they never serve leftover food and 51.8, 5.1 and 4.4% respectively of Africans, Whites and Coloured said they keep foods refrigerated until it was time to cook/serve them. 7.1% and1.4% said they did not know. Less than 1% of Indians responded to the questionnaire item and their responses did not affect the results of the study. Significant correlations ($P \geq 0.05$) were found between races and food safety attitudes and practice (Figure 4.17).

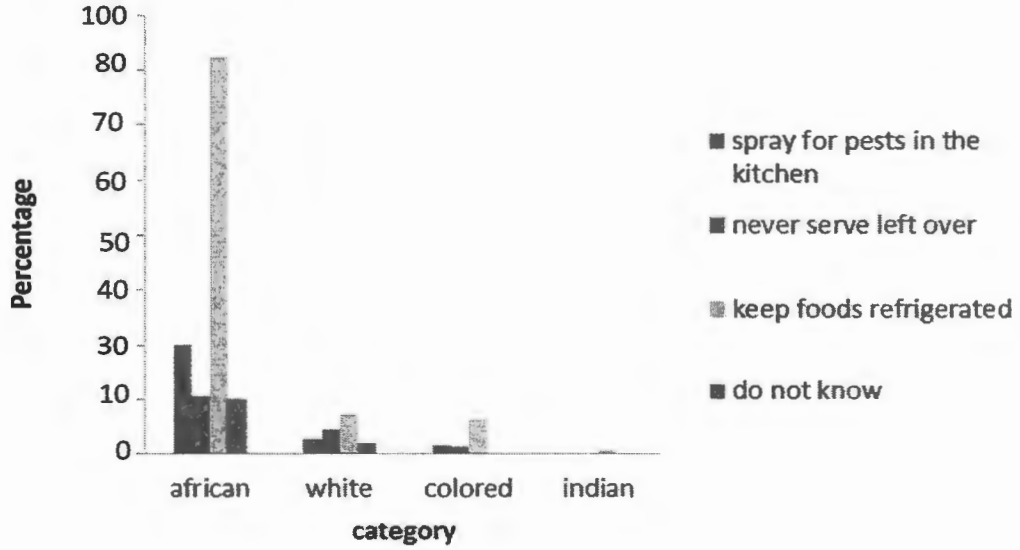


Figure 4.17: Summary of participants' responses based on race groups on "the best way to prevent food poisoning"

Respondents were asked on how they preserve food if one of the family members was going to be late for dinner (question 18). Based on race, 37.9, 2.5, 4.1 and 0.2% of respondents (Africans, White, Coloured and Indians) said they would store it in the refrigerator and re-heat it when the person was ready to eat. 8.3,3.4, 0.4 and 1.7% African, White, Coloured and Indian respondents respectively said they would "store it in the kitchen counter while 32.2%, 3.5%,0.14% said they would store it in the cool oven. Finally, 2.4%, 2.2% and 0.7% of respondents (Africans, White and Coloured) said they did not know the correct answer (Figure 4.19).

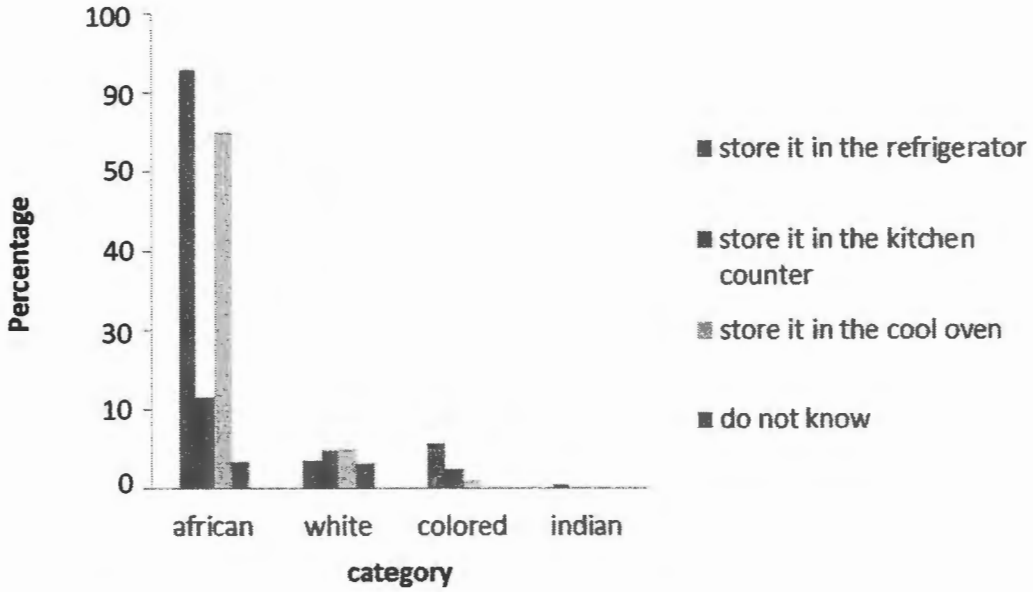


Figure 4.18: Distribution of responses based on race on "how respondents preserved food if one of the family members is going to be late for dinner"

Respondents were asked what they would do with a knife after cutting raw meat. The results shown in Figure 4.21 based on race reveal that Africans (10%, 18.6% 38.3% and 13.8%) said they would use it as it was, wipe it with a cloth, rinse in clean water and rinse it with soap and water. White respondents interviewed said they would use it as it was (18%), wipe it with a cloth (1%), rinse in clean water and soap. Coloured respondents said they would use it as it was (1%), wipe it with a cloth (2.4%), rinse in clean water (4.7%) water and rinse with soap. Among Indians, one said he or she would use it as it was, 0.4% of them prefer to wipe it with a cloth and 0.42% said they would rinse with clean water.

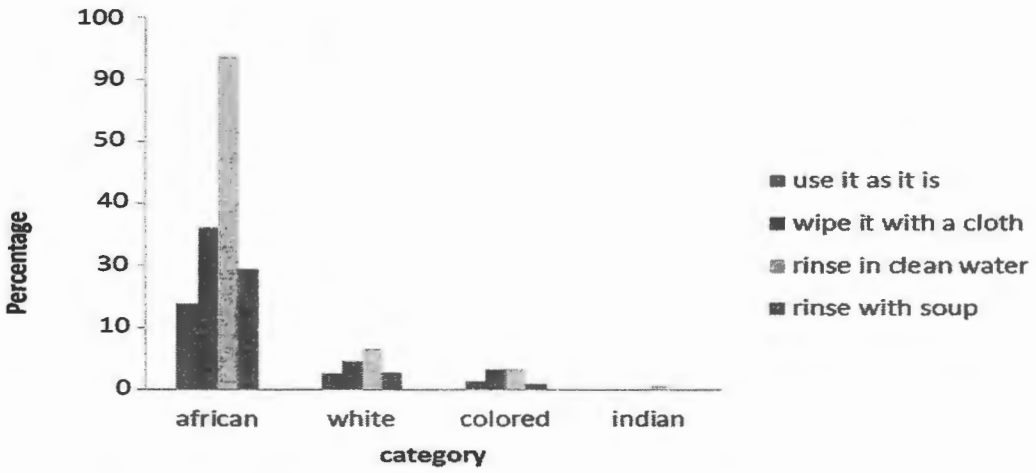


Figure 4.19: Summary of participants' responses based on race groups on what they would do with a knife after cutting raw meat

When asked what they would do if ever they had a sore (wound) in the hand while preparing food for other people (question 23), based on race, Africans (14.6%), Whites (1.8%) and Coloured (1.5%) indicated that they would cover the wound with a bandage. Africans (15.3%), Whites (4%) and Coloured (0.8%) said they would prepare food if they wear gloves, while 15.3; 4.2 and 2.5% of Africans and Whites respectively said, "yes" if only they bandaged the sore and/or wear gloves. Finally, Africans (35.6%), Whites (1.7%) and Coloured (1.5%) said they would not prepare food until the sore was healed (Figure 4.21).

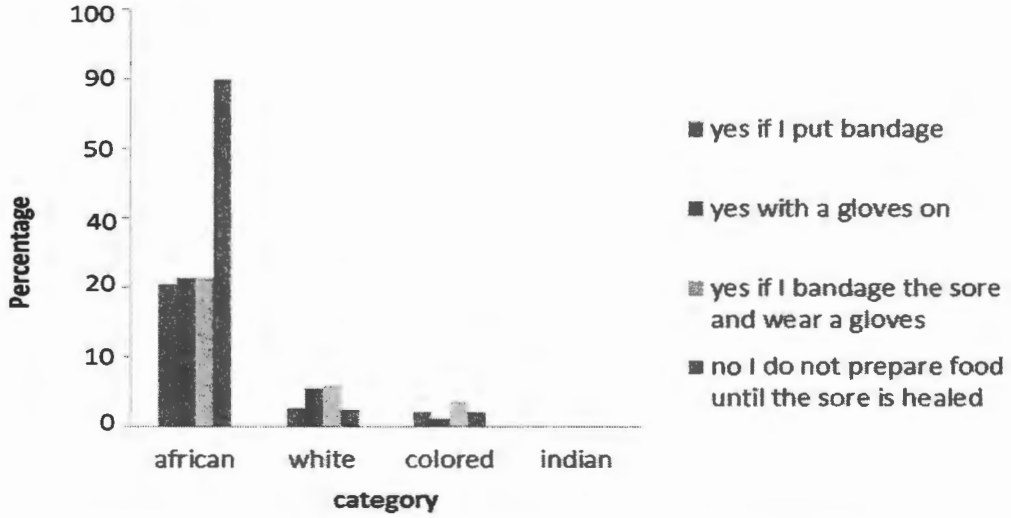


Figure 4.20: Summary of participants' responses bases on race groups on their attitude when they have a sore in the hand and want to prepare food for other people

Question 25 was to understand how often respondents sanitised their drains and kitchen sinks. Africans (46.5%), Whites (3.5%), Coloured (4.5%) and Indians (0.5%) said they did it on a daily basis. Africans (12.7%), Whites (3.5%) and Coloured (0.8%) did it weekly while 9.7; 1.8; 0.4% did it monthly. Statistical analysis based on race showed that there was a significant relationship between race and responses given by respondents (Figure 4.22).

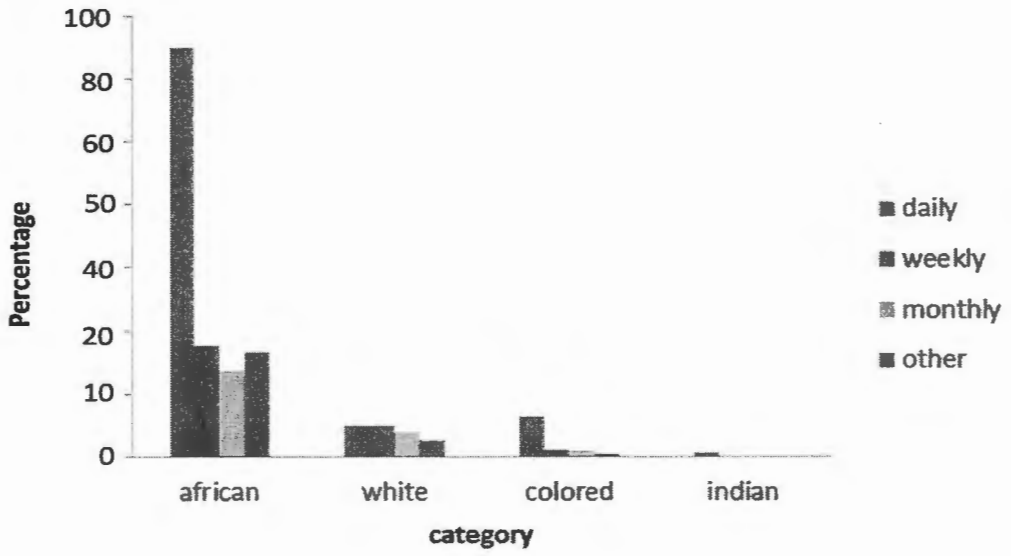


Figure 4.21: Summary of participants' responses based on race groups on how often kitchen sinks and drains in the home were sanitised

Due to the disparity in the number of respondents for the different races, it was very difficult to establish any correlation between races and knowledge and attitude towards food safety. Africans were the most respondents in this study and food-borne illnesses remain a public health problem, with most recent estimates of 9.4 million cases reported per year in some countries leading to 1,351 deaths (Bredbenner *et al.*, 2007). Prevalence rates of food-borne illnesses have not customarily been tracked by race, ethnicity or income. Other studies have also shown that individuals of minority racial and ethnic groups suffer from greater rates of food-borne illnesses (Lay *et al.*, 2000). The Foodborne Diseases Active Surveillance Network (FoodNet) (CDC, 2013) quantifies and monitors the incidence of laboratory-confirmed cases of *Salmonella, Campylobacter, Listeria, Shiga-toxin* producing *E. coli, Shigella, Yersinia* and *Vibrio.* The Tables show the different responses given by respondents.

4.4.2 Consumers' attitudes and practices on food safety based on marital status

Marital status is one of the aspects that has not been studied or examined as to whether it plays a role in body weight gain (Sobal *et al.*, 1984). This suggests that marriage may

influence body weight through food intake. The following charts show various responses given by respondents for the questionnaire item.

For how long did you keep your food in the fridge after cooking it? Based on marital status of respondents, married (11.4%), single (39.3%), divorced (4.2 %) and widowed (2.1%) said they did it immediately. 6.7% (married), 22.2% (single), 2.1% (divorced) and 0.8% (widowed) said they do it after 2 hours. The remaining number could not remember what they always did (Figure 4.24).

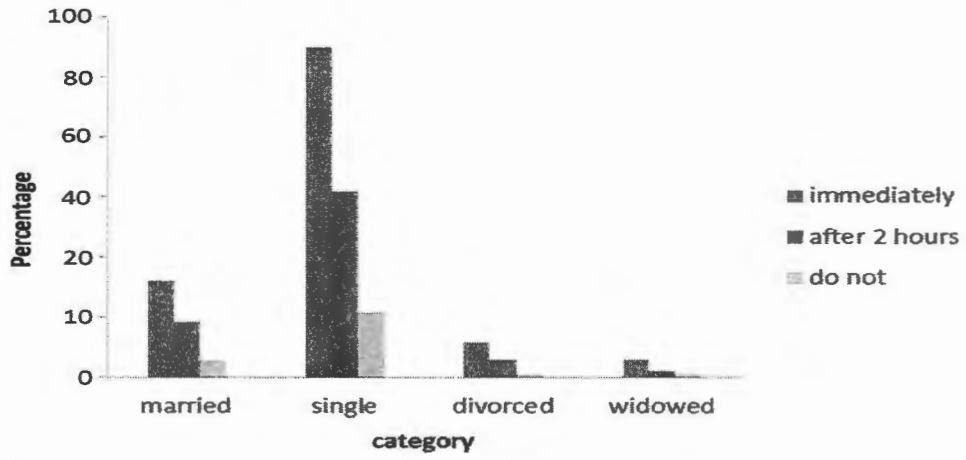


Figure 4.22: Responses to question 5 based on marital status

Have you ever experienced food poisoning? Based on marital status, 59.3% of married respondents said "yes" while 20.8% said "no", 19.9% said they did not remember. Among divorced respondents, 0.71% said "yes", 3.2% said "no" and 2.7% said they did not remember. Among widowed respondents, 1.1% said "yes", less than 0.8% said "no" and 2.7% did not remember (Figure 4.23).

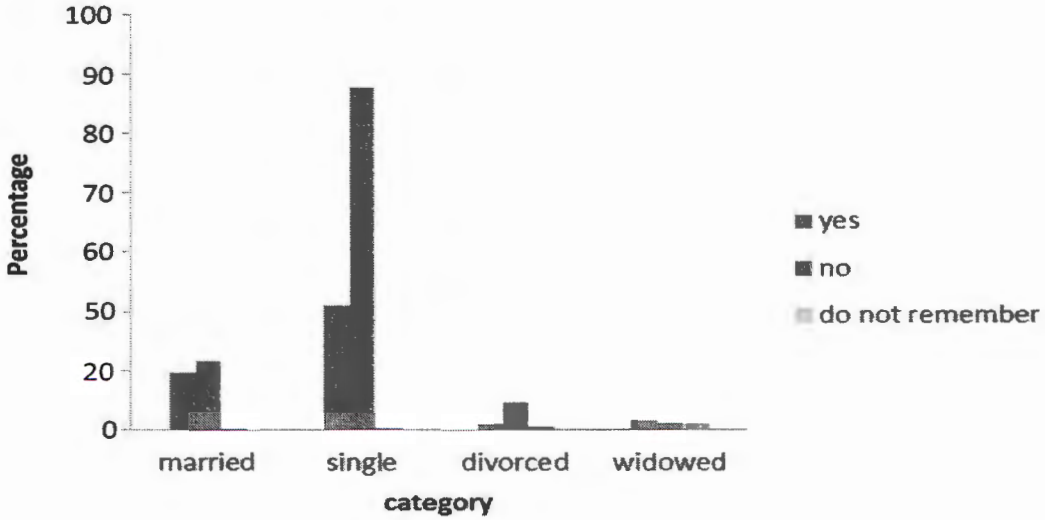


Figure4.23: Distribution of responses according to marital status in terms of respondents have you ever experienced food poisoning before

Item14 of the questionnaire sought to know if respondents have ever taken educational courses on food safety. According to marital status (Figure 4.24), 6.3% of married respondents said they had taken such courses while 12.1% had never, 1.8% of them said they did not remember". Among single respondents, only 17% of them said yes with 4.4% of them indicating they had not done it, while 7.7% did not remember". 2.4% of divorced respondents said yes, 3.8% said they had not done it, while 0.4% did not remember". 1.1% of widows said yes, 1.4% of them had not yet done any course on food safety, only 0.7% of widows said they did not remember.

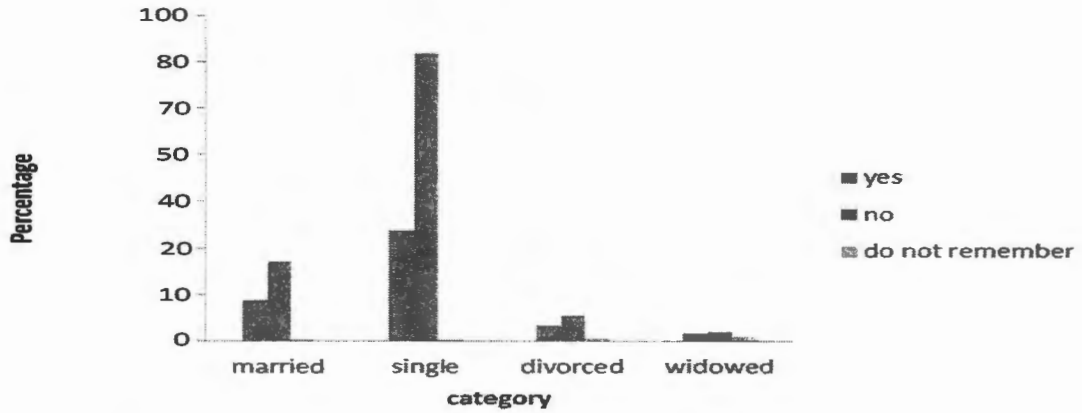


Figure 4.24: Distribution of responses based on marital status

Sanitation in the kitchen is important to avoid and eliminate contamination and control bacterial growth. Question 17 sought to find out what was the best way to prevent food poisoning. Based on marital status, 3.7% of married respondents said they sprayed for pests in the kitchen, 3.8% of them said they never served leftover food, 11.6% of them said they kept food refrigerated until time to cook and only 1.1% said they did not know the correct answer. When asked the same question, single respondents (11.4%) said they sprayed for pests in the kitchen, 6.1% never served leftover food, 45% kept food refrigerated until time to cook" and 6.7% of them said "do not know". 1.2% of divorced respondents said they would sprayed for pests in the kitchen, 1.4% never served leftover food and 3.4% kept food refrigerated until it was time to cook while 0.5% said they did not know. 0.5% of widowed respondents said they would spray for pests in the kitchen, 0.5% never serve leftover food, 1.7% kept food refrigerated until it was time to cook while 0.14% did not know. Significant correlations were observed between marital status and knowledge of safety attitudes and practice (Figure 4.25).

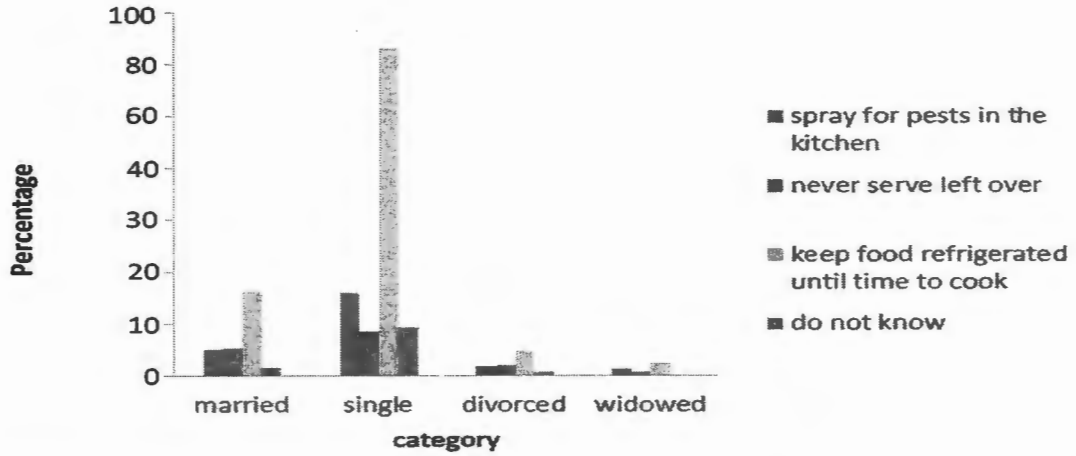


Figure 4.25: Summary of participants' responses based on their marital status for the best way considered to prevent food poisoning

"How do you preserve food if one of the family members is going to be late for dinner" was one of the questions asked to all respondents based on their marital status and the following responses were obtained: 1% of married respondents said they stored it in the refrigerator and reheated it when the person is ready to eat, 3.7% stored it in the kitchen counter, 4.8% stored it in the cool oven and 1.2 % did not know what they would do. Among respondents who were single, 30.8% stored it in the refrigerator and reheated it when the person was ready to eat, 8% store it in the kitchen counter, 28.6% store it in the kitchen counter and 2% do not know". 1.1% of widowed respondents stores it in the refrigerator and reheat it when the person is ready to eat", 0.7% store it in the kitchen counter, 1 stored it in the cool oven and 0.2% did not know the correct answer (Figure 4.26).

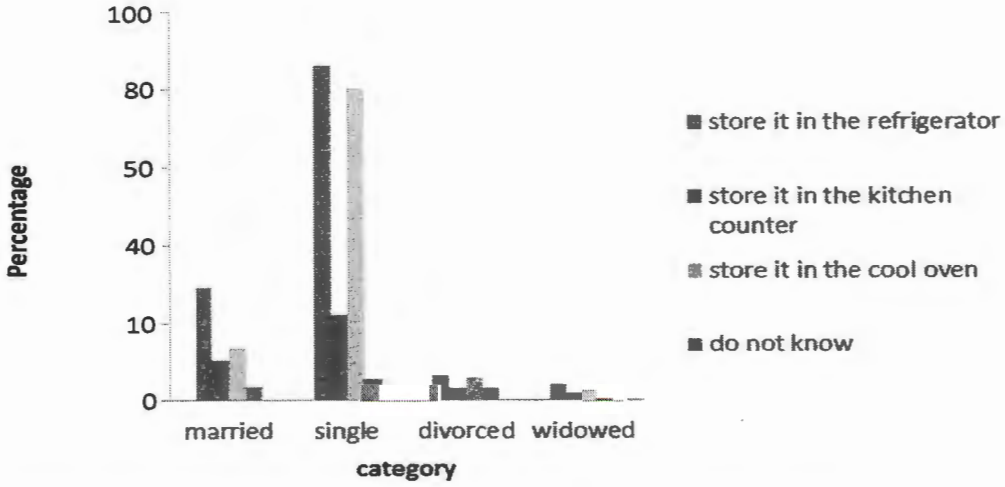


Figure 4.26: Summary of responses based on marital status of participants on how to preserve food if one of the family members is going to be late for dinner

Question 20 sought to find out the behaviour of respondents after using a knife to cut meat. 2.8% of respondents (married) said they use it as it is, 5.1% wipe it with a cloth, 8.7% rinse it in clean water and 3.5% rinse with soap and water" only. 7.5% of single respondents said they would use it as it is, 17 % said they would wipe it with a cloth,32.9% indicated that they will rinse it in clean water while 11.8% rinse with soap and water. Among divorced respondents, 1.7% said they use it as it is while 2.5 % maintained they wipe it with a cloth. 2.7% of divorced respondents rinse with clean water and less than 0.57% "rinse with soap and water". 0.7% of respondents (widowed) said they use it as it is, 0.57% wipe it with a cloth and 1.5% rinse with soap and clean water (Figure 4.27).

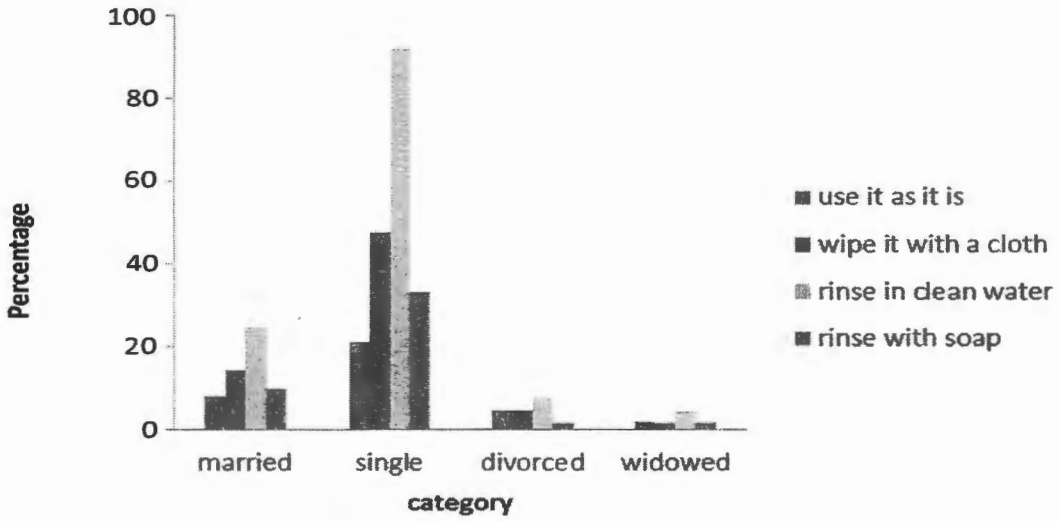


Figure 4.27: Distribution of responses based on marital status

If you have a sore in your hand, do you prepare food for other people? According to marital status, 4% of married respondents indicated that said they cook if putting on a bandage, 5.7% said if they put on gloves, 4.8% said they do not prepare food until the sore is healed. Among single respondents, 11.8% said yes if they put on a bandage, 12.3% indicated "yes with gloves on", 13.0% said "yes, if I bandage the sore and put on gloves" and 32.2% said "no they do not prepare food until the sore is completely healed". 1.4% of divorced respondents said "yes if bandaged, 1.5% and 2.7%, respectively said "yes if I bandage and wear gloves on and no they will wait until the sore is healed (Figure 4.28).

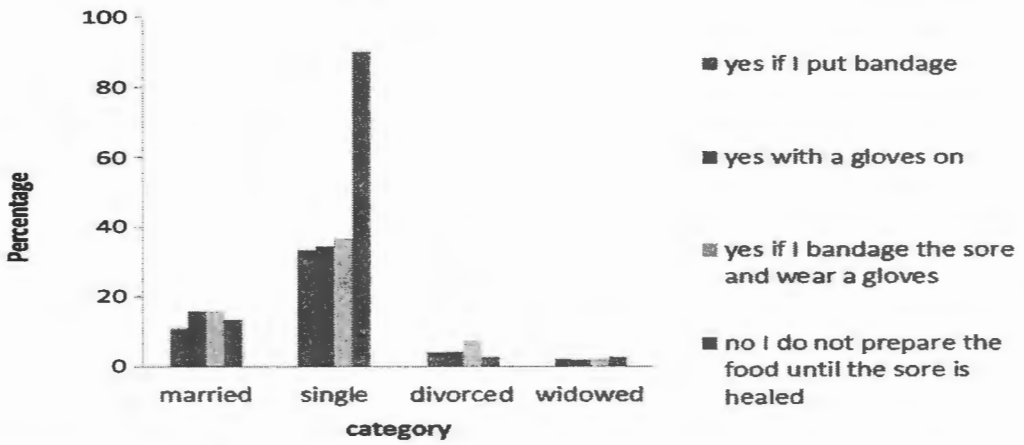


Figure 4.28: Distribution of responses based on marital status regarding the item 'if you have a sore in your hand do you prepare food for other people?"

One of the items on the questionnaire sought to find out "how often the kitchen sink drain in the home was sanitised". 10.3% of married respondents said "daily", 4.7% indicated "weekly" and 2.7% said "monthly". 39.5% of single respondents said "daily", 11.1% said "weekly", 8.4% said "monthly" while 10.3% said "other". 3.1% of divorced respondents said "daily", only one percentage said "weekly" and 1.8% said "monthly". Widowed respondents also gave their responses based on the question asked above. 2.2% said "daily", 0.2% said "weekly",0.2% and 0.57% said "monthly" and "other" respectively (Figure 4.29).

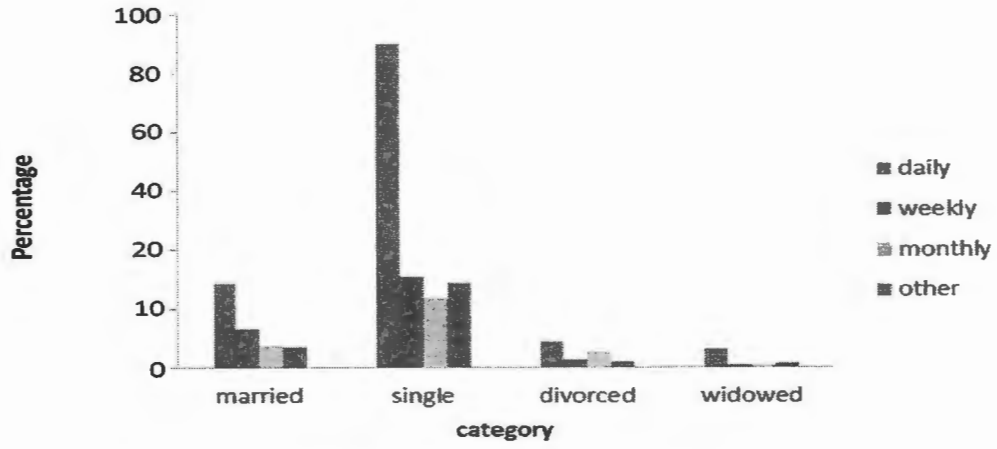


Figure 4.29: Summary of responses based on marital status of respondents based on how often the kitchen sink drain was sanitised

4.4.3 Educational level of consumers' knowledge and practices on food safety

Education on food safety has been regarded as the most actual once the messages are directed in shifting conducts that are expected to have an outcome in food-borne illnesses. Personal hygiene, adequate cooking, avoiding cross contamination, keeping food at safe temperatures

as well as avoiding foods from unsafe sources are considered as the most important control aspects for pathogens to consumers in the control of food-borne illnesses (Altekruse *et al.*, 1997). Therefore, pathogens that have been associated with poor personal hygiene have the highest incidence and costs. Inadequate cooking and cross-contamination have lower incidences. Keeping food at safe temperatures and unsafe food sources have the lowest incidence, though costs per case are sometimes very high. Education on food safety should primarily focus on hand washing, adequate cooking, and avoiding cross-contamination with secondary messages that should focus on keeping food at safe temperatures and avoiding food from an unsafe sources. Assessment outfits are compulsory to value self-reported behaviour changes. The evaluation questions must focus on prominent activities that lead to food-borne illnesses and must undergo severe standards of consistency and weight. Below are various responses advanced by different respondents.

Question 5 sought to find out how long respondents kept their food in the fridge after cooking it. Respondents provided the following responses: Participants with no qualification (26.7%) said immediately, 8.85% said after 2 hours, 4.0% said they did not keep the food in the fridge. 2.6% of respondents with primary education said immediately, 2.3% said after 2 hours while 4.3% said they did not keep the food in the fridge. 39.6% of respondents with secondary education said immediately, 22.2% said after 2 hours and 5.88% said they did not keep the food in the fridge. 31.0% of respondents with tertiary education said immediately, 10.9% said after 2 hours and 3.01% said they do not keep food in the fridge.

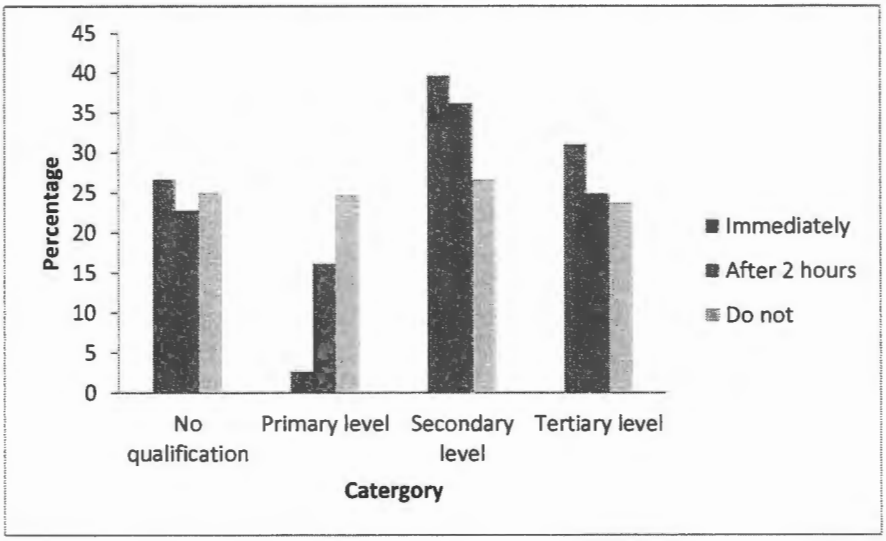


Figure 4.30: Summary of responses based on education level of participants regarding the time it takes to keep food in the fridge after cooking it

When asked if they have ever experienced any kind of food poisoning (Question 11),based on different categories (Figure 4.31), 32.01% of respondents with no qualification said yes 27.0% said no and 25.7% said they did not remember. 19.5 % of respondents with primary education said yes, 18.9% said no and 20.75% said they did not remember. 20.72% of respondents with secondary education accepted that they have experienced food poisoning before against 20.01% who provided negative responses. 20.6% of respondents said they did not remember having suffered from food poisoning in the past. In addition, 33.4% of respondents with tertiary education agreed that they had experienced food poisoning in the past, 28.46% provided negative responses while 32.9% said they did not remember.

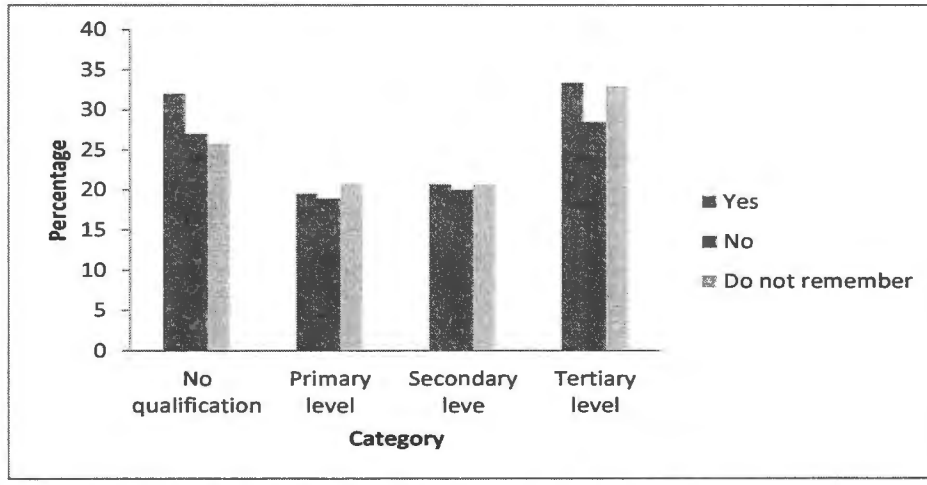


Figure 4.31: Summary responses of participants based on their educational level and the experiences regarding food poisoning

Data obtained here also confirmed that there was no correlation between respondents' level of education with experience on food poisoning. This can also be linked to the fact that education or knowledge does not necessarily pair with the application of food safety by consumers (Verbeke *et al.*, 2007).

Item 14 of the questionnaire sought to know if respondents have ever taken educational courses in food safety. Data obtained revealed that consumers with no educational qualification (9.9%) said yes, 16.4% provided negative responses, while only 2.29% could not remember. Among respondents with primary education, 0.28% confirmed to have attended a food safety training course, 1.72% were never exposed and 1.14% said they could not remember. 16.64% of consumers with secondary education said yes, 43.61% said no and 7.17% said they could not remember. 73.19% of respondents with tertiary education had also been exposed to food safety training, 37.32% of them said no while 0.40% said they could not remember.

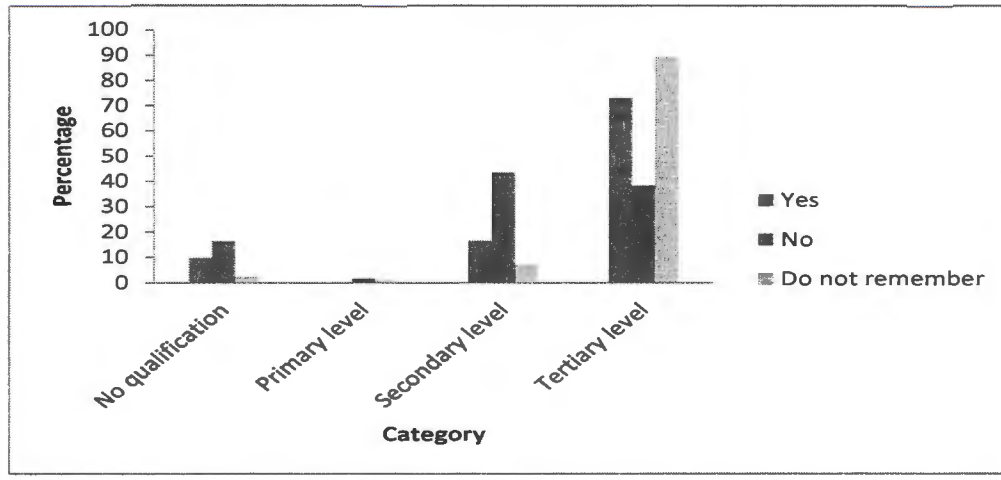


Figure 4.32: Distribution of responses based on educational level to the question participants have had a food safety training course

Question 17 sought to find out "which is considered the best way of preventing food poisoning". 4.8% of respondents with no qualification said they sprayed for pests in the kitchen every week, 3.87% never served leftover food, 38.32% kept food refrigerated until it was time to cook/serve it and only 2% said they did not know. 1.29% of respondents with primary education said they sprayed for pests in the kitchen every week, less than one percent (0.28%) said they never serve leftover food while 1.72% said they keep food refrigerated until it is time to cook/serve it. The majority of respondents (91.41%) said they did not. Participants with secondary education gave the following responses: 11.33% sprayed for pests in the kitchen every week; 7.74% never serve leftover food; 17.93% kept food refrigerated until it was time to cook/serve it; and 0% said they do not. Majority of respondents with tertiary education (82.51%) said they sprayed for pests in the kitchen every week, 88.11% never serve leftover food, 42.03% keep food refrigerated until it is time to cook/serve it and 6.59% said they do not.

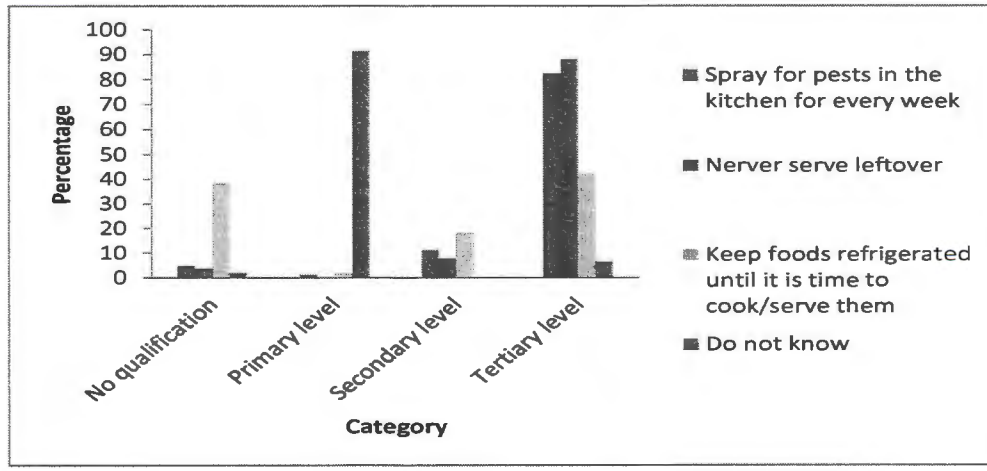


Figure 4.33: Responses on the best way considered to prevent food poisoning in terms of educational level

The safe storage of food is considered the best way to prevent food-borne illnesses. How do you preserve food if one of your family members is going to be late for dinner? Respondents with no qualification said they spray for pests in the kitchen every week (16.49%), 4.16% never serve leftover food, 6.31% keep food refrigerated until it is time to cook/serve it while only 1.72% said they did not know. 2.29% of respondents with primary education spray pests in the kitchen every week, 0.57% never serve leftover food, 0.28% keep food refrigerated until it is time to cook/serve it and 95.28% said they did not know. 22.82% of respondents with secondary educational said they spray pests in the kitchen every week, 8.89% said they never serve leftover food, 30.12% keep food refrigerated until it is time to cook/serve it and 2.86% said they did not know. 55.40% of respondents with tertiary educational said they spray pests in the kitchen every week, 86.38% said they never serve leftover food, 63.29% keep food refrigerated until it is time to cook/serve it and only 0.14% said they did not know.

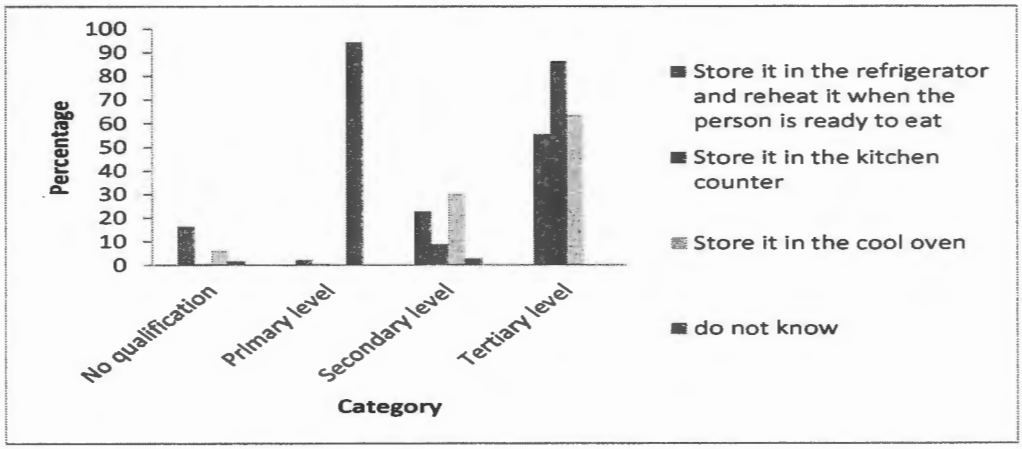


Figure 4.34: Summary of responses to question 18 (how to preserve food if one of the family members is going to be late for dinner based on educational level)

All the utensils should always be clean to avoid cross contamination. Consumers were asked what they do with a knife after cutting raw meat. Respondents gave different responses based on their educational level. 3.58% of respondents with no qualification said they use it as it is, 6.45% said they wipe with a cloth, 14.20% rinse in clean water and 4.44% said they rinse with soap and water. 1% of consumers with primary education said they use it as it is, 0.57% said they wipe with a cloth,1% rinse in clean water while 0.71% rinse with soap and water. 8.17% of respondents with secondary education said they use it as it, 17.50% wipe with a

cloth, 30.55% rinse in clean water while 11.47% said they rinse with soap and water. 87.25% of respondents with tertiary education said they use it as it is, 75.48% wipe with a cloth, 54.25% rinse in clean water and 83.38% rinse with soap and water. Statistical analysis revealed that there is a significant relationship between educational level of respondents and food safety attitudes and practices regarding this item of the questionnaire.

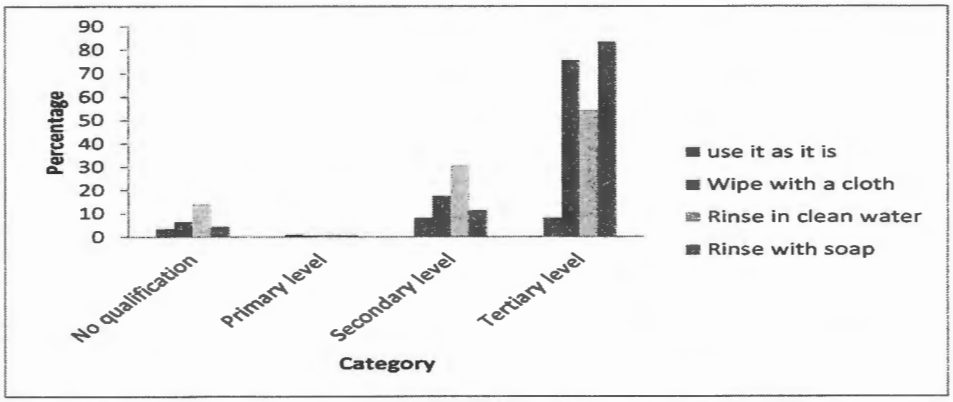


Figure 4.35: Distribution of responses based on educational level to question 20 of the questionnaire

One of the items of the questionnaire also sought to identify the knowledge and practice consumers have when they have a wound (sore) in their hands and if they would prepare food for other people. Different participants responded differently according to their knowledge and level of education. 5.59% of respondents with no educational qualification said yes, if they put on a bandage, 6.45% said yes with gloves on, 8.03% said yes, if they bandage the sore and wear gloves, 8.60% said no, they do not prepare food until the sore is completely healed. 0.57% of respondents with primary education said yes, if they put on a bandage, 0.86% said yes, if they bandage the sore and wear gloves, 1.29% said yes, if they bandage the sore and wear gloves while 0.57% said no, they do not prepare food until the sore is completely healed. 11.90% of respondents with secondary education said yes, if they put on a bandage, 12.76% said yes, with gloves on, 13.05% said yes, if they bandage the sore and wear gloves and 29.98% said no, they do not prepare food until the sore is completely healed. 81.94% of respondents with tertiary education said yes, if they put on a bandage, 79.93% said yes, with gloves on, 77.63% said yes, if they bandage the sore and wear gloves and 60.85% said no, they do not prepare food until the sore is completely healed.

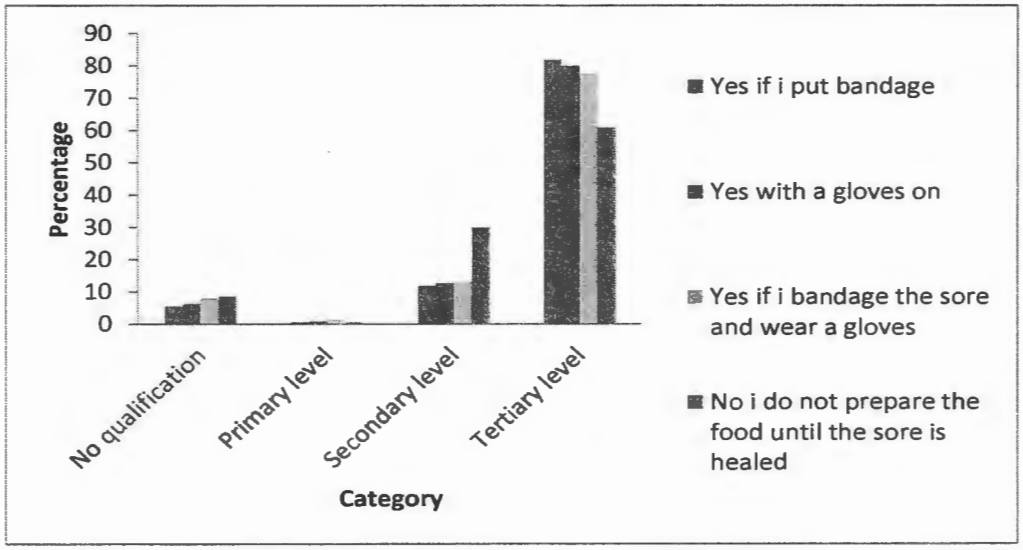


Figure 4.36: Distribution of responses based on educational level regarding the item 'if you have a sore in your hand do you prepare food for other people?'

This question was asked in order to assess the knowledge of consumers on how often the kitchen sink drain should be sanitised. 35.43% of respondents with no qualification said daily, 11.19% said weekly, 9.75% said monthly and 11.33% said other. 2.58% of respondents with primary education said "daily", 0.43% said weekly, 0% said monthly and 0.28% said other. 16.92% of respondents with secondary education said daily, 5.59% said weekly, 3.58% said monthly and only 2.58% said other. 45.07% of respondents with tertiary education said daily, 82.79% said weekly, 86.67% said monthly and 85.81% said indicated other.

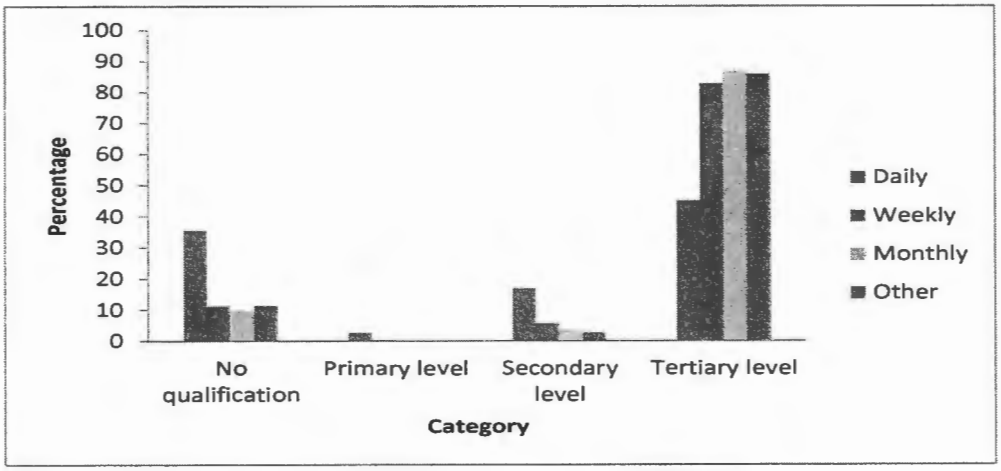


Figure 4.37: Summary responses of participants based on their educational level and how often they sanitise the drain in their kitchens

In this study, questions were asked to assess the knowledge, attitudes and practices regarding food of animal origin. Millions of people worldwide are dying from food-borne diseases and illnesses due to the consumption of contaminated food each year. This has become one of the most disturbing public health concerns in the whole world.

It was observed in this study that age and working status of respondents did not influence knowledge on food safety. It was revealed in this study that there was only 10% correlation between respondents' knowledge on food safety, their working status and age. These results are in agreement with the findings of Mohammad *et al.* (2010). In their study on the same topic conducted in Pakistan and Ghana respectively, they also found that age was not the major factor influencing knowledge and attitude towards food safety. However, these results are not in line with the study carried out by Al-Sakkaf (2013) who found in New Zealand that age was a significant influence on knowledge of food safety and attitude. It has been revealed that age influences food safety attitude and practices (Towns *et al.*, 2006; Brennan *et al.*, 2007; Al-Sakkaf, 2013).

This study showed that a significant relationship ($P<0.05$) was observed between race (65%), educational level 70% and knowledge on food safety. The results obtained in this study are in line with the findings of Booth *et al.* (1991); Mohammad *et al.*, (2010), Stein *et al.*, (2010) and Gerson *et al.*, (2013). In their studies conducted in the USA, United Arab Emirates (UAE) and USA respectively, they also found that race and ethnicity largely influence the knowledge and attitude of respondents.

It was observed that respondents with at least primary education showed a better understanding regarding food safety compared to those with no qualification. These results are also in line with findings obtained by Booth *et al.*, (1991); Mohammad *et al.*, (2010), Stein *et al.*, (2010) and Gerson *et al.*, (2013) and Sun Jinfeng *et al.*, (2014). Although educational level influenced knowledge and practices of respondents (70%), there is still room for improvement. All stakeholders should thus be involved in the education of populations on food safety. In addition, schools, especially primary schools, should increase food safety education and awareness. On the contrary, results obtained in this study are not in line with those obtained by Gerson *et al.*, (2013) who in their study, did not find any correlation between educational level and knowledge on food safety among respondents in Ghana.

In this study, gender and marital status did not have much impact ($P>0.05$) on food safety knowledge with 20 and 30% of correlation in all questions posed. These findings are not in line with those of Lin (1995); Sanlier and Konaklioglu (2012); Gerson*et al.*, (2013) and

Jinfeng Sun *et al.*, (2014). In their study, they observed that gender plays a significant role in food safety risk perception. They observed that women tend to have a better knowledge on food and the ability to judge health risks related to food safety than men. However, results obtained in this study are in line with the findings of Sanlier and Konaklioglu (2012); Gerson *et al.,* (2013) and Sun Jinfeng *et al.,* (2014). They also observed that women scored better than men in terms of knowledge on food safety. Studies conducted by Flynn *et al.,* (1994); Knight and Warland (2004 and 2005) revealed that gender can be associated with race with regard to knowledge on food safety.

Redmond and Griffith (2003) found that knowledge does not always reflect through behaviour. Regarding attitude and practices of respondents towards food safety, results obtained in this study showed that age, gender and employment status did not really have an impact on respondents' food safety attitude and practices. In this study, it was observed that there was a significant correlation ($P<0.05$) at 15.38% for the mentioned parameters. In addition, a significant correlation ($P<0.05$) was observed at 23.07% between marital status and food safety attitudes and practices in this study.

In this section, the race of respondents influenced their attitudes and practices towards food safety. At 46.15%, a significant ($P<0.05$) correlation was observed between race and food safety attitude and knowledge. These findings correlate with the results obtained by other researchers elsewhere such as Booth *et al.,* (1991); Mohammad *et al.*, (2010), Stein *et al.*, (2010) and Gerson *et al.,* (2013).

Educational level was an important parameter considered to have because a huge significant link was observed between education (61.53%) and food safety attitudes and practices. The findings of this study correlate with those of other researchers who also obtained similar results (Mohammad *et al.*, 2010; Stein *et al.*, 2010 and Gerson *et al.*, 2013; SunJinfeng *et al.*, 2014).

This study provides information and reveals many serious disputes on knowledge, attitudes and food safety practices among consumers in the Mafikeng local municipality, North West Province. Knowledge can positively encourage attitude formation, and the recipient's ability of health facts, therefore, positive attitude formation leads to positive behaviour. Studies by Sun Jinfeng *et al.,* (2014) have shown that training and education are effective tools to increase food safety knowledge. However, Stein *et al.,* (2010) confirmed that more knowledge does not necessarily lead to positive food practices. Consumers' attitude is also an important and crucial factor that may influence food safety behaviour and practices, thus a

decrease in the number of food-borne diseases (Abdulla *et al.,* 2014). This was also seen in this study where not all educated respondents provided the correct answers regarding food safety attitude.

Consumers' attitudes towards food safety are not only an independent issue, but also, are linked to consumers' demographics as well as financial status. The reviews also show that different attitudes do not essentially lead to behaviours that increase the safety of food consumed. It can be concluded that there is a need for professional guidelines towards consumers regarding issues of food safety.

Limitations of the study

The limitations of this study are as follows: Data was self-reported, random and convenient sampling was used in the study which did not represent a wide range of the population in Mafikeng. In addition, considering the fact that Mafikeng is a black dominated city, a study based on race was not evenly represented.

CHAPTER 5

GENERAL CONCLUSION AND RECOMMENDATIONS

Consumers' knowledge and attitude towards basic food safety rules remain an important way to prevent food-borne diseases. To date, nothing has been reported in the Mafikeng local Municipality, North West Province in South Africa.

To achieve this, 698 participants from different races, age group, education and social backgrounds in the Mafikeng District Municipality were randomly interviewed to evaluate their knowledge and determine attitudes towards food safety, especially food of animal origin.

Overall, the results from this study revealed that most participants (67.7%) already had proper knowledge on food safety. Significant correlations ($P \geq 0.05$) were observed between respondent's education, gender and knowledge on food safety. These results confirmed other studies (Unisan, 2005; Verbeke *et al.,* 2007; Abdullah *et al.,* 2014; Samapundo *et al.,* 2015) published in other countries that education is always linked to food safety knowledge. In addition, Abdullah *et al.,* (2014) conclude that the socio economic profile of respondents had an influence on food practices and knowledge. This was also observed in this study with the majority of highly educated and employed respondents providing correct answers to the questionnaire items.

Gender significantly influenced knowledge and attitude of respondents in this study with female respondents scoring far better than males. This was confirmed by most studies (Unisan, 2005; Verbeke *et al.*, 2007; Abdullah 2014; Samapundo *et al.*, 2015) already published in other places.

In addition, it was found in this study that attitudes and practices of respondents towards food safety were not in associated with their age, gender and employment status. However, it was not possible to establish any significant association between respondents' race and their knowledge and attitude towards food safety. This is mainly because of the low number of other participants from other races mainly white and Indians. Mafikeng Local Municipality, being predominantly an African (Black) city, with few inhabitants from other races (Whites, coloured and Indians), the race distribution did not favour the outcomes of this study. Other races responded similarly while a significant difference of knowledge and attitude was observed among African (Black) respondents towards knowledge on food safety and attitudes.

It was also observed that cultures (Batswana, BaSotho, Zulu and Venda) influenced respondents' attitudes towards food safety. This correlates with the findings of other studies. This might also explain the correlation observed in this study between race and food knowledge, attitude and practices by different races.

This study has also revealed that although the educational level of respondents was found to be in correlation with knowledge on food safety and attitudes, data obtained in this study also confirmed that not all educated people responded correctly to all the questions. This shows that there is still a need to improve education on food safety among the population through schools, the media and pamphlets. Communication on food safety should be made as simple as possible in order to assist understanding by media such as local radio stations which are accessible to the majority of people and should also be used to communicate threats associated with foods to the public. This study brings out the differences between adults and the youth. In responding to issues, respondents with tertiary education showed a better understanding compared to pensioners who are not educated. This is imperative in order to reduce food-borne related diseases.

The results obtained revealed that respondents have a better knowledge on food safety because almost all respondents when rated, scored more than 50% in all the questions asked, though the majority of them (62.1%) did not have proper education on food safety. However, knowledge does not always turn into safe practices most of the time. This study has revealed that though the majority of respondents showed better knowledge on food safety, they are not translating that knowledge into practice. Data obtained in this study also revealed that there was not necessarily a significant correlation between respondents' educational level, education and food safety attitude. This also was in agreement with other studies conducted elsewhere confirming that knowledge does not necessarily link to food safety practices. A great number of respondents (70.9%) showed interest on food safety education, therefore, educational efforts should be the priority in high-risk groups, as well as those preparing food for people in these groups. Food preparers should pay greater attention to the importance of cross contamination, cleaning raw material, and factors determining the growth of pathogenic organisms in food. In particular, academic, education and training should be done as early as high school level so that when people grow older, and can prepare food for them, they should know about food safety and its implications.

Creating awareness on food safety and handling practices as well as promoting it among consumers should be cherished by all stakeholders involved in food security and consumer's

health. The different food safety measures should also be accepted. The television should be used as a source of information on food safety in order to promote better knowledge on food-borne diseases and the countless willingness to change cooking practices. The use of print media has a similar effect on willingness to change. Consumers can profit from home food safety education. Such education includes information on how to check the expiry date, temperature control both in store and at home; correct home food preparation practices and cross-contamination in the kitchen and storage of food. Consumer education messages should also include the ubiquity of micro-organisms, a broad description of food-borne illnesses as well as prevention strategies. Product labels should comprise food-handling information and advices for special populations, and foods processed by newer safety-enhancing technologies should be more widely available. Knowledge of the penalties of unsafe practices can amplify motivation and faithfulness to safety guidelines.

Educational materials need to emphasise safe food handling practices that should start with the youth and continue to be refined throughout life in order to avoid food-borne illnesses. Food safety information should be age-specific, school-based, and reinforced through classes. This study also recommends that government educates consumers through organisations such as the Food Information Council Foundation where only basic food safety education could be provided, that is, temperature control in the kitchen and how to wash hands before and after touching raw foods to prevent cross contamination.

In conclusion, educational efforts among populations, regardless of gender, should include the most current, research-based scientific facts related to food safety, the link between inappropriate practices and threats to their health, and preferred delivery methods. The introduction of food safety education in schools should be accentuated to reduce the risk of food poisoning, food-borne diseases such as cholera, salmonellosis and Ebola. Education should also be emphasised at local clinics and local radio stations for the elderly to have access to information. Such educational efforts will support safe food handling at home and, thus, the continued independence of consumers in their homes, reduce food-borne diseases hence promote healthy lifestyles for consumers who will be more productive. The current globalisation and the movement of both foods and people remains a big threat to food safety in big cities such as Johannesburg and this can be carried over to cities such as Mafikeng. Closer collaboration between all stakeholders involved in food production (farmers, department of Agriculture, industries); food transformation (food industries; abattoirs; restaurants); health services and education departments remains key in insuring that consumers are educated and also protected from food-borne diseases.

REFERENCES

Abdul-Mutalib NA, Abdul-Rashid ME, Mustaf S, Hamat RA, Osman M, (2012): Kmowledge, attitudes and practices regarding food hygiene and sanitation of food handlers in kualapilah, Malaysia, food control. 27(2): 289-293.

Abdussalam M, Foster C, KaÈferstein F, (1989): Food-related behaviour. In: Hamburg D, Sartorius N, eds. Health and behaviour. Cambridge, Cambridge University Press 45-64.

Adams MR and Moss MO, (2008): "Food Microbiology," 3rd Edition, the Royal Society of Chemistry, Cambridge.

AdegbolaRA, Alabis SA,Akinkuade FO, Coker AO, Odugbemi T, (1990): Correlation between human and animal bioserogroups of Campylobacter isolates in Nigeria Journal Tropical Medicine and hygiene 93: 280-283.

Agricultural research council (ARC), (2000): Surveillance Programme of the safety and hygiene of meat in the North West Province. Pretoria: ARC.

Al-Kandari D, Jukes JD, (2011): Incorporating HACCP into national food control systems analysing progress in the United Arab Emirates Food Control 851-861.

Altekruse SF, Street DA, Fein SB, Levy AS, (1997): Consumer knowledge of food borne microbial hazards and food-handling practices. Journal of Food Protection 59:287-94.

Altekruse SF, Yang S, Timbo BB and Angulo FJ, (1999): A multi-state survey of consumer food-handling and food consumption practices. American Journal of Preventive Medicine 16: 216-221.

Amponsah GA, Anamoaba EB (2011): Evaluation of food hygiene knowledge attitudes and practices of food handlers in food businesses in Accra, Ghana. Food and Nutrition Sciences 2:830-836.

A-Sakkaf A, (2012): Evaluation of food handling practice among New Zealanders and other developed countries as a main risk factor for campylobacteriosis rate. Food control 27: 330-337.

Anonymous, (1995): Report of the twenty-first session of the Codex Alimentarius Commission, 3-8 July. Food and Agriculture Organisation, Rome.

Anonymous, (1997): International code of practice general principles of food hygiene. CAC/ECP 1-1969, Revision.3-1997. Food and Agriculture Organisation/World Health Organisation, Rome.

Aragon M, Barreto A, Chambule J, Noya A, Tallarico M, (2003): Shigellosis in Mozambique: outbreak rehabilitation a follow-up study 25: 159-162.

Bach SJ, McAllister TA, Veira DM, Gannon VPJ, Holley RA, (2002): Transmission and control of Escherichia coli O157:H7 82: 475-490.

Banatvala N, Griffin PM, Greene KD, Barrett TJ, Bibb WF, Green JH, (2001): The United States National Prospective Haemolytic Uremic Syndrome Study: microbiologic, serologic, clinical, and epidemiologic findings. Journal Infectious Disease.183: 1063-1070.

Baron S and Jennings PM, (1991): Salmonella medical microbiological, Churchill Livingstone, New York, USA, 3rd edition. 317-335.

Bas M, Ersun AS and Kıvanc G, (2004): The evaluation of food hygiene knowledge, attitudes and practices of food handlers in food businesses in Turkey. Journal of Food Control. 17:317-322.

Bean CL, Hansen JJ, Margolin AB, Balkin H, Batzer G, Widmer G, (2007): Class B alkaline stabilization to achieve pathogen inactivation International Journal of Environment Public Health. 53-60.

Bentham G, Lanford GH, (1995): Climate change and the incidence of food poisoning in England and Wales. International Journal of Biometeorology. 39:81-86.

Bogaerts J, Verhaegen J, Munyabikali JP, Mukantabana B, Lemmens P, Vandeven J, Vandepitte J, (1997): Antimicrobial resistance and serotypes of Shigella isolates in Kigali, Rwanda (1983 to 1993): increasing frequency of multiple resistance diagnosis microbiological infectious disease. 28: 165-171.

Booth S and Smith A, (1991): 'Food security and poverty in Australia-challenges for dieticians', Australian Journal of Nutrition and Dietetics. 58: 150-6.

Bortolussi R, (2008): Listeriosis: A Primer, Canadian medical association journal, Volume. 179: 795-797.

Brazil SM, Steelman CD, Szalanski AL, (2007): Detection of pathogen DNA from filth flies (Diptera: Muscidae) using filter paper spot cards. Journal of Agricultural and Urban Entomology. 24 (1): 13-18.

Brennan M, McCarthy M and Ritson C, (2007): Why do consumers deviate from best microbiological food safety advice? An examination of 'high-risk' consumers on the island of Ireland Appetite. 49: 405-418.

Brenner FW, Villar RG, Angulo FJ, Tauxer R, Swaminathan B, (2000): Salmonella nomenclature Journal of Clinical Microbial. 38: 2465-2467.

Bruhn CM, (1997): Consumer concerns: motivating to action. Emerging Infectious Diseases 3: 511-515.

Bruhn CM and Schutz HG, (1999): Consumer food safety knowledge and practices. Journal of Food Safety. 19:73-87.

Bryan FL, (1988): Hazard analysis critical control point: What the system is and what is not. Journal of environmental health. 50(7): 400-407.

Buccheri C, Mammina C, Giammanco S and Casuccio MG, (2010): Knowledge, attitudes and self-reported practices of food service staff in nursing homes and long-term care facilities, food control. 21: 1367-1373.

Byrd-Bredbenner C, Wheatley V, Schaffner D, Bruhn C, Blalock L and Maurer J, (2007): Development of food safety psychosocial questionnaires for young adults. Journal of Food Science Education. 6: 30-37.

CDC, (2006): Centre for Disease Control and Prevention Health and Safety Topics: E. coli outbreaks (http://www.cdc.gov/ecoli/).

CDC, (2011): National Centre for Zoonotic, Vector-Borne, and Enteric Diseases, "Listeriosis-General Information and Frequently Asked Questions."

CDC and Prevention (2013): Foodborne Disease Active Surveillance Network (FoodNet). Available online: http://www.cdc.gov/foodnet/ (accessed on 15 June 2013).

Chase-Topping M, Gally D, Low C, Matthews L, Woolhouse M, (2008): "Super-shedding and the link between human infection and livestock carriage of Escherichia coli O157".

China B, Pirson V, Jacquemin E, (1997): Pathotypes of bovine verotoxigenic *Escherichia coli* isolates producing attaching/effacing lesions in the ligated intestinal loop assay in rabbits ,in: Paul (Ed.) et al ., Mechanisms in the pathogenesis of enteric diseases Plenum Press, New York. 311-316.

China B, Pirson V and Mainil J, (1998): Prevalence and molecular typing of attaching and effacing E. coli among calf population in Belgium veterinary microbiologically. 63:249-259.

Christensen BB, Rosenguist H, Sommer HM, Neilsen NL, Fagt S, Andersen NL, and Norrung B, (2005): A model of hygiene practices and consumption patterns in the consumer phase. Risk Analysis. 25: 49-60.

Christopher PR, David KV, John SM and Sankarapandian V, (2010): Antibiotic therapy for Shigella dysentery Cochrane Database System Review. CD06784.

Codex Alimentarius Commission (CAC), (2003): Recommended international code of practice: general principles of food hygiene. CAC/ RPP 1-1969, Revision 4.

Codjia G, (2000): FAO technical support for improvement within the street food sector, Gauteng province, Pretoria. Unpublished.

Cook CC, and Casey R, (1979): Assessment of a food service management sanitation course. Journal of Environmental Health. 41(5): 281-284.

Costello C, Gaddis T, Tamplin M and Morris W, (1997): Evaluating the effectiveness of two instructional techniques for teaching food safety principles to quick service employees. Journal of Food Service Systems. 10(1):41-50.

Das MS, Roy DK and Dash S, (1990): Occurrence of salmonellae in the slaughtered pigs, goat meat, meat handlers and slaughter house workers Journal of Communicable Disease. 22:39-42.

Da-Wen Sun, (2001): Advances in food refrigeration, Yen-Con Hung, Cryogenic Refrigeration, 318, Leatherhead Food Research Association Publishing.

D'Aoust, JY (1997): Salmonella species M.P. Doyle, L.R. Beuchat, T.H. Montville (Eds.), Food Microbiology, Fundamentals and Frontiers, ASM Press, Washington: 129-158.

Day C, (2001): Gastrointestinal disease in the domestic setting: what can we reduce from surveillance data? Journal of Infection. 43(1): 30-35.

Dewall CS, Alderton L and Liebman B, (1999): Food Safety Guide. Nutrition action health letter. 26: 1-9.

Dima FK, Victor K and Ewen T, (2015) Investigating a link of two different types of food business management to the food safety knowledge, attitudes and practices of food handlers in Beirut, Lebanon. 55: 166-175. http://dx.doi.org/10.1016/j.foodcont.2015.02.045

Dosman DM, Adamowicz WL and Hrudey SE, (2001): Socioeconomic determinants of health and food safety-related risk perception. Risk analysis: an international journal. 21: 307-310.

Duffy G, (2003): Verocytoxigenic Escherichia coli in animal faeces, manures and slurries. Journal of Applicable Microbiol. Symposium Supplement. 94: 94S-103S.

Ehiri JE, Morris GP and Mcewen J, (1997): A survey Of HACCP Implementation in Glasgow. International Journal of Environmental Health Research. 7(7): 71-84.

Ehiri JE, Morris GP and McEwen J, (1997b): Evaluation of a food hygiene training course in Scotland. Food Control. 8(3): 137-147.

Elizabeth Weise September 30, (2011): "Listeriosis toll rises to 15 dead, 84 sickened". USA Today. Retrieved September 30, 2011.

Evans HS, Madden P, Douglas C, Adak GK, 0'Brien SJ and Djuretic T, (1998): General outbreaks of infectious intestinal diseases in England and Wales 1995-1996. Communicable diseases and public health. 1(3): 165-171.

Eves A and Kipps M, (1995): Food hygiene and HACCP. Oxford: Butterworth- Heinemann.

FAO/WHO, (2003): Codex Alimentarius, Basic Text on Food Hygiene. 3rd edition, Italy.

FAO (2006). "Food Security"

Finch C and Daniel E, (2005): Food safety knowledge and behaviour of emergency food relief organization workers: effects of food safety training intervention. Journal of Environmental Health. 67(9):30-34.

Finucane ML, Alhakami A, Slovic P and Johnson SM, (2000): The affect heuristic in judgements of risks and benefits. Journal of behavioural decision making. 13: 1-7.

Flynn J, Slovic P and Mertz CK, (1994): Gender, race and perception of environmental health risks. Risk analysis. 14: 1101-1338.

Food Inc. Directed by Robert Kenner, Independent Films 2009.

FoodNet Surveillance Annual Reports, (2004): FoodNet Surveillance Annual Reports, 1997-2004. Foodborne Diseases Active Surveillance Network CDC's Emerging Infections program (http://www.cdc.gov/foodnet/reports.htm).

Food safety education: Chill Cold Storage Chart, (2004): Retrieved June 1, 2009, http://www.foodsafety.gov.

Food Standards Australia New Zealand (2011): Listeria and Food. Canberra. (www.foodstandards.gov.au/consumerinformation/listeria/)

The Food Quality Protection Act (FQPA) of 1996," EPA report, 1996.

Francis FJ, (1997): Consumers confusion of food protection. 42: 679-682.

Frank L (1972): Emerging foodborne diseases II-factors that contribute to outbreaks and their control.

Frank O Mahony, (2014): Rural dairy technology. Experiences in Ethopia. International livestock Centre for Africa. 102-105.

Frost JA, Gillespie IA and O'Brien SJ (2002): Public health implications of Compylobacter outbreaks on Wale and England, 1995-1999: epidemiological and microbiological investigations. Epidemiology Infection. 128: 111-118.

Gender in Agriculture Sourcebook (2007): The World Bank, Food and Agriculture Organisation, International Fund for Agricultural Development. ISBN 978-0-8213-7587-7.

Gender in Agriculture Sourcebook (2009): World Food Bank, Food and Agriculture Organization and International Fund for Agricultural Development.

Genigeorgis C, Carniciu M, Dutulescu D and Farver TB, (1991): "Growth and survival of Listeria monocytogenes in market cheeses stored at 4 to 30 degrees C". Journal of Food Protection. 54 (9): 662-668.

Gerson A, Goto K, Wolff C, Giovanni M (2013): Food Health and Values: The Effects of Attitudes and Behaviors RegardingSustainable Food Practices on Overall Diet Quality among College Students. Californian Journal of Health Promotion 2013. 2: 53-60

Gettings MA and Kiernan NE, (2003): Practices and perceptions of food safety among seniors who prepare meals at home. Journal of Nutrition Education. 33:148-154.

Geurin PJ, De Jong B, Heir E, Hasseltvedt V, Kapperud G, Styrmo K, Gondrosone B, Laassen J and Andersson Y, (2004): Outbreak of salmonella Livingstone infection in Norway and Sweden due to contaminated fish products. Epidemiology Infection. 132: 883-895.

Gill CO, (2007): Microbial control with cold temperatures. In VK juneja and JN Sofos. Control of foodborne Microorganisms. New York.

Goulet J, de Valk H, Pierre O, Stainer F, Rocourt J, Vaillant V, (2001): Effect of prevention measures on incidence of human *listeriosis*, France, 1987-1997.Emerging Infectious Diseases. 7 (2001): 983-989.

Craig SA, (2013): Gastroenteritis. In Marx JA, Hockberger RS, Walls RM, et al, eds. Rosen's Emergency Medicine: Concepts and Clinical Practice. 8th edition. Philadelphia, Pa: Mosby Elsevier. 2013: chapter 94.

Greenwood D, Salck R and Peutherer J, (1997): Salmonella medical microbiological, ChurchillLivingstone, New York, USA, 15th edition. 252-261.

Greig JD, Todd ECD, Bartleson C and Michaels B, (2010): "Infective Doses and Pathen Carriage", 19-20, USDA 2010 Food Safety Education Conference.

Griffith CJ, (2000): Food safety in catering establishments. In JM Farber and EC Todd (Eds.), Safe handling of foods,New York: Marcel Dekker. 235-256.

Griffith CJM (2003): Consumer food handling in the home: a review of food safety studies. Journal of food protection. 66: 130-161

Gründling A, Burrack LS, Bouwer HGA and Higgins DE, (2004): "Listeria monocytogenes regulates flagellar motility gene expression through MogR, a transcriptional repressor required for virulence" USA. 101: 12316-12323.

Haapala I and Probart C, (2004): Food safety knowledge, perceptions, and behaviours among middle school students. Journal of Nutrition Education and Behaviour. 36: 71-76.

Hanak E, Boutrif EFP and Pineiro M, (2000): Food safety management in developing countries Proceedings of the international workshop CIRAD-FAO, December 2000, Montpellier, France.11-13.

Harris L, (1997): Hamburger hell: Better risk communication for better health. In DA. Powell and W. Leiss (Edition.), Mad cows and mothers milk: The perils of poor risk communication. 77-98.

Hathaway SC, (1997): Development of food safety risk assessment guidelines for foods of animal origin in international trade Journal of Food Protection. 60: 1432-1438.

Heldman DR, (2006): "International Food Technology and the Food Science Profession." Food Technology. October, 11.

Helms M, Simonsen J, Olsen KE and Molbak K, (2005): Adverse health events associated with antimicrobial drugs resistances in compylobacterspeces: a registry-based cohort study. 191(7): 1050-1055.

Henson S and Traill B, (1993): Consumer perceptions of food safety and their impact on food choice. In GG Birch and G. Campbell-Platt (Eds.), Food safety-the challenge ahead. 39-55.

Hilton J, (2002): Reducing food-borne disease: meeting the food standards agency's targets. Nutrition and Food Science. 32(2): 46-50.

Hines J, Hungerford H and Tomera A, (1987): Analysis and Synthesis of Research on Responsible Environmental Behaviour: A Meta-Analysis Journal of Environmental education.18 (2): 8-22.

Hugas M and Tsigarida E, (2008): Pros and cons of carcass decontamination: the role of the European food safety authority, meat Science. 78:43-52.

Hollingworth P, (1996): Developing foods for the next millennium. Food technology. 50: 110-118.

Holm L and Kildevang H, (1996): Consumer's view on food quality. A qualitative interview study, Appetite. 27: 1-4.

Holt G and Henson SJ, (2000a). Information for good practice in small businesses, British Food Journal. 102(4):320-337.

Howes M, McEwan S, Griffiths M, and Harris L, (1996): Food handler certification by home study: measuring changes in knowledge and behaviour. Dairy food and environmental sanitation. 16(11):737-744.

Innis S, Bahlo E and Kardinaal A, (1999): Beyond implementation: the role of physicians, health care professionals and consumers in the development and use of food products. European Journal of Clinical Nutrition. 53: S25-S29.

International food information council foundation, (2014): Northwest Research Station, 6686 South Centre Highway Traverse, City, Michigan: 49684-9550

Janda JM and Abott SL (1998): The *Salmonella* typhi and *Salmonella* paratyphi A, B, C. The enterobacteria . Lippincott-Raven. Philadelphia, USA: 80-109

Jacxsens L, Uyttendaele M, Devlieghere F, Rovira J, Oses Gomez S and Luning P, (2010): Food safety performance indicators to benchmark food safety output of food safety management systems International Journal of Food Microbiology, 141: 180-187.

Jay JM, (1996): Modern food microbiology. 5th edition. Chapman and Hall. New York, NY.

Jaykus LA, Acuff RG, Busta FF, Dickson JS, Hollingsworth CA, Marcy J and McNamara AM, (2004): Managing food safety: a systematic approach Food Technology, 58: 37-39.

Jeffery RW and Rick AM, (2002): Cross-sectional and longitudinal associations between body mass index and marriage-related factors. Obese Res; 10:809-15.

JoNelAleccia October 5, (2011): "Woman's miscarriage blamed on listeria-tainted cantaloupe". MSNBC. Retrieved October 13, 2011.

Jones R, Jonesa H, Hussein M, Monique Z, Gale B and John RT, (2008): Isolation of lactic acid bacteria with inhibitory activity against pathogens and spoilage organisms associated with fresh meat. Food Microbial, 25: 228-234.

Kalua F, (2001): The Relationship between Knowledge, Attitude and Practices Ofcare Givers and Food Hygiene in Day Care Centres. M. Tech degree dissertation, Pretoria, Technikon Pretoria.

Katherine Z, (2004): Mayo foundation for medical education and research.

Keene WE, (1999): Lessons from investigations of foodborne disease outbreaks. JAMA. 281:1845-1847.

Kennedy J, Jackson V, Cowan C, Blair I, McDowell D and Bolton D, (2005b): Consumer food safety knowledge: segmentation of Irish home food prepares based on food safety knowledge and practices. British food journal, 107: 441-452.

Kennedy M and agencies (2011): E. coli outbreak: WHO says bacterium is a new strain. Guardian 2 June 2011. (www.guardian.co.uk)

Keusch GT and Bennish ML, (1989): Shigellosis: recent progress, persisting problems and research issues Pediatr Infectious Disease Journal, 8: 713-719.

Khan MS, (1982): An epidermiological study of *Compylobater* enteritis outbreak involving dogs and man. *Compylobacter*: Epidermilogy, phathogenesis and biochemistry, MTP press, Lancaster: 257-719.

Khandke S and Mayes T, (1998): HACCP implementation: a practical guide to the implementation of the HACCP plan Food Control, 9 (2-3):103-109.

Kim MR, Jeon MK and Kim HC, (2006): Analysis of the Effects of an Educational Program regarding Food Safety for Children. Journal of Korean Home Economics Association; 44:113-120.

Kirby MP and Gardiner K, (1997): The effectiveness of hygiene training for food handlers. International Journal of Environmental Health Research, 7(3): 251-258.

Kimberling CV, (1988): Disease causing abortion. In Kemberling CV (ed), jensen and swiff's diseases of sheep 3rd Edition, Philadelphia LA and Fabiger: 57-63.

Klontz KC, Timbo B, Fein S, and Levy A, (1995): Prevalence of selected food consumption and preparation behaviours in the United States. Journal of Food Protection, 58: 1405-1411.

Knight A, and Warland R, (2005): Determinants of food safety risks: a multi-disciplinary approach. Rural sociology, 70: 253-275.

Knight PG1, Jackson JC, Bain B, Eldemire-Shearer D (2013): Household food safety awareness of selected urban consumers in Jamaica International journal food science nutrition. 2003 July, 54(4): 309-320.

Kobayashi M, Sasaki T, Saito N, Tamura K, Suzuki K, Watanabe H and Agui N, ((1999): House flies: not simple mechanical vectors of enterohemorrhagic Escherichia coli O157:H7Am. Journal of tropical medication hygiene, 61: 625-629

Koeppl P and Robey E, (1998): USDA/FDA food safety initiative. Evaluating the placement of food safety education in American schools. <www.foodsafety.gov/-dms/fseduunini.html> Accessed 07.07.2004

Konemanna WE, Allen SD, Janda WM, Schreckenberger PC and Winn WC, (1997): Enterobacteriaceae, diognostic microbiological, lippincott-raven, Philadelphia, USA,15th edition: 56-71.

Koohmaraie TM, Arthur JM, Bosilevac M, Guerini SD, Shackelford F and Wheeler TL, (2005): Post-harvest interventions to reduce/eliminate pathogens in beef. In: 51st International Congress of Meat Science and Technology, 7-12 August 2005, Maryland, USA [Online]: http://www.meatscience.org/Pubs/rmcarchv/2005/invitedpapers.html [Accessed: 26/04/2008].

Lay J, Varma J, Vugia D, Jones T, Zansky S, Marcus R, Segler S, Medus C and Blythe D, (2000): The EIP FoodNet Working Group. Racial and Ethnic Disparities in Foodborne Illness, 2000. Infectious Diseases Society of America: Chicago, IL, USA.

Li-Cohen AE, and Bruhn CM, (2002): Safety of consumer handling of fresh produce from the time of purchase to the plate: A comprehensive consumer survey. Journal of Food Protection, 65: 1287-1296.

Lior H, (1994): *Compylobacter*epidermiological markers dairy food and environmental sanitation, 14: 317-324.

Liebana E, Guns D, Garcia-Migura L, Woodward MJ, Clifton-Hadley FA and Davies RH, (2001): Molecular typing of Salmonella serotypes prevalent in animals in England: assessment of methodology Journal of Clinical Microbial, 39: 3609-3616.

Lin CTJ, (1995): Demographic and socioeconomic influences on the importance of food safety in food shopping. Agricultural and resource economics review, 24: 190-198.

Londa N,Karen B andKaren P, (2014): Safe Food Storage: The Refrigerator and Freezer.Kansas State University Agricultural Experiment Station and Cooperative Extension Service.http://www.bookstore.ksre.k-state.edu/pubs/MF3130.pdf downloaded 27/07/2015

Lorber R and Bennett E, (2000): "Listeria monocytogenes," in Mandell, Douglas and Bennett's principles and practice of infectious diseases, Fifth Edition, Chapter 195: 2208.

Lund BM, Baird TC, Parker, Gould GW, (2000): The Microbiological Safety and Quality of Food. Volume 1. Aspen Publishers, Gaithersburg, MD: 122-145.

MacPherson C, Haggans C and Reicks M, (2000): Interactive homework lessons for elementary students and parents: A pilot study of nutrition expedition. Journal of Nutrition Education. 32:49-55.

Marquitta Webb and AbbigailMorancie, 2015. Food safety knowledge of foodservice workers at a university campus by education level, experience, and food safety training.Food Control. 50: 259-264.

Mary Clare Jalonick September 29, (2011): "Cantaloupe deaths and illnesses: CDC on ways to combat". Christian Science Monitor. Retrieved October 7, 2011.

Mayo Clinic, (2009): Listeria infection (listeriosis). Retrieved November 1, 2009 from Mayo Clinic.

McIntosh WA, Christensen LB and Acuff GR, (1994): Perceptions of risks of eating undercooked meat and willingness to change cooking practices. 22: 83-96.

Mead CG, (1994): Microbiological hazards from red meat. British Food Journal. 96(8):33-36.

Mead PS, Slutsker L, Dietz V, McCaig LF, Bresee JS and Shapiro C, (1999): Food-related illness and death in the United States .Emerging infectious disease. 5: 607-625.

Mederios L, Hillers V, Kendall P and Maso A, (2001): Evaluation of food safety education for consumers. Journal of Nutrition Education and Behavior. 33: S27-S34.

Medeiros LC, Hillers VN, Chen G, Bergmann V, Kendall P, and Schcredler M, (2004): Design and development of food safety knowledge and attitude scales for consumer food education. Journal of the American Dietetic Association. 104(11):1671-1677.

Mitakakis TZ, Sinclair MI, Fairley CK, Lightbody PK, Leder K and Hellard ME, (2004): Research note: food safety in family homes in Melbourne Australia. Journal of Food Protection. 67(4): 818-822.

Mohamed AK, (2005): Use of comparative genomics as a tool to assess the clinical and public health significance of Escherichia coli serotypes. In: 51st International Congress of Meat Science and Technology, 7-12 August 2005, Maryland, and USA [Online]. Available from: http://www.meatscience.org/Pubs/rmcarchv/2005/invitedpapers.html.

Mohamed AE, Mohamad S and Hussain H, (2010): Food gifts in Kelantanese Malay Weddings: Custom and Interpretation. Jurnal e-Bangi.5(1): 103-115.

Moody K, Charlson ME and Finlay J (2002): The Neutropenic Diet: What's the Evidence? J. Ped. Hemat/Oncol.24:717-721.

Morrone M and Rathburn A, (2003): Health education and food safety behaviour in the university setting. Journal of Environmental Health. 9: 15-28.

Moriya K, Fujibayashi T, Yoshiihara T, Matsuda A, Sumi N, Umezaki N, Kurahashi H, Agui N, Wada A and Watanabe H, (1999): Verotoxin-producing Escherichia coli O157:H7 carried by the house fly in Japan Medical veterinary entomology. 13: 214-216.

Mortlock MP, Peters A C and Griffith C, (1999): Food hygiene and hazard analysis critical control point in the United Kingdom food industry: practices, perceptions and attitudes. Journal of Food Protection. 62(7): 786-792.

Mossel DAA, Weenk GH, Morris GP and Struijk CB, (1998): Identification, assessment and management of food-related microbiological hazards: historical, fundamental and psychosocial essentials. International Journal of Food Microbiology. 39: 19-51.

Motarjemi Y and Käferstein FK, (1997): Global estimation of foodborne diseases. World Health Statistics Quarterly.50(1-2): 5-11.

Motarjemi Y and Mortimore S, (2005): Industry's need and expectations to meet food safety, 5th International Meeting, Noordwijk Food Safety and HACCP Forum, 9-10 December 2002 Food Control. 16 (6): 523-529.

Nachamkin I, Ung H, Moran AP, Yoo D, Prendergast MM, Nicholson MA, Sheikh K, Ho T, Asbury AK, McKhann GM and Griffin JW, (1991): Ganglioside GM1 mimicry in Campylobacter strains from sporadic infections in the United States. Journal of Infectious Disease. 179:1183-1189.

Nakamura Y, Naoyuki Y, Kumi S and Toshiaki T, (June 1, 1995): "Antihypertensive Effect of Sour Milk and Peptides Isolated from It That are Inhibitors to Angiotensin I-Converting Enzyme" . Journal of Dairy Science.78 (6): 1253-1257.

National institute of allergies and infectious diseases (2007a): Escherichia coli. [Online]. S.I.: S.n Available from: http://www3.niaid.nih.gov/healthscience/healthtopics/ecoli/default.htm [Accessed: 26/04/2008].

National institute of allergies and infectious diseases (2007b): Food-borne Diseases [Online]. S.I.:S.n.Available.from:http://www3.niaid.nih.gov/healthscience/healthtopics/foodborne/default.htm [Accessed: 26/04/2008].

Neill MA, Tarr PI, Clausen CR, Christie DL, Hickman RO, (1987): Escherichia coli O157:H7 as the predominant pathogen associated with the hemolytic uremic syndrome: a prospective study in the Pacific Northwest. Paediatrics. 80:37-40.

Nesbitt A, Majowicz S, Finley R, Marshall B, Pollari F, Sargeant J, (2009): High-risk food consumption and food safety practices in Canadian community. Journal of food protection. 72: 2575-2586.

NevinSanlierEceKonaklioglu (2012): "Food safety knowledge, attitude and food handling practices of students", British Food Journal, Volume. 114 Iss 4: 469-480 http://dx.doi.org/10.1108/00070701211219504

Notermans S, Gallhof G, Zweitering M and Mead G, (1995): Identification of critical control point in the HACCP system with a quantitative effect on the safety of food products. Food microbiology. 12: 93-98.

Old DC, McLaren IM and Wray C, (1995): A possible association between *Salmonella* livingstone strains from man and poultry in Scotland. 137: 544.

Oliver SP, Jayarao BM, and Almeida RA, (2005): Foodborne pathogens in milk and the dairy farm environment: Food safety and public health implications. Foodborne Pathogens and Disease. 3:115-129.

Pebody RG, Ryan MJ and Wall PG, (1997): Outbreaks of *Campylobacter* infection rare events for a common pathogen. Communicable diseases report review. R33-R37.

Pilling VK, Brannon LA, Shanklin CIW, Kevin R, Roberts KR, Barrett BB and Howells A D, (2008): Food Safety Training Requirements and Food Handlers' Knowledge and Behaviours. Food Protection Trends. 28 (3): 192-200.

Popoff MY, Bockmuhl J and Gheesling LL, (2003): Supplement 2001 (no 45) to the Kauffmann-White Scheme Res Microbial. 154: 173-174.

Powell SC, Attwell RW and Massey SJ, (1997): The impact of training on knowledge and standards of food hygiene, a pilot study. International Journal of Environmental Health Research. 7(4): 329-334.

Ramaswamy V, Cresence VM, Rejitha JS, Lekshmi MU, Dharsana KS, Prasad SP and Vijila HM, (2007): "Listeria – review of epidemiology and pathogenesis."(PDF). Journal of Microbiology Immunology Infection. 40 (1): 4–13. PMID 17332901. Retrieved 2010-09-05.

Rangel JM, Sparling PH, Crowe C, Griffin PM and Swerdlo DL, (2005): Epidemiology of Escherichia coli O157:H7 outbreaks, United States, 1982-2002 Emerging infectious disease. 11: 603-609

Redmond EC and Griffith CJ, (2002): Consumer food handling in the home: a review of food safety studies. Journal of Food Protection. 66(1): 130-161.

Redmond EC, Griffith C J, (2003): Consumer food handling in the home: A review of food safety studies. Journal of Food Protection. 66: 130-161.

Regulation (EC) No. 852/2004 of the European Parliament and the Council on the hygiene of foodstuffs. Official Journal L 139. 30 April 2004.

Repetto R and Baliga SS, (1996): Pesticides and the immune system. Washington DC, World Resources Institute, 1996.

Riley LW, Remis RS, Helgerson SD, McGee HB, Wells JG and Davis BR, (1983): Hemorrhagic colitis associated with a rare Escherichia coli serotype. N English Journal of Medicine. 308: 681-685.

Rimal X, Fletcher SM, McWatters KH, Misra SK and Deodhar S, (2001): Perception of food safety and changes in food consumption habits: A consumer analysis. International Journal of Consumer Studies. 25(1): 43-52.

Ropkins K and Beck A, (2000): Evaluation of worldwide approaches to the use of HACCP to control food safety. Trends in Food Science and Technology. 11 (1): 10-21.

Rozin P, Imada S, Sarubin A, Fischler C and Wrzesniewsk A, (1999): Attitudes too food safety and role of food in life in the USA, Japan, Flemish Belgium ND France: possible implications for the diet-health debate appetite. 33: 163-180.

Samapundo S, Climat R, Xhaferi R and 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.

Sammarco ML, Ripabelli G and Grasso GM, (1997): Consumer attitude and awareness towards food-related hygienic hazards. Journal of Food Safety. 17:215-221.

SanlierK and Konaklioglu E, (2012): Food safety knowledge, attitudes and food handling practices of students. British food journal. 114(4): 469-480.

Scallan E, Hoekstra RM, Angulo F, Tauxe RV, Widdowson M-A, Roy SL, Jones JL and Griffin PM, (2011): Foodborne illness acquired in the United States-Major pathogens. Emerging infectious disease. 17: 7-15.

Scheule B, (2004): Food safety education: Health professionals' knowledge and assessment of WIC client needs. Journal of the American Dietetic Association. 104:799-803.

Schiller LR, Sellin JH. Diarrhea. In: Feldman M, Friedman LS, Brandt LJ, (2010): editions. Sleisenger and Fordtran's Gastrointestinal and Liver Disease.9th edition. Philadelphia, Pa: Saunders Elsevier; 2010: chapter 15.

Seafood HACCP Alliance (2007): "Compendium of Fish and Fishery Product Processes, Hazards, and Controls, Chapter 15: Listeria monocytogenes". Seafood Network Information Centre. Retrieved January 28, 2009.

Shale K, Jacoby, A and Plaatjies Z, (2006): The impact of extrinsic sources on selected indicator organisms in a typical deboning room. International Journal of Environmental Health Research. 6(4): 263-272

Silver HM, (1998): "Listeriosis during pregnancy," obstetrical and gynecological survey. 12: 737-740.

Smith R, (1994): Food hygiene training: the chance to create a coherent training policy. British Food Journal. 96(7): 41-45.

Smith R, (1996): Food hygiene training, the chance to create a coherent training policy. British food journal. 96(7): 41-45.

Smithers R, (2012): "Sainsbury's changes food freezing advice in bid to cut food waste". *The Guardian*. Retrieved February 10, 2012.

Sobal J, (1984): obesity and dieting. Marriage Family Review. 7(1/2): 115-39.

Sobal J and Rauschenbach BS, (2003): Gender, marital status, and body weight in older U.S. adults. Gender Issues. 21: 75-94.

Sobal J, Rauschenbach B and Frongillo EA, (2003): Marital status changes and body weight changes: a U.S. longitudinal analysis. Social Science Medicine. 56: 1543-1555.

Sockett PN, (1995): The epidemiology and costs of disease of public health significance in relation to meat products. Journal of Food Safety. 15: 91-112.

Sodha SV, Griffin PM, Hughes JM, (2009): Foodborne disease. In: Mandell GL, Bennett JE, Dolin R, eds. Principles and Practice of Infectious Diseases. 7th edition. Philadelphia, Pa: Elsevier Churchill Livingstone; chapter 99.

Soner A and Ozgen I, (2002): International hygiene standards for food-beverage businesses. Health and nutrition in the tourism sector; problems and solutions symposium. Bas_kentUniversitesi, Alanya, Turkiye.

Southern African Development Committee: Measures to address food security in the SADC region:http://www.sadc.int/fanr/food_security/docs/Measures%20to%20Address%20Food%20Security%20i n%20the%20SADC%20Region.pdf.

Southern African Development Community, 'Declaration and Treaty of SADC', http://www.sadc.int/index/browse/page/119.

SOUTH AFRICA, (1967a): Animal Slaughter, Meat and Animal Products Hygiene Act, No. 87 of 1967. Government Gazette, 1186(2540), Oct. 09:1-83.

SOUTH AFRICA, (1992a): Abattoir Hygiene Act, No. 121 of 1992. Government Gazette, 1909(14125) July 10.1-31.

SOUTH AFRICA, (2000): Meat Safety Act, No. 40 of 2000. [Online]. Available from: http://www.polity.org.za/attachment.php?aa_id=3555 [Accessed: 22/04/2008].

SOUTH AFRICA. 2004c. Red Meat Regulations. Government Gazette, 26779, Sep. 17. (Regulation No. 1072 of 2004).

Staff writer (September 27, 2011). "Listeria-cantaloupe-linked deaths rise to 16". CBS News. Retrieved September 27, 2011.

Staff writer September 28 (2011): "Cantaloupe outbreak is deadliest in a decade". USA Today. Retrieved September 28, 2011.

Staff writer October 4 (2011): "Health officials say listeria in cantaloupe is linked to 18 deaths in 8 states" Washington Post. Retrieved October 7, 2011.

Steffen W, (1984): *Salmonella*livingstone-Ausbruch in einemKinderkurheim (in German). Z. Ges. Hygiene, 30: 222-223.

Stein LJ, Nagai H, Nakagawa M, Beauchamp GK, (2010): Effects of repeated exposure and health-related information on hedonic evaluation and acceptance of a bitter beverage. Appetite 40:119-129

StoychevaMV,andMurdjava MA, (2006): Antimicrobial therapy of salmonelloses, current state and perspectives filia medication (plodiv) 48: 5-10.

Sufenliua, Zhenhualiua, HengZhanga, Lingling Luc, Junhua Liang, QiongHuangc, (2015). Knowledge, attitude and practices of food safety amongst food handlers in the coastal resort of Guangdong, China. Food Control. 47: 457-461

Sun, Jinfeng (2014): "Evaluation of a Food Safety Education on Knowledge, Attitude and Practice among 1300 College Students of Henan Province, China." Journal of Food and Nutrition Research 2.4: 136-140.

Tarr PI, Gordon CA and Chandler WL, (2005): Shiga-toxin-producing Escherichia coli and haemolytic uraemic syndrome Lancet. 365: 1073-1086.

Tent H, (1999): Research on food safety in the 21th Century, Food Control. 10: 230-241.

Threlfall MJ and Ward LR, (2001): Decreased susceptibility to ciprofloxacin in salmonella enterica serotype typhi, united kingdom, emerging infectious. 448-450.

Tones B K and Tilford S, (1994): Health education: effectiveness efficiency and equity (2nd edition.) London: Chapman and Hall.

Towns RE, Cullen RW, Memken JA, and Nnakwe NE, (2006): Food safety-related refrigeration and freezer surrounding counties. Journal of food protection. 69: 1640-1645.

Tressler Evers, (2001): The Freezing Preservation of Foods. 213-217

World Health Organization (2004b): Weekly Epidemiology Record. 79(18): 173-180.

Unusan N, (2007): Consumer food safety knowledge and practices in the home in Turkey. Food Control. 18(1): 45-51.

Uzzau DJ, Brown T, Wallis S, Rubino G, Leori S, (2000): Host adapted serotypes of Salmonella enterica Epidemiology infectious. 125: 229-255.

Van Duynhoven YT, De Jager CM, Kortbeek LM, Vennema H, Koopmans MPF, Van Leusden WH. Van der poel MJ and Van den Broek, (2005): Explosive Project Team. A one year intensified study of outbreak of gastroenteritis in the Netherlands epidemiology Infection. 133: 9.

Van Zyl AP (ed), (1998): Red Meat Manual for Veterinary Public Health. Pretoria: Government Printer.

Verbeke W, Viaene J, (2007): Belief, attitudes and behaviourtowards fresh meat consumption in Belgium: empirical evidence from a consumer survey, food quality and preference. 10: 437-445.

Victora CG, Huttly SR, Fuchs SC, Barros FC, Garenne MO and Leroy O, (1993): International differences in clinical patterns of diarrhoeal deaths: a comparison of children from Brazil,Senegal, Bangladesh and India I Diarrhoeal Dis Res. 11: 25-29.

Vinh H, Wain JM, Chinh MT, Tam CT and Trang PT, (2000): Treatment of bacillary dysentery in Vietnamese children: two doses of ofloxacin versus 5 days of nalidixic acid Trans R Social tropical Medicine Hygiene. 94:323-326.

Ward LR, De sa JD and Rowe B, (1987): A phage-typing scheme for *Salmonella* Enteritiditis Epidemiology infection. 99: 291-294.

Ward TJ, Gorski L, Borucki MK, Mandrell RE, Hutchins J and Pupedis K, (2011): "Intraspecific Phylogeny and Lineage Group Identification Based on the prfA Virulence Gene Cluster of Listeria monocytogenes. Journal of Bacteriology 186. (15):4994-5002.

Wheeler JG, Sethi D, Cowden JM, Wall PG, Rodrigues LC, Tompkins DS, Hudson JM and Roderick PJ, (1999): Study of infectious intestinal disease in England: rates in the community, presenting to general practice and reported to national surveillance. BMJ 318, 10461050.

Williamson DM, Gravani RB and Lawless HT, (1992): Correlating food safety knowledge with home food preparation practices, Food Technology. 46: 94-100.

World Health Organization, (1988): Health education in food safety. Geneva, (unpublished document WHO/EHE/FOS/88.7).

World health report, (1995): Geneva, World Health Organization, 1995.

WHO Advisory Committee on Health Research. A research policy agenda for science and technology. Geneva, World Health Organization, (1998): (unpublished document WHO/RPS/ACHR/ 97.4.

WHO, (1999): Food safety: an essential public health issue for the new millennium.

WHO, (2000): Foodborne disease: A focus for health education. Geneva: WHO.

WHO http://www.who.int/csr/don/2003 11 05/en/, 2003.

WHO, (2004): Surveillance Programme for Control of Foodborne Infections and toxications in Europe 8th report 1999-2000, Country reports: Turkey.

World Health Organization (WHO), (2007): Five Keys to Safer Food Manual; WHO: Geneva, Switzerland, 2007.

Worsfold D and Griffith C, (1997): Assessment of the standard of consumer food safety behaviour. Journal Food Protect. 60:399-406.

Williamson DM, Gravani RB and Lawless HT, (1992): Correlating food safety knowledge with home food preparation practices. Food Technology. 46: 94-100.

Yarrow L1, Remig VM, Higgins MM, (2009): Food safety educational intervention positively influences college students' food safety attitudes, beliefs, knowledge, and self-reported practices.Journal environmental health. 2009 Jan-Feb. 71(6): 30-5.

Yousuf AHM, Ahmed MK, Yeasmin S, Ahsan N, Rahman MM and Islam MM, (2008): Prevalence of microbial load in shrimp, Penaeusmonodon and prawn, Macrobrachiumrosenbergii from Bangladesh. World Journal of Agricultural Science. 4:852-855.