FOOD HYGIENE AND SAFETY PRACTICES OF FOOD HANDLERS IN TUCK SHOPS AT SECONDARY SCHOOLS IN UMLAZI

Submitted in fulfillment of the requirements of the Masters of Applied Science in Food and Nutrition with the Department of Food and Nutrition Consumer Sciences, Faculty of Applied Sciences at the Durban University of Technology

KAITE NOKUTHULA DLOMO

Master of Applied Science in Food and Nutrition

Supervisor: Prof. C.E. Napier

Co-Supervisor: Prof O.A Ijabadeniyi

Co-Supervisor: Mrs. S. I. Vermeer

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DECLARATION

- This work has not previously been accepted in substance for any degree and is not concurrently submitted in candidature of any degree.

- This dissertation is being submitted in fulfillment of the requirements for the degree of Masters of Applied Science in Food and Nutrition.

- This dissertation is the result of my own work/investigation except where otherwise stated. Other sources are acknowledged by giving explicit references. A bibliography is appended. I hereby declare that I did not commit plagiarism.

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ABSTRACT

Objective: To determine the food safety and hygiene practices of the food handlers at secondary school tuck shops in Umlazi, Durban, South Africa in order to assess the risk of exposure to harmful bacteria that may cause food poisoning by conducting knowledge questionnaires and microbial tests from food handlers' hands, counter surfaces and kitchen cloths.

Research Methods: A total of 18 secondary schools, 48 food handlers and 24 managers were included in the study. The observational, descriptive and analytical study consisted of quantitative data collection methods. Quantitative data was obtained through a food hygiene and safety questionnaire designed for food handlers and tuck shop owners/managers, an observational checklist and microbial swab tests from food handlers' hands, counter surfaces and kitchen cloths for analysis of microbial presence before preparation, during preparation and after preparation of food. The microbes tested for were *Staphylococcus aureus, Escherichia coli, Salmonella, Listeria monocytogene, Aerobic spore formers and anaerobic spore formers*. Data was captured in Excel and analyzed using a statistical package for social sciences (SPSS) version 24 for descriptive statistics.

Summary of Findings: Eighty-seven percent of the food handlers indicated that the tuck shops did not have soap and none of the tuck shops had hot running water. Furthermore, 70% of the tuck shops had insufficient correct cleaning chemicals and food handlers had never been trained on food hygiene and safety, food preparation, prevention of cross-contamination of food, and prevention of contamination and illness in the workplace. The researcher's observations showed that the majority (66.7%; n=16) of the tuck shops did not have designated rubbish bins while none (100%; n=24) of the rubbish bins were covered, 79.1% (n=19) were unclean and 70.8% (n=17) had waste lying outside the rubbish bins. Higher ranges of microbial counts were obtained for food handlers' hands, kitchen cloths and tuck shop contact surfaces. Although microbial counts are significantly different ($p \leq 0.05$), the values obtained were very close in magnitude for all microbial analyses conducted. Food handlers' hands presented means for *Staphylococcus aureus* (SA), Total plate count (TPC), Aerobic spore formers (ASF) and Anaerobic spore former (ANSF) counts ranged between 6.8061-7.9452, 6.977-7.6031, 6.0776-7.7323 and 6.2274-7.6180 log cfu/ml respectively. Kitchen surfaces presented mean ranges for *Staphylococcus aureus* (SA), Total plate count (TPC), Aerobic spore formers (ASF) and Anaerobic spore former (ANSF) counts ranged between 7.3873-8.0194 and 6.7558-7.6468,

7.2455-7.7450 and 6.7804-7.6409 log cfu/ml respectively. Counter surfaces presented means for *Staphylococcus aureus* (SA), Total plate count (TPC), Aerobic spore formers (ASF) and Anaerobic spore former (ANSF) counts ranged between 7.2161-7.8228, 6.9293-7.8088, 7.0606-7.7822 and 7.1350-7.6532 log cfu/ml respectively. Generally, the highest microbial counts were obtained for food contact surfaces across all samples taken. The lowest microbial counts were obtained in School A for food handlers operating tuck shops around this school. *Escherichia coli* was found mostly on kitchen cloths, followed by counter surfaces and the least amount was found on food handlers' hands. *Salmonella* was found mainly on food handlers' hands and to a lesser degree on counter surfaces. *Listeria monocytogene* was found mostly on the kitchen counters and to a lesser degree on food handlers' hands, and the smallest amount was found on kitchen cloths.

Conclusion: The majority of the food handlers had never received training on food hygiene and safety which resulted in higher microbial outcomes and which posed the risk of food poisoning.

Chapter 1

1.1Introduction

The global burden of foodborne disease is considerably high and affects everyone, particularly children and people living in low-income regions (World Health Organisation (WHO) 2015). The epidemiology of foodborne disease seems to be increasingly driven by poor hygiene standards particularly in Africa. South Africa (SA) has the highest problems with poor areas most affected by poor hand hygiene (Steyn, Labadarios, Maunder, Nel, Lombard and Directors of the National Food Consumption Survey 2005; Von Holy and Makhoane 2006). As reflected in the statistics published by the South African Department of Health (DoH) in 2006, a total number of 1886 of foodborne illnesses and 51 foodborne-illness related deaths had been reported in SA and the majority of the cases were reported in the Eastern Cape (EC) followed by Kwa-Zulu Natal (KZN). In 2011 in SA 2 560 outbreaks of foodborne diseases were reported, of which the majority (1 700) were learners of primary and secondary schools (Stats SA 2014). Hence, the current study conducted on food hygiene and safety practices of food handlers in tuck shops at secondary schools in Umlazi, the second largest township in SA and the largest township in KZN. According to Spies and WHO 2018, a News 24 media statement by the Minister of Health Dr Aaron Motsoaledi (2017) on the listeriosis outbreak in SA reported this outbreak as the largest recorded globally, with approximately 948 confirmed cases. In early 2017 the listeriosis outbreak began in SA, in March 2018 traces of listeria were found in ready-to-eat processed meat in the Limpopo province. By the time the source was confirmed, 180 deaths were reported.

Processes have been set up to support the food safety guidelines in ensuring that food service tuck shops comply with legislation. Internationally it has been advocated by the WHO that food safety procedures are the best policy mechanisms to avert the spread of foodborne diseases (WHO 2015). Consequently, the South African government through the DoH gazetted the Health Act No. 63 of 1977 to encourage proper hygiene and handling procedures on food premises. The Foodstuffs Cosmetics and Disinfectants Act of 1972 also emphasizes the controls and restrictions pertaining to food premises. Moreover, the Hazard Analysis Critical Control Point (HACCP) enforces the implementation and recording of procedures to reduce potential hazards in food production. Hence, the responsibility of the service provider is to offer safe food to the consumer (Fuller 2007).

In SA, food safety is enforced through laws, but not much has been done to follow the implementation of these laws up to micro level such as at food tuck shops and food vendors (Tirado and Schmidt 2001). For example, data obtained from the National Institute of Communicable Diseases indicated that in 2014 approximately 279 students suffered food poisoning after ingesting a meal prepared by the school feeding scheme in North-West province. Also, food handlers involved in the school feeding scheme programmes in Mpumalanga lacked adequate knowledge and awareness, and in addition displayed a poor attitude with regards to microbial food safety hazards resulting in a large number of people being affected (Sibanyoni, Tshabalala and Tabit 2017). Considering these reported cases, firstly a large number of people were affected by a feeding scheme where food handlers are preparing food and secondly handlers who are producing the food for consumption are seemingly at fault not knowing enough. Both of these situations are putting Consumers at risk therefore leading to the purpose of this study and the necessity of doing this research. Hence, there is a need to re-evaluate the factors responsible for the crisis of foodborne diseases in SA. The current investigation seeks to contribute to this body of knowledge.

1.2 Purpose of the study

This research sought to investigate the adherence of food handlers in school tuck shops preparing cooked food in Umlazi Township to the gazetted policies as advocated by the DoH regarding food safety. Under this topic, assessment of food safety and hygiene knowledge of food handlers and managers was also carried out, preparation behaviours, cleanliness and the presence of foodborne pathogens on food preparation areas within school tuck shops was also investigated. These assessments are expected to identify gaps in knowledge and policy and identify the current behaviour patterns of food handlers and managers that can be corrected to ameliorate the persisting problem of foodborne disease outbreaks.

1.3 Aim of the study

The aim of this study was to evaluate food hygiene practices, food safety and hygiene knowledge and the microbiological levels and hygiene standards of tuck shops and food handlers involved in food preparation at secondary schools in Umlazi.

1.4 Specific research objectives

To Establish questionnaires that will determine the knowledge of food handlers and tuck shop managers at the school tuck shops

To determine the food safety knowledge and hygiene practices of the tuck shop managers in secondary schools at Umlazi through a tuck shop manager's questionnaire.

To determine the food safety knowledge and hygiene practices of the tuck shop food handlers in secondary schools at Umlazi through a food handler's questionnaire.

To assess the management of the food tuck shops receiving, storage, preparation, hygiene and service through an observational checklist.

To conduct microbial swab tests (on the hands of food handlers, cloths and work surfaces) in the tuck shop kitchens to determine the presence and level of bacteria that may pose health risks to students.

1.5 Hypothesis

Predictably there will be policy inconsistencies between what is advocated by the DoH and what is practically implemented by the tuck shop food handlers at Umlazi. This hypothesis is based on the argument of Meaker (2012), who showed that 70% of food vendors in Pietermaritzburg measured the quality of the food based on the expiry dates. However, deeper investigations revealed that some of the packaging did not reflect expiry dates. This rendered the quality narrative offered by the food vendors doubtful. Secondly, a study conducted by Afolaranmi, Hassan, Bello, Tagurum, Miner, Sule and Daboer (2014) assessing the knowledge, attitudes and practices of food safety and food hygiene among food handlers showed that 98.5% of the food handlers had poor knowledge of food hygiene and food safety. Similarly, the school feeding scheme programmes in Mpumalanga showed that most of the food handlers involved in food preparation lacked adequate knowledge concerning microbial food safety hazards (Sibanyoni *et al*. 2017). Hence, the researcher hypothesised that the food handlers at Umlazi secondary schools also lacked knowledge of food hygiene and safety which impacts on the microbial counts found in food prepared at the school tuck shops posing a risk to students.

1.6 Background to the study of all the South African provinces, KZN has the second largest population of 11.1 million people (19.9%). Sixty-two percent of the South African population reside within the urban areas (WHO 2013). More than a quarter (30.1%) of the population in KZN is between the ages of one to fifteen years and reside within the township areas (Stats SA 2016). Moreover, children between the ages of six and eighteen, who spend a considerable time in school every day, have been observed to purchase significant quantities of unhealthy food from the school tuck shops. The purchase of unhealthy food from tuck shops increased as children in primary schools became young adults in secondary schools (Bekker 2012). Tee, Laubscher, Botha and Jerling (2015) also added that teenagers were at a higher risk of food poisoning due to the increase in unhealthy fast food consumption. Considering the above findings, it is important to investigate the food preparation knowledge, behaviour and hygiene practises of food handlers at school tuck shops.

The WHO (2006) stated that 90% of school children used pocket money to purchase food from tuck shops at or close to the schools they attended. Similarly, a study by Wiles, Green and Veldman (2013) revealed that 86% of students purchased food from school tuck shops. Tee *et al.* (2015) in a study on the intake and quality of breakfast consumption in adolescents attending public secondary schools in the North-West province contradicted recent findings that more than 51% of children indicated they did not carry lunch boxes to school while some indicated they carried money for lunch to school but did not do so daily. However, school tuck shops sold ready-to-eat foods which were either prepared many hours before lunch break or during serving. Research thus shows that a large number of school children purchase food from school tuck shops, therefore this research aimed to seek and identify concerns associated with the distribution of food items to a group of school students.

A major concern was the hygienic quality and safety of foods since it was usually prepared in environments with limited access to potable water, garbage disposal and sanitary services. The WHO (2011) stated that inadequate water supply in facilities that produce food was one of the causes of unsatisfactory sanitation and poor hygiene practices found to be common in developing countries. Thus, water and food contamination could lead to illness and full-blown foodborne disease outbreaks (Campbell 2011; Kibret and Abera 2012). Meaker (2012) observed that approximately 70% of food vendors included in her study lacked knowledge of hand washing after handling money. This evidence was further affirmed by Lambrechts, Human, Doughari and Lues (2014), who showed that approximately 97% of food borne illnesses were caused by poor personal hygiene. The recent findings concerning food handling

and hygiene contributes to the body of evidence and motivation to conduct this study among food handlers.

School tuck shops in township areas are strategic places to investigate food poisoning crises. As suggested by Kim (2012), school tuck shops could potentially be associated with low standards of food quality and poor sanitation facilities. Fakuda (2015) estimated that diarrhoeal infections, which are conveyed by contaminated food and water, resulted in the death of approximately two million children each year worldwide. During the year 2015, the WHO reported that approximately 220 million children contracted diarrhoeal diseases while 96 000 died each year worldwide. Notably, children were the most vulnerable group for intestinal parasite infections while food infections created a vicious cycle of diarrhoea and malnutrition which threatened the nutritional status of vulnerable groups (WHO 2015). Therefore, the importance of a healthy school environment supports the investigation of the safety and hygiene of food served by tuck shops.

Ideally, managers of food service tuck shops should be highly knowledgeable in respect of food safety and hygiene practices; however, Fuller (2007) reported that approximately 69% - 76% of managers had not received proper training, while unsatisfactory levels of hand hygiene were found among food service employees in Gauteng (Lambrechts *et al.* 2014). Choudhury, Mahanta, Goswami, Mazumder and Pegoo (2011) suggested that vendors or food handlers who sold food to large groups of people were potential sources of food poisoning. Consequently, it has been found that a lack of adequate knowledge of food safety seems to be prevalent among food handlers.

According to Bas, Safak-Ersun and Kivanc (2006), unsafe handling of food, cross-contamination from equipment, work surfaces or poor hygiene practices were sources of pathogens. Furthermore, Choudhury *et al*. (2011) agreed with the above statement and added that poor storage of food and drink, inappropriate preparation and cooking and unclean hands were some of the contributors to food poisoning or foodborne illnesses. The definition of food safety is making sure that the food is suitable to be consumed by humans. This could be achieved by monitoring transportation, handling, processing, food delivery and storage (Campbell 2011). In addition, the safety of food for human consumption was affected by the quality of raw materials (Kibret and Abera 2012; Liu, Zhang and Zhang 2014).

According to Upadhayay and Pashu (2013) most of the populace in developing countries were affected by foodborne pathogens. Food poisoning takes place when contaminated food with

pathogenic micro-organisms is ingested. One of the strains of bacteria, *Salmonella,* was found to be the major cause of food poisoning worldwide and was mainly found in dishes containing eggs (Smith, Gouws, Hoyland, Sooka and Keddy 2007). Foodborne illness is also caused by the *Staphylococcal* enterotoxins produced as a result of the growth and metabolic activities of the pathogenic bacteria *staphylococcus aureus*. Food poisoning is suspected when an individual displays symptom which include nausea, vomiting, abdominal cramps and diarrhoea. Such symptoms may be observed one to eight hours after food is ingested. In classification, a food poisoning outbreak is defined as an incident involving two or more people having the same illness, pathogens or symptoms and having consumed food from the same source (Borchers, Teuber, Keen and Gershwin 2010). About 70% of diarrhoeal diseases were associated with the consumption of contaminated food in developing countries (Afolaranmi *et al.* 2014). In research environmental swabs could be a useful tool for testing food and clinical specimens, particularly on food preparation surfaces (Boxman, Dijkman, teLoeke, Hägele, Tilburg, Vennema and Koopmans 2009). Considering this research, swabs from the food preparation counter surfaces, hands of food handlers and cloths used in the food preparation environment were used to establish the microbial load of food preparation sites.

1.7 Background to the problem: a global perspective

About 93.8 million cases of gastroenteritis infections due to Salmonella species occur globally per year. It is estimated that 80.3 million deaths are caused by foodborne disease (Majowicz, Musto, Scallan, Angulo, Kirk, O'brien and International Collaboration 2010). There are an estimated 2.8 billion cases of diarrhoeal disease each year worldwide. Diarrhoea is considered a common illness among humans in Australia, Canada, Ireland and the United States (Scallan, Majowicz, Hall, Banerjee, Bowman, Daly and Angulo 2005). The definition of an outbreak includes time, place, and person distribution (Jahan 2012). A proper environmental assessment and timely investigation should be undertaken in the event of a foodborne illness outbreak so that appropriate prevention strategies can be identified. Due to the lack of resources for investigation and lack of timely reporting this exacerbates rampant foodborne illness and leads to outbreaks. In addition, persons who did not seek timely healthcare intervention and the limited testing of specimens are also contributory factors in the failure to determine the cause of foodborne illness outbreaks (Lynch, Tauxe and Hedberg 2009).

Numerous foodborne illness outbreaks have been reported from various parts of the world. A study conducted in Qassim province, Saudi Arabia, analysed the foodborne illness surveillance

data for the year 2006. During the study period, 31 foodborne illness outbreaks comprising of 251 cases were reported. The most common etiologic agent was Salmonella spp, followed by Staphylococcus aureus (Jahan 2012). A study was conducted in 2015 to assess the microbiological quality of street-vended food samples from Dhaka, Bangladesh, the study's objective was to identify the presence of common pathogens (Escherichia coli, Shigella spp, Salmonella and Vibrio spp). Out of 50 food samples, six (12%) were confirmed to contain different species of E. coli and Shigella (Islam, Doyle, Phatak, Millner and Jiang 2004).

According to the WHO, greater opportunities for food contamination have evolved from diverse sources, which include globalization of the food trade, urbanization, changes in lifestyle, advances in food technology and international travel, and which have all made the food distribution chain and food production more complex. Consequently, governments all over the world have been intensifying their efforts to promote food safety, which is becoming an increasingly important public health issue. These efforts were made in response to an increasing number of food safety problems and rising consumer concerns (WHO 2001). The FAO and WHO (1997) defined food safety as a guarantee that food prepared and consumed will not cause harm to the consumer. Millions of people suffered from serious disorders, fell ill, suffered from enduring complications or died as a result of food poisoning (FAO 2007). The heavy burden of foodborne diseases caused substantial losses to individuals, households, health systems and nations, and economic losses as a result of rejected food exports due to shortcomings in food safety which were often very significant (WHO 2004).

In developing countries, street-vended food is very common and well utilized but unfortunately, previous studies have shown a scarcity of data with regard to the prevalence of foodborne diseases linked to vended food. Conditions in the streets where vendors prepared their food were not acceptable for food consumption due to the preparation practices and facilities (Bryan 1988; Mosupye and Holy 2000). Additionally, due to poverty and illiteracy, food safety knowledge and safe handling of foods was of little concern and importance to street vendors (WHO 1996) and as a result, the safety of food prepared on the streets raised serious concerns (FAO 2013). This chapter overviews previous studies about food safety attitudes, knowledge and food handling practices among food vendors selling food on the street and at designated tuck shops. Furthermore, the overview incorporates available food safety and handling legislation in SA as well as findings from different studies on the microbial value of street food and their role in escalating foodborne diseases.

In developing countries implementation of food safety policies, legislation and plans of action was found to be poor, regardless of the available food safety strategies in public health and economic development (Jia and Jukes 2013). Globally, consumers rely on fast food but have no control over its preparation, hence food safety issues have become a serious issue and many people end up eating meals outside their homes due to their busy lifestyles. A large proportion of fast food in developing countries is sold on the streets. If it is not hygienically handled and correctly stored, occurrence of foodborne illness is bound to take place (Jia and Jukes 2013). A study in Asia showed that fast food was consumed by all age groups (WHO 2006). However, types of consumers differed, depending on the locality (Mensah, Manu, Owusu-Darko and Ablordey 2002). Often, children under five years are thought to be fed at home but Mensah *et al*. (2002) reported that many parents working at markets did buy food from tuck shops to feed their young ones and this had serious implications for their children's health (WHO 2006). There has been regular documentation of reported illnesses in humans due to consumption of street-vended or food obtained from tuck shops (Mahale, Khade and Vaidya 2008). Foodborne illnesses originating from microbes were a significant international health problem associated with food safety and a major cause of death in developing countries (WHO 2002a; WHO 2002b).

1.8 Background to the problem: an African perspective

The WHO (2006) reported that 40% of food budgets were used to purchase food from tuck shops within the low-income strata of society. The deprived urban consumers living on the street rely primarily on tuck shop food as a coping strategy for daily consumption, and these consumers are mostly children. According to Smith *et al*. (2007), food poisoning outbreaks were frequent in SA but illnesses were rarely reported. Food safety was a concern in respect of the number of outbreaks worldwide, with huge adverse health effects on individuals (Egan, Raats, Grubb, Eves, Lumbers, Dean and Adams 2006). Von Holy and Makhoane (2006) and Christison, Lindsay and Von Holy (2008) conducted a study in Johannesburg among food vendors to ascertain the food safety and hygiene practises of ready-to-eat food. The microbial tests included total bacterial counts, coliforms and foodborne bacterial pathogens. The results of the food samples tested showed relatively low bacterial counts, this was because the foods were freshly prepared and served immediately. According to a study conducted by Omemu and Aderoju (2008) among 185 street vendors in Nigeria, food handlers did not wash their hands before preparing food and continuously scratched their infected body surfaces while handling

food. They also acknowledged that they had been sick a couple of times during the year but only 22.7% had reported to the clinic for medical examination. Similarly, another study by Omemu and Aderoju (2008) showed that of the 87 food handlers surveyed in their study, only 31% had medical certificates that indicated an annual medical check-up. Additionally, most the food handlers acquired the knowledge of handling food through observation. Eighty percent of food handlers did not receive any written training material when training was conducted. From these findings, it could be inferred that food handlers lacked adequate knowledge of food safety and management was not sufficiently involved in food preparation. Therefore, it was recommended that management should implement proper training on a regular basis for food handlers (Klingenberg 2008).

Campbell (2011) assessed food safety among street vendors at public transport centres in Johannesburg. This study revealed that food was usually not effectively protected from dust and flies which may harbour foodborne pathogens, safe food storage temperatures were difficult to maintain, and people lacked knowledge of the food safety concept. A primary school located in the Mpungose tribal area in KZN had a year-end function which resulted in a foodborne outbreak where 216 hospitalised people presented with gastroenteritis (Niehaus, Apalata, Coovadia, Smith and Moodley 2011). Food poisoning could be avoided through the thorough cooking of food, thorough re-heating and proper storage of food, avoiding cross-contamination and protecting food from exposure to insects and rodents. In the current study attention regarding the reheating and storage of food was included in the knowledge questionnaire as these are important contributing factors to food poisoning.

Table 1.1 presents an overview of food safety studies conducted in SA during the last 10 years.

The table below illustrates the study population, measuring instruments used and the results obtained in each of the conducted South African studies. The studies focused on food handlers to determine food hygiene practices, knowledge and microbiological status within the food establishments.

Author and reference	Study population	Measuring instrument used	Results
Khuluse (2015), "Food hygiene and safety practices of food vendors at a University of Technology in Durban".	A total number of 15 vending stalls qualified and participated in this study. Altogether, there were 15 managers and 39 food handlers.	• Food handler's questionnaire • Food manager's questionnaire • Observational checklist • Nutrition analysis	FHs did not wash hands as regularly as expected in the kitchen and working surfaces were not sanitised before and after food preparation.
Campbell (2011), "Assessing the Knowledge, Attitudes and Practices of Street Food Vendors in the City of Johannesburg regarding Food Hygiene and Safety".	The study population consisted of 400 street food vendors who had received training in food hygiene and safety.	• Food handler's questionnaire • Observational checklist.	This study revealed that the food vendors did not have knowledge of the five food safety principles.
Cele (2009), "Microbiological quality and safety of perishable food sold by take-away food outlets in the central operational entity of eThekwini municipality – Durban".	The study sample size was 100 take-away food outlets that were either licenced or not within the Central Operational Entity of eThekwini Municipality.	Pre-structured checklist forms were used.	Ninety-four percent of the food premises were found to be either in an excellent, good or fair condition, the rest of the food premises were found to be in a poor or very poor condition. About 80% of the food samples showed a high total plate count for aerobes. Coliform count test Fifty percent of the food samples tested revealed *Coliforms Escherichia coli* and *Staphylococcus aureus*; none of the 100 samples tested revealed the microbe, Salmonella.
Meaker (2008), "An observational cross-sectional investigation of food service management and general management in schools running the NSNP in the formal and informal areas of Pietermaritzburg, Kwa-Zulu Natal, South Africa".	A total number of 48 schools within the Pietermaritzburg area were sampled.	• Site manager's questionnaire • Food handler's questionnaire • Observational checklist	Observation of sanitising after food preparation and hand washing before serving was significantly low.

Christison, Lindsay and Von Holy (2006), "Microbiological survey of ready-to-eat foods, associated preparation environments and cleaning tools sampled from retail delicatessens: a pilot study".	Four ready-to-eat foods including filled baguettes, assorted salads, sliced processed meats and hot meals sold by four retail delicatessens in Johannesburg were sampled.	• A microbiological survey. • Bacteriological status of associated plastic chopping boards, preparation and storage refrigerators • Hands of food handlers' • Display ice was also assessed.	Results showed that filled baguettes and assorted salads had the highest mean bacterial counts and incidences of potential foodborne pathogens.
Sibanyoni *et al.* (2017), "Food safety knowledge and awareness of food handlers in school feeding programmes in Mpumalanga, South Africa".	The study population consisted of NSNP food handlers in various primary and secondary 69 public schools in the Mpumalanga Province, South Africa.	A questionnaire which consisted of six sections: socio-demographic characteristics, details of 80 NSNP food service facilities at schools, training information of NSNP food service staff, 81 microbial food safety hazard knowledge of the staff of the NSNP, food safety awareness of 82 NSNP food handlers and food safety attitudes of NSNP food service staff.	The school feeding scheme programmes in Mpumalanga showed that the majority of the food handlers involved in food preparation lacked adequate knowledge concerning microbial food safety hazards

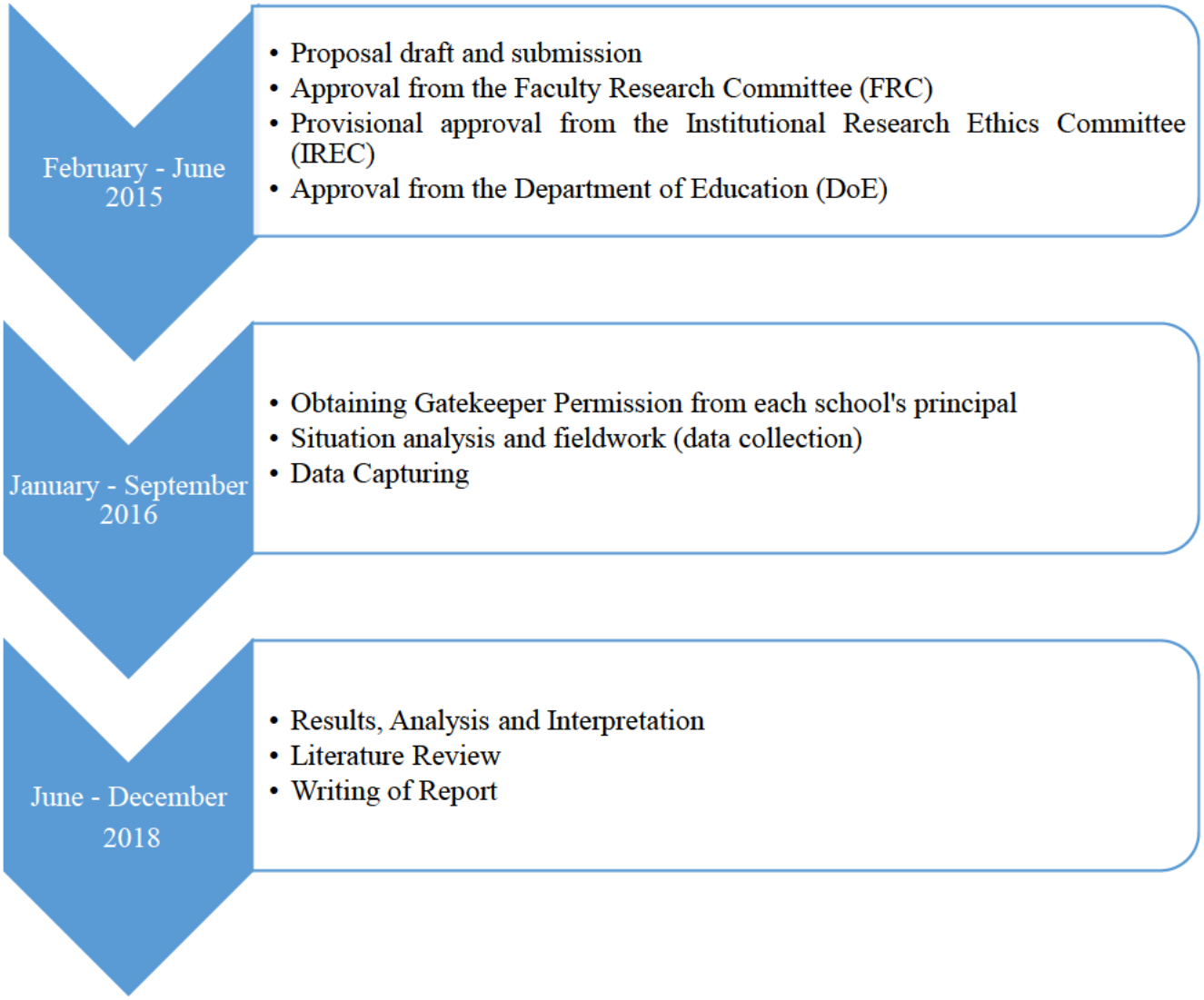
1.9 Motivation for the study

Very few studies have been conducted on food hygiene and safety practices of food handlers in South African township schools and particularly in tuck shops. Also, none of the studies have focused on combining the assessment of knowledge, observation of practices and microbial analysis into one study, which could be useful in finding evaluating the knowledge of food handlers, knowledge of managers and microbial analysis. It was therefore important to conduct a study in a township setup which was predominantly underdeveloped. The research will assist in assessing the problems involved in improving the efficiency and safety of foods and for improved service delivery.

1.10 Timeline of the study

Master of Applied Science in Food and Nutrition

Food hygiene and safety practices of food handlers in tuck shops at secondary schools in Umlazi



1.11 Structure of the dissertation

Chapter 1: Introduction	Chapter 2: Literature Review	Chapter 3: Methodology	Chapter 4: Results
• Introduction. • Background to the study. • Purpose of the study, aims, objectives, hypothesis. • Background to the problem: an African perspective. • Studies conducted among food handlers and food safety in South Africa. • Motivation for the study. • Timeline of the study • Structure of the dissertation.	• A summary of the research studies and relevant information involving the problems addressed in the study.	• Methods and tools used to conduct the research.	• Discussion and presentation of the results obtained during data collection.

Chapter 5: Discussion	Chapter 6: Conclusions and Recommendations	References
• Discussion of the results in relation to literature. • Limitations of the study.	• Suggestions for future studies that can be conducted within the same field. • Conclusions about the outcomes of the study.	• A list of references used throughout the dissertation.

CHAPTER 2

Literature review

2.1 Introduction

In the United State of America (USA) an estimated 48 million cases of foodborne diseases resulted in an estimated 3 000 deaths each year and 128 000 hospitalizations (Centre for Disease Control and Prevention 2013), while in Europe in 2011, 5 262 foodborne disease outbreaks causing 43 473 cases of foodborne disease, 25 deaths and 4 695 hospitalizations were reported (European Food Safety Authority 2012). Data regarding foodborne illnesses remains scarce in most developing countries (WHO 2007). The WHO has indicated that the third leading cause of death in underprivileged countries is diarrheal diseases, which caused 1.8 million deaths around the globe in 2005 alone (WHO 2013). Generally, consumption of contaminated food and water resulted in these cases (WHO 2013).

2.2 School tuck shops/canteens/cafeterias

In many countries there was a high concentration of fast-food outlets near schools and a relatively low concentration of stores that sold fruit and vegetables (WHO 2007). In Belgium, of the 183 secondary schools included in a study on school food policy at primary and secondary schools, it was revealed that only 27% of the schools had tuck shops and 80% had vending machines (Vereecken, Inchley, Subramanian, Hublet and Maes 2005). Challenges faced by school children often included a lack of hygiene-enabling facilities, basic water supply and sanitation (Adams and World Health Organisation 2009).

In the United Kingdom (UK), snack foods are eaten at least once a day by 91% of children and 75% of adults. This behaviour is encouraged by the various cafeterias inside schools (Chopra, Galbraith and Darnton-Hill 2002). Seventy-nine percent of the students in some schools located in Cape Town, SA were observed to eat breakfast at school and the three most frequently purchased items at school were potato chips, candies/chocolate and French fries (Temple, Steyn, Myburgh and Nel 2006). An overview of international vs South African trends on the use of tuck shops and vending machines, indicate that South Africans tend to purchase more from school tuck shops than from vending machines, the former part of the current research.

2.3 Importance of tuck shops

A study by Wiles, Green and Veldman (2013) revealed that 86% of students purchased food from school tuck shops and there is evidence to show that if children observe one of their peers eating a specific type of food, they are likely to do so themselves (Henry 2012); hence the importance of tuck shops. According to Kim (2012), school tuck shops sell ready-to-eat food which has either been prepared hours before lunch break or is prepared during serving. The use of tuck shops is a major concern in respect of hygiene standards and food safety regulations due to food usually being prepared under conditions with limited access to potable water, garbage disposal and sanitary services. Furthermore, school tuck shops are commonly associated with low standards of food safety and sanitation facilities.

2.4 School feeding programmes in SA

The aim of school feeding programmes in SA was to increase the accessibility of healthy food in schools. Meals such as breakfast and lunch were provided free of charge in certain government schools in SA. These programmes could either be accessed by every child or eligibility determined by family economic or child health criteria (WHO 2007). There were several ways in which a child's learning ability could be affected. Millions of school children contract infections, which impair the child's physical development and their cognitive development is retarded through pain and discomfort, anaemia and a lack of nutrients, with organs and tissues being impaired. Chemical contaminants in water such as arsenic and lead could cause impaired learning ability. Other factors that led to absenteeism from school were the occurrence of diarrhoeal diseases, helminths and malaria infection. Nutritional standards for school foods were advocated by the WHO in the school policy framework of 2008. A variety of foods consisting of fruits, vegetables, cereals, starch, legumes, meat, poultry and dairy helped to meet the nutrient and energy needs of students (Adams and World Health Organisation 2009). In the context of school feeding schemes, Sibanyoni *et al.* (2017) conducted a study in Mpumalanga on the school feeding program in Mpumalanga and found that most of the food handlers (388) lacked knowledge, awareness and attitude on many important microbial counts and 389 lacked knowledge on food safety hazards. In South African government schools, some children have access to food through the school tuck shop or the school feeding programmes which is why all food service environments within the school premises had to be included in the current study.

2.5 Street food vending

Food that is prepared and consumed on the street without further preparation is street-vended food (Martins and Anelich 2000). The safety of street vended food is an important aspect in nutrition security. One of the major public health issues is unsafe street food and due to the increasing number of street food vendors who lack adequate knowledge about food safety, the incidence of foodborne diseases is high. Food contamination resulted from unhygienic handling of foods by some vendors (Dawson 1991). A study conducted in India in 2004 by Mishra revealed that 42% of working women and men in the 25 – 45 age group, and 61% of students in the 14 – 21 age group consumed street vended food more than once a day. About 23% of working women preferred to consume lunch sold on the street rather than carrying it from home. Concerning hygiene of street vended food, a study showed that 57% of working-class customers were particular about the vendors' hygiene and cleanliness while the remaining percentage could not care less (Mishra 2004). Similarly, in SA Statistics SA (2016) showed that about 82% of people in all age groups preferred street vended food and only 18% preferred to eat in restaurants. These facts show the growth of street vended food to different age groups both globally and in SA which needs to be managed with regards to food safety due to the increased risk of people who can be infected with food poisoning.

2.6 International guidelines developed by the WHO on school tuck shops – food preparation, hygiene and safety and nutritional value of food

The following guidelines were illustrated by Adam and World Health Organisation (2009), there are a total of seven guidelines with an overview of personal hygiene, cleanliness, separation of cooking equipment, cooking temperatures, food temperatures at rest and at serving, cooking with clean water, situations where children bring food from home, and contamination from animal sources. These guidelines were chosen because they are directed to food handlers and school tuck shops.

Guideline 1: This guideline refers to the personal hygiene of food handlers before, during and after preparing food. "Food handlers must wash their hands after using the toilet and whenever they start work, change tasks or return after an interruption. Soap and water should be available at all times during food preparation and handling, to ensure that handwashing is convenient" (Adams and World Health Organisation 2009).

This aspect of the guideline refers to food safety training for food handlers which helps to reduce the incidence of food contamination due to illness in the workplace. “Food handlers should be trained in basic food safety. If kitchen staff and carers have colds, influenza, diarrhoea, vomiting or throat and skin infections, or have suffered from diarrhoea and vomiting within the last 48 hours, they should not handle food unless it is packaged. All infections should be reported, and sick staff should not be penalised for reporting infections. Eating utensils should be washed with hot water and detergent immediately after each use, and then air dried. The sooner utensils are cleaned, the easier they are to wash. Drying cloths should not be used, as they can spread contamination” (Adams and World Health Organisation 2009).

According to Adams and World Health Organisation (2009) this guideline ensures cleanliness of the food preparation environment, utensils and cleaning cloths. “Food-preparation premises should be kept meticulously clean. Surfaces used for food preparation should be washed with detergent and safe water and then rinsed or wiped with a clean cloth that is washed frequently. Scraps of food should be disposed of rapidly, because they are potential reservoirs for bacteria, and can attract insects and rodents. Refuse should be kept in covered bins and disposed of quickly and safely”.

Guideline 2: Separation of cooking equipment, cooked and raw food as well as separating different kinds of meat to avoid cross-contamination of food. “Separate equipment and utensils (e.g. knives and cutting boards) should be used for handling raw foods or they should be washed and sanitized in-between use. Food should be stored in containers to avoid contact between raw and prepared foods. It is particularly important to separate raw meat, poultry and seafood from other foods” (Adams and World Health Organisation 2009).

Guideline 3: Adams and World Health Organisation 2009 stated that “All parts of foods cooked must reach 70 °C to kill dangerous micro-organisms. To ensure this, soups and stews should be brought to boiling, and meat should be heated until juices are clear, not pink. Cooked food must be reheated thoroughly to steaming hot all the way through”.

Furthermore, Guideline 4: indicates that “Cooked food to be served should be kept hot (more than 60 °C) before serving. Cooked food and perishable food should not be left at room temperature for more than two hours and should be prepared or supplied fresh each day. All

food should be kept covered to protect it from flies and dust" (Adams and World Health Organisation)

Guideline 5. This guideline explains the importance of using clean water to wash fruit and vegetables. Furthermore, it places emphasis on the correct storage procedure for food, chemicals and pesticides and on protection from pests and rodents. "Only safe water should be used for food preparation, handwashing and cleaning. If there is any doubt about the cleanliness of raw fruit and vegetables, they should be peeled just before serving or cooked. Non-perishable foods should be stored safely in a closed, dry, well-ventilated store, and protected from rodents and insects. They should not be stored in the same room as pesticides, disinfectants or any other toxic chemicals. Containers that have previously held toxic chemicals should not be used for storing foodstuffs. Bought food should not be used beyond its expiry date" (Adams and World Health Organisation 2009).

Guideline 6: "In many situations, school children bring food with them from home to school. In these cases, the school hygiene committee or equivalent should work with the families of the school children to ensure that food is prepared hygienically and that they avoid foods that carry a high risk if stored at ambient temperature. Food sold to children by street vendors or in cafes may be unsafe. School authorities should seek local solutions to protect school children from disease from this source"

Guideline 7: This guideline emphasizes contamination from animal sources. "Food should be protected from insects, rodents and other animals, which frequently carry pathogenic organisms and are a potential source of contamination of food" (Adams and World Health Organisation 2009).

2.7 International and South African food safety standards

Jia and Jukes (2013) suggested that food safety issues could well be dealt with by a single agent within a given country. The operational classification for food safety authorities includes authorities across the farm to fork range involved in food legislation, food control, risk assessment and management. They also involve food inspection services, foodborne disease surveillance and response, laboratory services for monitoring and surveillance of foods and foodborne diseases and food safety information, education and communication.

Food production operations risks are assessed using the hazard analysis, for example, growing, harvesting, processing, manufacturing, distributing, marketing and preparing to identify those activities where control is essential to ensure food safety and quality. The hazard analysis and critical control point (HACCP) system is equally applicable in food service tuck shops in developed and developing countries and consists of the above-mentioned elements (WHO 1989). In SA, the implementation of HACCP as a food safety management system has been driven by international trade requirements where foods are exported to countries such as the European Union or the United States of America (USA). A national regulation requiring HACCP implementation was broadcast in 2003. Local and international food safety standards were used to ensure the compliance of food producers and processors with the HACCP system (WHO 2011).

WHO stated in a report published in 2011 that the Organisation identified a simple global health message to educate all types of food handlers, including ordinary consumers. "The Five Keys to Safer Food message: 1. Keep clean; 2. Separate raw and cooked foods; 3. Cook food thoroughly; 4. Keep food at safe temperatures; and 5. Use safe water and raw materials". Associated training materials were developed to provide countries with resources that are easy to use, reproduce and adapt to different target audiences. Currently, 95 countries have adopted and adapted the Five Keys to Safer Food message and developed educational programs. After being launched for the first time in China during the 2008 Beijing Olympics, The Five Keys concept was later adopted by the DoH of SA as part of their health promotion campaign during the FIFA World Cup in 2010.

The Food and Drug Administration Amendment Act of 2007 (FDAAA) required the Secretary of the United States Department of Health and Human Services to establish a reportable food registry within the US FDA to receive notification of instances of "reportable foods" via an electronic portal. The FDAAA further required submissions from two potential sources: mandatory reports from industry and voluntary reports submitted by federal, tribal, state, or local health officials. Mandatory reporters are given 24 hours from the time they become aware of the situation to file the report electronically, requiring the portal to be available 24 hours a day, 7 days a week (Jackson 2011).

Among the many local standards are SABS 049:2001, South African National Standard, Code of Practice – Food Hygiene, Regulation 918 of the Health Act, Act 63 of 1977, Foodstuffs,

Cosmetics and Disinfectants Act, 1972, CAC/RCP 39-1993, SANS 10330:2007, and the ISO 22000:2005 standard uses the management approach known as PDCA – Plan, Do, Check, Act as the foundation for its structure (Jackson 2011).These standards formalize the involvement of management as the underpinning structures of the technical aspects of the food safety management system. Figure 2.1 how's the steps taken at various government levels to ensure safety and hygiene in schools. Food safety authorities around the globe are constantly challenged with insufficient data and time constraints when assessing and managing risks, specifically during emergencies. By sharing risk assessments internationally, members can learn from one another and improve their capacity in this area (Adams and World Health Organisation 2009).

Figure 2.1: Essential steps in managing water, sanitation and hygiene standards in schools at national, district and local level (Adams and World Health Organisation 2009).

2.8 Factors contributing to foodborne illnesses

There are various factors that contribute to foodborne illnesses which are presented in figure 2.2 below, Guidelines to reading the figure will be from the center which is food borne illness and the factors that contribute to food borne illness read in a clockwise direction.

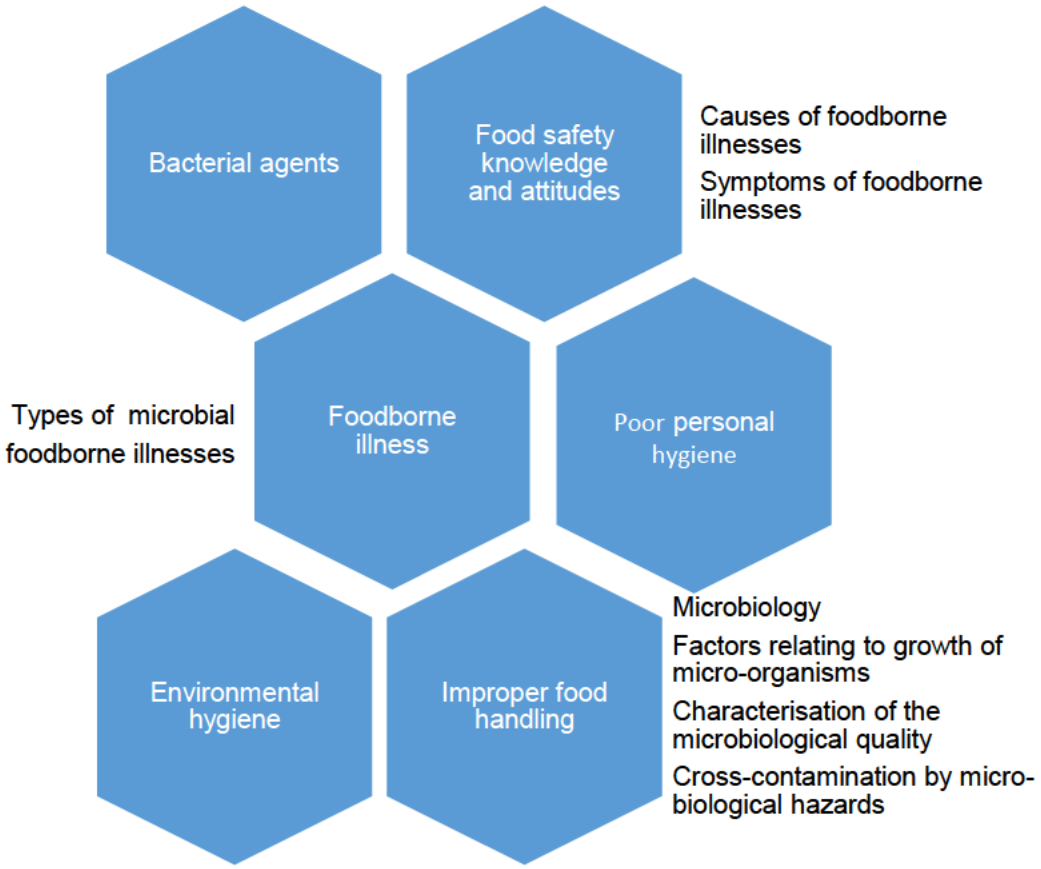


Figure 2.2: The factors that contribute to foodborne illness (Jacob and WHO 1989).

2.8.1 Food safety knowledge and attitudes

Food safety was declared an essential public health function by the WHO in 2000. Henson and Traill (1993) defined food safety as "the probability of not suffering some hazard from consuming a specific food", which is the inverse of food risk. One can prevent illnesses by changing behaviour and attitudes because improper food handling can cause sickness (Schafer, Bultena and Hoiberg 1993). However, if knowledge regarding the source and importance of foodborne disease is lacking, there is a good chance that the people who lack this information will not change their attitudes. Although improved knowledge may not necessarily lead to change in behaviour, food safety knowledge is important in preventing foodborne illnesses. Hence the importance of correct attitude on the part of food handlers (Henson and Traill 1993).

Gotsch, Keck and Spencer (2012) defined knowledge as "a complex process of remembering, relating or judging an abstract phenomenon or idea". Additionally, they also defined it as an "attitude, state of mind, feelings or beliefs about a particular matter (affective abilities) in which someone is motivated and ready to move to action". Attitude is a result of exposure to information and is shaped by knowledge (McIntosh, Acuff, Christensen and Hale 1994).

Rozin and Fallon (1980) indicated that perception results from social, cultural and economic influence which shapes one's knowledge, attitude and practice. Due to the possible risk of food poisoning in the UK, about 45% of customers were encouraged not to eat certain foods as reported in a study conducted in the UK in 1996 by Henson. Assessment of food safety knowledge and the attitudes of street vendors was studied by Campbell in 2011; this study was conducted as a comparison with developed countries where very limited studies had been conducted in food safety knowledge and attitudes of both the consumer and street food consumers. However, observations showed that consumers themselves could act in preventing an unknown proportion of foodborne diseases (Medeiros, Hillers, Kendall and Mason 2001).

According to the Food and Agriculture Organization (FAO), when choosing a street food vendor, consumers attached importance to hygiene; however, their knowledge on hazards that affect health in connection with food prepared on the streets was limited (FAO 2013). Sockett (1995) advised that basic rules of food hygiene should be known. Demographic and socio-economic background differences are another factor that contributed to the consumers' attitude and knowledge (Wilcock, Pun, Khanona and Aung 2004). Altekruse, Yang, Timbo and Angulo (1999) indicated that more men were exposed to the risk of foodborne illnesses than women and in addition, increased socio-economic status increased the prevalence of risky behaviour. Contradictory findings were reported by McIntrye, Vallaster, Wilcott, Henderson and Kosatsky (2013) when they indicated that college and university qualified food handlers achieved a higher score in food safety knowledge when compared with food handlers with only an incomplete or just completed high school education. Also, untrained workers had significantly lower scores than trained workers (McIntrye *et al.* 2013). A study conducted in Belgium revealed that male consumers attached more importance to food safety compared to female consumers (Verbeke and Viaene 1999). A study conducted in the USA showed that food safety knowledge was seen to be more prevalent in students involved in a type of programme that included food safety information compared to other students who enrolled in other programmes (Unklesbay, Sneed and Toma 1998).

A global postal survey conducted in the USA showed that consumers had insufficient knowledge of the micro-organisms that cause food poisoning, food sources of these micro-organisms, the need to eliminate cross-contamination and cooking properly to the correct stage (Williamson, Gravani and Lawless 1992). A study conducted by Woodburn and Raab in Oregon, USA in 1997 indicated that respondents could not indicate which group of people were at high risk of food poisoning and lacked knowledge about foodborne illness. Consumers are more interested in the convenience and saving time than following correct procedures for food handling and preparation (American Meat Institute 1996). In most cases their description of food safety was about visual appearance and odour (Seward 2003).

Different studies indicated that generally, street food vendors had little knowledge of food safety (PAHO 1992; FAO 2013). Demographic characteristic of vendors did not play a significant role in food safety knowledge (Soares, Almeida, Ellayne, Cerqueira and Carvalho 2012; Annor and Baiden 2011) whereas from the education level perspective, studies showed quite different results. Contradicting results were found where Soares *et al.* (2012) and Cuprasitrut, Srisorrachatr and Malai (2011) reported a positive relationship between education level and vendors' knowledge yet Annor and Baiden (2011) and Omemu and Aderoju (2008) did not discover any significant relationship.

A study done by Bas *et al*. (2006) on the "evaluation of food hygiene, knowledge, attitudes and practices of food handlers in Turkey" revealed that food safety knowledge of the food handlers was poor with regard to participants who had previously received food safety training (47.8%). Participants who had knowledge about temperature control constituted 45.5% while participants who had knowledge about food poisoning constituted 42.7%. According to Bas *et al*. (2006), 53.4% of participants had knowledge of cross-contamination and 31.8% had knowledge of personal hygiene. Bas *et al*. (2006) went on to state that most of the food safety questionnaires were answered incorrectly. Resultantly, the participants' failure to correctly answer the questions asked illustrated an inability among the participants to understand the questions asked. A study conducted by Afolaranmi *et al.* (2014) on the "assessment of knowledge, attitudes and practice of food safety and hygiene among food handlers in primary schools in Jos, Plateau State, North Central Nigeria" revealed that most (98.5%) of the participants had a poor knowledge of food safety and hygiene. The above reviews on food safety knowledge and attitude clearly show that there is a problem from an international level to national level on food handlers knowledge concerning food safety and hygiene, hence the

current research seek to investigate if the problem also persists in secondary schools located at Umlazi Township.

2.8.2 Foodborne illnesses

There have been several cases documented on food poisoning outbreaks due to street food, but there is inadequate epidemiological data documented to suggest that street food has contributed to a substantial number of food poisonings. For example, in the 2011 outbreak of *Escherichia coli* in Europe, more than 2000 individuals took ill and 22 or more fatalities were reported (News24 2011). Each year in the United States, 31 pathogens caused 37.2 million illnesses, of which 36.4 million were domestically acquired; of these, 9.4 million were foodborne (Scallan *et al.* 2011). The patients who succumbed to the *E. coli* infection developed hemolytic-uremic syndrome (HUS), which can cause permanent damage to the kidneys and nervous system and can prove fatal (Kennedy 2011). Diseases like cholera, typhoid fever and food poisoning are examples of foodborne diseases that people who frequently consume street food have been reported to suffer from (Todd 1992). Globally, foodborne and waterborne diarrheal diseases are the major leading causes of illnesses that kill an estimated 2.1 million people annually, mostly being children in developing countries (WHO 2001). WHO (2011) suggested that major underlying food and water safety problems are the main reasons for the high prevalence of diarrheal diseases in most developing countries.

Acute and life-long diseases ranging from diarrheal diseases to various forms of cancer (WHO 2011) can be caused by unsafe food. About 2.2 million people are killed annually by foodborne and waterborne diarrheal diseases with 1.9 million of them being children (WHO 2011). Fast food can cause food poisoning outbreaks and remains a threat globally, with the most significant problem being microbiological contamination (FAO 1998). Major health hazards are foodborne pathogens associated with fast food, through dependency primarily on type of food, and the processes of preservation and preparation (FAO 1998; WHO 2005). Foodborne disease incidence outbreaks were reported yearly in Bangladesh (MOH 2003). Virulence coding genes present in genomic regions identified as pathogenicity islands regulate the pathogenicity and virulence of an organism (Hacker and Kaper 2000). The most prevalent pathogen known for causing several foodborne outbreaks was *Staphylococcus aureus* (Kadariya, Smith, and Thapaliya 2014), a gram positive, coagulase positive and catalase micro-organism enterotoxin *Staphylococcus aureus* in contaminated food that causes staphylococcal

enterotoxins (SEs) intoxication and related symptoms are vomiting and diarrhoea (Kadariya, Smith and Thapaliya 2014).

Serological enterotoxins that have been characterized as major are: SEA, SEB, SEC, SED, and SEE (Robbins *et al*. 1977) and recently SEG, SEH, SEI, SEJ, SEK, SEL, SEM, SEN, SEO, SEP, SEQ, and SEU (Letertre, Perelle, Dilasser and Fach 2003; Yarwood, McCormick, Paustian, Orwin, Kapur and Schlievert 2002). Followed by SED, SEA is a primarily common SE associated with foodborne outbreaks. The group of bacteria strains responsible for the occurrence of human disease are Shiga toxin-producing *Escherichia coli* (Besser, Griffin, and Slutsker 1999). Primarily, the transmission of the pathogen is through food (Besser 1999). The subdivision enterohaemorrhagic *E. coli* contains the relatively important serotype O157:H7 and more than 100 other non-O157 strains (Besser *et al.* 1999). Food is the primary source of transmission while direct contact with water is a secondary source of infection transmission (Besser *et al.* 1999). *Shigella dysenteriae* type I and Shiga toxin-producing *Escherichia coli* are among the variety of organisms that produce the family of toxins known as Shiga toxin. They are known to have a cytotoxic effect on the intestinal epithelial cell that causes the characteristic bloody diarrhoea. Specialized media is used in the lab for the identification of *E. coli* O157:H7. Non-O157 Shiga toxin-producing *Escherichia coli* strains identification involves detection of the Shiga toxin gene by polymerase chain reaction or DNA probe for virulence genes *stx1, stx2 and eae* (Besser *et al.* 1999).

Enterococcus genus took the place of fecal coliforms in 2004 as the novel centralized standard for water quality in public beaches in Hawaii USA, providing an advanced correlation that fecal coliforms with numerous human pathogens often originated in the city of Dhaka (knee, Layton, Street, Boehm and Paytan 2008). However, *Enterococci* does not increase in size in water, particularly in low organic matter, and is less abundant than *Escherichia coli* (Edberg, Rice, Karlin and Allen 2000).

Mensah, Manu, Owusu-Darko and Ablordey (2002) reported a case where there was an increase in the risk for both acute and persistent diarrhoea among children whose diet was supplemented with street food. Higher contamination levels were observed in the street food given to these children than in food cooked at home (Mensah *et al*. 2002).

For a few Latin American cities, the incidence of fecal contamination in street-vended foods ranged from 9.4% to56.7%, with the most implicated types of food being meat and fish (87.5%) with a heavy presence of coliforms (Almeida, Schuch, Gelli, Cuellar, Diez and Escamilla 1996). In addition, a study on street food conducted in Zaria, Nigeria revealed contamination with *B. cereus* was found in 26.3% of the samples and *S. aureus* was found in 15% of the samples examined (Umoh and Odoba 1999). Concurrently, a large proportion of street foods have been observed to be contaminated with unacceptable levels of bacteria (Mensah, *et al.* 2002). About 41% of the bacterial load was above bacteriological limits in foods. *E. coli* contamination was found in 4.5% to 7.2% of samples while 0.4% to 3% were contaminated with *B. cereus* and 1.9% to 10.1% were contaminated with *S. aureus*, respectively (Garin, Aïdara, Spiegel, Arrive, Bastaraud, Cartel, Aissa and Duval 2002).In South Africa, a study conducted in Johannesburg revealed that *B. cereus* was detected in 17% while *S. aureus* was present in 3% of street-vended food samples examined (Mosupye and Holy 2000). Also, a study conducted in Bangkok showed that of the 92 samples of street-vended foods collected, 14 (15.2%) had an unacceptable total bacterium count and 38 (41.3%) had an unacceptable total coliform count (Cuprasitrut *et al.* 2011).

2.8.3 Causes of foodborne illnesses

It was estimated in the United States that each year 5.5 million (59%) foodborne illnesses were caused by viruses, 3.6 million (39%) by bacteria, and 0.2 million (2%) by parasites. The pathogens that caused the most illnesses were norovirus (5.5 million, 58%), nontyphoidal Salmonella spp. (1.0 million, 11%), C. perfringens (Scallan *et al.* 2011). Chemical contamination of foods could be as a result of inadequate storage of pesticides, detergents, rodenticides and sterilizing agents, which may lead to leakage and spillage into agricultural products and processed foods. Also, toxic chemicals stored in unmarked containers may be confused for food ingredients and could be directly ingested or mixed with foods. The use of pesticide and detergent containers for food packaging without prior decontamination and sterilization may also impart toxic chemicals on foods, leading to foodborne illnesses. Rodents and insects, including rats, mice and cockroaches, are destructive and dangerous sources of food infection, and as such, any surface they touch must be regarded as contaminated. They are vectors of pathogenic micro-organisms and easily infect foods and food contact surfaces. They also breed rapidly and destroy foods in fields and stores (WHO 1989; Lee *et al.* 2001; Scallan *et al*. 2011).

Little is known about the toxin dose required for parasitic infections on food and the precise mode of transfer for infective agents to host is difficult to investigate. Different foodborne infections are a result of different disease-causing microbes or pathogens that contaminate foods. Additionally, foodborne diseases are also aggravated by the presence of harmful substances or poisonous chemicals in foods. Cross-contamination occurs from hand to food or directly from polluted water (WHO 1989) and WHO (2009) stated that inadequate and poor water supply to food processing facilities was one of the major causes of deprived sanitation and poor hygiene practices and found to be common in developing countries as water and food contamination is a major source of illness to humanity (Campbell 2011; Kibret and Abera 2012).

2.8.4 Symptoms of foodborne illnesses (Refer to table 2.2)

Peristalsis is the main mode of propelling food through the alimentary canal. The walls of the canal contract in waves and progressively propel foods towards the stomach. Reverse peristalsis is induced when poisonous or irritant substances enter the stomach and in combination with contractions of the abdominal muscles and diaphragm results in vomiting. However, if irritant substances are not removed by vomiting, they are passed into the intestines, producing contraction, pain and diarrhoea (WHO 1989; Buzby 2001).

Foodborne illness is a public health problem that is common, costly but also preventable. Statistics show that due to the consumption of contaminated foods or beverages one in six Americans get ill every year. Bacteria, viruses and tiny parasites are micro-organisms that we can’t see, smell or taste but the truth is, they are everywhere in the environment. Foodborne illness poses a constant challenge to consumers, researchers, governments and the food industry (CDC 2015).

2.8.5 Poor personal hygiene

Buying ingredients and foods which are ready for consumption from street or market vendors poses a substantial risk to the health of the public. This is so because of the poor hygienic practices that have been observed. In most instances where research on street food vending has been done, the vendors lack adequate facilities for washing, and some vendors start their daily activities without taking a proper bath since they spend the night at the vending sites so as to

protect their commodities (Ehiri, Azubuike, Ubbaonu, Anyanwu, Ibe and Ogbonna 2001). Ensuring food safety throughout the chain of food production, processing, storage and preparation is an important role played by food handling personnel. Food vendors may also play a role in enabling pathogens to survive and multiply sufficiently by being in contact with food and negligence of hygienic measures, resulting in illness of customers (Rane 2011). Consistently, WHO (2011) also stated that if food handlers mishandle and disregard hygienic measures, pathogens may be introduced to foods and in some cases the pathogens may survive and proliferate in adequate numbers to cause infection in the consumer. Biological hazards are also causal factors introduced by food handlers through cross-contamination after handling raw materials when suffering from diseases. Polyethylene bags were mostly used by vendors to pack food for the customers and while packing, they allowed a number of pathogens to pass on to the customer by blowing air into the bags while trying to open them (Rane 2011). Research carried out in Colombia discovered that more than 30% of a group of food handlers examined were carriers of pathogenic micro-organisms, including *Salmonella typhi*, *Staphylococcus aureus*, *Salmonella enteritis*, and *Shigella* (Buchanan, Robert, and Whiting 1998).

Thirty-one pathogens are known to cause foodborne illnesses (CDC 2013). *Staphylococcus aureus, Listeria, Escherichia coli*, *Salmonella, Bacillus cereus,* and *Clostridium perfringens* are among the most common pathogens found in street vended foods (Mosupye and Holy 2000). In a study done in Sao Paulo city, Brazil, 35% of the street food samples were found to be unsafe for consumption and contained the following microbes: *B. cereus* (12.5%), *S. aureus* (2.5%) and *E. coli* (22.5%) (Hanashiro, Morita, Matte, Matte and Torres 2005). In Johannesburg, in 23 (17%) out of 132 street food samples, *B. cereus* was detected to be the most prevalent bacteria (Mosupye and Holy 2000). In the same study, *S. aureus* was detected in two raw beef and two stew samples, and *C. perfringens* in one raw chicken sample of street-vended foods (Mosupye and Holy 2000).

2.8.6 Improper food handling

With reference to figure 2.1, improper food handling is the major route through which transfer of pathogens to food samples occurs and the microbes contained in food prepared on the street are usually from different sources, including the environment and the human body and also as a result of many improper handling practices (Rane 2011). Storage of foods at improper temperatures, as well as improper heating of food produces heat-stable toxins by pathogens

such as *C. perfringens* and *B. cereus.* Contaminated water is related to pathogens such as *E. coli*, fecal *Streptococci*, *Salmonella* and *Vibrio cholera* while the contamination of vegetables and spices could be traceable to spore formers like *Bacilli* and *Clostridium* and other pathogens including *L. monocytogenes*, *Shigella* and *Salmonella* (Rane 2011). In the Dominican Republic, a study showed that aerobic mesophilic colony counts exceeded 8 logs CFU/g in beans collected from a vendor, which was left overnight at ambient temperature and in Pakistan, aerobic mesophilic counts of over 7 log CFU/g were detected in leftover rice and beef purchased from a vendor located at the bus station (Bryan 1988). These studies also reported that average food holding temperatures ranged from 26^0C to 50^0C, which is ideal for the rapid growth of mesophilic bacteria (Bryan 1988). Microbial cross-contamination could also occur as a result of the use of utensils and equipment previously contaminated by water, dish cloths and food handlers (WHO 1996).

2.8.7 Environmental hygiene

Handling of raw materials by food handlers when they are suffering from specific diseases may introduce biological hazards through cross-contamination (Ohiokpehai 2003; Mensah *et al*. 2002). Some vendors position themselves in overcrowded areas in order to reach out to the unexpected numbers of likely customers, hence leading to limited access to some of the basic sanitary facilities. Therefore, the contamination of street vended foods is often allied to the waste that is generated by food processing, which in most instances is dumped near the vending site. The lack of adequate sanitary facilities for wastewater and liquid drainage as well as the lack of garbage disposal promotes the disposal of waste into nearby streets and gutters. Such areas act as breeding points for flies, dwelling places for rodents and media for growth of micro-organisms. In an African study, 85% of the vendors prepared foods like fruit salad, roasted maize, and fish and chips in conditions that were unhygienic, given that dirty waste and garbage were evident adjacent to the stalls (Muinde and Kuria 2005). African studies on street foods have shown that the tremendous growth of the street-food trade has resulted in a strain on city resources such as water supply and the drainage and sewage systems. An example is the explosive increase in food service Tuck shops, with urbanization revolutionizing the food preparation chain. Several foodborne illness reports have emerged from numerous African countries. There is scientific evidence demonstrating the poor microbial quality of street foods in the African region (Mensah *et al*. 2002; Garin *et al.* 2002; Muleta and Ashnafi 2001; Aidara

2000). Most problems with safety of food and foodborne disease epidemics were caused by pathogens such as *Salmonella* and *Escherichia coli*.

Our daily lives are affected by pollution growth that has interfered with the city plans through littering and undesirable congestion (Muinde and Kuria 2005). Environmental contamination or improper food handling and hygienic practices cause pathogenic bacteria resulting in serious food poisoning outbreaks (Muinde and Kuria 2005). Barro, Bello, Aly, Ouattara, IIboudo and Traaore (2006) in a study on the hygienic status assessment of dish-washing water, utensils, hands and pieces of money from street food processing sites in Ouagadougou (Burkina Faso), revealed that most vendors were poorly educated and untrained and worked under unhygienic conditions. The major source of alarm for food control officers was the state of hygiene of vending Tuck shops (Patience, Yeboah, Kwaku and Anthony 2002). Food vending stands are usually structures which are not finished and with no running tap water available. Washing facilities and toilets are not satisfactory and washing of dishes is mostly done in bowls or buckets and this leads to improper sewage disposal, hence the attraction of rodents and insects to such sites. Patience *et al*. (2002) in a study on street foods in Accra, Ghana indicated that unavailability of refrigeration results in food not being sufficiently protected from flies.

Mwangi (2002) revealed that Kenya has an increasing number of street vendors in Nairobi where vendors sell both cooked and raw food on the streets. Rapid growth and change in food demands has prompted an increase in food vending as a result of the necessity to develop and implement different sources of income in the face of diminishing incomes. A study conducted in Kenya indicated that dirty waste and garbage were noticeable close to the stands of vendors. Lack of garbage receptacles cause the vendors to dispose of their garbage near the food stalls and as a result the surrounding environment was usually filthy (Muinde and Kuria 2005). There are a lot of factors that can contribute to food borne illnesses including garbage disposal, cleanliness, food handling practices and bacterial activity. In the current research, the researcher included questions on all of the above and conducted observations to evaluate the food tuck shops and practices.

2.8.8 Types of microbial foodborne illnesses

In humans, microbial foodborne diseases result from the consumption of contaminated water and food, from feasible pathogenic cells or food containing toxins produced by toxigenic

bacteria and moulds. These illnesses can be arbitrarily divided into three modes: infection, intoxication and toxic infection.

Infection is illness caused by viruses or entero-pathogenic bacteria through consumption of contaminated food and water. Viruses or entero-pathogenic bacteria cells remain alive during consumption of food and water hence the sickness. Salmonellosis and Hepatitis A are examples of diseases that are caused by these cells potentially growing and multiplying in the digestive tract.

Intoxication: Preformed bacterial or mould toxin usually grows in food and the consequence of ingesting such toxin causes illness but a toxin has to be existing in the contaminated food. There is no need for the presence of viable cells to cause illness during consumption of food but just the production of toxin in food by micro-organisms. An example of this disease is *staphylococcus aureus* food poisoning.

Toxic infection: When viable cells of some pathogenic bacteria are consumed in large numbers through contaminated food and water it causes illness. It is either sporulation or death of the bacterial cells that then release toxin to produce symptoms and *Clostridium perfringens* gastroenteritis is an example of this disease.

Additionally, not only pathogenic micro-organisms are associated with foodborne illnesses, but some bacterial species and strains usually considered as nonpathogenic cause gastroenteritis, particularly in susceptible individuals and they are considered opportunistic pathogens. Being alive and present in large numbers during consumption through contaminated food is their primary requirement (Ray 2004).

2.8.9 Bacterial agents of foodborne illnesses

There are various bacterial agents that can cause food borne illnesses, below are a few commonly found of these bacteria when food is not handled properly through the process of farm to fork.

I *Staphylococcus aureus*

Many pathogenic bacteria produce complex enzymes that destroy protein and tissues. These enzymes are known as toxins and some toxins, such as those produced by *Staphylococci*, are heat-resistant and could survive cooking temperatures. *Staphylococci* could survive on the skin, or in the nose or throat of healthy humans, making them carriers of these pathogens. Most staphylococcal outbreaks are caused as a result of hands contaminated by body fluids coming into contact with cooked food, and the fluid sources can come from the mouth, nose, skin or wounds. Regularly, prepared foods are contaminated with staphylococci when it is touched by carriers of this pathogen while the food is at a warm temperature. In favourable conditions, *Staphylococci* multiply and produce toxin in the food, especially during extended storage. Frequent hand washing by food handlers is very important in preventing contamination risks from *Staphylococci* and people who have open wounds on any part of their body and come directly in contact with food should not handle food (WHO 1989).

II *Salmonella* species

Salmonella is an important bacterial genus which causes one of the most common forms of food poisoning worldwide. It can cause a variety of disease syndromes: bacteremia, enteric fever, fecal infections and enterocolitis (Darwin and Miller 1999). It is also one of the most extensively characterized and studied bacterial species and pathogens in terms of its physiology, genetics, cell structure and development. It is the most extensively characterized bacterial pathogen and is a leading cause of bacterial gastroenteritis. *Salmonella* is a motile, rod-shaped aerobic and facultative anaerobe, gram-negative and non-spore-forming organism that is able to grow at a wide range of temperatures (5°C up to 47°C) with an optimum temperature of 37°C. It is heat sensitive and can be readily destroyed by pasteurization. *Salmonella* is a general name used for a group of more than 2000 bacteria. Each *Salmonella* serotype shares common antigens and has its own name. *Salmonella* causes illness by reproducing in the digestive tract and *Salmonella enteritidis* is the commonest serotype isolated from human clinical specimens (Bayu, Asrade, Kebede, Sisay and Bayu 2013).

Salmonella causes headache, enteric fever, enlarged spleen, anorexia as well as constipation and severe abdominal discomfort. Surprisingly, common enterocolitis characterized by abdominal pain, headache, vomiting, nausea, dehydration and diarrhoea may result without

enteric fever. It has a case fatality of 16% reduced to 1% with antibiotic therapy (Adams and Moss 2000). Infected animals are the major source of human illness. *Salmonellosis* is described as a zoonotic infection. It is transmitted by the fecal–oral route. Primary vehicles are eggs, milk, meat and poultry which can cross-contaminate other foods that have not been cooked thoroughly. They may contaminate indirectly via contaminated kitchen equipment. In the transmission of *salmonellosis* human carriers are generally less important than animals. Human transmission can occur when contaminated food from an infected food handler's hand is consumed, mostly when there had been room for microbial growth (Adams and Moss 2000).

III *Escherichia coli*

E. coli is a predominant facultative anaerobe and inhabits the gut of warm-blooded animals and humans. Strains of *E. coli* are known to be the cause of gastroenteritis and diarrhoea in infants. Based on their virulent properties, diarrhoea-causing strains of *E. coli* are classified into three types: entero-invasive *E. coli* (EIEC), entero-pathogenic *E. coli* (EPEC) and entero-toxigenic *E. coli* (ETEC). They are the major causal organisms of childhood diarrhoea in many underdeveloped countries but are not usually related to foodborne disease in developed countries (Adams and Moss 2000). *Escherichia* is the genus type of the *Enterobacteriaceae* family and *E. coli* is a species of the genus. It is a Gram-negative, non-motile, non-sporing rod, oxidase-negative, catalase-positive and fermentative micro-organism. It is also active biochemically as it can ferment sugar lactose. *E. coli* can be separated from other members of the *Enterobacteriaceae* family on the basis of sugar-fermentation and other biochemical tests (Adams and Moss 2000). Genetically, *E. coli* is closely related to the genus *Shigella* and can be difficult to distinguish from *Shigella*. Diarrhoeagenic *E. coli* has four major categories based on distinct virulence properties:

Enterotoxigenic *E. coli* (ETEC). After ingestion of the organism, illness usually occurs between 12 and 36 hours. Symptoms can range from stomach pains, vomiting, and a mild afebrile diarrhoea to a severe cholera-like syndrome of watery stools without blood or mucus. The illness can persist for two to three days but is usually self-limiting. In developing countries ingestion of ETEC is a common cause of infantile diarrhoea where it can cause serious dehydration (Walker, Steele, Aguado, and Ad Hoc ETEC Technical Expert Committee 2007).

Entero-invasive *E. coli* (EIEC). EIEC invades and multiplies within the epithelial cells of the colon causing ulceration and inflammation. EIEC shows classical symptoms normally associated with *Shigella* of an invasive bacillary dysentery, though *shigella* toxins are not produced by EIEC strains. Symptoms of EIEC infection are abdominal discomfort, fever, malaise and often watery diarrhoea syndrome preceding the passage of stools containing mucus, blood, and fecal leukocytes. The infective dose of EIEC is thought to be a reflection of the organism's greater sensitivity to gastric acidity which appears to be substantially higher than for *Shigella* (Beutin, Gleier, Kontny, Echeverria and Scheutz 1997).

Enteropathogenic *E. coli* (EPEC). After ingestion of EPEC, illness usually occurs between 12 and 36 hours. Symptoms of EPEC infection can range from vomiting, malaise and diarrhoea with stools containing mucus but rarely blood. The illness is more severe in infants and is more common than many other diarrheal infections and can persist for longer than two weeks in some cases (Ochoa and Contreras 2011).

Enterohaemorrhagic *E. coli* (EHEC). EHEC, the Verotoxin producing *E. coli* (VTEC), is known to be the most frequent cause of diarrhoea. The most common EHEC serotype reported is *E. coli* O157:H7. EHEC has attracted attention because the illness effects can range from a non-bloody diarrhoea, through hemorrhagic colitis, to the life-threatening conditions haemolytic uraemic syndrome (HUS) and thrombotic thrombocytopenic purpura (TTP). Foodborne transmission is more common than other diarrhoeagenic *E. coli* (Adams and Moss, 2000); (Sperandio and Nguyen 2012).

The tolerance of *E. coli*'s to bile, surfactants and other selective agents such as aniline dyes and the ability of many of its strains to grow at temperatures around 44°C are utilized in the selective test techniques. Although the selective and differential media for the selective identification of E. coli have been variously modified, its essential characteristics have remained unchanged. Bile salts (and sometimes the aniline dye, crystal violet) act as inhibitors of Gram-positive and some fastidious Gram-negative bacteria. Lactose is included as a fermentable carbohydrate with a pH indicator. Strong acid producers such as *Klebsiella, Enterobacter and Escherichia* produce pink colonies while non-lactose fermenters such as *Salmonella, Proteus,* and *Edwardsiella,* with very rare exceptions, produce colourless colonies (Adams and Moss 2000).

In outbreaks of EPEC, EIEC and ETEC contaminated food handlers and fecal contamination of water supplies have been most frequently implicated. Undercooked ground meat products and occasionally raw milk have been greatly involved in the outbreaks caused by EHEC serotype O157:H7. Therefore, cattle are important reservoirs of O157:H7 (Adams and Moss 2000); (Beutin *et al.* 1997); (Ochoa and Contreras 2011) and (Sperandio and Nguyen 2012).

IV *Listeria monocytogenes*

Listeria monocytogenes is a bacterium that causes listeriosis, a disease characterized with severe consequences. It can result in miscarriages in pregnant women and can be fatal in immunocompromised individuals and the elderly. *L. monocytogenes* exists in a very wide range within the environment as it has been isolated from domestic and wild animals, soils, vegetation, water, floors, drains and food processing areas within households and factories. *L. monocytogenes* is a Gram-positive, non-spore forming rod-shaped bacterium belonging to the genus *Listeria* together with *L. ivanovii*, *L. innocua*, *L. welshimeri*, *L. selligeri* and *L. grayi* (Rocourt and Buchrieser 2007). *L. monocytogenes*, which infects humans and animals, and *L. ivanovii*, which mainly infects ruminants, with few cases of human incidences, are the two major pathogenic species from the genus (Guillet, Join-Lambert, Le Monnier, Leclercq, Mechaï, Mamzer-Bruneel and Vazquez-Boland 2010). There are thirteen known serotypes of *L. monocytogenes*, which include 1/2a, 1/2b, 1/2c, 3a, 3b, 3c, 4a, 4ab, 4b, 4c, 4d, 4e and 7 while the ones most often associated with human illness are 1/2a, 1/2b and 4b (FDA 2012).

Many factors influence the growth and survival of *L. monocytogenes* in foods. They include temperature, water activity, salt concentration, pH and the presence of preservatives. The range of temperatures for the survival of *L. monocytogenes* is between -1.5 and 45°C, the optimal temperature being 30–37°C while 50°C and above are lethal to its survival. Freezing can also lead to a reduction in *L. monocytogenes* (Lado and Yousef 2007). Since *L. monocytogenes* can grow in very low temperature environments, it has the capacity to multiply slowly in foods during refrigeration. The broad range of pH for its survival is 4.0–9.6 (Lado and Yousef 2007). *L. monocytogenes* appears to be relatively tolerant to acidic conditions, although survival below pH 4 is yet to be widely documented. The pathogen is more sensitive to acidic conditions at higher temperatures and like many bacteria, it grows optimally at a water activity (aw) of 0.97, although it can also survive lower water activity foods and environments (Lado and Yousef 2007). *L. monocytogenes* is capable of surviving for extended periods at a water capacity value

of 0.81 (Johnson, Tyler Ewan, Ashton, Pollard and Rozee 1991). *L. monocytogenes* has been reported to grow in 13–14% sodium chloride and its survival in a high salt content environment is influenced by storage temperature with its survival chances enhanced at low storage temperatures (Lado and Yousef 2007).

L. monocytogenes can survive both aerobic and anaerobic conditions, although it grows better in an anaerobic environment (Sutherland, Shattock, Baker and Hearse 2003; Lado and Yousef 2007). The combined effects of temperature, pH, salt content and water activity determine the effectiveness of preservatives on the growth of *L. monocytogenes* (refer to table 2.1). Sorbates and parabens could effectively prevent the growth of *L. monocytogenes* at lower storage temperatures and pH and the addition of sodium chloride and/or lowering the temperature improves the ability of lactate to prevent *L. monocytogenes* growth. Also, at low temperatures (such as refrigeration storage), sodium diacetate, sodium propionate and sodium benzoate are more effective in preventing growth of *L. monocytogenes* (Lado and Yousef 2007).

Table 2.1: Limits for growth of *L. monocytogenes* when other conditions are near optimum (Lado and Yousef 2007)

	Minimum	Optimum	Maximum
Temperature (°C)	-1.5	30–37	45
pH	4.0	6.0–8.0	9.6
Water activity	0.90	0.97	–

The two major forms of illnesses associated with *L. monocytogenes* infection are noninvasive and invasive listeriosis. The non-invasive form is milder than the invasive form which could be severe and fatal (FDA 2012). The incidence of invasive listeriosis depends on factors such as host susceptibility, the enormity of organisms consumed and the virulence of the strain ingested (WHO/FAO 2004), and the symptoms of non-invasive listeriosis include fever, muscle ache, drowsiness, vomiting, nausea, diarrhoea and fatigue. Signs of invasive listeriosis include the presence of *L. monocytogenes* in the blood, central nervous system fluid (resulting in meningitis) and in the uterus of pregnant women resulting in spontaneous abortion or stillbirth (20% of cases) and neonatal infection (63% of cases). Also, symptoms relating to

those of influenza and gastrointestinal disorder may occur in pregnant women with invasive listeriosis. For non-pregnant women, invasive listeriosis exists in the form of bacterial meningitis with a fatality rate of 30% and symptoms include fever, seizures, malaise, atacia and altered mental status (Painter and Slutsker 2007). The incubation period before onset of invasive listeriosis was reported to range from 3 days to 3 months (FDA 2012).

L. monocytogenes has been isolated from many ready-to-eat food products. Meldrum, Ellis, Mannion, Halstead and Garside (2010) showed the prevalence of *L. monocytogenes* in some ready-to-eat foods in Wales to be 4.1% in crustaceans, 6.7% in smoked fish, 2% in sushi and 0.9% in green salad. Wong *et al*. (2005) found *L. monocytogenes* in 1% of ham and 1.7% of pate samples in New Zealand. *L. monocytogenes* has also been isolated from dairy products as it was detected in 1.3% of fresh cheese in Spain, 0.3% of ice cream in Italy and 0.2% of hard cheese in the United Kingdom (Busani, Cigliano, Taioli, Caligiuri, Chiavacci, Di Bella and Ricci 2005; Cabedo, Picart, Barrot and Teixidó i Canelles 2008). The prevalence of *L. monocytogenes* in bulk milk tanks internationally is put at 1–60% (FSANZ 2009). The presence of *L. monocytogenes* in ready-to-eat products could majorly be linked to cross-contamination after processing as a result of the additional handling steps undergone by processed foods, including peeling, slicing and packaging. In retail and food service outlets, cross-contamination of ready-to-eat foods may also occur as a result of transference of the pathogen from infected foods and hands to non-infected ones. (Lianou and Sofos 2007). In a survey of retail packaged meats, there was a significantly higher presence of *L. monocytogenes* in products cut into cubes (61.5%) (n=13), compared with sliced products (4.6%) (n=196) (Angelidis and Koutsoumanis, 2006) and this could be traced to handling.

V Anaerobic spore formers

These organisms are anaerobic and are mostly dangerous as they can form spores in canned and vacuum-packed foods, in the absence of air. Toxin produced as botulism releases *Clostridium botulinum* which grows in food. The toxin is poisonous even in minor doses, it causes fatal illness and affects the nervous system. Hazards occur in the presence of inadequate heat, salt and acids. The integrity of commercially canned foods is generally extremely high, but cases of botulism have occurred in people after consuming commercially produced canned foods (WHO 1989)

Table 2.2: Micro-organisms, symptoms and sources (Gerba and Smith 2005)

Causing agent	Symptoms	Duration of illness	Food sources
Salmonellae	Diarrhoea, abdominal pain, vomiting	Several days; up to 3 and fever weeks	Meat, milk. eggs, poultry, vegetable products, meat salads, chocolate, dried coconut, baked goods
Staphylococcus aureus	Nausea, vomiting, abdominal pain, prostration, dehydration, and subnormal temperatures	1-2 days	Cooked foods stored at ambient temperatures
Clostridium perfringenes	Diarrhoea and abdominal pain. Vomiting is rare.	1-2 days	Meat, poultry, fish, vegetables, dehydrated food products such as gravies, sauces, soups and prepared foods stored at ambient temperatures
Clostridium botulinum	Dizziness, headache, tiredness and double vision, accompanied by dryness of the mouth and throat, followed by an inability to speak due to paralysis of the throat muscles. Death often occurs as a result of paralysis of the respiratory centres.	3-7 days in fatal cases. Otherwise months or years to recovery.	Low-acid canned foods, meats, fish, vegetables, seafood
Bacillus cereus	Acute diarrhoea and occasional vomiting. An acute attack of nausea and vom1tmg with some diarrhoea.	Generally, no longer than 24 hours	Milk, meat, cereal, vegetables, cream pastries, soups, puddings

2.8.10 Microbiology

The study of understanding the association and importance of micro-organisms, especially pathogenic bacteria in food, has been ongoing since the 20th century. As a result, specific methods for their isolation and identification have been developed. Also, the importance of sanitation in handling food has been recognized as a way of reducing contamination by micro-organisms. Methods relating to the prevention of growth as well as destroying spoilage and pathogenic bacteria have been studied. Isolation of beneficial bacteria related to food fermentation, particularly dairy fermentation and studying their characteristics has raised some interest. However, food microbiology entered a new era after the 1950s (Ray 2004). New borders in food microbiology have been opened through the availability of basic information on the biochemical, physiological and biological characteristics of diverse types of food, biochemistry and genetics, interactions in food environments and microbial physiology and immunology (Ray 2004).

2.8.11 Factors relating to growth of micro-organisms

Factors affecting the growth of micro-organisms are subdivided into two divisions including intrinsic and extrinsic parameters. Intrinsic parameters include moisture content, pH, oxidation-reduction potential (Eh), nutrient content (water, source of energy, source of nitrogen, vitamins and related growth factors, minerals), antimicrobial constituents and biological structures. Storage environment properties affecting both food and their micro-organisms are referred to as extrinsic parameters and they play a crucial role in the wellbeing of foodborne organisms. They include relative humidity of the environment, temperature of storage, concentration of gases and multiplication of other micro-organisms. Potential problems from micro-organisms are reduced by food processing in several ways including their removal or destruction by trimming, washing, heating, pickling, by adding chemicals or by encouraging competition by acid- or alcohol-forming organisms. Minimizing contamination from equipment, people and the environment and from unprocessed foods could be achieved by cleaning and sanitizing processing equipment and in the product itself by adjusting storage temperature, pH and other environmental factors (Ray 2004)**.**

2.8.12 Categorization of the microbiological quality of foods.

Foods are placed into four categories: satisfactory, marginal, unsatisfactory or potentially hazardous, based on the level of indicator organisms, the aerobic plate count and the number of present pathogens. Satisfactory yields come from good microbiological quality and therefore there is no need for any action. Marginal yields from foods mean that they are within acceptable limits but show possible hygiene problems particularly during food preparation. In cases like this, re-sampling of food may be necessary. Food handling controls at food premises should be investigated regularly. Unsatisfactory results from food imply that food handlers have poor food handling practices and lack personal hygiene practices hence foods have microbes that are outside of acceptable limits. Foodborne illnesses could result from such microbial levels and therefore instantaneous counteractive measures should be engaged. Recall action or withdrawing of any food that is still available for distribution or sale should be considered. As a corrective action, an investigation must be conducted into the practices or production methods so as to identify the source of the problem. There are three levels of food processing including the food type, the handling and the processing (International Commission on Microbiological Specifications for food (ICMSF) 2001).

2.8.13 Cross- contamination by microbiological hazards

Microbiological hazards on the other hand are a huge problem to food safety because pathogenic micro-organisms can multiply in the human body once the food has been ingested (Tent 1999). Poor hygiene practices, operating in unsanitary environments and insufficient food safety knowledge are major risk factors leading to the production of microbiologically unsafe street foods.

Some of the contaminations in the food industry include pathogenic bacteria, viruses and parasites which pose a microbiological hazard regarding food safety. Training and hygienic practices by employees can assist in reducing micro-organism contamination. A leading cause of illness was food contamination as a result of poor hygiene of employees and this was of importance to food sanitation (Higgins 2002). A serious change of mindset is required in operational measures to control food hygiene. Wilson, Murray, Black, and McDowell (1997) indicated that statistically, 70% of bacterial food poisoning outbreaks emanate from the catering industry, and this finding was higher than in any of the other food sectors. Wilson *et*

al. (1997) also revealed that about 70% of food poisoning outbreaks were due to insufficient control of food temperature while 30% resulted from cross-contamination. A transmission route in the spread of foodborne diseases is the hands due to poor personal hygiene or cross-contamination. Toilet use is a source of transmission especially if hands are not washed after use, and bacteria can also spread from one food to another through the hands of the food handler. Inappropriate food handling practice is one of the core causes of foodborne disease outbreaks. A study conducted in the USA agreed that about 97% of illness in food service Tuck shops and homes was due to inappropriate handling of food (Ehiri and Morris 1996).

2.8.14 Bacterial indicators for contamination

A bacterial indicator such as bacteriological examination is used to detect when a person is infected, or a food sample can be used to detect contamination. There are different ways to collect specimens for examination. For example, swabs can be collected using sterile cotton wool on the end of a stick to collect a small amount of infected material from a wound. Faeces may be collected in sterile glass or plastic containers. Samples of food material or swabs from food preparation areas may also be collected (WHO 1989).

2.9 Conclusion

Street vended foods form an important and integral part of modern diets and their consumption is increasing with the rapid increase in urbanization. Hygiene of street food vendors is highly questionable as many are not knowledgeable about good hygiene practices for food processing as well as personal hygiene requirements for food handlers, basically because they have not been adequately trained. Foodborne illnesses are caused by pathogenic micro-organisms that are readily available in the air, water and food contact surfaces and these pathogenic organisms are transmissible by contaminated foods, food handlers and consumers. Foodborne illnesses could be fatal, with high mortality and hospitalization rates. Although there are established school feeding programmes, food safety standards as well as food safety training and compliance enforcement programmes, school pupils regularly patronising street food vendors are prone to foodborne disease-causing micro-organisms largely because of negligence and lack of training on the part of food handlers and laxity of enforcement by food safety authorities. This research was aimed at evaluating the food safety knowledge of food tuck shop managers and handlers around secondary schools in Umlazi, KwaZulu-Natal, South Africa and

assessing the microbiological quality of their food contact surfaces. In the next chapter focuses on the methodology and instruments used to conduct the research.

CHAPTER 3

Methodology

3.1 Introduction

This chapter outlines the research study design and detailed methodological procedures. Most of the measuring tools used in this study were previously used in a study conducted by Meaker (2012) within the Pietermaritzburg region of KwaZulu-Natal.

The aim of the current study was to investigate food hygiene practices, food safety knowledge and practices of food handlers and managers working in various secondary school tuck shops situated at Umlazi, Durban, KwaZulu-Natal. The study also aimed to determine the microbiological quality of food handling environments through the microbial analyses of food handlers' hands, cloths and tuck shop counter surfaces.

3.2 Ethical considerations

Figure 3.1: Ethical consideration steps

Permission to conduct the study in secondary schools was obtained in June 2015 (Ref.:2/4/8/453) (Annexure A) from the Department of Education (DoE). An information letter and application form as gazetted by the DoE were completed in the request for permission to conduct the study within the schools. A list of all the secondary/high schools in Umlazi was obtained from the DoE, Umlazi District Office. The study was approved by the Faculty Research Committee (FRC) of the Durban University of Technology in July 2015. Conditional approval from the Institutional Research Ethics Committee (IREC) was obtained in August 2015, pending the submission of a gatekeeper's letter obtained from the school principals whereupon full approval would be granted. Gatekeeper's permission was obtained from the principal of each school and a consent form was signed upon each principal's approval (Annexure D). Approvals from the principals were obtained during January to February 2016. Subsequent to the submission of the gatekeeper's letter, full approval was granted by the IREC

in February 2016 (IREC 091/15). Subsequently, the tuck shop owners and food handlers were approached to participate in the study.

Prior to conducting the research, the study was explained to all the participants at each school supported by a detailed information letter for added clarity. Information letters and consent forms for the food handlers were written in IsiZulu which was the preferred language of communication (Annexure D and E). Statistically, in KwaZulu-Natal (KZN) the main African language spoken is IsiZulu (Rudwick 2008). The information letters, which contained detailed information about the study and the consent forms, which had to be signed before the study commenced, were used as a formal agreement for participation in the study. It was clearly stated in the information letter that the information gathered would be strictly confidential and would not jeopardize either the schools' or the businesses' reputations. The participants were informed that participation in the study was voluntary and there would be no financial gain. The participants understood that withdrawal from the study would be permitted at any time and they were clearly told that the data collected would be stored in a locked cupboard at the Department of Food and Nutrition for five years after which it would be disposed of.

3.3 Design and methods

The observational, descriptive and analytical study consisted of quantitative data collection methods. Quantitative data were obtained through a food hygiene and safety questionnaire designed for food handlers and tuck shop owners and an observational checklist. All the questionnaires and checklist were designed by Meaker and previously used in a study conducted in 2012. Authorization to use the questionnaires and checklist was obtained from Meaker and no additional questions were added onto the questionnaires. Certain questions were omitted from the questionnaires as they were not part of the current study, there were no additions nor rewording of questions from the questionnaires. Tuck shop kitchens were observed for hygiene and potential for microbial growth during food preparation. Experimental procedures were completed by collecting swabs before, during and after food preparation and then analyzed for microbial growth.

3.4 Selection and sampling procedure

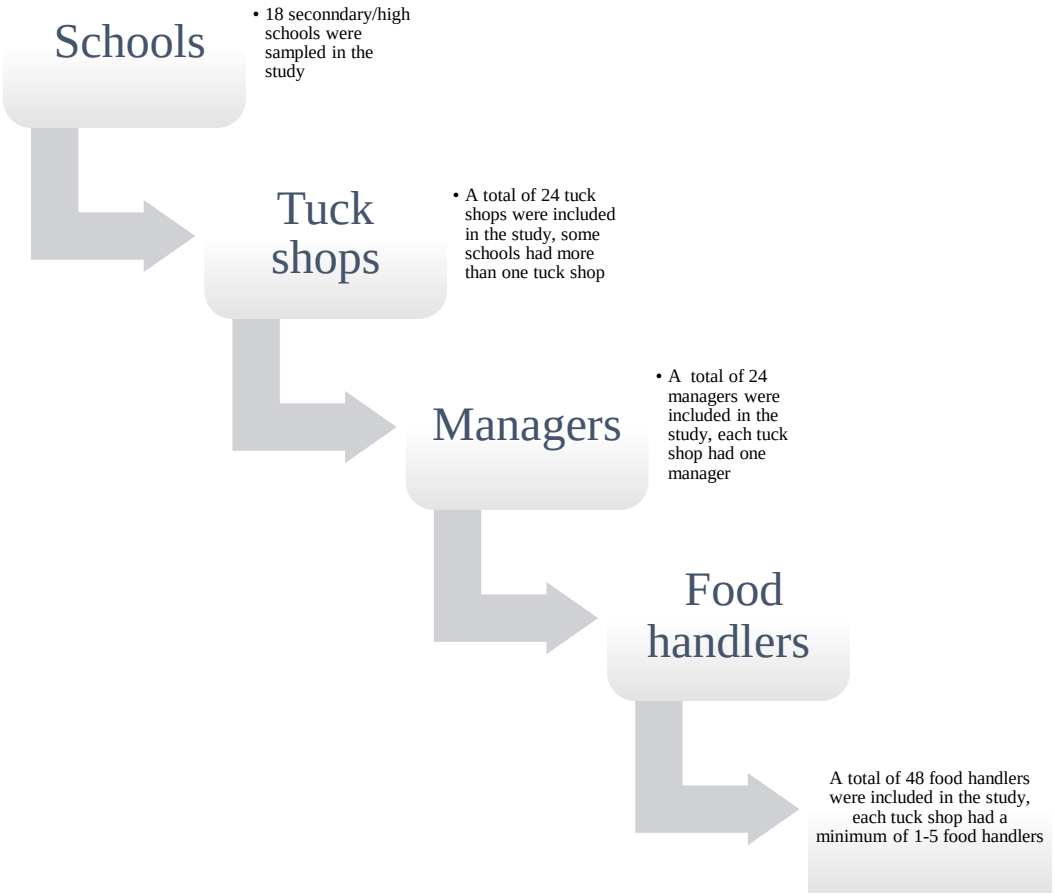


Figure 3.2: Sample selection steps

Purposive sampling techniques are usually used in quantitative studies in selecting units such as groups of individuals (Teddie and Yu 2007). In this study, a purposive sampling procedure was used to select the secondary schools to be included in the study. The purpose was to select secondary schools that had tuck shops on the school premises that prepared food directly from raw ingredients on site. There were 43 secondary/high schools in Umlazi; 20 schools were selected and approached but only 18 agreed to participate in the study. Schools that did not have a tuck shop on the premises and relied primarily on street vendors who prepared food at home were not sampled.

3.4.1 Sample population

A sample size of 20 schools out of 39 schools in Umlazi was estimated to be a reliable sample (Annexure C). All secondary schools were approached but nine schools had to be excluded due to them not meeting the inclusion criteria, and two schools declined the invitation to participate. It is naturally not practical or feasible to study the whole population in any study. Hence, a set of participants is selected from the population (Kadam and Bhalerao 2010). A total of eighteen (n=18) schools were included. The study included all the food handlers and managers from the schools' tuck shops, and this resulted in:

- 48 food handlers (at least two per school)
- 24 tuck shop managers

3.4.2 Inclusion criteria

- Secondary schools located in the Umlazi area.
- Secondary schools with tuck shops where managers and handlers prepare food directly from raw ingredients on site.
- Tuck shops located on the school premises.
- Food handlers working in tuck shops on the school premises.
- Secondary school tuck shop owners/managers.

3.4.3 Exclusion criteria:

- Secondary schools located outside the Umlazi area.
- Secondary schools that did not have tuck shops and did not prepare food from raw ingredients.
- Non-food handlers.
- Tuck shops located outside the schools' premises.
- Non-tuck shop owners.
- Street vendors.

3.4.4 Selection of questionnaires

A standardized food hygiene and safety practice questionnaire for food handlers (Annexure F), a tuck shop manager's questionnaire (Annexure G) and an observational checklist (Annexure H) were used and permission obtained from Meaker 2012 (See attached Annexure I) . The questionnaires were slightly adapted to accommodate the proposed study. Questionnaires were

completed in person during interviews with the tuck shop owners/managers and with the food handlers.

3.4.6 Data enumerators

3.4.6.1 Data enumerators: selection

Field workers were selected from a list of third year students in the Department of Food and Nutrition at DUT who needed field work or community engagement hours. Field workers were selected according to language proficiency and proximity to the study site (Umlazi) so as to make the field workers accessible to the respondents. The researcher worked with two fieldworkers who were recruited to assist with the data collection. The fieldworkers assisted with food handlers and managers questionnaires only and the researcher further did the observational checklist and microbial swabs.

3.4.6.2 Data enumerators: training

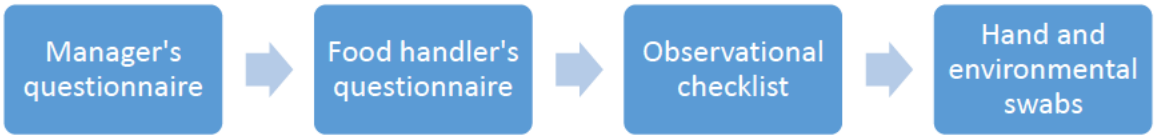
Field workers underwent training prior to the data collection. A training manual (Annexure J) was developed to create an understanding about the study, the expected behaviour of a fieldworker and how to conduct interviews. The training was conducted for three hours. The fieldworkers were also given an opportunity to ask questions or raise potential problems that might arise during the interview session with the participants to ensure clarity and create confidence.

3.4.6.3 Data enumerators: supervision

During the data collection, the researcher was always available to observe how the questionnaires were being completed, how questions were being asked and to assist in answering any questions asked by the participants. The consent forms and the questionnaires from the participants were checked by the researcher straight after the interviews to ensure that all the consent forms were signed, and the questions answered correctly before everyone left the school premises.

3.5 Data collection tools and method of data collection

Figure 3.2 below outlines the data collection tools used to complete the study. It includes the food handler's questionnaire, the manager's questionnaire and the observational checklist. Microbial tests were also conducted to obtain food microbiological quality data.



3.5.1 Manager's questionnaire

A validated and previously used Demographic and Food Hygiene and Safety Practices Questionnaire was completed by tuck shop managers to assess their knowledge of food handling practices and food safety knowledge (Meaker 2012). Questionnaires also included questions on knowledge of receiving, storage, general management practices, checks and record keeping and training (Annexure G). The questionnaire was divided into four sections, with 73 semi-structured questions in English. The tuck shop managers were also interviewed in person by the researcher and fieldworkers in the participants' preferred language of communication, IsiZulu. Each questionnaire was completed in about 30 minutes and data collection from the questionnaires was completed within 2 weeks.

3.5.2 Food handler's questionnaire

A validated and previously used Food Hygiene and Safety Practices Questionnaire (Meaker 2012) was administered to food handlers to assess their food safety knowledge and food handling practices. The questionnaire also asked whether the food handlers had previously received any form of training and for how long or how frequently the training was conducted (Annexure F). The questionnaire was divided into seven sections and consisted of 42 questions. The questions were semi-structured, and interviews were conducted in person with the food handlers by the researcher and field workers. The interviews lasted approximately 15-20 minutes for each food handler. The questionnaires were written in English and IsiZulu, but the interviews were conducted only in IsiZulu, which was the participants' preferred language of communication.

3.5.3 Observational checklist

A one-day observation checklist was completed by the researcher for each tuck shop with regard to food preparation, serving and holding practices to identify possible modes of contamination (Annexure H). The researcher arrived at 7:30am at each of the tuck shops for observation and left the premises once the observation process was completed. The checklist had different sections starting from preparation to serving the food to students, the researcher

observed the practices of food handlers during the preparation including cleanliness and the food premises.

3.5.4 Hand and environmental swabs

The researcher visited all of the 18 schools, spending a day at each school collecting swabs while conducting an observation of the tuck shops. The first swab was collected after the food handlers washed their hands, in between the fingers, on the palm to extract all microbes than could be trapped in between fingers. The hand swabs helped to determine the number of microbes that might be transferred to food before handling the food. The second swabs were taken from the kitchen cloths after the food was prepared. The third swabs were collected from the counter surfaces after food preparation to determine the number of microbes found on the surface where food is directly in contact with the surface during preparation. The collection of swabs from the food handlers (n=48) hands and counter surfaces (n=24) was done using a dry swab transporter. The swab transporter was applied on the food handlers' hands, counter surfaces and kitchen cloths to extract microbes. Swab transporters had to be applied for more than 30 seconds for the microbes to be extracted. After extraction, the swab transporter was sealed using paraffin sealer and stored in a cooler box with ice cubes to maintain the temperature of the microbes before testing and analysis. The swabs were tested in a laboratory at the Department of Food Technology and Biotechnology at DUT for Total Plate Count (TPC), Aerobic spore formers (ASF), Anaerobic spore formers (ANSF) *Staphylococcus aureus (SA), E coli (EC), Salmonella spp (S)* and *Listeria monocytogenes (Lm),* which are the most common bacteria found on surfaces and hands (Campos, Cardonha, Pinheiro, Ferreira, Azevedo and Stamford 2009).

Total Plate Count: Swabs were thoroughly mixed with 10ml buffered peptone water (BPW). A ten-fold dilution series was done in duplicate, 0.1ml of the dilution was spread onto the Nutrient Agar and incubated at 37°C for 24 hours according to the method of ISO (2013).

Aerobic and anaerobic spore-formers count: Twenty (20) ml of the solution of 10^{-1} dilution was then pipetted into two test tubes where one test tube served as a control. These two test tubes were then placed into a water bath with a thermometer placed in the control test tube. These test tubes were held at 75°C for 20 minutes. Further serial dilution was done and thereafter 0.1 ml of the sample was pipetted into petri dishes with Trypticase Soy Agar. Both aerobic and anaerobic plates were incubated at 35°C for 48 hours. The anaerobic plates were placed into anaerobic jars with an aerocult according to the method of MFLP (2012).

S. aureus: A dilution series was done on all samples prepared using BPW, after which 0.1ml of the dilution was spread-plated onto Baird-Parker agar with egg-yolk tellurite emulsion and incubated at 35°C for 24 hours according to the method by ISO (1999).

E. coli: A modified method of MFHPB (2002) was used for this study where one gram of food sample was inoculated into 10ml double strength of Lauryl Sulfate Tryptose (LST) broth and incubated for 24 hours. After 24 hours a 1ml aliquot was transferred into 10ml of Brilliant Green Lactose (BGLB) broth and incubated at 35°C for 24 hours. After 24 hours 1ml aliquot was transferred into Escherichia Coli (EC) broth tubes in a water bath at 45°C. This was transferred into Eosin Methylene Blue (EMB) agar, which was incubated in a water bath at 45°C.

Salmonella: The method by SABS (2003) was used for this experiment and the dissolved swab on BPW was incubated at 35°C for 16 to 20 hours (pre-enriched sample). 0.1ml of the pre-enriched sample was then transferred into a test tube containing 10ml of Rappaport Vassiliadis Enrichment Broth (RVB) and another 10ml of pre-enriched medium was transferred into a bottle containing 100ml of sterile Selenite Cystine Medium (SCM). The RVB was incubated at 42°C for 24 hours and the SCM at 35°C for 48 hours. The culture obtained from RVB after incubation for 24 hours and the culture obtained from SCM after incubation for 48 hours was then inoculated onto the surface of Salmonella HI Chrome Agar and XLD agar to obtain isolated colonies.

L. monocytogenes: The method used by Ijabadeniyi and Naidoo (2014) was also used for this experiment. Half-strength and full-strength Fraser Listeria Selective Enrichment Broth (FLSE) was prepared as stipulated by the manufacturer. One ml of the test sample was inoculated into 9ml of half-strength FLSE and incubated at 35°C for 24 hours. The 0.1ml culture obtained in the previous step was then inoculated into a test tube containing 10 ml of full-strength FLSE and incubated at 35°C for 24 hours. The culture obtained from the half-strength FLSE and incubated for 24 hours was streaked onto Oxford Listeria Selective Agar to observe growth of colonies and incubated micro-aerobically at 35°C for 24 hours. The plates were re-incubated for a further 24 hours if there was slight growth or if no colonies were observed and the same procedure was followed for the culture obtained from the full-strength FLSE.

3.6 Data Analysis

The food handler's questionnaire, manager' questionnaire and observational checklist responses were recorded on the questionnaires, and then captured in Excel using codes for question numbers and responses. The data was captured on Excel and analyzed using the Statistics Package for Social Sciences (SPSS) version 23 for descriptive stats including the mean and standard deviation. The results were presented in graphs and tables and comparisons drawn between the food handlers' and managers' results by observing the two results found between food handlers and managers questionnaires. Microbial counts of swabs obtained from food handlers and tuck shop environments were presented in tables and significant differences in microbial counts were analyzed using one-way ANOVA at 95% confidence level ($p<0.05$).

3.7 Conclusion

The methods and measuring tools used in this study assisted in generating results from the obtained responses and drawing conclusions with regard to the knowledge and practice of food handlers and managers working in secondary school tuck shops at Umlazi as well as the condition of the food Tuck shops. In the next chapter, results obtained from the food handlers and managers questionnaires will be presented as well as the observational checklist and microbial results from food handlers' hands, kitchen cloths and counter surfaces. Furthermore, discussion of the results will be elaborated with the support of findings from other studies.

CHAPTER 4

Results and Discussion

4.3 Introduction

This chapter presents and discusses the results obtained from the quantitative, observational and analytical data of the study. Information was gathered using a food handler's questionnaire, a manager's questionnaire, observational checklists and microbial swabs and comparisons between food handlers' and managers' responses were presented in tables.

4.4 Demographic profile of managers/owners

The managers' socio-demographic data were presented in different categories, namely: business ownership, number of employees, length of service in the business, gender, age, level of education and previous food service experience. The results were presented using numbers and percentages.

Table 4.1 indicates that a total number of 24 tuck shop managers participated in the study and all (100%; n=24) of the participants were managers/owners of the tuck shops. Thirty-three-point three percent (33.3%; n=8) of the tuck shop managers had one employee, 33.3% (n=8) had two employees, 20.8% (n=5) had three employees and 12.5% (n=3) had four or more employees. The majority (54.2%; n=13) of the tuck shop managers/owners had been in the business for three or more years while only 12.5% (n=3) had been in the business for two to three years. Remarkably, 83.3% (n=20) of the managers were females, 83.3% (n=20) were above the age of 30 years with 41.7% (n=10) having matric/grade 12 as their highest level of education. Some of the managers/owners (33.3%; n=8) had achieved standard 6-9/grade 8-11 and only 12.5% (n=3) had a post matric and university qualification. Some (45.8%; n=11) of the managers/ owners of the business had previous experience while 54.2% (n=13) did not have previous experience in food service.

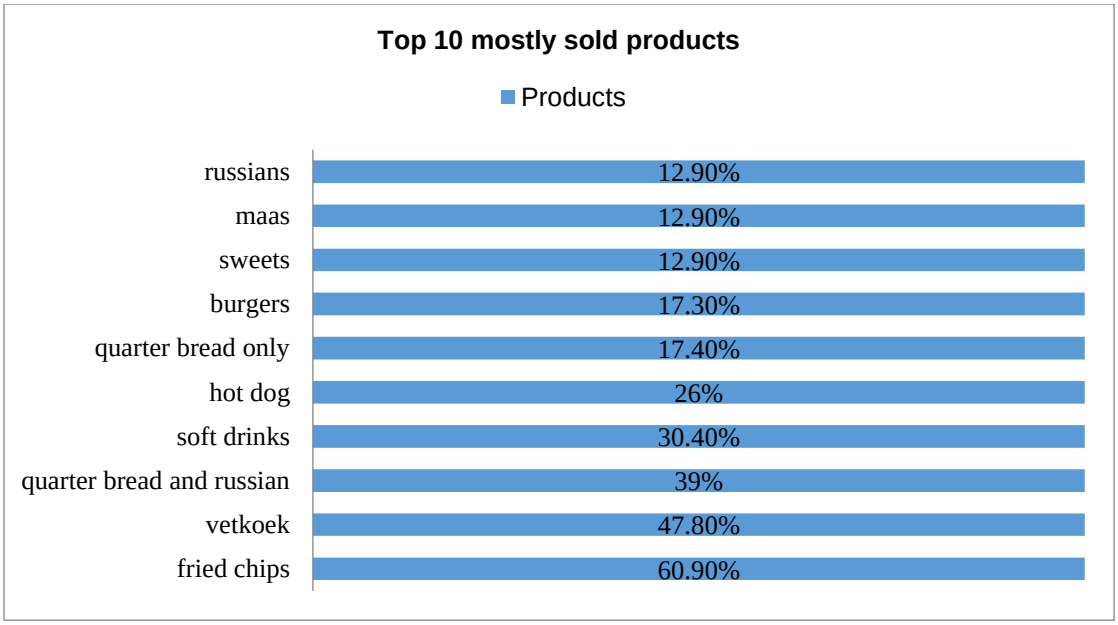
Table 4.1: Demographic profiles of tuck shop managers/owners (n=24)

Variables	Numbers (n=24)	Percentages (%)
Business ownership		
Yes	**24**	**100**
Number of employees		
One	**8**	**33.3**
Two	**8**	**33.3**
Three	**5**	**20.8**
Four or more	**3**	**12.5**
Length of time in the business		
< one year	**4**	**16.7**
One to two years	**4**	**16.7**
Two to three years	**3**	**12.5**
Three or more years	**13**	**54.2**
Gender of the manager/owner		
Male	**4**	**16.7**
Female	**20**	**83.3**
Manager/owner's age		
< 30	**4**	**16.7**
30 and above	**20**	**83.3**
Level of education		
Std 6-9/ Grade 8-11	**8**	**33.3**
Matric/ Std 10/ Grade 12	**10**	**41.7**
Post–matric diploma/Technikon	**3**	**12.5**
University	**3**	**12.5**
Previous experience in food service		
Yes	**11**	**45.8**
No	**13**	**54.2**

4.2.1 Processed foods sold at school tuck shops

The results presented below were extracted from the tuck shop managers questionnaires on the different foods sold at each tuck shop. The top 10 mostly sold products at the school tuck shops were fried chips (60.9%; n=15), followed by vetkoek (47.8%; n=12), quarter bread (*kota*) and Russian (39%; n=10), soft drinks (30.4%; n=8), hot dogs (26%; n= 7), quarter bread (*kota*) only (17.4%; n= 4), burgers (17.3%; n=4), sweets (12.9%; n=3), *maas* (12.9%; n=3) and Russians only (12.9%; n=3) (Table 4.2).

Table 4.2: Products sold at each tuck shop and the sales percentages (n=24)



4.3 Business infrastructure

The food handlers and managers questionnaires had questions based on the business infrastructure, also on the observation checklist, the researcher observed the business infrastructure and ticked according to the observations.

Menu availability

This question was based on finding out if the tuck shops had menu's which they follow on a daily basis. There was disparity in respect of the opinions about the availability of menus with tuck shop managers and food handlers giving different answers. A low number of the food handlers (41.7%; n=20) indicated that the tuck shop had a menu with only 25.0% (n=3) of the managers indicating that a menu was available. The researcher observed that only12.0% (n=3) of the tuck shops had menus (Table 4.3).

Table 4.3: Percentage of tuck shops that have or do not have a menu (n=24)

Menu availability	Food handlers % (n=48)	Managers % (n=24)	Researcher's Observation (n=24)
Yes	41.7 (20)	25.0 (6)	12.0 (3)
No	58.3 (28)	75.0 (18)	88.0 (22)

4.3.2 Menu development response from managers

Where tuck shops had a menu it was developed either by the owner of the tuck shop (16.7%; n=4), or a nutritionist (8.3%; n=2) (Fig. 4.1). From Figure 4.2 it is evident that the tuck shops had different reasons for developing a menu from the managers responses. Eight percent (n=2) developed the menu in line with the locally available food and people's favourite foods. Some of the reasons were economic (4.2%; n=1) and some had to do with locally accepted food (4.2%; n=1).

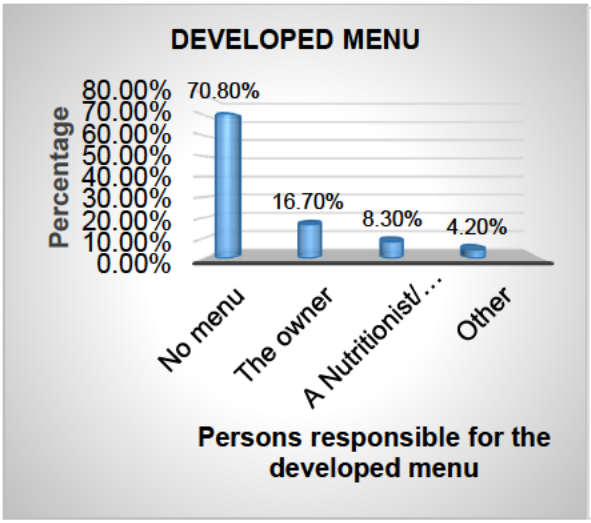


Figure 4.1: Persons responsible for developing the Menu (n=24)

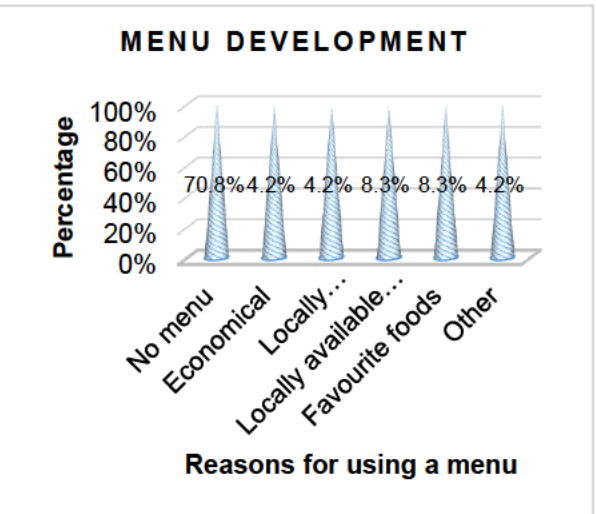
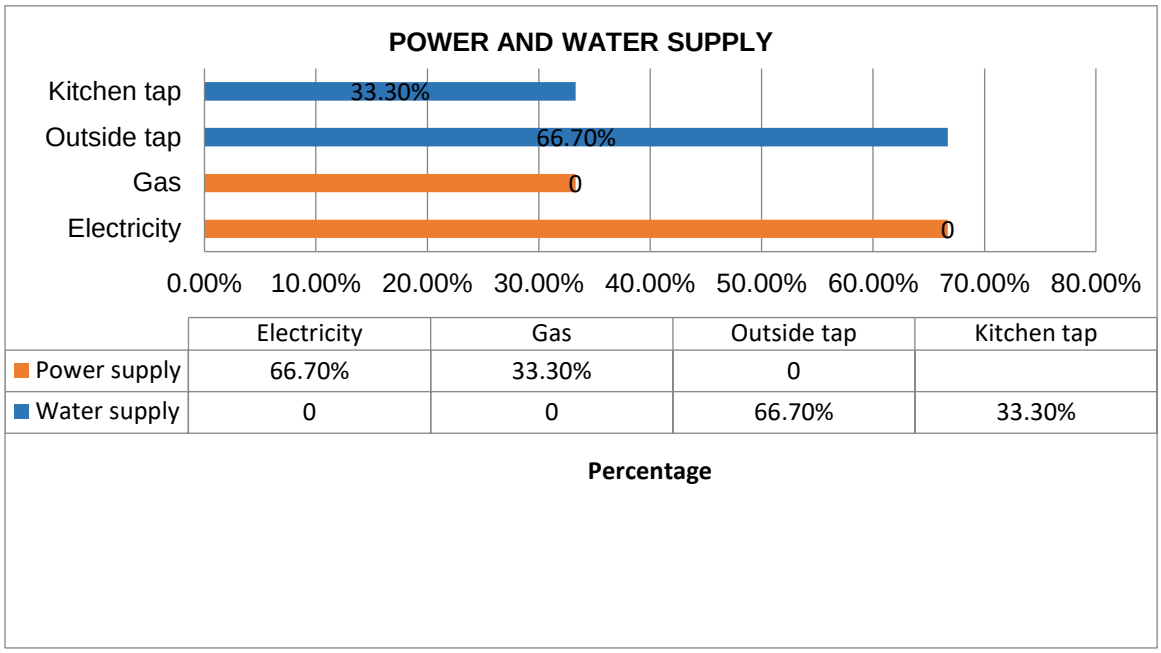


Figure 4.2: Different reasons for menu development.

4.3.3 Managers responses in respect of water and power supply

The water supply for most of the tuck shops (66.7%; n=16) came from outside taps, some tuck shops (33.3%; n=8) had taps installed inside the kitchen and none of the tuck shops used water tanks, communal water supply or any other supply. The majority of the tuck shops (66.7%;

n=16) used electricity as a source of power and the rest (33.3%; n= 8) used gas stoves. None of the tuck shops used any other type of power supply (Fig. 4.3).



	Electricity	Gas	Outside tap	Kitchen tap
Power supply	66.70%	33.30%	0	
Water supply	0	0	66.70%	33.30%

Figure 4.3: The tuck shops' water and power supply (n=24)

4.4 Monitoring of staff

4.4.1 Staff monitoring and delegation from managers

Monitoring of staff members was a response from the tuck shop managers. In case where the managers were not on duty, delegation of staff was essential as well as monitoring the staff during production. The results in Table 4.4 show that the majority of the tuck shop managers monitored staff duties daily (66.7%; n=16). Some managers monitored monthly (4.2%; n=1), two managers seldom monitored the staff (8.3%; n=2) and 20.8% (n=5) of the managers did not monitor the staff at all. The tuck shop managers monitored their employees by being there physically to supervise their daily food processing and handling activities. A large percentage of the tuck shop managers delegated staff duties (58.3%; n=14) while 41.7% did not delegate any staff duties. Tuck shop managers who delegated staff duties delegated to food handlers (54.2%; n=13).

Table 4.4: Monitoring and delegation of staff duties (n=24)

Variables	Number (n=24)	Percentage (%)
Staff monitoring		
Daily	**16**	**66.7**
Monthly	**1**	**4.2**
Seldom	**2**	**8.3**
Never	**5**	**20.8**
Delegation of staff duties		
Yes	**14**	**58.3**
No	**10**	**41.7**
If yes, to whom?		
No person	**10**	**41.7**
Food handler	**13**	**54.2**
Assistant manager	**1**	**4.2**

4.4.2 Business policies and procedures

As shown in Fig. 4.4, the majority of the school tuck shops did not have written policies and procedures in place for the service they provided within the tuck shops ranging from receiving (83.3%; n=20), storage (87.5%; n=21), serving (87.5%; n=21), hygiene (87.5%; n=21) or administration (87.5%; n=21). There were a few tuck shops that had written policies and procedures for receiving (16.7%; n=4), storage (12.5%; n=3), serving (13%; n=3), hygiene (13%; n=3) and administration (13%; n=3).

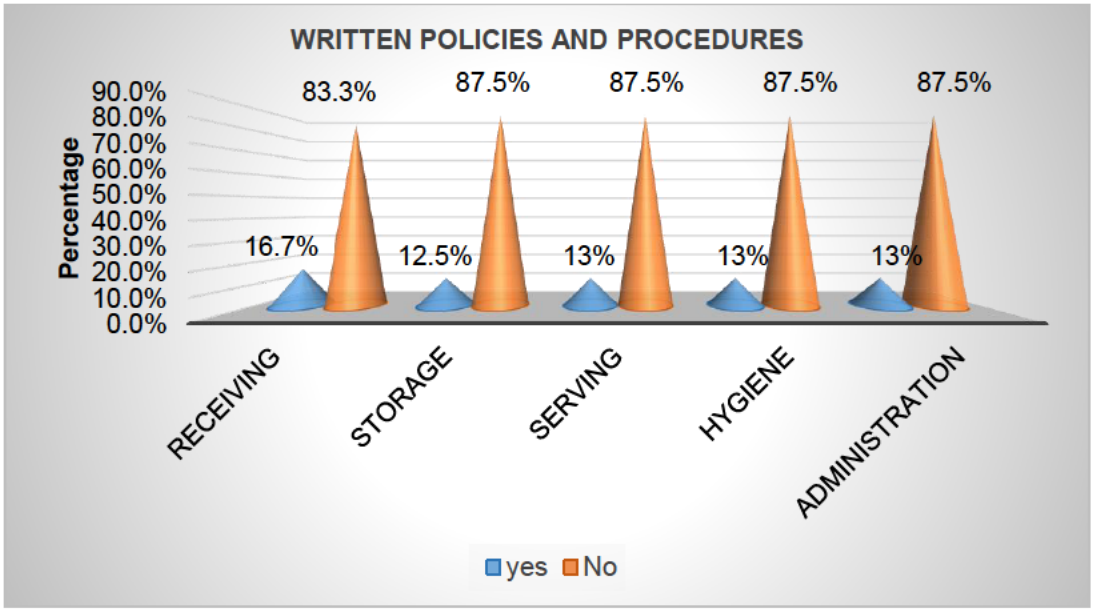


Figure 4.4: Tuck shops' written policies and procedures (n=24)

4.6 Demographic profile of food handlers

The demographic profile of food handlers (Table 4.5) outlines the number of employees per tuck shop. (16.7%; n=8) the tuck shops had one employee, (37.5%; n=18) had two employees, (20.8%; n=10) had three employees or five employees. The food handlers' length of service in the school tuck shops ranged from one to 12 months (37.6%; n=18), up to 12-24 months (12.6%; n=7). Most (56.3%; n=27) of the food handlers did not have previous experience in the food service environment while 43.8% (n=21) had experience in the food service environment.

Table 4.5: Food handler's demographic profile (n=48)

Variables	Numbers (n=48)	Percentage (%)
Number of food handlers		
1	**8**	**16.7**
2	**18**	**37.5**
3	**10**	**20.8**
4	**0**	**0**
5	**12**	**25.0**
Length of service in months		
1-12	**18**	**37.6**
16-40	**18**	**37.6**
46-72	**6**	**12.6**
120-264	**6**	**12.6**
Previous experience in food service		
Yes	**21**	**43.8**
No	**27**	**56.3**

4.6 Food handlers' knowledge

Table 4.6 shows that the majority (93.8%; n=45) of the food handlers indicated that expiry dates on products were checked while only 6.4% (n=3) indicated that expiry dates were not checked. When food handlers were asked about the implication of expiry dates printed on food products, the majority (97.9%; n=47) responded that it means that the product is no longer suitable for consumption while the rest did not know what the implications were.

Table 4.6: Food handler's knowledge about the food expiry date (n=48)

Variables	Numbers (n=48)	Percentage (%)
Expiry date checks		
Yes	**45**	**93.8**
No	**3**	**6.35**
If the expiry date on the food packaging is 20 August 2014, what does this mean?		
The product is expired and not suitable for consumption	**47**	**97.9**
I don't know	**1**	**2.1**

4.9 Food preparation

The majority (97.9%; n=47) of the food handlers indicated that food was prepared in a designated kitchen while 8.3% (n=4) reported preparing food both in the designated kitchen and a temporary kitchen. Only 2.1% (n=1) of the food handlers prepared food in a temporary kitchen. In most of the school tuck shops (54.2%; n=26), the managers are responsible for food preparation, while in 41.7% (n=20) of the tuck shops, food handlers were solely responsible for food preparation. In some (39.6%; n=19) tuck shops, both the manager and food handlers were responsible for food preparation, while in 4.2% (n=2) of the tuck shops other people worked in food preparation. Most (72.9%; n=35) of the tuck shops had adequate space for food. The majority (68.8%; n=33) of the tuck shops had adequate cooking space while 31.3% (n=15) were observed to have inadequate cooking space. The majority (95.8%; n=46) of the school tuck shops had enough water for cooking while only 4.2% (n=2) of the tuck shops did not have sufficient water for cooking (Table 4.7).

Table 4.7: Food handler's responses on tuck shops' preparation environment (n=48)

Variables	Numbers (n=48)	Percentage (%)
Food preparation		
Designated kitchen	**47**	**97.9**
Temporary kitchen	**1**	**2.1**
Both designated kitchen and temporary kitchen	**4**	**8.4**
Persons responsible for food preparation		
The manager	**26**	**54.2**
The food handler	**20**	**41.7**
Other	**2**	**4.2**
Both manager and food handler	**19**	**39.6**
Adequate food preparation space		
Yes	**35**	**72.9**
No	**13**	**27.1**
Adequate cooking space		
Yes	**33**	**68.8**
No	**15**	**31.3**
Total	**48**	**100**
Sufficiency of water for cooking		
Yes	**46**	**95.8**
No	**2**	**4.2**

4.9.1 Food preparation equipment

The food handlers responded to questions about the adequacy of food preparation equipment at each tuck shop (Table 4.8). The majority of the tuck shops had enough knives (83.3%; n=40), serving spoons (54.2%; n=26) and mixing tools (79.2%; n=38) while some tuck shops (58.3%; n=28) had insufficient chopping boards and some (62.5%; n=30) had insufficient measuring equipment.

Table 4.8: adequacy of equipment used for food preparation (n=48)

Adequacy of food preparation equipment			
Knives	Yes	**40**	**83.3%**
Chopping boards	No	**28**	**58.3%**
Measuring equipment	No	**30**	**62.5%**
Serving spoons	Yes	**26**	**54.2%**
Mixing tools	Yes	**38**	**79.2%**

4.9.2 Recipes

Most (81.3%; n=39) of the school tuck shops did not have recipes and 79.2% (n=38) did not use recipes. The tuck shops that used recipes had obtained the recipes from the managers (6.3%; n=3), the food handlers (8.3%; n=4), or the Department of Education (2.1%; n=1) and some were obtained from other sources (4.2%; n=2) (Table 4.9).

Table 4.9: Availability of recipes (n=48)

Recipe availability		
No	**39**	**81.3%**
Recipe usage		
No	**38**	**79.2%**
Source of recipe used		
The manager	**3**	**6.3%**
Food handler	**4**	**8.3%**
Department of Education	**1**	**2.1%**

4.9.3 Food holding time

Fig. 4.4 shows that the holding time of food between cooking and serving was indicated as less than 15 minutes (42.0%; n=20), between 15- 30 minutes (37.0%; n=18), between 30-45 minutes (19.0%; n= 9) and for more than 45 minutes (2.0%; n=1).

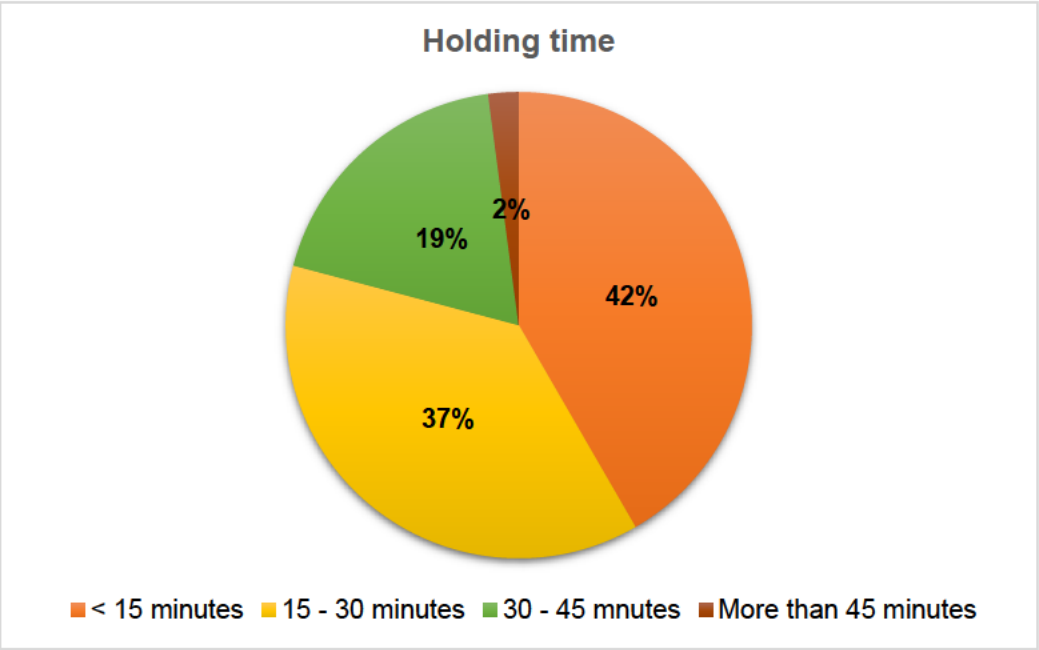


Figure 4.5: Length of holding time between cooking and serving (n=48)

4.9.4 Serving

Figures 4.5-4.8 and table 4.10 illustrate the adequacy of tuck shop serving spaces, the satisfaction of students with the sizes of meal portions served at each tuck shop, the way food leftovers were handled by the tuck shops and waste disposal methods respectively. Table 4.10 provides insight into the methods used to re-heat leftover food. There were 68.7% (n=33) of the tuck shops that had adequate serving space and in almost all the tuck shops (97.9%; n=47), food handlers responded that the tuck shops served meal portion sizes that satisfied the students. It is interesting to note the responses from food handlers concerning leftovers, left overs were never thrown away by food handlers as they were either eaten (10.4%; n=5), kept for the next day (8.3%; n=4), or given to students free of charge (22.9%; n=11). Also, 8.3% (n=4) of the tuck shops reported no left-over foods. Most of the tuck shops had waste bins (93.7%; n=45); however, 85.4% (n=41) of these waste bins were not covered with lids. Over half of the tuck shops situated their waste bins outside the shops (54.2%; n=26) and the majority (75.0%; n=36) emptied these waste bins once a day. The leftover foods kept in the food buckets for the next day were reheated through various means, the most prominent being microwave heating (12.5%; n=6). In the opinion of food handlers reheating of leftovers was not applicable in 79.2% (n=38) of the tuck shops meaning that they did not leave left overs for reheating the next day.

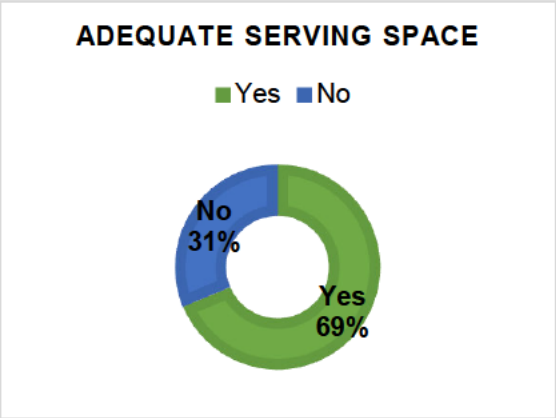


Figure 4.6: The adequacy of tuck shops' Serving space (n=48)

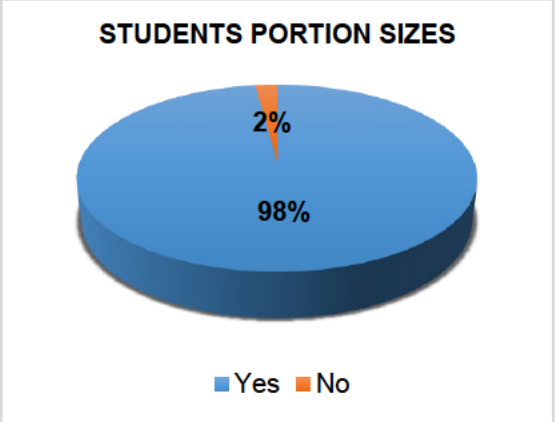


Figure 4.7: Food handler's response to students satisfactory regarding portion Size (n=48)

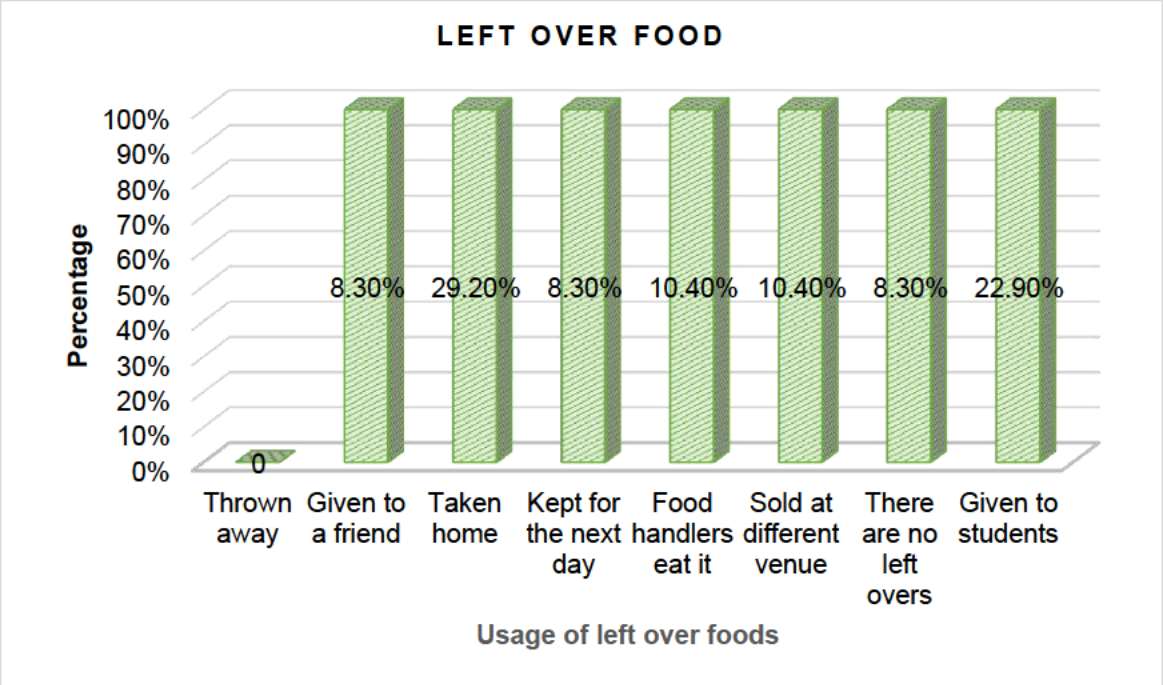


Figure 4.8: Leftover food at tuck shops (n=48)

Table 4.10: Quantity of leftover food and methods used to reheat left over food (n=48)

Variables	Food handlers % (n= 48)
Quantity of leftover food	
None	**45.8 (22)**
Less than a quarter	**54.2 (26)**
Reheating left over food and serving	
Yes	**22.9 (11)**
No	**77.1 (37)**
Methods of reheating food	
On the stove	**4.5 (2)**
In the microwave	**12.5 (6)**
Not applicable	**79.2 (38)**

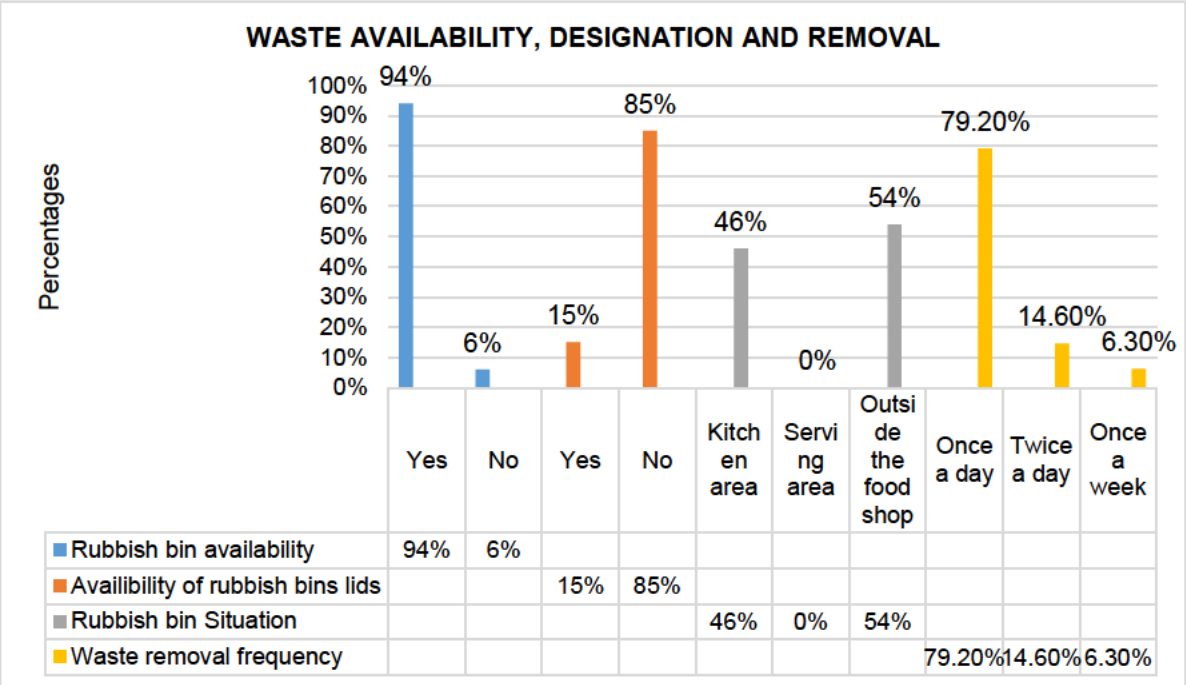


Figure 4.9: Availability, designation and removal of rubbish bins within the tuck shops (n=48)

4.10 Food hygiene and safety training

Table 4.11 represents the negative responses from the food handlers and managers with regard to the training received on food safety and hygiene practices. Results show that well above two

thirds of the food handlers (75.0%; n=36) and 66.7% (n=16) of the managers had not received any form of formal training on any aspect of food hygiene and safety, or menu planning. Eighty-seven point seven percent (n=42) of food handlers and (87.5%; n=21) of managers had not been trained on cross-contamination of food, (79.2%; n=38) of food handlers and (70.8%; n=17) had not been trained in respect of personal hygiene, and (54.2%; n=26) of food handlers and (50.0%; n=12) of managers were not trained. The only exception was in respect of handwashing where only 41.0% of food handlers and managers had not been trained. Most of the food safety and hygiene training received by those who had been trained was provided by previous employers (20.8%; n=10), other cooks or food handlers (6.3%; n=3) and other trainers. Food handlers and managers were least trained by established training institutions such as the Department of Health and the Department of Education, which had not provided enough training (Fig. 4.9). Up to 41.7% (n=20) of food handlers and 45.8% (n=22) of managers had never received any form of food hygiene and safety training, while the few who had been trained had been trained long ago (Fig. 4.10). Despite the fact that trainers and managers strongly agreed that there was a need for food hygiene and safety training and wanted to be trained (Table 4.12), they had only been infrequently visited or never visited by the Department of Health.

Table 4.11: Food handlers and manager's training on food safety and hygiene.

Variables	Food handlers % (n= 48)	Managers % (n=24)
Has training on food safety and hygiene been provided?		
No	**75.0 (36)**	**66.7 (16)**
Have you received training on menu planning?		
No	**87.5 (42)**	**87.5 (21)**
Have you received any training on food preparation?		
No	**75.0 (36)**	**66.7 (16)**
Have you received training on prevention of food contamination?		
No	**70.8 (34)**	**70.8 (17)**
Have you received training on cross contamination of food?		
No	**79.2 (38)**	**70.8 (17)**
Have you received training on illness in the workplace?		
No	**81.3 (39)**	**83.3 (20)**
Have you received training on injury in the workplace?		
No	**81.3 (39)**	**83.3 (20)**
Have you received training on first aid?		
No	**87.5 (42)**	**83.3 (20)**
Have you received training on personal hygiene?		
No	**54.2 (26)**	**50.0 (12)**
Have you received training on hand washing?		
No	**47.95 (23)**	**41.0 (10)**
Have you received any other training?		
No	**93.8 (45)**	**100 (24)**

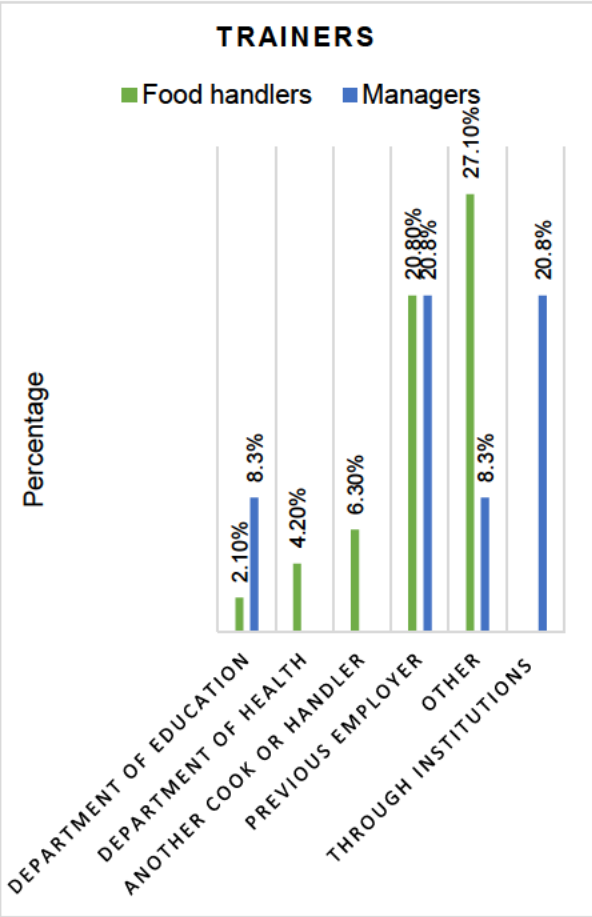


Figure 4.10: Food safety and hygiene training providers (n=48)

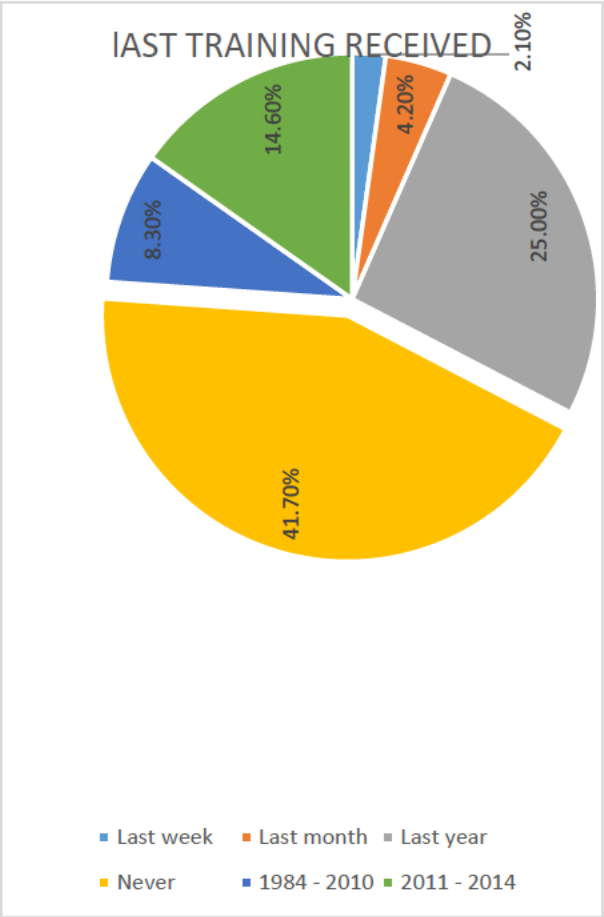


Figure 4.11: Last training received by food handlers (n=48) and managers (n=24)

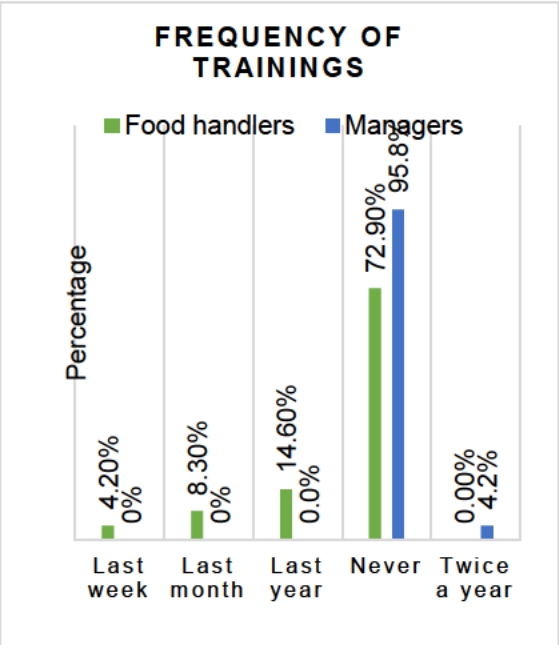


Figure 4.12: Frequency of training conducted for food handlers (n=48) and managers (n=24)

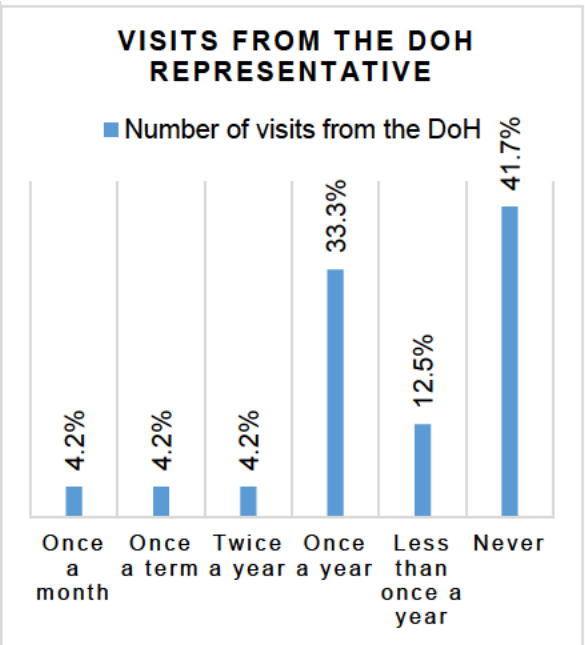


Figure 4.13: Managers' responses on visits from the DoH representative (n=24)

Table 4.12: Food handlers' (n=48) and managers' (n=24) training desires

Variables	Managers % (n=24)
Managers' further training needs	
Yes	**75.0 (18)**
Food handlers' further training needs	
Yes	**66.7 (16)**
Types of training required	
Food hygiene and safety	**50.0 (12)**
Personal hygiene	**25.0 (6)**
Food preparation	**25.0 (6)**
Business training	**8.3 (2)**
HACCP	**4.2 (1)**
First aid	**12.5 (3)**

4.11 Cleaning

A number of the food Tuck shops did not have soap according to 97.9% (n=47) of the food handlers and 87.5% (n=21) of the managers. Both food handlers (83.3%; n=40) and managers

(91.7%; n=22) agreed that cold water was widely used. Cooking utensils and stoves were cleaned after work was finished every day as reported by 52.1% (n=25) of the food handlers and 66.7% (n=16) of the managers (Tables 4.13 and 4.14).

Table 4.13: Food handlers' and managers' responses to water and soap availability

Variables	Food handlers % (n= 48)	Managers % (n= 24)
Soap availability		
No	**97.9 (47)**	**87.5 (21)**
Running hot tap water availability		
No	**87.5 (42)**	**100 (24)**
Running cold tap water availability		
Yes	**83.3 (40)**	**91.7 (22)**
Frequent utensil washing		
During preparation	**8.3 (4)**	**12.5 (3)**
After food is ready	**39.6 (19)**	**20.8 (5)**
After work is finished	**52.1 (25)**	**66.7 (16)**
Both during preparation and after work is finished	**0**	**4.2 (1)**

Table 4.14: Food handlers' and managers' responses to stove cleaning

Variables	Food handlers % (n= 48)	Managers % (n= 24)
Stove cleaning		
During preparation	**4.2 (2)**	**4.2 (1)**
After food is ready	**29.2 (14)**	**16.7 (4)**
After work is finished	**54.2 (26)**	**66.7 (16)**
Both during preparation and after work is finished	**2.1 (1)**	**0**
Both after food is ready and after work is finished	**2.1 (1);**	**0**
2 – 3 days	**8.4 (4)**	**4.2 (1)**
Once a week	**2.1 (1)**	**4.2 (1)**
Once a month	**2.1 (1)**	**0**
Never	**2.1 (1)**	**0**
No stove	**0**	**4.2 (1)**

The majority of food handlers (62.5%; n=30) and managers (75.0%; n=18) agreed that correct cleaning chemicals were not available; however, 62.5% (n=30) of food handlers and 50.0% (n=12) of managers reported that adequate cleaning tools were available.

Table 4.15: Food handlers' (n=48) and managers' (n=24) responses to cleaning chemicals and tools

Variables	Food handlers % (n= 48)	Managers % (n= 24)
Correct cleaning chemicals availability		
No	**62.5 (30)**	**75.0 (18)**
Adequate cleaning tools		
Yes	**62.5 (30)**	**50.0 (12)**
Cleaning of the preparation area		
During preparation	**6.3 (3)**	**25.0 (6)**
After the food is ready	**20.8 (10)**	**16.7 (4)**
After work is finished	**70.9 (35)**	**58.3 (14)**
Both during preparation and after work is finished	**0**	**4.2 (1)**
Work area sanitization		
No	**93.7 (45)**	**91.7 (22)**
Frequency of sanitizing		
None	**95.8 (46)**	**91.7 (22)**
Daily	**4.2 (2)**	**4.2 (1)**
Seldom	**0**	**4.2 (1)**

4.5.4 Frying oil

Figure 4.14 shows the frequency of reusing or discarding frying oil. Frying oil was usually changed weekly according to 20.8% (n=10) of food handlers' responses and 37.5% (n=9) of managers' responses, but some food handlers (39.6%; n=19) and managers (37.5%; n=9) reported it was done after two to three days.

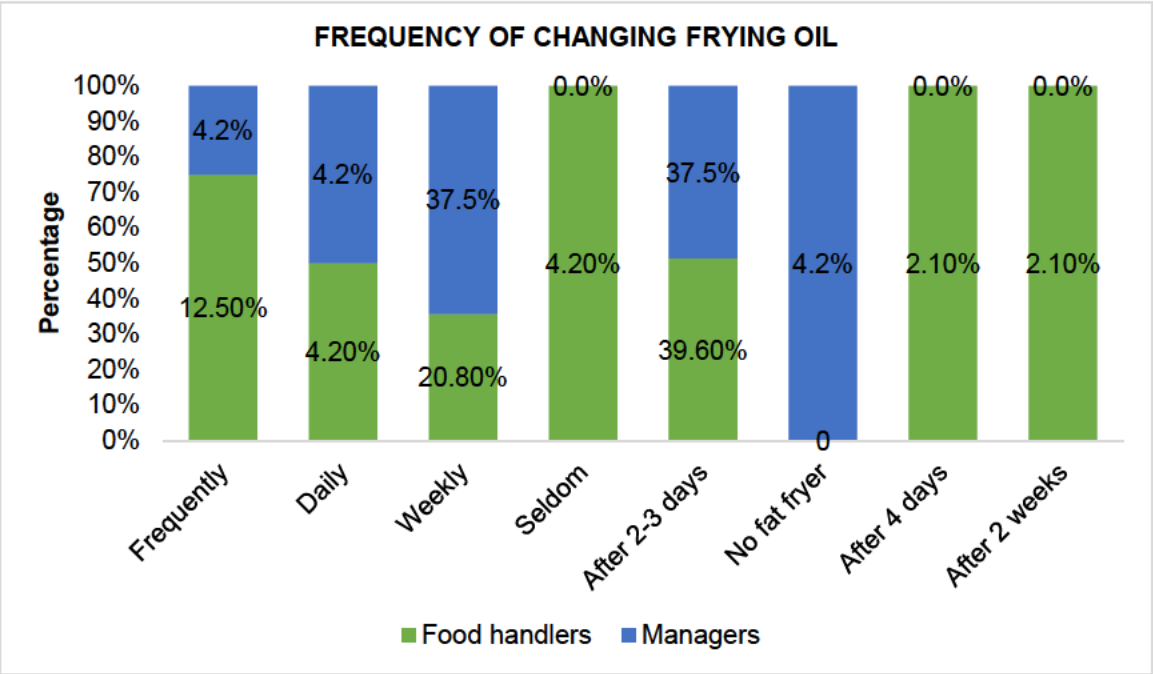
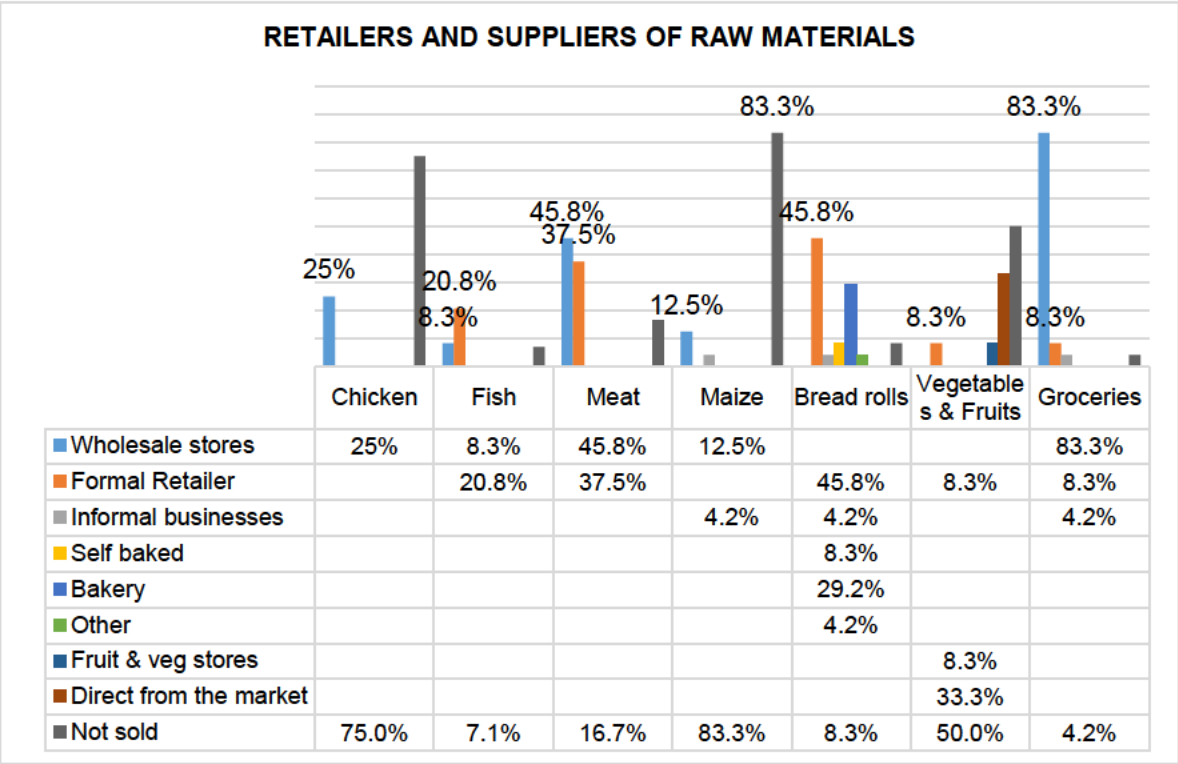


Figure 4.14: Food handlers and manager's responses to the changing of frying oil in the deep fat fryer

4.12 Purchasing and receiving

4.6.1 Suppliers of raw materials — responses given by managers

Figure 4.15 presents the supplier of raw materials response from managers. For all tuck shops, raw materials were obtained from wholesale stores, formal and informal retailers, bakeries or directly from local markets. Groceries (83.3%; n=20) and meat (45.8%; n=11) were mostly obtained from wholesale stores. Meat (37.5%, n=9) and bread rolls (45.8%; n=11) were also obtained from formal retail businesses and very small percentages of raw materials were obtained from informal retail outlets. Deliveries were made with no planned schedule (79.2%; n=19) in place and (70.8%; n=17) said they had no contracts with suppliers. Most of the food (50.0%; n=12) was bought from retailers.



	Chicken	Fish	Meat	Maize	Bread rolls	Vegetables & Fruits	Groceries
Wholesale stores	25%	8.3%	45.8%	12.5%			83.3%
Formal Retailer		20.8%	37.5%		45.8%	8.3%	8.3%
Informal businesses				4.2%	4.2%		4.2%
Self baked					8.3%		
Bakery					29.2%		
Other					4.2%		
Fruit & veg stores						8.3%	
Direct from the market						33.3%	
Not sold	75.0%	7.1%	16.7%	83.3%	8.3%	50.0%	4.2%

Figure 4.15: Retailers and other suppliers of raw materials (n=24)

Table 4.16: Transportation of raw materials

Variables	Managers % (n= 24)
Supplier contracts	
None	**70.8 (17)**
Planned delivery schedule	
None	**79.2 (19)**
Person responsible for delivery	
Commercial supplier	**20.8 (5)**
Local community member	**4.2 (1)**
Both commercial supplier and local community member	**4.2 (1)**
Other	**20.8 (5)**
Bought directly from retail stores	**50.0 (12)**
Total	**100 (24)**
Delivery of non-perishable food	
Open truck	**8.3 (2)**
Closed truck	**29.2 (7)**
Bought directly from retail stores	**54.2 (13)**
Other	**8.3 (2)**
Total	**100 (24)**
Delivery of perishable food	
Open truck	**12.5 (3)**
Closed truck	**20.8 (5)**
Bought directly from retail stores	**58.3% (14)**
Other	**8.3% (2)**
Total	**100 (24)**

4.13 Managers' food quality and safety assessment

4.13.1 Food quality responses by managers

Tuck shop managers mostly checked the physical appearance of raw materials to decide on their quality (95.8%; n=23) and they also adequately stored perishable products in cold storage conditions. Other forms of assessment of food quality used by managers included checking the

brands (41.7%; n=10), expiry dates (54.2%; n=13), visual examination (4.2%; n=1) and a combination of these attributes (20.8%; n=5 and 8.3%; n=2) (Table 4.17), with regards to inadequate quality of the food, most of the food was returned to supplier (83.3%; n=20).

Table 4.17: Managers' responses to the quality of food (n=24)

Variables	Managers (%) (n=24)
Adequate quality of food	
Yes	**95.8 (23)**
Storage of perishable products	
Fridge/freezer	**58.3 (14)**
Cooler box	**4.2 (1)**
No perishable foods sold	**37.5 (9)**
Total	**100 (24)**
Assessment of food quality	
Brand	**41.7 (10)**
Expiry date	**54.2 (13)**
Visual appearance	**4.2 (1)**
Both brand and expiry dates	**20.8 (5)**
Both expiry date and visual appearance	**8.3 (2)**
Both brand and grade	**4.2 (1)**
Inadequate quality of food	
Returned to supplier	**83.3 (20)**
Received and thrown away	**8.3 (2)**
Other	**4.2 (1)**
Both returned to supplier and thrown away	**8.3 (2)**

4.13.2 Receiving of goods

Goods were mostly received by the owners of tuck shops, followed by the managers (Table 4.18) for goods that are not received, those goods are bought directly from the retail stores and in many tuck shops the same person was responsible for receiving these raw goods (66.7%; n=16). Receivers often (75.0%; n=18) do not use food specification notes to check the quality of goods received; however, delivery notes and invoices are more frequently checked (54.2%; n=13). Counting and weighing were the methods mostly (16.7%; n=4) used to check the items supplied.

Table 4.18: Receiving and checking of goods responses by managers (n=24)

Variables	Managers % (24)
Persons responsible for receiving goods	
Owner	**37.5 (9)**
Manager	**20.8 (5)**
Food handler	**4.2 (1)**
No goods are received	**37.5 (9)**
Both owner and food handler	**4.2 (1)**
The same person every time	
Yes	**66.7 (16)**
Food specification manual availability	
No	**75.0 (18)**
Checking of delivery notes and invoices	
Yes	**54.2 (13)**
Checking of all food items	
Yes	**87.5 (21)**
Method used to check items	
Weighed	**33.3 (8)**
Counted	**41.7 (10)**
Both weighed and counted	**16.7 (4)**
None	**8.3 (2)**

4.13.3 Food safety and hygiene knowledge

In Table 4.19 the results show that most (75.0%; n=18) of the food managers believed that containers of raw and cooked foods should be separated, and hands must be washed after visiting the toilet and preparing foods (79.2%; n=19). Also, raw foods were mostly stored separately away from the cooked foods (83.3%; n=20). All of the respondents agreed that raw fruits and vegetables must be thoroughly washed before they are eaten or prepared, and it was mostly agreed that keeping food contact surfaces thoroughly washed, as well as separating raw foods from cooked ones could reduce the incidences of foodborne illnesses. About 66.7% (n=16) of the respondents supported the fact that it is unsafe to leave cooked foods out of cold storage for over two hours and 87.5% (n=21) believed that raw and cooked foods must be separated during storage.

Table 4.19 Knowledge of food safety and hygiene of food managers (n=24)

Variables	Managers % (n= 24)
Separation of utensils and containers containing raw and cooked foods	
Yes	75.0 (18)
Washing of cooking utensils	
Hot water and detergent	58.3 (14)
Cold water and detergent	29.2 (7)
Other	12.5 (3)
Hand washing	
After visiting the toilet	12.5 (3)
Before preparing food	8.3 (2)
Both after visiting the toilet and before preparing food	79.2 (19)
Wiping cloths can spread micro-organisms	
Yes	70.8 (17)
The same cutting board can be used for raw foods and cooked foods	
Yes	**39.5 (9)**
Raw food needs to be stored separately away from cooked food	
True	**83.3 (20)**
Cooked food does not have to be thoroughly reheated	
True	**66.7 (16)**
Cooked meat can be left out of the fridge to cool overnight before refrigeration	
False	**70.8 (17)**
Cooked food should be kept very hot before serving	
True	**62.5 (15)**
Wash fruits and vegetables before eating/preparing	
True	**100 (24)**
Safe water can be seen visually	
True	**79.2 (19)**
Frequent hand washing during food preparation is worth the extra time	
Agree	**87.5 (21)**
Keeping kitchen surfaces clean reduces the risk of contracting illness	
Agree	**87.5 (21)**

Keeping raw and cooked food separate helps to prevent illness	
Agree	**70.8 (17)**
Thawing food can be done on the counter	
Agree	**25.0 (6)**
Not sure	**25.0 (6)**
Disagree	**50.0 (12)**
It is unsafe to leave cooked food out of the fridge for more than 2 hours	
Agree	**66.7 (16)**
Not sure	**12.5 (3)**
Disagree	**20.8 (5)**
Separate raw and cooked food during storage	
Agree	**87.5 (21)**
Inspect food for freshness and ensure quality	
Agree	**95.8 (23)**
It is important to throw away food that has reached its expiry date	
Agree	**91.7 (22)**

4.13.4 Storage

Responses to questions about the storage of perishable and non-perishable foods are shown in Fig. 4.15. About half of the respondents believed that perishable foods should be stored in the kitchen area while only 20.80% (n=5) agreed that it should be stored in designated rooms away from the kitchen. Of all the respondents, only 4.20% (n=1) did not sell perishable foods.

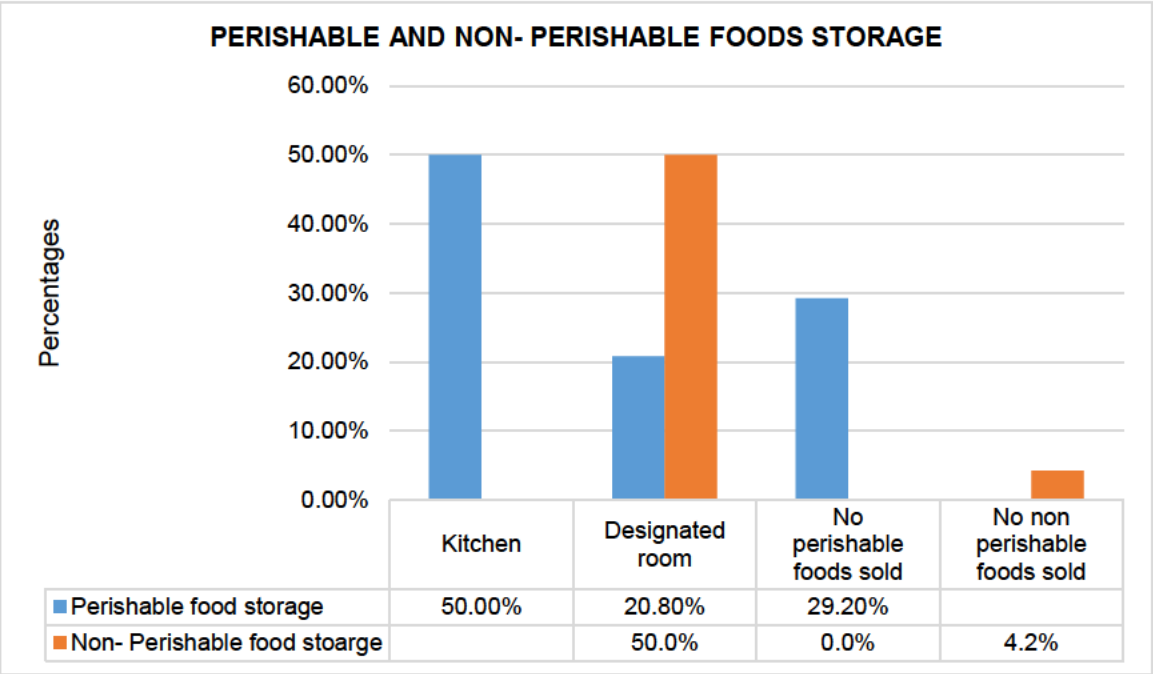


Figure 4.16: Storage of perishable and non-perishable food items (n=24)

4.13.5 Cleaning schedule responses by managers

Responses to questions about cleaning schedules and frequency of cleaning in tuck shops are presented in Fig. 4.16-4.17. There were no established cleaning schedules in the majority of the tuck shops (83.3%; n=20). However, cleaning of storage areas was performed every day of the week in (58.30%; n=14) of tuck shops, followed by twice a week in 20.80% (n=5) of the tuck shops.

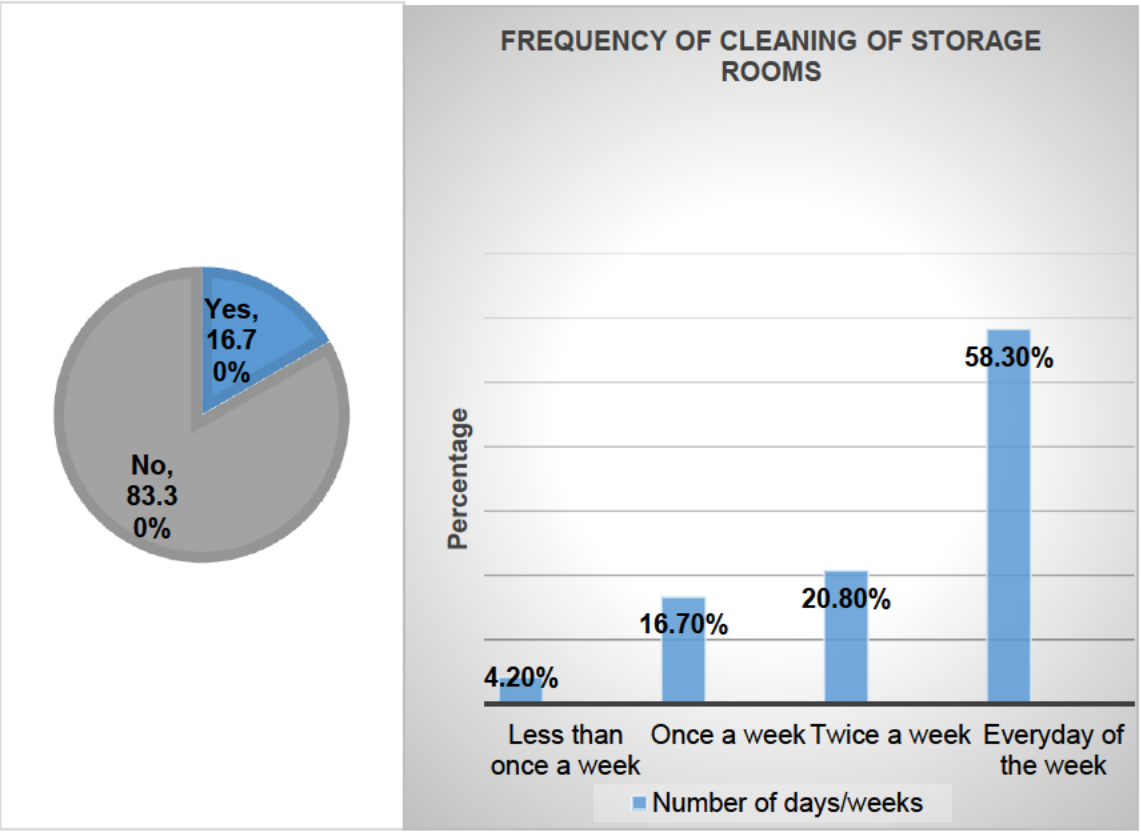


Figure 4.17: Availability of cleaning schedule (n=24)

Figure 4.18: Frequency - number of days/weeks that storage rooms cleaning (n=24)

4.13.6 Stock check for quality and expiry dates responses by managers

Figure 4.18 shows the frequency of checks carried out on food items by tuck shop owners, managers and handlers. Responses showed that only 50.0% (n=12) of tuck shops checked the quality and expiry of raw materials every day of the week, followed by 25.0% (n=6) who checked only twice a month. About 8.3% (n=2) did not check the quality and expiry dates of stocks received at all.

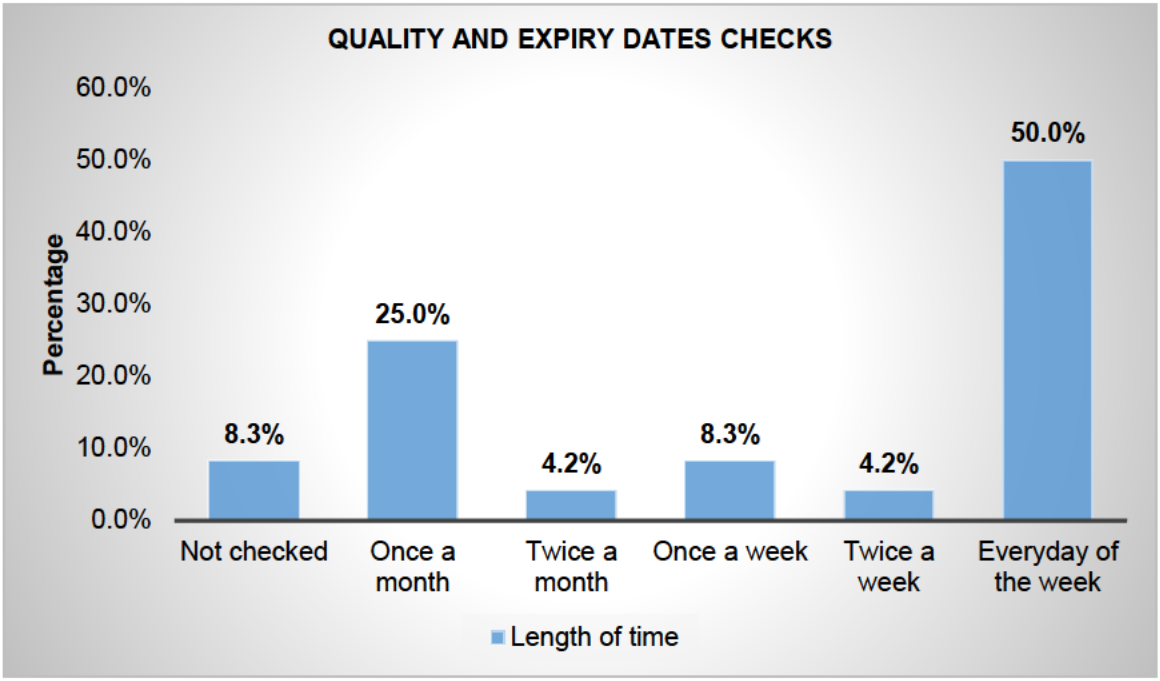


Figure 4.19: Frequency of checking quality and expiry dates are checked (n=24)

4.13.7 Frequency of stock-taking responses by managers

Stock-taking of foods (raw and cooked) was not done in 70.8% (n=17) of the tuck shops and only 12.5% (n=3) took stock every day of the week. The methods of stock-taking included the use of delivery dates (4.2%; n=1), expiry dates 29.2% (n=7) and the first-in-first-out principle (33.3%; n=8) (Table 4.20).

Table 4.20: Frequency and methods of stock-take (n=24)

Variables	Managers % (n=24)
Frequency of stock takes	
Not done	**70.8 (17)**
Once a month	**8.3 (2)**
Once a week	**4.2 (1)**
Twice a week	**4.2 (1)**
Every day of the week	**12.5 (3)**
Stock rotation	
Yes	**66.7 (16)**
Methods used for stock taking	
Delivery dates	**4.2 (1)**
Expiry dates	**29.2 (7)**
First in first out	**33.3 (8)**
Not done	**33.3 (8)**

4.14 Observation findings

4.8.1 General observations of tuck shop management

Tables 4.21—4.25 show the observations made with regard to the availability of menus, receiving of raw ingredients, storage methods, stock management, food preparation, recipes and cooking fuels, food holding, waste management and general hygiene of food handlers. The observation took one full day at each tuck shop. It was observed that there was no evidence of monitoring policies and procedures for all the tuck shops (100.0%; n=24). Also, there were no records of the condition of goods delivered to the tuck shops. Although storage and stock management were not properly done in the majority of the tuck shops, it is important to note that expiry dates of food items were adhered to, and the storage areas were free of unpleasant odours in the majority of the tuck shops. There was also no physical evidence of any decay of fresh produce in all the tuck shops visited. All (100%; n=24) the tuck shops operated without established or standardized recipes and the internal temperature of foods was not checked in any of the tuck shops. Seventy-point eight percent (n=17) of the tuck shops did not use electricity as the power source for stoves and water was not accessible or easily available at

70.8% (n=17) of these tuck shops. Food was mostly not served immediately after preparation (91.6%; n=22) as food was held back for up to six hours before serving (Table 4.24). During this holding period, foods were not kept warm in 79.1% (n=19) in these tuck shops. Up to 50.0% (n=12) of food prepared was not immediately served and 25.0% (n=6) of this food was not properly stored (Table 4.25) meaning that hot food was not kept hot, and food was not covered. In all cases, students were unable to finish their food portions and the leftovers were not satisfactorily disposed of, constituting food wastage. Waste bins were mostly (100%; n=24) not covered and in the majority of these cases (70.8%; n=17), waste was found lying outside these bins.

Table 4.21: Menu availability and receiving of goods (n=24)

Variables	Negative observations (No) % (n=24)
Evidence of monitoring procedures	100.0 (24)
Evidence of policies and procedures	100.0 (24)
Delivery date written onto the product	100.0 (24)
Delivery temperatures checked	100.0 (24)

Table 4.22: Storage and stock (n=24)

Variables	Negative Observations (No) % (n=24)
Perishable food stored in a cold room/fridge/freezer	33.3 (8)
Non-perishable foods stored in a separate room	70.8(17)
Cleaning items stored with food	62.5(15)
Storage areas kept locked	87.5 (21)
Adequate light in the storage areas	58.3 (14)
Adequate space in the storage areas	54.1 (13)
Food stored in original packaging	83.3 (20)
Products clearly labeled	37.5 (9)
Expiry dates on food items	87.5 (21)
Food that has passed the expiry dates	100.0 (24)
Products are transferred to storage containers, and the expiry date recorded	95.8 (23)
Foods that are past their expiry date used	100 (24)

All containers covered	66.6 (16)
Any of the food old or stale	100.0 (24)
Any evidence of decay in the fresh produce	100 (24)
The storage areas are clean	62.5 (15)
The storage areas are neatly arranged	62.5 (15)
Food stored directly on the floor	66.6 (16)
Refrigerated storage available	75.0 (18)
If yes, is the refrigerated storage in working order?	75.0 (18)
Stock sheet kept	95.8 (23)
The old stock of food used before the new stock (FIFO)?	100.0 (24)
Any evidence of pest (rodents/insects) infestation?	62.5 (15)
Unpleasant odours in the storage area	91.6 (22)

Table 4.23: Food preparation, recipes and cooking fuel (n=24)

Variables	Negative Observations (No) % (n=24)	
Adequate space for food preparation	45.8 (11)	
Adequate space for serving/ portioning	45.8 (10)	
Recipe availability	100.0 (24)	
Recipe standardization	100.0 (24)	
Adequate food preparation utensils	58.3 (14)	
Fuel source used for cooking (e.g. wood, gas, electricity)	Gas	33.3 (8)
	Electricity	70.8.0 (17)
Internal temperature of the food checked	100 (24)	
Easy access to water for cooking?	70.8 (17)	

Table 4.24: Holding of food before serving and adequacy of utensils (n=24)

Variables	Negative Observations (No) % (n=24)	
Food served immediately following cooking	91.6 (22)	
Food held back between cooking and serving	30 minutes- 1 hours	33.3 (8)
	1 hour – 2 hours	33.3 (8)
	2 hours – 4 hours	33.3 (8)

	6 hours	4.1 (1)
Food kept warm at this time	79.1 (19)	
If yes, how is the food kept warm?	Not applicable 75.0 (18)	
If yes, is the internal temperature checked?	91.6 (22)	
SERVING		
Adequate food serving utensils	4.1 (1)	
	Not applicable 45.8 (11)	
Adequate eating utensils	8.3 (2)	
	70.8 (17)	
Portion sizes standardized	100.0 (24)	

Table 4.25: The tuck shops' waste management (n=24)

Variables	Negative Observations (No) % (n=24)
Is all the prepared/ cooked food served?	50.0 (12)
If not, is the leftover food stored properly?	25.0 (6)
	Not applicable 54.1 (13)
Is the internal temperature of reheated food checked?	100.0 (24)
Students finish their food	100 (24)
Plate waste/ food thrown away	100 (24)
Designated rubbish bins	66.6 (16)
Dust bins covered	100.0 (24)
Dust bins clean	79.1 (19)
Waste lying outside the dustbins	70.8 (17)

4.8.2 Hygiene

The results of observing hygienic practices in tuck shops (Table 4.26) show that correct cleaning chemicals such as dish washing liquid, detergents for cloths and sanitizers were not available in most of the tuck shops (87.5%; n=21), most of the areas were not frequently cleaned during food preparation (62.5%; n=15) and areas were not sanitized during food preparation (100%). It was observed that the majority of food servers did not wash their hands before serving (95.8%; n=23), as 60% of tuck shops did not have water available for food

handlers to wash their hands and all the students did not wash their hands before eating (100%; n=24).

Table 4.26: Food handler's hygiene and hand washing procedures (n=24)

Variables	Negative Observations (No) % (n=24)
Kitchens utensils clean	**45.8 (11)**
Kitchen equipment clean	**54.1 (13)**
Correct cleaning chemicals available	**87.5 (21)**
Adequate cleaning supplies e.g. cloths, scourers, etc.	**45.8 (11)**
Work areas clean	**62.5 (15)**
Area cleaned frequently during food preparation	**62.5 (15)**
Area sanitized following food preparation	**100 (24)**
Water available for cleaning	**66.6 (16)**
Food handlers wash their hands regularly	**79.1 (19)**
Water available for the food handlers to wash their hands	**62.5 (15)**
Soap available for hand washing	**95.8 (23)**
Food handlers' overalls/ clothes clean	**100.0 (24)**
Servers wash their hands before serving	**95.8 (23)**
Students wash their hands before eating	**100 (24)**
Cooked food kept separately from raw food items	**100 (24)**

4.8.3 Microbial analyses

Microbial counts obtained from swabs of food handlers' hands and clothes, as well as the food preparation surfaces are presented in Tables 4.26-4.28. The microbial counts (log cfu/ml) of food handlers' hands and clothes as well as the tuck shop food processing contact surfaces are as stated in Tables 4.27—4.29. In respect of food handlers' hands, *Staphylococcus aureus* (SA), Total plate count (TPC), Aerobic spore formers (ASF) and Anaerobic spore former (ANSF) counts ranged between 6.8061-7.9452, 6.977-7.6031, 6.0776-7.7323 and 6.2274-7.6180 log cfu/ml respectively. Higher ranges of microbial counts were obtained for food handlers' clothes and tuck shop contact surfaces. Although microbial counts are significantly different ($p \leq 0.05$),

the values obtained were very close in magnitude for all microbial analyses conducted. Generally, the highest microbial counts were obtained for food contact surfaces across all samples taken. The lowest microbial counts were obtained in school A for food handlers operating tuck shops around this school.

Table 4.27 illustrates the microbial counts in log with randomly selected food handler's results from each school tuck shop. The higher means signify a higher microbial load for the particular micro-organism. The alphabet letters at the beginning of each log number signify the level of significance. The log number prefixed with the alphabet letter (A) is significantly higher than those prefixed with the alphabet letters B and C etc. All the food handlers' hands in each tuck shop showed evidence of a significant amount of *Staphylococcus aureus*, total plate count, aerobic spore formers and anaerobic spore formers.

Table 4.27: Microbial counts from food handlers' hands obtained from swab samples collected (n=48).

Samples (school and food handler)	Staphylococcus aureus (mean+ STD. deviation)	Total plate count (means+ STD. deviation))	Aerobic spore formers (means+ STD. deviation))	Anaerobic spore formers (means+ STD. deviation))
AFH001	6.8061±0.009h	6.9776±0.006f	6.3965±0.049h	6.5424±0.052fg
BFH001	7.0755±0.005g	7.4885±0.001c	7.8195±0.000a	7.5243±0.006b
BFH002	7.3909±0.002e	7.4377±0.002c	7.5092±0.001c	7.0898±0.004e
CFH001	7.5746±0.000a	7.6031±0.000a	6.7402±0.011g	6.3786±0.051g
DFH001	7.7965±0.000b	7.2764±0.003d	7.3802±0.002e	7.2648±0.003d
DFH002	7.2695±0.003d	7.0951±0.007f	7.6641±0.004b	7.6180±0.004a
EFH001	7.5676±0.002c	7.17605±0.008e	7.5314±0.001c	7,2417±0.123d
EFH002	7.6117±0.001b	7.2877±0.012d	7.4623±0.002g	7.1382±0.006de
EFH003	7.2683±0.004f	7.1382±0.006f	7.5453±0.003c	7.1612±0.012de
EFH004	7.7867±0.002a	7.1902±0.011e	7.6757±0.002c	7.2174±0.003e
FFH001	7.4899±0.001d	7.2000±0.001d	7.5465±0.003bc	7.2877±0.012d
FFH002	7.5085±0.004cd	7.3838±0.002c	7.0644±0.005f	7.1205±0.004de
GFH001	7.5308±0.002d	7.2429±0.010d	7.6444±0.002a	7.1522±0.004de
GFH002	7.4727±0.002d	7.2392±0.008d	7.5652±0.002c	7.1874±0.007d
GFH003	7.4533±0.002d	7.5932±0.001b	7.6444±0.001b	7.3364±0.005b
HFH001	7.3970±0.001e	7.3979±0.002c	7.6190±0.001b	7.3273±0.007c

IFH001	7.7075±0.001ab	7.5581±0.002b	6.0776±0.051h	6.2274±0.072g
IFH002	6.7402±0.011h	6.9293±0.007f	7.1430±0.004e	6.3798±0.025g
JFH001	7.3891±0.002e	7.1613±0.004e	7.3304±0.002d	7.2787±0.006cd
JFH002	7.2304±0.003f	7.4913±0.001c	7.6655±0.001b	7.3463±0.005d
JFH003	7.7611±0.003a	7.2648±0.003d	7.5250±0.001d	7.3354±0.004e
JFH004	7.5465±0.001c	6.9343±0.014f	7.1818±0.001f	7.1335±0.004e
KFH001	7.4727±0.002c	7.2392±0.008d	7.5652±0.002d	7.1874±0.007d
KFH002	7.2683±0.004g	7.1382±0.006e	7.5453±0.003e	7.1612±0.012e
LFH001	7.5204±0.000e	7.4533±0.002c	7.1731±0.004e	7.0898±0.004e
LFH002	7.7184±0.003a	7.1221±0.006e	7.3891±0.002d	7.1460±0.008e
LFH003	7.5352±0.001cd	7.4216±0.002d	7.6085±0.001b	7.4510±0.003a
LFH004	7.6748±0.002b	7.4996±0.003c	7.5390±0.001c	7.2503±0.006cd
LFH005	7.1088±0.002g	6.6126±0.014g	6.3419±0.027h	7.3117±0.002c
MFH001	7.9452±0.000a	7.4899±0.001c	7.2213±0.009e	7.1930±0.007d
MFH002	7.4313±0.004d	7.6963±0.002a	7.5865±0.001bc	7.2201±0.003d
MFH003	7.6117±0.001b	7.5640±0.004b	7.2877±0.003e	7.2648±0.003cd
MFH004	7.4158±0.003d	7.1553±0.004g	7.0085±0.006f	7.3453±0.004c
MFH005	7.7664±0.001a	7.5428±0.001c	7.3540±0.005e	7.2161±0.009d
NFH001	7.3802±0.002e	7.1254±0.011g	7.5051±0.003c	7.1037±0.009d
OFH001	7.6483±0.001b	7.1818±0.004g	7.5740±0.001bc	7.4031±0.002bc
OFH002	7.0333±0.011e	7.3424±0.002c	7.6053±0.001b	7,2147±0.011d
PFH001	7.6627±0.003b	7.5132±0.003c	6.4057±0.03g	7.1270±0.004e
PFH002	7.5078±.001cd	7.1583±0.008e	7.6334±0.001b	7.3364±0.002cd
PFH003	7.5831±0.001c	7.5899±0.001b	7.26711±0.009d	7.3710±0.002c
PFH004	7.3802±0.002f	7.1254±0.011f	7.5051±0.003c	7.1037±0.009e
PFH005	7.5037±0.005cd	6.5680±0.016g	7.0718±0.01f	7.0312±0.014f
QFH001	7.4712±0.004d	7.1003±0.009e	7.4369±0.005cd	7.1303±0.004e
QFH002	7.3283±0.002ef	7.1287±0.002e	7.7323±0.001a	7.3719±0.009b
QFH003	7.3882±0.008e	7.1760±0.008e	7.3502±0.005e	7.1302±0.013e
QFH004	7.4871±0.002d	7.1461±0.004e	7.5327±0.001c	7.1716±0.010de
RFH001	7.5514±0.003c	7.1846±0.004e	7.1760±0.004f	7.1612±0.012de

A-R: Codes for different schools where samples were taken; 001, 002…: Codes for different tuck shops. Different letters of the alphabet signify significant differences in microbial counts across each column.

Table 4.28 illustrates the microbial count results in log format in respect of randomly selected kitchen cloths (if there were more than one cloth used, only one cloth that is widely used in the preparation area was used for swabs) taken from each school tuck shop. A higher count signifies a higher microbial load for the particular micro-organism. *Staphylococcus aureus* (SA), Total plate count (TPC), Aerobic spore formers (ASF) and Anaerobic spore formers (ANSF) counts ranged between 7.3873─8.0194 and 6.7558─7.6468, 7.2455─7.7450 and 6.7804─7.6409 log cfu/ml respectively the alphabet letters at the end of each log number indicate the level of significance. The log numbers prefixed by the alphabet letter (A) are significantly higher than the ones prefixed by alphabet letters (B) and (C). For each tuck shop sampled, the majority of the kitchen cloths tested positive for a significant amount of *Staphylococcus aureus*, total plate count, aerobic spore formers and anaerobic spore formers.

Table 4.28: Microbial counts of kitchen cloths obtained from swab samples collected n=24.

Samples (school and kitchen cloths)	Staphylococcus aureus (mean+ STD. deviation))	Total Plate count (means+ STD. deviation))	Aerobic spore formers (means+ STD. deviation))	Anaerobic spore formers (means+ STD. deviation))
A-cloth 001	7.7075±0.002c	6.7558±0.010g	7.3324±0.002d	7.1552±0.008de
B-cloth 001	7.8712±0.001b	7.4892±0.002b	7.4533±0.002c	7.1398±0.004e
C-cloth 001	7.5390±0.001d	7.5943±0.001ab	7.5670±0.003b	7.2148±0.003a
D-cloth 001	8.0194±0.028a	7.2659±0.001b	7.1430±0.004d	7.1319±0.006c
E-cloth 001	7.3909±0.002ef	7.2239±0.005d	7.7371±0.003a	7.2213±0.009de
E-cloth 002	7.2130±0.005g	7.2671±0.003c	7.6852±0.003ab	7.4698±0.002b
F-cloth 001	7.3617±0.002f	7.3626±0.003c	7.6870±0.001ab	7.3502±0.002c
G-cloth 001	7.5774±0.003d	7.1397±0.013e	7.2405±0.003e	7.3756±0.003c
G-cloth 002	7.4697±0.006c	7.2174±0.003d	7.5532±0.002bc	7.1461±0.004e
H-cloth 001	7.4899±0.001de	7.5932±0.001ab	7.5848±0.000bc	7.3961±0.002c
I-cloth 001	7.5263±0.003d	7.3987±0.003bc	7.6875±0.002ab	7.2121±0.003d
J-cloth 001	7.70671±0.001b	7.2095±0.003f	7.4608±0.002e	7.2095±0.003g
J-cloth 002	7.5390±0.001d	7.1958±0.003g	7.53907±0.001c	7.4510±0.005b
K-cloth 001	7.4031±0.002e	7.0128±0.005f	7.2455±0.003e	7.3873±0.005c
L-cloth 001	7.3873±0.002f	7.3710±0.002c	7.1788±0.012d	7.0898±0.004e

M-cloth 001	7.4207±0.005e	7.3424±0.005c	7.6232±0.001b	6.7804±0.777f
M-cloth 002	7.6154±0.003cd	7.0211±0.005f	7.3128±0.004d	6.8571±0.017f
M-cloth 003	7.4158±0.003e	7.1553±0.004g	7.0085±0.006g	7.3453±0.004c
N-cloth 001	7.8109±0.002b	7.3443±0.005c	7.5158±0.003b	7.3873±0.005c
O-cloth 001	7.0755±0.005h	7.6468±0.002a	7.6052±0.003b	7,6409±0.003a
P-cloth 001	7.7585±0.001b	7.5670±0.001ab	7.7130±0.001a	7.3502±0.002c
Q-cloth 001	7.4864±0.003e	7.0413±0.011f	7.4039±0.006c	7.3116±0.011c
Q-cloth 002	7.7422±0.008bc	7.1270±0.009e	7.7450±0.002a	7.0948±0.022e
R-cloth 001	7.4899±0.001e	7.0643±0.010f	7.1430±0.004f	7.3891±0.002c

A-R: Codes for different schools where samples were taken; 001, 002…: Codes for different tuck shops. Different letters of the alphabet signify significant differences in microbial counts across each column.

The table below shows the results of microbial counts in log format with regard to randomly selected work surfaces from each school tuck shop. A high number signifies a high microbial load for the particular micro-organism. *Staphylococcus aureus* (SA), Total plate count (TPC), Aerobic spore formers (ASF) and Anaerobic spore former (ANSF) counts ranged between 7.2161─7.8228, 6.9293─7.8088, 7.0606─7.7822 and 7.1350─7.6532 log cfu/ml respectively the alphabet letters at the end of each log number indicate the level of significance. The log number prefixed with the alphabet letter (A) is significantly higher than the ones prefixed by the alphabet letters (B) and (C). All the tuck shop work surfaces (100%) had significant amounts of *Staphylococcus aureus*, ASF and ANSF. This constitutes a huge threat of cross-contamination to ready-to-eat foods processed on these surfaces irrespective of the microbial conditions of the food handlers' hands and clothes.

Table 4.29: Microbial counts of tuck shop food processing surfaces obtained from swab samples collected n=24.

Samples (school and kitchen surface)	Staphylococcus aureus (mean+ STD. deviation))	Total Plate count (means+ STD. deviation))	Aerobic spore formers (means+ STD. deviation))	Anaerobic spore formers (means+ STD. deviation))
A-surf 001	7.3864±0.001e	7.1318±0.011e	7.5132±0.003b	7.3838±0.002c
B-surf 001	7.5526±0.005c	7.6138±0.002ab	7.5477±0.001b	7.4182±0.002b
C-surf 001	7.5224±0.001c	7.5699±0.002b	7.6720±0.001ab	7.3053±0.006c
D-surf 001	7.6998±0.001ab	7.3085±0.001cd	7.6180±0.001ab	7.0549±0.008d

E-surf 001	7.2161±0.001f	7.3095±0.006cd	7.5314±0.001b	7.1350±0.011de
E-surf 002	7.3104±0.001e	6.9293±0.007f	7.4082±0.007cd	7.2380±0.003cd
F-surf 001	7.5797±0.001c	7.7275±0.001a	7.5865±0.001b	7.6532±0.001a
G-surf 001	7.2658±0.014ef	7.1334±0.013e	7.4955±0.001b	7.3682±0.006c
G-surf 002	7.4842±0.002d	7.4553±0.681bc	7.0606±0.005f	7.2718±0.006cd
H-surf 001	7.6429±0.002ab	7.5138±0.004b	7.3729±0.002d	7.2900±0.003c
I-surf 001	7.5263±0.003c	7.3987±0.003c	7.6875±0.002ab	7.2121±0.003cd
J-surf 001	7.7671±0.003a	7.5562±0.003b	7.3783±0.002d	7.1702±0.004d
J-surf 002	7.2624±0.003ef	7.3541±0.002cd	7.5526±0.003b	7.4082±0.002b
K-surf 001	7.5797±0.001c	7.7275±0.001ab	7.5865±0.001b	7.6532±0.001a
L-surf 001	7.6247±0.000ab	7.8088±0.001a	7.6665±0.001ab	7.4432±0.003b
M-surf 001	7.4517±0.002d	7.3364±0.005d	7,1122±0.007e	7.1583±0.008d
M-surf 002	7.7185±0.001a	7.2922±0.003d	7.5327±0.001b	7.0530±0.005d
M-surf 003	7.4158±0.003d	7.1553±0.004g	7.0085±0.006g	7.3453±0.004c
N-surf 001	7.6980±0.001ab	7.2944±0.006d	7.2612±0.001d	7.2877±0.006c
O-surf 001	7.2741±0.006ef	7.6954±0.001ab	7.7539±0.001b	7,3747±0.002c
P-surf 001	7.8228±0.001a	7.26716±0.003d	7.1658±0.006e	7.3085±0.004c
Q-surf 001	7.5848±0.000b	7.6857±0.001b	7.7032±0.001a	7.4082±0.004b
Q-surf 002	7.5949±0.003c	7.1476±0.006e	7.5982±0.002b	7.1746±0.006d
R-surf 001	7.3783±0.002e	7.2148±0.007d	7.7828±0.002a	7.0933±0.009e

A-R: Codes for different schools where samples were taken; 001, 002…: Codes for different tuck shops. Different letters of the alphabet signify significant differences in microbial counts across each column.

4.8.4 Incidences of *Salmonella, L. monocytogenes* and *E.coli* for food handlers and tuck shop environments

Percentage occurrence of fecal pathogenic microbes: *Salmonella, L. monocytogenes* and *E. coli* detected on food handlers' hands (n=48), tuck shops counter surfaces (n=24) and cloths (n=24) are presented in Table 4.29. Percentage presence of *E col*i was highest for kitchen cloths (79.1%; n=19) compared to food handlers' hands (35.4%; n=17) and counter surfaces (62.5%; n=15). Occurrence of *Salmonella* was the lowest among all the fecal micro-organisms tested and was found to be 8.3% (n=4) for food handlers' hands, 8.7% (n=2) for counter surfaces and none was found on cloths. The highest incidence of *L. monocytogenes* was also found on food handlers' hands (20.8%; n=10).

Table 4.30: Percentage occurrence of *Salmonella*, *L. monocytogenes* and *E.coli* for food handlers and tuck shop environments.

Variables	Number of samples	Number positive for *Salmonella*	Number positive for *L. monocytogenes*	Number positive for *E. Coli*
Food Handlers (Hands)	48	4 (8.3%)	10 (20.8%)	17 (35.4%)
Counter Surfaces	24	2 (8.7%)	2 (8.7%)	14 (60.9%)
Cloths	24	0 (0%)	1 (4.4%)	18 (78.3%)

4.9 Discussion

This section compares the current study's findings with published literature. It also attempts to describe the strengths and the weaknesses of the data. The findings of the study provide information on the managers' and food handlers' demographic profiles, food hygiene and safety knowledge, researchers' observation results and microbial analyses results.

This study intended to evaluate food hygiene practices, food safety knowledge and practices of food handlers working in various secondary school tuck shops situated in Umlazi Township, Durban, South Africa. The study also aimed to estimate the microbiological hygiene of tuck shop environments and food handlers' hands. The rationale to undertake this study was to assess these factors within tuck shops in schools located in the Township of Umlazi. There have been minimal studies done to investigate food hygiene safety in Umlazi Township.

4.9.1 Managers' demographic profile

A total number of 18 secondary/high schools in the region of Umlazi Township qualified to participate in the study. Altogether there were 24 tuck shop managers and 48 food handlers. The majority 83.3% (n=20) of the managers were females above the age of 30 years and this is consistent with previous studies conducted on food hygiene and safety practices of food handlers (Campbell 2011; Annor and Baiden 2011; Grobbelaar and Napier 2014; Khuluse 2015 and Owusu, Nartey, Gamor and Mensah 2017). All the tuck shop owners/managers had been in the business for three or more years. Studies conducted by Annor and Baiden (2011) on the evaluation of food hygiene knowledge, attitudes and practices of food handlers in food businesses in Accra, Ghana and by Khuluse (2015) on food hygiene and safety practices of food vendors at Durban University of Technology also found that the majority of the managers

had three or more years' experience in the food service business. The managers' highest level of education was grade 12 (41.7%; n=10) with 11 (33.3%; n=8) having achieved grade 8 level. However, several studies have consistently noted that more than 50% of food handlers had a secondary school education level (Chukuezi 2010; Campbell 2011; Takalkar and Kumavat 2011 and Grobbelaar and Napier 2014).

4.9.2 Management training

The tuck shop managers monitored staff duties on a daily basis (66.7%; n=16). With regard to training, most of the tuck shop managers had never received training on food safety and hygiene (66.7%; n=16), prevention of food contamination (70.8%; n=17), cross-contamination of food (70.8%;n=17), illness in the workplace (83.3%; n=20), injury in the workplace (83.3%; n=20), first aid (83.3%; n=20) and personal hygiene (50.0%; n=12). Some of the managers who had received training were trained by their previous employers (20.8%; n=5),) or through institutions such as Further Education and Technology colleges (20.8%; n=5). Forty-one percent (n=10) of the tuck shop managers indicated that they had never been visited by a representative of the Department of Health while some (33.3%; n=8) had been visited once a year. The majority (75.0%; n=18) of the managers had indicated to the DoH the need for further training for themselves and their employees 66.7% (n=16). The type of training proposed was food hygiene and safety (50.0%; n=12), personal hygiene, food preparation, business training, HACCP and first aid.

4.9.3 Managers' responses on business infrastructure

Eighty-seven percent (n=21) of the tuck shop managers indicated that the tuck shops did not have soap and all 100% (n=24) of the tuck shops did not have running hot tap water. Owusu *et al*. (2017) in a study on the knowledge and practices of hygiene of fresh-cut fruit vendors entitled A case study of New Juaben Municipality in the Eastern Region of Ghana found that 34.8% of food handlers used only cold tap water to wash their hands, which is insufficient to kill bacteria. Most of the utensils were washed and stoves were cleaned after work was finished (66.7%; n=16); however, 75% (n=18) of the tuck shops had insufficient appropriate cleaning chemicals while 50% (n=12) of the tuck shops had enough cleaning tools. According to the World Health Organisation (WHO 1989) in a report on Safe food handling: a training guide for managers in food service Tuck shops, it was stated that food preparation and storage surfaces should be kept clean at all times. In the current study, it was indicated that preparation areas were to be cleaned after food preparation and 91.7% (n=22) of the surfaces were not

sanitised. Frying oil was either changed after two to three days (37.5%; n= 9) or weekly (37.5%; n= 9) and this is in line with the findings of Chaurie (2010) who reported that 72.4% of the food handlers reused oil for frying.

4.9.4 Food handlers' responses on business infrastructure

Findings by Meaker (2008) on food service management and general management of schools running the NSNP programmes in formal and informal urban areas of Pietermaritzburg revealed that school tuck shops usually have one to three food handlers. Similarly, in this study, most of the tuck shops had one to five employees. The majority (66.7% n=16) of the tuck shops' water supply was accessed from outside taps and electricity was also the main power supply (66.7%; n=16). With regard to the responses, the researcher also observed that the majority (70.8%; n=17) used electricity as a power source for cooking. Most (87.5%; n=21) of the food handlers had indicated that school tuck shops did not have any written policies and procedures for receiving (83.3%; n=20), storage (87.5%; n=21), serving (87.5%; n=21), hygiene (87.5%; n=21) and administration (87.5%; n=21). This clearly shows that the tuck shops do not have any policies and records for food safety. However, most (97.9%; n=47) of the food preparations were done in designated kitchens with adequate space for food preparation and they had utensils such as knives, serving spoons and measuring bowls. However, the researcher observed that 45.8% (n=11) of the tuck shops had inadequate space for food preparation, 45.8% (n=11) had inadequate space for serving/ portioning, all 100% (n=24) tuck shops had no recipes and 58.3% (n=14) had inadequate food preparation utensils, which could expose the foods to the potential risk of cross-contamination. Additionally, the researcher observed that 37% (n=9) of the Tuck shops had evidence of rodent/insect infestation and 8.3% (n=2) had unpleasant odours in the storage areas.

4.9.5 Purchasing and receiving

Most (70.8%; n=17) of the tuck shops did not have any contracts or planned delivery schedules with suppliers (79.2%; n=19). Also, 50.0% (n=12) of the tuck shops bought food from retail stores or from commercial suppliers 20.8% (n=5). Fifty-four-point two percent (n=13) of non-perishable foods and 58.3% (n=14) of perishable foods was bought directly from retail stores or delivered in a closed truck (20.8%; n=5). The researcher observed that no (100%; n=24) delivery dates were recorded on products and delivery temperature checks were not conducted. Also, 33.0% of the tuck shops stored perishable foods in cold rooms/fridges/freezers but the

majority (75.0%; n=18) of the tuck shops had refrigerators that were not in correct working order. while 70.8% (n=17) of the tuck shops did not store non-perishable foods in separate rooms Receiving raw foods in open trucks where the environment is not controlled increases the risk of contamination of these raw foods, and also predisposes them to extraneous materials including dust (Khuluse 2016). Most of the tuck shops did not sell chicken and their raw meat was mostly bought from wholesale stores and formal retailers. Goods were either received by the owner (37.5%; n=9) or bought from the stores (37.5%; n=9). Fifty-four percent (n=13) of delivery notes and invoices were checked to see that all the food items were present and in good order. Consistent with other studies, Khuluse (2016) also found in a study on a University campus in Durban that 73.33% (n=11) of the managers purchased food and delivered perishable goods using their own transport. Food items were checked by weighing (33.3%; n=8), counting (41.7%; n=10) or both weighing and counting (16.7%; n=4). This purchase and receiving mechanism could prevent the tuck shops from having a full understanding of the history and condition of their raw materials and hence they would have little or no control over the microbiological hygiene of foods supplied to them.

4.9.6 Managers' responses on food hygiene and safety knowledge

The majority (95.8%; n=23) of the managers indicated that the tuck shops sell food of adequate quality. The food quality assessment was evaluated in terms of brand (41.7%; n=10), expiry date (54.2%; n=13) and a combination of brand and expiry date (20.8%; n=5). A study by Iwu, Uwakwe, Duru, Diwe, Chineke, Merenu and Ohale (2017) on knowledge, attitude and practices of food hygiene among food vendors in Owerri, Imo State, Nigeria found that 60.5% of the respondents assessed food quality based on the freshness of the product.

The majority of the managers indicated that raw and cooked foods were packaged separately using separate utensils and containers (75.0%; n=18). However, the researcher observed cooked food kept with raw food in all the tuck shops (100%; n=24). Consistent with these findings, El Kadmiri, Bakouri, Bassir, Barmaki, Rachad, Nadifi, and Amina (2016) in a study on food hygiene assessment in catering Tuck shops in Hay Hassani district-Casablanca found several anomalies regarding hygiene of hands and body and also regarding storage of food and food preparation. Cooking utensils were washed using either hot water or detergent (58.3%; n=14) or cold water and detergent (29.2%; n=7).

A plentiful supply of warm water, soap, nail brushes and disposable towels should be available for hand washing as stated in a report on Safe food handling: a training guide for managers in food service Tuck shops (WHO 1989). In this study, tuck shop managers indicated that hands needed to be washed after using the toilet (12.5%; n=3), before preparing food (8.3%; n=2) and both after visiting the toilet and before preparing food (79.2%; n=19). The researcher observed that 79.0% (n=19) of the tuck shop food handlers did not wash their hands regularly and 66.7% (n=16) had inadequate water to wash their hands while 95.0% (n=23) did not have soap for hand washing. Abdulla, Suliman, S. and Bakhiet (2009) and Takalkar and Kumavat (2011) found that the majority of food vendors considered that hands should be washed frequently. Surprisingly, Owusu, Nartey, Gamor and Mensah (2017) in a study on the knowledge and practices of hygiene of fresh-cut fruit vendors entitled A case study of New Juaben Municipality in the Eastern Region of Ghana, found that 43.9% of respondents indicated not washing hands before touching fruits while 34.8% used only cold tap water to wash their hands. Concurrently, Iwu, Uwakwe, Duru, Diwe, Chineke, Merenu, and Ohale (2017), in a study on knowledge, attitude and practices of food hygiene among food vendors in Owerri, Imo State, Nigeria, found that 70.5% of the respondents washed hands using cold tap water and detergent. Lambrechts, Human, Doughari, and Lues (2014), in a study on bacterial contamination of the hands of food handlers as an indicator of hand-washing efficacy in some convenient food industries in South Africa, also found higher counts of pathogenic organisms when they analyzed the microbiological hygiene of food handlers and food processing surfaces in some South African convenience food industries. Such high microbial counts predispose food prepared by these food handlers to cross-contamination and predispose consumers (school pupils) to foodborne illnesses, with the attendant risk of a substantial outbreak, since pupils mostly buy food from these shops. The presence of *Salmonella* was positive on 8.3% (n=4) of the food handlers' hands. *Listeria monocytogenes* was present on 20.8% (n=17) of the food handler's hands. All of the food handlers' hands in each tuck shop indicated a significant amount of *Staphylococcus aureus*, Total plate count, aerobic spore formers and anaerobic spore formers.

Salmonella, *L. monocytogenes* and *E. coli* are fecal micro-organisms and their presence could be attributed to fecal contamination from the hands of food handlers and/or from contaminated working surfaces and utensils (Lues, Mpeli, Venter and Theron 2006). *E. coli* have long been used as indicators of food processing environment hygiene and food safety with respect to foodborne bacterial pathogens. *E. coli* was present on 35.4% (n=17) of the food handlers'

hands. Humans are carriers of *Staphylococcus aureus* and the organism may be found in a healthy human population. Throughout the eight food premises, *S. aureus* could not be detected on the hands of food handlers. The detection of *S. aureus* is very important for microbiological safety considerations. This is because *Staphylococcus aureus* is a part of the normal micro flora of the skin of humans (Annor and Baiden 2011). A study was conducted to evaluate the microbiological quality, including total mesophilic counts and markers of bacteriological hygiene, as an indicator of food safety of three categories of the most consumed meals in a university restaurant by Cenci-Goga in 2005 and resulted in lower aerobic plate counts and a lower incidence of S. aureus, E. coli being detected, whereas Salmonella spp. and L. monocytogenes were not found in all 894 samples studied. The microbial results of this study demonstrated that personnel training together with HACCP application contributed to improve the food safety of meals served in the restaurant.

Generally, it was observed that the respondents had a not-too-satisfactory level of knowledge of food hygiene (Annor and Braiden 2011). Results from a study entitled Assessing food safety and associated food handling practices in street food vending by Lues *et al.* (2006) confirmed that specific attention to proper personal hygiene, particularly with regard to hand-washing after visiting the toilet, is of utmost importance, especially since it directly affects the hygienic situation at the food prepared in these tuck shops.

Seventy percent (n=17) of the managers responded that wiping cloths can spread micro-organisms. In connection with these findings, Campbell (2011) also found in a study assessing the knowledge, attitudes and practices of street food vendors in Johannesburg regarding food hygiene and safety that 91% of the food vendors had knowledge that cleaning cloths spread micro-organisms. The use of the same cutting board in preparing different raw foods may lead to food contamination and cross-contamination. In this study, 39.5% (n=9) of the managers responded that the same cutting board could be used for raw food and cooked food. More than 80% (n=20) of the managers knew that raw food needs to be stored separately from cooked food. In connection with these findings, Cele (2009) in a study on Microbial quality and safety of perishable food sold by take-away food outlets in the central of eThekwini Municipality found that 96% of the food handlers stated that cooked food was well separated from uncooked food to reduce the risk of cross-contamination. With regard to cooked food, the majority (66.7%; n=16) of the managers believed that cooked food does not have to be thoroughly reheated, 70.8% (n=17) believed that cooked meat cannot be left out of the fridge to cool overnight before refrigeration and 62.5% (n=15) believed that cooked food should be kept very

hot before serving. All (100%; n=24) of the managers knew that fruits and vegetables should be washed before preparation and eating. Campbell (2011) in a study entitled Assessing the knowledge, attitude and practices of street food vendors in Johannesburg regarding food hygiene and safety and Grobbelaar and Napier (2014) in a study on child and youth care workers: Profile, nutrition knowledge and food safety and hygiene practices in KwaZulu-Natal also found that more than 90% of food vendors knew that raw ingredients needed to be washed before preparation. In this study, the majority (79.2%; n=19) of the managers responded that the safety of water could be visually judged. The perception that uncontaminated water may be detected with the naked eye is of huge concern and consumption of such water may predispose consumers to infections such as cholera. More than 87% (n=21) of the managers believed that frequent hand-washing during food preparation was worth the extra time. Similar to the current study's findings, 83% of the food vendors in a study assessing the knowledge, attitude and practices of street food vendors in Johannesburg regarding food hygiene and safety agreed that frequent hand-washing is necessary and worth the effort (Campbell 2011).

Eighty-seven percent (n=21) of the managers knew that keeping kitchen surfaces clean reduces the risk of contracting illness and that keeping raw and cooked food separate helps to prevent illness. The researcher observed that some (45.8% (n=11) of the tuck shops had unclean kitchen utensils and 54.1% (n=13) had unclean kitchen equipment. Hence, there was a microbial count of *Salmonella* on 8.4% (n=2) of the counter surfaces and 60.9% (n=15) of the counter surfaces were contaminated with *E. coli*. All the tuck shop work surfaces (100%) had a significant amount of *Staphylococcus aureus,* ASF and ANSF. This constituted a huge threat of cross-contamination to ready-to-eat foods processed on these surfaces irrespective of the microbial conditions of the food handlers' hands and clothes. The high counts of aerobic and anaerobic spore formers indicated a high threat of consumption of heat resistant pathogenic micro-organisms. These results indicated high microbiological quality of food handlers' hands and food contact surfaces of tuck shops investigated, and consumption of foods prepared from these shops had the potential to cause a foodborne illness outbreak among school pupils in the area. However, Lues *et al.* (2006) on a study on Assessing food safety and associated food handling practices in street food vending did not detect *Listeria monocytogenes* in any of the food or on any of the contact surfaces surveyed. Campbell (2011), in a study assessing the knowledge, attitudes and practices of street food vendors in Johannesburg regarding food hygiene and safety reported that 85% of the food vendors in the study agreed that it was important to prevent cross-contamination by separating raw and cooked foods. Contamination of raw foods and food

contact surfaces in different households within KwaZulu-Natal province by *Salmonella*, *L. monocytogenes* and *E. coli* was previously reported by Mkhungo, Oyedeji and Ijabadeniyi (2018) in a study on Food safety knowledge and microbiological hygiene of households in selected areas of KwaZulu-Natal, South Africa.

If frozen foods are not properly thawed before cooking, the heat applied may not adequately penetrate the whole carcass or joint, and bacteria may still be alive in the centre at the end of cooking as stated in the Safe food handling: a training guide for managers in food service Tuck shops report (WHO 1989). In the current study, 25.0% (n=6) of the managers indicated that food thawing could be achieved on the counter and 66.7% (n=16) stated that it was unsafe to leave cooked food out of the fridge for more than two hours. Unfortunately, 20.8% (n=5) of the managers disagreed with the above statement. A study conducted in Johannesburg in 2011 on assessing the knowledge, attitudes and practices of street food vendors in Johannesburg regarding food hygiene and safety also reported that 71% of the food vendors agreed that it was unsafe to keep foods unrefrigerated for more than two hours. In this study 87.5% (n=21) of the managers agreed that raw and cooked food should be separated during storage. Campbell (2011) also found that 89% of the food vendors observed knew that cooked and raw food had to be separated during storage.

According to a report on Safe food handling: a training guide for managers in food service Tuck shops (WHO 1989), managers should be sufficiently trained and experienced to judge the quality and freshness of food by its look, feel, smell or taste and be able to conduct a detailed examination in order to detect deception, adulteration or contamination. Interestingly, 95.8% (n=23) of the managers inspected food for freshness and ensured its quality, while 91.7% (n=22) also indicated it was important to throw away foods that had reached its expiry date. Campbell (2011), on assessing the knowledge, attitudes and practices of street food vendors in Johannesburg regarding food hygiene and safety, also found that 87% of the food vendors ensured the freshness and quality of ingredients. None of the tuck shops 100% (n=24) had a cleaning schedule. The researcher observed that 37.5% (n=9) of the tuck shops' cleaning items were stored together with food, 87.5% (n=21) of the storage areas were kept unlocked and 58.3% (n=14) had inadequate lighting. Most (50.0%; n=12) of the tuck shops checked quality and expiry dates every day of the week and some (25.0%; n=6) checked once a month. The researcher thus observed that most (100%; n=24) of the tuck shops did not have any old or stale food nor any evidence of decay in the fresh produce. The majority (70.8%; n=17) of the tuck shops did not do stock takes and of those that did stock takes, 33.3 % (n=8) used the first in

first out procedure or checked expiry dates (29.2%; n=7). However, the researcher observed that the majority (83.3%; n=20) of the food in the various tuck shops was stored in the original packaging. Most (66.7%; n=16) of the food was stored directly on the floor, and 95.8% (n=23) of the foods had no documentation for a stock sheet. Additionally, 95.8% (n=23) of the products transferred to storage containers had no expiry date recorded and 66.6% (n=16) of the containers were not covered.

4.9.7 Food handlers' demographic profile

The school tuck shops had between one and five food handlers per tuck shop, with an average of two food handlers. Meaker (2008), in a study on food service management and general management of schools running the NSNP programmes in formal and informal urban areas of Pietermaritzburg, found that the number of food handlers in each school was between one and three. Most of the food handlers had been working in the school tuck shop for 1-24 months. However, most 56.3% (n=27) of the food handlers did not have previous experience in the food industry. Similarly, Abdalla *et al.* (2009), in a study on Food safety knowledge and practices of street food vendors in Atbara City, reported that 78% of the food vendors included in their study had been working in the business for less than five years. In contrast to these findings, Akabanda, Hlortsi and Owusu-Kwarteng (2017), in a study on Microbiological characteristics of Ghanaian traditional fermented milk products, found that out of the 235 food handlers participating in the study, 76.2% had working experience of more than five years in the food industry.

4.9.8 Food handler's knowledge of food hygiene and safety

Akabanda *et al.* (2017), in a study on Microbiological characteristics of Ghanaian traditional fermented milk products, found that food handlers were knowledgeable about hygiene practices, cleaning and sanitation procedures. However, in this study, contrasting results were obtained for the majority of the food handlers. Most (42.0%; n=20) foods were held for less than 15 minutes after cooking and before serving while 37.0% (n=18) of the food was held for between 15-30 minutes. Some of the tuck shops did not have any leftover food while those that had leftover food either took it home (10.4%; n=5) or gave it to students (22.9%; n=11). However, the researcher observed that food was not served immediately after cooking (91.6%; n=22), and 33.3% (n=8) of the tuck shops held food back for 30 minutes to an hour, one to two hours and two to four hours. Seventy-nine percent (n=19) of the foods were not kept warm during holding time and 91.6% (n=22) of the internal temperatures were not checked. Also,

95% (n=23) of the servers did not wash their hands before serving food and all (100%; n=24) of the students did not wash their hands before eating. Chaukie (2010) found in a study that 71.43% of the food handlers stored food in covered warmers and that leftovers were either consumed or stored for use the next day. Waste-disposal units of suitable size and capacity should be provided in the kitchens to maintain a clean cooking environment and large bins should be carried away from the food premises to a special refuse storage area WHO (1989). The majority (93.7%; n=45) of the food handlers in this study indicated that the tuck shops had rubbish bins but 85.4% (n=41) of the rubbish bins did not have lids. The rubbish bins were either situated outside the tuck shops (54.2%; n=26) or situated in the kitchen area and removed once a day (75.0%; n=36). However, the researcher's observations revealed that the majority (66.7%; n=16) of the tuck shops did not have designated rubbish bins while none (100%; n=24) of the dust bins were uncovered, 79.1% (n=19) were unclean and 70.8% (n=17) had waste lying outside the dustbins. Kadmiri *et al.* (2016) in a study on food hygiene assessment in catering Tuck shops in the Hay Hassani district-Casablanca found several anomalies with the evacuation of waste from their observation of catering Tuck shops in Morocco. Also, Owusu *et al.* (2017) in a study on the knowledge and practices of hygiene of fresh-cut fruit vendors, entitled a case study of New Juaben Municipality in the Eastern Region of Ghana, found that the majority of the food Tuck shops had waste bins but only 34.1% of the waste bins were covered. Uncovered waste bins may attract pests into the food serving premises and hand-handled bins allow for food contamination.

4.9.9 Food handlers training

In order to reduce foodborne illnesses, employees' food safety training should be conducted. This is particularly important with employees who prepare food. However, training alone cannot reduce the propensity for employees to produce contaminated foods (Salazar *et al.* 2005). In this study, more than 70% (n=36) of the food handlers had never received training on food safety and hygiene, prevention of food contamination (70.8%; n=34), prevention of cross-contamination of food (79.2%; 38), illness in the workplace (81.3%; n=39), injury in the workplace (81.3%; n=39), first aid (87.5%; n=42), personal hygiene (54.2%; n=26) and hand washing (47.9%; n=23). Bas *et al*. (2006) in a study evaluating the food hygiene knowledge, attitudes and practices of food handlers in the food business in Turkey found that the majority of participants (47.8%) had not undergone food safety training and indicated that total food safety knowledge scores were higher in food handlers in the hospital food services (42.8 ± 12.1) and school food services (58.4 ± 15.8) than in catering Tuck shops. A study by Campbell

(2011) revealed that 27% of the food handlers were never trained on the prevention of cross-contamination. Iwu *et al.* (2017), in a study on the knowledge, attitude and practices of food hygiene among food vendors in Owerri, Imo State, Nigeria also found that 68% of the food handlers had never received training on food hygiene. A study on the food safety and hygiene practices of vendors involved in street food production chain in Florianopolis, Brazil revealed that fourteen vendors (33%) reported noncompliance due to never completing a mandatory food handling course (Cortese, Veiros, Feldman and Cavalli 2016). However, in a study by Campbell (2011), 67% of the food vendors had received food hygiene and safety training. Akabanda *et al*. (2017) revealed in their study that only 8.2% of the food handlers received training on food safety. In this study, 20.8% (n=10) of the training received was gained from previous employers, 2.1% (n=1) from the Department of Education, 6.3% (n=3) from another food handler and 27.1% (n=13) from other sources. Training was received in previous years before the study commenced. Campbell (2011) also reported that 5% of food vendors received training 12 months before their survey took place.

Hot water, combined with a moderate amount of detergent, removes grease from crockery and cutlery as reported in the Safe food handling: a training guide for managers in food service Tuck shops report (WHO 1989). Of huge concern in this study was the fact that 97.9% (n=47) of the tuck shops did not have soap, 87.5% (n=42) had no hot running tap water and most 83.3% (n=40) of the tuck shops had only cold running tap water. The researcher observed that most 70.8% (17) of the tuck shops did not have easy access to water for cooking and in 62.0% (n=15) of the tuck shops water used for cooking was fetched in buckets from school taps, 88.0% (n=21) had incorrect cleaning chemicals available, 45.8% had inadequate cleaning supplies e.g. cloths and scourers and 62.5% (n=15) had unclean work areas. In each tuck shop, the majority of the kitchen cloths had a significant amount of *Staphylococcus aureus*, total plate count, aerobic spore formers and anaerobic spore formers. *E. coli* was found in 78.3% (n=19) of the cloths.

According to WHO (1989), equipment for food preparation should be kept in good condition and be cleaned and disinfected frequently. In the current study, 52.1% (n=25) of the utensils, and 54.2% (n=26) of the stove surfaces and work areas were cleaned after food preparation. However, in 93.7% (n=45) of the tuck shops the work surfaces were not sanitised and 62.5% (n=30) of the tuck shops had incorrect cleaning chemicals. According to the responses received, none 100% (n=24) of the tuck shops used sanitizers and 66.7% (n=16) had insufficient water for cleaning. However, 100% (n=24) of the food handlers' clothes were observed to be clean.

Again, most of the food handlers indicated that the tuck shops changed frying oil after 2-3 days (39.6%; n=19) or weekly (20.8%; n=10**).**

4.10 Conclusion

Food handlers had poor knowledge of food hygiene and safety, managers had satisfactory knowledge and the majority of the food handlers and managers have never received training regarding food hygiene and safety. The food premises had inadequate cleaning equipment, storage to separate food from contamination, cleaning chemicals and lacked food safety practices such as washing hands, keeping hot foods hot and cold foods cold. The lack of knowledge and poor food preparation practices also contributed to the number of microbial activities found on the food handlers' hands, kitchen cloths and counter surface which can cause serious food bourne illnesses. The above findings have clearly presented a problem within tuck shops at secondary schools at Umlazi. These finding will help to develop further studies and recommendations which will be aligned in the next chapter.

CHAPTER 5

5.1 Introduction

This chapter details the significant contribution from the study, outlines each objective and how it was met throughout the study, limitations of the current study and recommendations for future research, Department of Health and the Department of Education.

5.2 Findings of the study

Food handlers included in the study were mostly females, each tuck shop had more than one food handler who had been working in the school between one and 24 months. However, most of the food handlers did not have previous experience in the food business. The tuck shop managers were mostly females and aged above the age of 30 years. The owners/managers of the tuck shops had been in the business for three or more years and the majority had grade 12, while others had grades 8-11 as the highest level of education. The food handlers were found to lack knowledge with regards to food safety and hygiene practices. Managers had fair knowledge of the food hygiene and safety practices but most of the processes such as receiving, and storing food appropriately were not followed correctly. The research observed some tuck shops without correct cleaning chemicals, cleaning equipment and food stored incorrectly without labels. The high counts of potentially pathogenic microbial organisms detected in swabs of the food handlers' hands, cloths, as well as the food processing contact surfaces of the tuck shops reflected the poor hygiene practices of the food handlers and poor management practices displayed by the food handlers and their managers. The foods were generally prepared and sold under unhygienic conditions, with a limited supply of clean water, and limited access to sanitation or garbage treatment facilities. Pathogenic microbial counts were very high for all tuck shops and food handlers evaluated, and this was justified by the responses of the food handlers and the managers, which indicated that they did not have documented food safety practice procedures. The poor practices may have resulted from their poor exposure to food safety knowledge and practices due to lack of proper training. Also, it could have been the result of the poor supervisory roles played by government regulatory bodies.

5.3 The aim of this study was to evaluate food hygiene practices, food safety and hygiene knowledge and the microbiological levels and hygiene standards of tuck shops and food handlers involved in food preparation at secondary schools in Umlazi.

The research methodology, measuring tools and results supported the aim of the study. The study made use of measuring equipment such as food handlers' questionnaires to evaluate the food safety and hygiene knowledge, tuck shop managers questionnaires to evaluate the food safety and hygiene knowledge at managers level. An observational checklist was used to evaluate the food hygiene practices and hygiene standards of the tuck shop environments as well as food handlers during food preparation. Lastly but not least, environmental swabs were done on food handlers' hands, counter surfaces and kitchen cloths to evaluate the microbial level at each tuck shop.

5.4 The first objective was to establish a questionnaire that will determine the knowledge of food handlers and tuck shop managers at the school tuck shops.

Food handler's hygiene and safety questionnaires, tuck shop managers questionnaires and observational checklists were taken from a similar study conducted in Pietermaritzburg by Meaker in 2012. Permission to use the questionnaires was granted by Meaker and the researcher was able to use the questionnaires to conduct the current study.

5.5 The second objective was to determine the food safety knowledge and hygiene practices of the tuck shop managers in secondary schools at Umlazi through a tuck shop manager's questionnaire.

The majority of the tuck shop managers had never received training on food safety and hygiene, menu planning, food preparation, prevention of food contamination, cross-contamination of food, illness in the workplace, injury in the workplace, first aid, personal hygiene and hand washing. If the tuck shop managers lack knowledge and trainings on various aspects concerning food safety and hygiene, it puts the tuck shop at risk because knowledge cannot be transferred to food handlers. The tuck shops' water supply was accessed from outside taps and majority of the school tuck shops did not have any written policies and procedures for receiving, storage, serving, hygiene and administration of food. This clearly shows that the tuck shops do not have any policies and records in respect of food safety. Most of the tuck shops did not have any contracts with suppliers and had no planned delivery schedule and bought food from retail stores or from commercial suppliers**.** Managers knew that hands needed to be

washed after using the toilet and before preparing food while the managers also indicated that separate utensils and containers should be used for raw and cooked food. Managers indicated that wiping cloths can spread micro-organisms, raw food needs to be stored separately from cooked food and frequent hand washing during food preparation is worth the extra time. The managers had some knowledge of food hygiene and safety procedures but also lacked administrative procedures to ensure food safety from receiving to serving. The implication of not having written policies and procedure would be no trace of food contamination and point of infection for control purposes.

5.5 The third objective was to determine the food safety knowledge and hygiene practices of the tuck shop food handlers in secondary schools at Umlazi through a food handler's questionnaire.

It was revealed that the majority of the food handlers had never received training on food safety and hygiene, menu planning, food preparation, prevention of food contamination, prevention of cross-contamination of food, illness in the workplace, injury in the workplace, first aid, personal hygiene and hand washing. These findings clearly indicated the poor level of food safety and hygiene knowledge among the food handlers which could implicate food poisoning and illnesses among students. With regard to food hygiene and safety behaviour, work surfaces were not sanitised which means bacteria were spread all over the counters, cloths and food handlers' hands posing a risk of food poisoning. Utensils, stove and counter surfaces were washed after the food was served in between food preparation, the spoons and other utensils used were exposed to flies and bacteria since they were not kept in water with chemicals to clean and disinfect. The food handlers indicated the insufficiency of chopping boards, measuring equipment and serving space in the tuck shops. Eighty-five percent of the rubbish bins did not have lids and were either situated outside the tuck shops or situated in the kitchen area. Notably, uncovered waste bins attract pests onto the food premises and plastic bins lying on the floor can allow food contamination.

5.6 The fourth objective was to assess the management of the food tuck shops receiving, storage, preparation, hygiene and service through an observational checklist.

The majority of the tuck shops did not have menus and could not produce evidence of monitoring procedures and policies. Delivery dates were not recorded on products and delivery temperature checks were not conducted in all the tuck shops. Foods had no expiry date recorded on the packaging and most 64% (n=16) of the storage containers were not covered. Forty one

percent (n=10) of the Tuck shops had evidence of rodent/insect infestation and 12% (n=3) had unpleasant odours in the storage areas. The majority of the tuck shops did not have designated rubbish bins, and the majority of the dust bins were uncovered and unclean and some had waste matter lying outside the dustbins.

Some of the tuck shops had unclean kitchen utensils and unclean kitchen equipment and most of them had incorrect cleaning chemicals available as well as inadequate cleaning supplies e.g. cloths, scourers etc. and unclean work areas. Most of the tuck shops did not clean up regularly during food preparation and none of the tuck shops used sanitizers and most of them had insufficient water for cleaning. Seventy-six percent (n=36) of the tuck shops' food handlers did not wash their hands regularly, there was insufficient water for hand washing, 92% (n=44) did not have soap for hand washing. The majority of the food handler's clothes were observed to be clean. However, most of the servers did not wash their hands before serving food and none of the students were seen washing their hands before eating; cooked food was observed being kept together with raw food items in all the tuck shops.

5.7 The fifth objective was to conduct microbial swab tests (on the hands of food handlers, cloths and work surfaces) in the tuck shop kitchens to determine the presence and level of bacteria that may pose health risks to students.

In respect of food handlers' hands, Staphylococcus aureus, total plate count, aerobic spore formers and anaerobic spore formers counts ranged between 6.8-7.57, 6.97-7.48, 6.39-7.61 and 6.39-7.44 log cfu/ml respectively. Higher ranges of microbial counts were obtained for food handlers' cloths and tuck shop counter surfaces. Generally, the highest microbial counts were obtained for food handlers' hands, counter surfaces and cloths across all samples taken. Salmonella was present in 8.3% (n=4) of the food handler's hands, 8.4% (n=2) of the counter surfaces and none were found on the cloths. Listeria monocytogenes was present on 20.8% (n=17) of the food handlers' hands, 8.7% (n=4) of the counter surfaces and 4.4% (n=2) of the cloths. Listeria monocytogenes was not detected in/on any of the food or surface samples. E. coli was present on 35.4% (n=17) of the food handlers' hands, 60.9% (n=15) of the counter surfaces and 78.3% (n=19) of the cloths. The high microbial counts clearly reveal the higher risks of food poisoning within the school tuck shop environments and students.

5.8 Research limitation the limitations of this study include:

- The sample size was too small, a total of 18 schools, 48 food handlers and 24 managers. If the sample size was larger, including all the schools there would be a wider range of results and robustness.
- The data collection period had to be extended due to school holidays and the observations could only continue when the tuck shops were fully operational. The researcher had to plan the study when schools and tuck shops was busy in order to get effective results of the tuck shops usual operations.
- Administration of questionnaires was time consuming for the food handlers and managers and they felt as if the researcher and field workers were taking most of their production time as they prepare food while students are in class rooms. In that case, the interest level dropped.
- Certain analyses could not be carried out because of the limitation of the sample size, for example, as regression analysis which could show the regression and associations between the food handlers or managers knowledge and microbial outcome.

5.9 Recommendations

- Food safety training is recommended for food handlers and managers in order for them to understand the basic principles of good hygiene practices (GHP) and good manufacturing practices (GMP).
- An intervention study for food handlers and managers is recommended that will include food safety and hygiene training as well as writing a pre- and post-test to determine their level of understanding.
- Implement practical training on hygiene and hand washing for students in schools.
- The Department of Education needs to intervene in educating students with regard to food hygiene and safety
- Schools need to have selection procedures and documentation for tuck shop owners.
- The Department of Health needs to implement training for food handlers and managers on hygiene and safety, as well as injury and illness in the workplace, cross-contamination of food and prevention of contamination. Also, regular training should be organized for food handlers.
- Regular, unannounced visits from the Department of Health to food retail outlets and tuck shops should be organized to monitor the hygiene of food handlers and managers.

- A workshop dedicated to the community by Department of Health representatives to create awareness about foodborne illnesses, food safety and hand washing.
- Introduction of fruits and salads to school tuck shops located in the townships.
- Hot water provision for school taps so that food handlers and students can have access to hot water when washing hands.
- Hand sanitizers at each of the school tuck shops and students taps.

5.10 Future research

- Further research should be done in all the schools in Umlazi Township, including primary and secondary schools. The research should be in the form of an intervention that involves food handlers and managers writing pre- and post- training tests on food safety and hygiene practices, food safety and practical aspects such as hand washing.
- Additional studies on developing guidelines for tuck shops on food safety as a prerequisite to running a tuck shop.
- Studies on menu development suitable for students.
- Inclusion criteria for all Primary and Secondary schools in Umlazi.
- Have a larger sample size in order to do regression analysis of data obtained.

5.11 Conclusion

The microbiological quality of food can be improved, especially with regard to bacterial contamination from food handlers' hands. The study revealed that hand hygiene was unsatisfactory, and it underlined the need to improve food handlers' hygiene knowledge by focusing on hand washing practices. It has become necessary that systems should be put in place to ensure that food handlers remain aware of all the procedures necessary to maintain the safety and hygiene of food. Basic training in food hygiene is recommended to ensure that food vendors follow the required rules for proper hygiene and sanitation.

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education

Department:
Education
PROVINCE OF KWAZULU-NATAL

Enquiries: Nomangisi Ngubane | Tel: 033 392 1004 | Ref.:2/4/8/453

Ms KN Dlomo
W 70 Umlazi Township
UMLAZI
4031

Dear Ms Dlomo

PERMISSION TO CONDUCT RESEARCH IN THE KZN DoE INSTITUTIONS

Your application to conduct research entitled: **"FOOD HYGIENE AND SAFETY PRACTICES OF FOOD HANDLERS IN TUCK SHOPS AT SECONDARY OR HIGH SCHOOLS IN UMLAZI"**, in the KwaZulu-Natal Department of Education Institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the intended research and interviews are to be conducted.
6. The period of investigation is limited to the period from 15 June 2015 to 31 July 2016.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department. Please note that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Miss Connie Kehologile at the contact numbers below.
9. Upon completion of the research, a brief summary of the findings, recommendations or a full report / dissertation / thesis must be submitted to the research office of the Department. Please address it to The Office of the HOD, Private Bag X9137, Pietermaritzburg, 3200.
10. Please note that your research and interviews will be limited to schools and institutions in KwaZulu-Natal Department of Education.

UMlazi District

Nkósinathi S.P. Sishi, PhD
Head of Department: Education
Date: 19 June 2015

KWAZULU-NATAL DEPARTMENT OF EDUCATION
POSTAL: Private Bag X 9137, Pietermaritzburg, 3200, KwaZulu-Natal, Republic of South Africa ...dedicated to service and performance
PHYSICAL: 247 Burger Street, Anton Lembede House, Pietermaritzburg, 3201. Tel. 033 392 1004beyond the call of duty
EMAIL ADDRESS: kehologile.connie@kzndoe.gov.za / Nomangisi.Ngubane@kzndoe.gov.za
CALL CENTRE: 0860 596 363; Fax: 033 392 1203 WEBSITE: WWW.kzneducation.gov.za

Institutional Research Ethics Committee
Faculty of Health Sciences
Room M5 49 Marshall Street Site
Steve Biko Campus
Durban University of Technology

P O Box 1334, Durban, South Africa, 4001

Tel: 031 373 2577
Fax: 031 373 2577
Email: irec@dut.ac.za
http://www.dut.ac.za/research/institutional_research_ethics

www.dut.ac.za

9 February 2016

IREC Reference Number: **REC 105/15**

Ms K N Dlomo
W 2 21
Umlazi Township
Durban
4031

Dear Ms Dlomo

Food hygiene and safety practices of food handlers in tuck shops at secondary schools in Umlazi

The Institutional Research Ethics Committee acknowledges receipt of your gatekeeper permission letters.

Please note that FULL APPROVAL is granted to your research proposal. You may proceed with data collection.

Yours Sincerely,

Professor J K Adam
Chairperson: IREC

DUT DURBAN UNIVERSITY OF TECHNOLOGY
2016 -02- 09
INSTITUTIONAL RESEARCH ETHICS COMMITTEE
P O BOX 1334 DURBAN 4000 SOUTH AFRICA

Annexure D

LETTER OF INFORMATION TO PRINCIPAL

Title of the Research Study:

Food hygiene and safety practices of food handlers in tuck shops at Secondary/High schools in Umlazi

Principal Investigator/s/researcher:

Kaite Dlomo, BTech: Consumer Sciences Food and Nutrition

Co-Investigator/s/supervisor/s:

Supervisor: Prof Carin Napier: DTech Food Service Management

Thank you for taking time to read through this document. I am a student at the Durban University of Technology (DUT), currently doing a Master's Degree in Food and Nutrition. I am trying to gather information on the food safety knowledge, and hygiene practices of food handlers at Secondary/High schools in Umlazi. Permission from the Department of Education has been obtained, please see approval attached.

Brief Introduction and Purpose of the Study:

Data obtained from various international countries have revealed that food bourne illnesses are recognized from improper food preparation practices (Redmond and Grifith 2003). Nevertheless, In South Africa, there seems to be no reported incidents and people lack knowledge of what exactly is food safety. There are very few studies conducted for investigating the food safety practices in South Africa and therefore, action need to be taken to eliminate the risks of people being exposed to food borne illnesses.

Outline of the Procedures:

There will be implementation of questionnaires, observations and swab tests for microbial presence. We will need 1 day to spend with the tuck shops staff in order to complete the questionnaires and observe food handling practices.

These are a list of questionnaires and procedures that will be conducted:

A food safety and hygiene practices questionnaires will be completed with the food handlers.

A demographic information, food safety and hygiene practices questionnaires will be completed with the managers of the tuck shops.

An observational check list for food hygiene and safety practices of the food handlers will be completed by the researcher.

Microbial tests for swabs (hands of food handlers and work surfaces) in the tuck shop kitchens will be conducted to determine hygiene levels.

Risks or Discomforts to the Participant:

There are no risks associated with the study, all information will be kept private and confidential.

Benefits: The report will be given back to the participants in order to improve on food hygiene, food safety practices and elimination of bacteria that might be found to be a risk for consumption.

Reason/s why the Participant May Be Withdrawn from the Study:

Certainly, you may withdraw from the study at any time or refuse to participate. Your participation is entirely voluntary, and you do not need to give a reason should you not wish to participate. Neither your employment nor level of services will be affected by the participation or refusal to participate in the study.

Remuneration:

There will be no financial gain for participation in the study.

Costs of the Study:

The participants will not be contributing financially to the study. The institution (DUT) has covered all the costs required for the study.

Confidentiality

The data collected will be stored in the Department of Food and Nutrition in a locked cupboard for 5 years after which it will be disposed of by shredding.

Persons to Contact in the Event of Any Problems or Queries:

Supervisor: Prof. Carin Napier D Tech: Food Service Management

Researcher: Kaite Dlomo, B Tech Consumer Science Food and Nutrition: Cell: 0835979652

Supervisor contact: +27 31 373 2326**email:**carinn@dut.ac.za

The Institutional Research Ethics administrator: +27 31 373 2900.

Complaints can be reported to the DVC: TIP, Prof S. Moyo on 031 373 2382 ormoyos@dut.ac.za.

Annexure C

Sample Size

The student wants to do a survey at uMlazi Township. Her target is High school Tuck Shops. She found that there are 32 High schools at uMlazi. Therefore, she regarded N = 32 as her population.

She wants to know the sample size she must use since she will be surveying from this population.

Since the population size is N = 32 and in statistics when the sample size is less than 30, we regard it as a small sample. She must go and do survey to at least 20 schools. That would be a good sample size that will reflect this population.

Sizwe V. Mbona (Statistics Lecturer)

Department of Statistics, Mariam BEE, Ground floor

Tell: 031 373 5703

E-mail: sizwem@dut.ac.za

Annexure D

LETTER OF INFORMATION FOR THE TUCKSHOP MANAGER

Title of the Research Study:

Food hygiene and safety practices of food handlers in tuck shops at Secondary/High schools in Umlazi

Principal Investigator/s/researcher:

Kaite Dlomo, BTech: Consumer Sciences Food and Nutrition

Co-Investigator/s/supervisor/s:

Supervisor: Prof Carin Napier: DTech Food Service Management

Thank you for taking time to read through this document. I am a student at the Durban University of Technology (DUT), currently doing a Master's Degree in Food and Nutrition. I am trying to gather information on the food safety knowledge, and hygiene practices of food handlers at Secondary/High schools in Umlazi. Permission from the Department of Education has been obtained, please see approval attached.

Brief Introduction and Purpose of the Study:

Data obtained from various international countries have revealed that food bourne illnesses are recognized from improper food preparation practices (Redmond and Grifith 2003). Nevertheless, In South Africa, there seems to be no reported incidents and people lack knowledge of what exactly is food safety. There are very few studies conducted for investigating the food safety practices in South Africa and therefore, action need to be taken to eliminate the risks of people being exposed to food borne illnesses.

Outline of the Procedures:

There will be implementation of questionnaires, observations and swab tests for microbial presence. We will need 1 day to spend with the tuck shops staff in order to complete the questionnaires and observe food handling practices.

These are a list of questionnaires and procedures that will be conducted:

A food safety and hygiene practices questionnaires will be completed with the food handlers.

A demographic information, food safety and hygiene practices questionnaires will be completed with the managers of the tuck shops.

An observational check list for food hygiene and safety practices of the food handlers will be completed by the researcher.

Microbial tests for swabs (hands of food handlers and work surfaces) in the tuck shop kitchens will be conducted to determine hygiene levels.

Risks or Discomforts to the Participant:

There are no risks associated with the study, all information will be kept private and confidential.

Benefits: The report will be given back to the participants in order to improve on food hygiene, food safety practices and elimination of bacteria that might be found to be a risk for consumption.

Reason/s why the Participant May Be Withdrawn from the Study:

Certainly, you may withdraw from the study at any time or refuse to participate. Your participation is entirely voluntary, and you do not need to give a reason should you not wish to participate. Neither your employment nor level of services will be affected by the participation or refusal to participate in the study.

Remuneration:

There will be no financial gain for participation in the study.

Costs of the Study:

The participants will not be contributing financially to the study. The institution (DUT) has covered all the costs required for the study.

Confidentiality

The data collected will be stored in the Department of Food and Nutrition in a locked cupboard for 5 years after which it will be disposed of by shredding.

Persons to Contact in the Event of Any Problems or Queries:

Supervisor: Prof. Carin Napier D Tech: Food Service Management

Researcher: Kaite Dlomo, B Tech Consumer Science Food and Nutrition: Cell: 0835979652

Supervisor contact: +27 31 373 2326**email:**carinn@dut.ac.za

The Institutional Research Ethics administrator: +27 31 373 2900.

Complaints can be reported to the DVC: TIP, Prof S. Moyo on 031 373 2382 or moyos@dut.ac.za.

Annexure E

CONSENT FORM FOR MANAGERS

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, _____ (name of researcher), about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: _____,
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

_____	_____	_____	_____
Full Name of Participant	**Date**	**Time**	**Signature / Right Thumbprint**

I, _____ (name of researcher) herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

_____	_____	_____
Full Name of Researcher	**Date**	**Signature**

_____	_____	_____
Full Name of Witness (If applicable)	**Date**	**Signature**

Annexure D

INCWADI YESAZISO YABAPHATHI NABAPHEKI BOKUDLA

Isihloko socwaningo:

Ukuhlanzeka nokuphepha kokudla okwenziwa abapheki basezitolo ezingaphakathi kwezikole zebanga eliphezulu eMlazi.

Umphenyi wocwaningo:

Kaite Dlomo, BTech: Consumer Sciences Food and Nutrition

Umqaphi wocwaningo:

Prof.Carin Napier: DTech Food Service Management

Sithanda ukubonga isikhathi sakho ukuthi ufunde loludaba. Ngingu mfundi wase Durban University of Technology (DUT), ngenza izifundo ze Master's Degree kwi Food and Nutrition. Ngizama ukuthola ulwazi, ukuphepha Kanye nango kuhlanzeka kwabasebenzi abenza ukudla ezikoleni zemfundo ephakeme eMlazi.

IncazeloKafushanengocwaningo:

Ucwaningo oluvele emazweni amaningi angaphandle luveze ukuthi ukugula kwabantu ngembangela yokudla okungaphephile kudalwa ukudla okulungiswe esimweni esingahlanzekile (Redmond and Grifith 2003). Okwethusayo, Eningizimu Afrika akutholakali izikhalo zabantu abaguliswe ukudla okungahlanzekile ngoba abantu bengenalo ulwazi ukuthi yini ukuphepha kokudla Kanye nokuhlanzeka. Luncane kakhulu ucwaningo olwenziwe eNingizimu Afrika oluphathelene nezokuphepha kokudla Kanye nokuhlanzeka kwabaphatha ukudla nokudla imbala. Ngakhoke, ngithatha lelithuba ukwenza lolucwaningo okungasiza ukwehlisa izinga labantu noma izingane zesikole ezitholakala ziguliswa ukungaphephi noma ukungahlanzeki kokudla.

Izindlela zokwenza ucwaningo:

Kuzoba khona amaphepha anemibuzo abhekiswe kwabaphathi bokudla Kanye nomphathi wesitolo, kuzobhekwa inhlanzeko yesitolo kuphinde kuthathwe amasampula okungcola okusezandleni zabaphathi bokudla nase matafuleni ekulungiselwa kukho ukudla ukubheka amagciwane angase abekhona adale ukugula. Siyodinga usuku olulodwa ukuba nabasebenzi basesitolo ukuze sigcwalise lama phepha anemibuzo siphinde sibheke inhlanzeko.

Ubungozi ngokuba ingxenye yocwaningo:

Abukho ubungozi kulolu cwaningo, yonke imininingwane ezotholakala izogcinwa iyimfihlo.

Imivuzo yokungenelela ucwaningo:

Imiphumela yocwaningo izonikezwa abayingxenye yocwaningo ukuze bakwazi ukukhuphula izinga lokuhlanzeka nokuphepha kokudla Kanye nokufunda ngezindlela zokubulala amagciwane ekudleni okudliwa izingane zesikole.

Izinto ezingadala abangeneleli bocwaningo bakhishwe noma baphume:

Umuntu angaphuma kucwaningo noma inini noma unqabe ukuba ingxenye yocwaningo. Ukungenelela kwakho ucwaningo kungenxa yokuzinikela futhi asikho isidingo sokuchaza uma ungeke ukwazi ukungenelela kanti nomphathi wakho angeke wakuphoqa ukuthi ungenelele ucwaningo.

Ukuhola:

Akekho ozokhokhelwa ngokungenela ucwaningo.

Izindleko zocwaningo:

Abangeneleli bocwaningo angeke bakhiphe mali ngocwaningo, ucwaningo lizokhokhelwa abezemfundo I (DUT).

Izimfihlo

Ulwazi oluzotholakala luzothathwa lugcinwe kumnyango wezokudla nezomsoco (Department of Food and Nutrition). Lolulwazi zizokhiyelwa ekhabetheni iminyaka emihlanu maseluyalahlwa ngokuncozulwa.

Umuntu ongafonelwa uma kubakhona izinkinga noma imibuzo:

Umqaphi wocwaningo: Prof. Carin Napier D Tech: Food Service Management

Umseshi wocwaningo: KaiteDlomo, B Tech Consumer Science Food and Nutrition: Cell: 0835979652

Izinombolo zomqaphi wocwaningo: +27 31 373 2326**email:**carinn@dut.ac.za

iResearch Ethics administrator: +27 31 373 2900.

Izikhalazo zingabikwa ku DVC: TIP, Prof S. Moyo on 031 373 2382 ormoyos@dut.ac.za.

Annexure E

INCWADI YESIVUMELWANO NOMPHATHI WOKUDLA

Isivumelwano sokuba yingxenye yocwaningo:

- Ngiyavuma ukuthi ngichazeliwe ngu _____ ngalolucwaningo. Research Ethics Clearance Number:
- Ngiyifundile imininingwane yalolu cwaningo, noma ngilalelile ngezwa kuchazwa ngokomlomo. Ngakho-ke futhi ngiyasho ukuthi ngiyayiqonda.
- Ngiyazi ukuthi imiphumela yocwaningo, kanye neminingwane yami ayizukudalulwa.
- Ngiyavuma ukuthi imininingwane yocwaningo ihlaziywe ngekhomputha ngumcwaningi.
- Angiphoqiwe ukuba yingxenye yalolucwaningo, Ngingahoxa ukuba yingxenye yalolucwaningo nganoma yisiphi isikhathi ngaphandle kwokuhlawula noma ukulahlekelwa ukusizakala.
- Lapho ebenginemibuzo khona, ngichazeliwe kabanzi. Ngiyazikhethela mina ukuba yingxenye yalolucwaningo.
- Imiphumela yalolucwaningo ephathelene nami ekuqhubekeni kwaocwaningo ngizokwazi ukuyithola.

_____	_____	_____	_____
Igama lakho eliphelele	**Usuku**	**Iskhathi**	**Sayina**

(noma isthupha) ☐

Mina, _____ ngiyavuma ukuthi obhalwe ngaphezulu uchazelwe ngokuphelele ngalolucwaningo,

_____	_____	_____
Igama lomcwaningi	**Usuku**	**Sayina**

_____	_____	_____
Igama likafakazi	**Usuku**	**Sayina**

Annexure G

MANAGERS QUESTIONNAIRE

Information to be obtained from the Owner/Manager of the school tuck shop

INTERVIEW DATE:_____/_____/_____ DD/MM/YY INTERVIEWER'S NAME:	BUSINESS NAME/NO: BUSINESS ADDRESS:

Please tick the respondent's answers.

SECTION 1 – GENERAL /MANAGEMENT

List the three most important products/services your business sells in order of highest sales to lowest sales:

	What do you sell? (List in order of importance)	**Approximate % of total sales**
	e.g. Vetkoek 60 %	60%
1.		
2.		
3.		
4.		
5.		
	Total	**100%**

NO.	**QUESTIONS**	**ANSWERS**
1.	Are you the owner or the Manager of the business	a) Yes b) No c) Don't know
2.	How many employees including you does the business have?	a) One b) Two c) Three d) Four or more
3.	How long have you been running the business?	a) <One year b) One to two years c) Twoto three years d) Three or more years
4.	Gender	a) Male

		b) Female
5.	Age of respondent	a) < 30 b) 30 and above
6.	What is your highest level of education?	a) No education b) Std 1/Grade 1-3 c) Std 2-5 Grade 4-7 d) Std 6-9 Grade 8-11 e) Matric/Std 10/ Grade 12 f) Apprenticeship g) Post – matric diploma/Technikon h) University
7.	Do you have previous experience in food service?	a) Yes b) No
8.	Do you have a menu	a) Yes b) No
9.	What menu is used? Who developed the menu?	a) The owner b) A nutritionist or dietitian c) Nonethe food preparation staff d) Other: ……
10.	Why is this menu used?	a) Economical b) Locally accepted foods c) Locally available foods d) Favourite foods e) Other (please specify) ……
11.	Where does the tuck shop get water from?	a) Outside tap (i.e. running water) b) Kitchen tap (i.e. running water) c) Water tank d) Communal water supply (collected) e) Other (please specify) ……
12.	What power supply is used to prepare the food?	a) Electricity b) Gas c) Fire d) Other (please specify) ……

13.	How often do you monitor your staff regarding their duties?	a) Daily b) Weekly c) Monthly d) Once a term e) Seldom f) Never
14.	Do you delegate any of the monitoring duties to any staff members?	a) Yes b) No
15.	If yes, to whom?	a) Food handler b) Managers assistant c) Other (please specify) …….

16. Are there written policies and procedures regarding each of the following? (Answer all options)

16.1	Receiving	Y	N
16.2	Storage	Y	N
16.3	Serving	Y	N
16.4	Hygiene	Y	N
16.5	Administration	Y	N
16.5	Other (please specify)	Y	N

SECTION 2 – TRAINING AND FOOD SAFETY ISSUES

Training

17. Has any training about food safety and hygiene been provided?

Yes	Y
No	N

18. Have you received training regarding the following? (Answer all options)

18.1	Menu planning	Y	N
18.2	Food preparation	Y	N

18.3	Prevention of food contamination	Y	N
18.4	Prevention of cross-contamination of food	Y	N
18.5	Illness in the workplace	Y	N
18.6	Injury in the workplace	Y	N
18.7	First aid	Y	N
18.8	Personal hygiene	Y	N
18.9	Hand washing	Y	N
18.10	Other (please specify)	Y	N

19. If you have received training, whom did you receive the training from? (Answer all options)

19.1	Department of Education	Y	N
19.2	Department of Health	Y	N
19.3	Another cook/ handler	Y	N
19.4	Previous employer	Y	N
19.5	Through and institution as part of studies		
19.5	Other (please specify)	Y	N

20. When last was training conducted? (Select one)

20.1	Ongoing	1
20.2	Last week	2
20.3	Last month	3
20.4	Last term	4
20.5	Last year	5
20.6	Never	6

21. How frequently is training conducted? (Select one)

Ongoing	1
Weekly	2
Monthly	3
Once a term	4
Once a year	5
Never	6

22. Is there any administrative support from the DUT?

Yes	Y
No	N

23. In the past, how frequently did a representative from the Department of Health visit your food stall?

Once a month	1
Once a term	2
Twice a year	3
Once a year	4
Less than once a year	5
Never	6
Do not know (not here at that time)	7

24. Do you or your workers have any further specific training needs? If so, please specify the three most important training needs you have.

	Training Needed		**Type of training needed**
	Yes	**No**	
Yourself			1.
			2.
			3.
Your workers			1.
			2.
			3.

Cleaning and hygiene

25. Is there soap available for hand washing?

Yes	Y

No	N

26. Is there running tap water available for hand washing? (Answer all options)

26.1	Hot	Y	N
26.2	Cold	Y	N
26.3	None	Y	N

27. How frequently are utensils washed? (Mark all relevant options)

During preparation	1
After the food is ready	2
After the work is finished	3

28. How frequently is the stove cleaned? (Mark all relevant options)

During preparation	1
After the food is ready	2
After the work is finished	3
No stove	4

29. Are the correct cleaning chemicals available to clean the kitchen?

Yes	Y
No	N

30. Are there enough cleaning tools to clean the kitchen e.g. broom, mop, cloths, sponge, etc?

Yes	Y
No	N

31. How often is the preparation area cleaned? (Mark all relevant options)

During preparation	1
After the food is ready	2
After the work is finished	3

32. Are the work areas ever sanitised?

Yes	Y
No	N

33. If yes, how often? (Select one)

Frequently	1
Daily	2
Weekly	3
Seldom	4

34. How often is frying oil changed from the deep fat fryer

Frequently	1
Daily	2
Weekly	3
Seldom	4

SECTION 3: PURCHASING AND RECEIVING

Mention and Circle those that apply

	QUESTIONS AND FILTERS	**FOOD ITEM**	**CODING CATEGORIES**
35a	Where do you obtain your raw materials from?	Chicken	a) Abattoir b) Formal retailer c) Wholesale stores d) Informal businesses e) Other (specify) …… ……
		Fish	a) Abattoir b) Formal retailer c) Wholesale stores d) Informal businesses e) Other (specify)
35b		Meat	a) Abattoir b) Formal retailer c) Wholesale stores d) Informal businesses e) Other (specify) …… ……
35c		Maize	a) Formal retailer b) Wholesale stores c) Informal businesses d) Other (specify) …… …..
35d		Bread/ Rolls	a) Formal retailer b) Self (baked) c) Bakery d) Informal businesses e) Other (specify) …… ……

35e		Vegetables and fruit	a) Formal retailers b) Fruit & veg stores c) Direct from the farm d) Direct from the market e) Informal businesses
35f		Groceries	a) Formal retailer b) Wholesale stores c) Informal businesses d) Other (specify) ……
36.	Are there contracts with the suppliers?		a) Yes b) No
37.	Is there a planned delivery schedule?		a) Yes b) No
38.	Who delivers the supplies		a) Commercial supplier b) Local community member c) Both a & b d) Other (please specify)
39.	How is the non-perishable food delivered?		a) Open truck b) closed truck c) Car d) Other (please specify) ……
	How is the perishable food delivered?		a) Open truck b) Closed truck c) Refrigerated truck d) Car e) Other (please specify) ……
39.	Is the food of adequate quality?		a) Yes b) No
40.	Where do you store your perishable products? (Interviewer explains the term perishable). Circle all that apply.		a) Fridge/freezer b) Cooler box c) Newspaper d) Other (specify)

			…… ……
41.	How is the quality of the food assessed? (Mark all relevant options)		a) Brand b) Expiry date c) Grade d) Visually e) Other (please specify) …… ……
42.	What happens to the food that is judged to be of inadequate quality? (Mark all relevant options)		a) Returned to supplier b) Received and used c) Received an thrown away d) Other (please specify) …… ……
43.	Who receives the deliveries?		a) Owner b) Manager/supervisor c) Food handler d) Other (please specify) …… ……
44.	Is it the same person every time?		a) Yes b) No
	Do you have a food specification manual to check the quality of food against?		a) Yes b) No
45.	Does the delivery note / invoice get checked		a) Yes b) No
46.	Are all the food items checked		a) Yes b) No
47.	If yes, how (mark all relevant options)		a) Weighed b) Counted c) Both a & b d) Other (please specify) …… ……

SECTION 4: FOOD SAFETY & HYGIENE KNOWLEDGE

48.	Do you use separate utensils/containers for raw products and cooked foods?	a) Yes b) No
49.	How are cooking utensils washed?	a) Hot water & detergent b) Cold water & detergent c) Other (specify) ……
50.	When should you wash your hands?	a) After visiting the toilet b) Before preparing food c) Both a & b d) Neither e) Don't know f) Other (specify) ……
51.	Wiping cloths can spread microorganisms	a) Yes b) No
52.	The same cutting board can be used for raw foods and cooked foods provided it looks clean	a) Yes b) No
53.	Raw foods need to be stored separately from cooked food	a) True b) False
54.	Cooked foods do not need to be thoroughly reheated	a) True b) False
55.	Cooked meat can be left out of the fridge to cool overnight before refrigerating	a) True b) False
56.	Cooked foods should be kept very hot before serving	a) True b) False
57.	Wash fruits and vegetables before eating/preparing	a) True b) False
58.	Safe water can be seen by the way it looks	a) True b) False
59.	Frequent hand washing during food preparation is worth the extra time	a) Agree b) Not Sure c) Disagree
60.	Keeping kitchen surfaces clean reduces the risk of illness	a) Agree b) Not Sure c) Disagree

61.	Keeping raw and cooked foods separate helps to prevent illness	a) Agree b) Not Sure c) Disagree
62.	Thawing food can be done on the counter	a) Agree b) Not Sure c) Disagree
63.	I think that it is unsafe to leave cooked food out of the refrigerator for more than two hours	a) Agree b) Not Sure c) Disagree
64.	I separate raw and cooked food during storage	a) Most Times b) Sometimes c) Not often d) Never
65.	I inspect food for freshness to ensure quality ingredients	a) Agree b) Not Sure c) Disagree
66.	I think it is important to throw away foods that have reached their expiry date	a) Agree b) Not Sure c) Disagree

STORAGE

67. Where are the perishable food supplies stored? (Mark all relevant options)

Kitchen	1
Designated store room	2
Cooler boxes	3
Storage containers	4
Other (please specify)	5

68. Where are the non-perishable food supplies stored? (Mark all relevant options)

Kitchen	1
Designated store room	2
Cooler boxes	3
Storage containers	4
Other (please specify)	5

68. Is there a regular cleaning schedule for the storage areas?

Yes	Y
No	N

69. How often is the storage areas cleaned?

Less than once a week	1
Once a week	2
Twice a week	3
Three times a week	4
Four times a week	5
Every day of the week	6

70. How often is the stock checked for quality and expiry dates? (Select one)

Not checked	1
Once a month	2
Twice a month	3
< Once a week	4
Once a week	5
Twice a week	6
Three times a week	7
Four times a week	8
Every day of the week	9

71. How often is stock – take done? (Select one)

Not done	1
Once a month	2
Twice a month	3
< once a month	4
Once a week	5
Twice a week	6
Three times a week	7
Four times a week	8
Every day of the week	9

72. Is stock rotation in place?

Yes	
No	

73. If yes, how is this done? (Select one)

Delivery dates	1
Expiry dates	2
Correct storage on delivery	3
First in First Out	4
Other (please specify)	5

Annexure F

FOOD HANDLERS QUESTIONNAIRE/ *IMIBUZO EBHEKENE NABAPHEKI*

School/ Isikole #	

The aim of the questionnaire is to investigate the daily food hygiene and safety practices among food handlers.

Inhloso yalemibuzo elandelayo ukuthola inqubo yenhlanzeko Kanye nokuphepha kokudla okukhiqizwa abapheki balesikole.

NB: Please complete the answers in the blocks provided on your right hand side or indicate with a cross **X** for either a **yes** or **No** answer.

Isexwayiso: *Sicela ukuba ubhale izimpendulo zakho ebhokisini elingasokudla noma ufake isiphambano **X** uma uthi **yebo** noma **Cha***

GENERAL/ OKUJWAYELEKILE:

1. How many cooks/ food handlers are working at this Tuck shops?
   Bangaki abapheki abasebenza kuleli khishi?

Number/ Inombolo	

2. How long have you been a cook/ food handler for? Record the number of years and months.
   Usunesikhathi esingakanani usebenza njengompheki? Bhala iminyaka nezinyanga

Years/Iminyaka	
Months/Izinyanga	

3. Do you have previous experience in food service?
   Unalo ulwazi ngaphambilini lokusebenza ngokudla?

Yes/*Yebo*	
No/*Cha*	

4. Is there a menu?
   Likhona yini iphepha elibhalwe ukudla ngokulandelana kwakho?

Yes/*Yebo*	

No/*Cha*	

FOOD STORAGE/ *INDAWO YOKUGCINA UKUDLA*

5. Are the expiry dates checked on the foods?
   Niyakuqikelela ukubheka imibhalo emaphaketheni okudla eshoyo ukuthi ngabe ukudla konakele yini?

Yes/*Yebo*	
No/*Cha*	

6. If the expiry date on the food packaging is 20 August2014, what does this mean?
   (take a sample and show it to the cook / food handler)
   Uma usuku lokonakala ephakethenil okudla lingumhlaka 20 August 2014, kusho ukuthini?
   (thatha isampula utshengise umpheki)
   ……
   ……

FOOD PREPARATION/ *UKULUNGISA UKUDLA*

7. Where is the food prepared?
   Ukudla kulungiselwa kuphi?

Designated kitchen/*Endlini yokuphekela*	1
Temporary kitchen/ *Ikhishi lesikhashana*	2
Outbuilding/ *Endlini engaphandle*	3
Other (please specify)/ *Okunye (sicela uchaze)*	4

8. Who prepares the food?
   Ubaniolungisaukudla?

The Manager/*Umphathi*	1
The food handler/*Umphathi kudla*	2
Other (please specify)/ *Okunye(chaza)*	3

9. Is there adequate space for food preparation?

Kungabe indawo yokulungisela kudla ivuleke ngokwanele?

Yes/*Yebo*	
No/*Cha*	

10. Is there adequate space for cooking?

Kungabe indawo yokuphekela ivuleke ngokwanele?

Yes/*Yebo*	
No/*Cha*	

11. Is there enough water for food preparation?

Kungabe amanzi okulungisa ukudla akhona ngokwanele?

Yes/*Yebo*	
No/*Cha*	

12. Are there enough food preparation utensils? (Answer all options)

Zanele yini izitsha zokulungisa ukudla? (phendula yonke imibuzo)

Knives/ *Imimese*	Yes/*Yebo*	No/*Cha*
Chopping Boards/*Amabhodi okuqobela*	Yes/*Yebo*	No/*Cha*
Measuring equipment/*Izitsha zokukala*	Yes/*Yebo*	No/*Cha*
Serving spoons/*Izipuni zokudla*	Yes/*Yebo*	No/*Cha*
Mixing tools/*amathuluzi okuhlanganisa*	Yes/*Yebo*	No/*Cha*

13. Are recipes available?
Ikhona yini indlela yokupheka ukudla ebhalwe phansi?kusho amarecipe

Yes/Yebo	Go to Q 14/ *Qonda kumbuzo 14*	
No/Cha	Go to Q 16/ *Qonda kumbuzo 16*	

14. Are the recipes used?
Ziyasetshenziswa yini lezindlela zokupheka kusho amarecipe??

Yes/Yebo	Go to Q 15/	

	Qonda kumbuzo 15	
No/Cha	Go to Q 16/ *Qonda kumbuzo 16*	

15. Where were these recipes obtained?
Kungabe lama recipe athathwakephi?

The manager/ *Umphathi*	1
The food handler/*Umpheki*	2
Department of Health/ *Umnyango wezempilo*	3
Department of Education/ *Umnyango wezemfundo*	4
Other (please specify)/ *Okunye (Chaza)*	5

FOOD HOLDING/*UKUGCINWA KOKUDLA OSEKUPHEKIWE*

16. How long is the food held after cooking and before serving? (Select one).
Kubekwaisikhathiesingakananiukudlaemvakokuphekwanangaphambikokuphakwa? Khethaokukodwa.

Less than 15 minutes/*ngaphansi kwemizuzuengu 15*	1
15-30 minutes/ *imizuzuengu 15 kuyakwewu 30*	2
30-45 minutes/*imizuzu ewu 30 kuya kwe wu 45*	3
More than 45 *minutes/ngaphezul ukwemizuzu engu 45*	4

17. How is the food kept warm?
Kugcinwa kanjani kufudumele ukudla?

……

……

SERVING

18. Is there adequate space for serving / portioning?
Indawo yokuphakela ukudla ngabe yanele yini?

Yes/Yebo	
No/Cha	

19. In your opinion are the students happy with the portion sizes of their food?
Ngokombonowakhokungabeabafundibayanelisekaisikalisokudla?

Yes/*Yebo*	
No/*Cha*	

WASTE/ *UKUDLA OKUMOSHEKILE*

20. What happens to the food that is prepared but the students do not finish? i.e. left overs. (Mark all relevant options).
Kwenzakalani ngokudla okungathengiswanga kubafundi ngosuku? (khetha konke okufanele)

Thrown away/ *kuyalahlwa*	1
Given to a friend/ *kunikezwa umngani*	2
Taken home/*kuthathwa kuyiswe emakhaya*	3
Kept for the next day/*kugcinelwa usuku olulandelayo*	4
Food handlers eat it/*abapheki bayakudla*	5
Other ([please specify)/*okunye (chaza)*	6

21. How much left over food do you throw away after every day that was not served or sold? (Select one)
Kungakanani ukudla okulahlwayo ngosuku okunga dayiswangwa? (Ketha okukodwa)

None/*akukho*	1
Less than a quarter/*okungaphansi kwekota*	2
Half/ *uhalf*	3
More than half/ *okungaphezulu kwa half*	4
Don't know/ *awazi*	5

22. Is left over food reheated and served the following day?
Kungabe ukudla okusalile ngosuku oledlule kuyafudumezwa kuphinde kudayiswa?

Yes/*Yebo*	
No/*Cha*	

23. If yes, how is it reheated?
Uma impendulo kuwu yebo, kufudumezwa kanjani?

On the stove/ *estofini*	1
In the microwave/*kwi microwave*	2
In the food warmer/*kwimfudumezi*	3
Other (please specify)/ *okunye (chaza)*	4

24. Is there a designated rubbish area?
Ikhona indawo yokulahla udoti?

Yes/*Yebo*	
No/*Cha*	

25. If yes, where is it situated?
Uma ikhona, ikuphi nendawo?

In the kitchen food preparation area/ *lakulungiswa khona ukudla ekhishini*	1
In the serving area,*lakuphakelwa khona*	2
Outside the food shop/*ngaphandle kwesitolo*	3
Other (please specify)/*okunye (chaza)*	4

26. How often is it removed /cleaned?
Ususwa kangaki noma uhlanzwa kangaki?

Once a day (morning / afternoon)/ *Kanye ngosuku (ekuseni/ntambama)*	1
Twice a day (midday & afternoon)/ *kabili ngosuku(emini na ntambama)*	2
Once a week/*Kanye ngesonto*	3
Other (please specify) */okunye (chaza)*	4

27. Does the rubbish bins have tightly fitting lids?

Kungabe imigqomo inazo yini izivalo zawo eziqinile?

Yes/*yebo*	1
No/*cha*	2
Some/*eminye*	3

TRAINING & FOOD SAFETY/*UKUQEQESHA NOKUPHEPHA KOKUDLA*

28. Have you received any training about food safety and hygiene?
Ngabe kukhona yini ukuqeqesha ngokuphepha nangokuhlanzeka kokudla?

Yes/*Yebo*	
No/*cha*	

29. Have you received training regarding the following? (Answer all options)
Usuke wathola yini ukuqeqeshwa mayelana nezinto ezilandelayo?

Menu planning/ *ngohlelo olulandelayo lokuphekwa*	Yes/yebo	No/cha
Food preparation/ *ukulungisa ukudla*	Yes/yebo	No/cha
Prevention of food contamination/*ukuvikela ukudla emagciwaneni*	Yes/yebo	No/cha
Prevention of cross-contamination of food/*ngokuvikela ukushintshana kwamagciwane ekudleni*	Yes/yebo	No/cha
Illness in the workplace/*ukugula endaweni yokusebenza*	Yes/yebo	No/cha
Injury in the workplace/*ukulimala endaweni yokusebenza*	Yes/yebo	No/cha
First aid/*ngosizo lokuqala*	Yes/yebo	No/cha
Personal hygiene/*ngokuhlanzeka komuntu*	Yes/yebo	No/cha
Hand washing/*ngokugeza izandla*	Yes/yebo	No/cha
Other (please specify)/*okunye (chaza)*	Yes/yebo	No/cha

30. If you have received training, whom did you receive the training from? (Answer all options)
Uma usuke waqeqeswa, wawuqeqeshwa ubani? Phendula yonke imibuzo

Department of Education/ *Umnyango wezemfundo*	Yes/Yebo	No/Cha
Department of Health/*umnyango wezempilo*	Yes/Yebo	No/Cha
Food handler/ *omunye umpheki*	Yes/Yebo	No/Cha
Previous employer/*umsebenzi odlule*	Yes/Yebo	No/Cha
Other (please specify)/ *okunye(chaza)*	Yes/Yebo	No/Cha

31. When last was training conducted? (Select one)
Ukuqeqeshwa kwakugcine nini? Khetha okukodwa

Ongoing/*kusaqhubeka*	1
Last week/*ngesonto eledlule*	2
Last month/*ngenyanga edlule*	3
Last term/*ngethemu eledlule*	4
Last year/*ngonyaka owedlule*	5
Never/ *akukaze kwenzeke*	6

32. How frequently is training conducted? (Select one)
Ngabe ukuqeqeshwa kwenziwa kangaki? Khetha okukodwa

Ongoing/*kusaqhubeka*	1
Last week/*ngesonto eledlule*	2
Last month/*ngenyanga edlule*	3
Last term/*ngethemu eledlule*	4
Last year/*ngonyaka owedlule*	5
Never/ *akukaze kwenzeke*	6

33. Is there soap available for hand washing?
Ikhona insipho yokuwasha izandla?

Yes/yebo	

No/cha	

34. Is there running tap water available for hand washing? (Answer all options)
Kungabe akhona yini amanzi ompompi okugeza izandla?

Hot	Yes/yebo	No/cha
Cold	Yes/yebo	No/cha
None	Yes/yebo	No/cha

35. How frequently are utensils washed? (Mark all relevant options)
Zigezwa kangaki izitsha? Khetha konke okulungelekile

During preparation/ *uma kulungiswa ukudla*	1
After the food is ready/ *uma ukudla sekulungile*	2
After the work is finished/*uma sekuqedwe ukusetshenzwa*	3

36. How frequently is the stove cleaned? (Mark all relevant options)
Istofu sihlanzwa kangaki? Khetha konke okulungelekile

During preparation/ *uma kulungiswa ukudla*	1
After the food is ready/ *uma ukudla sekulungile*	2
After the work is finished/*uma sekuqedwe ukusetshenzwa*	3

37. Are the correct cleaning chemicals available to clean the kitchen?
Kungabe imithi yokuhlanza ikhishi okuyiyo ikhona yini?

Yes/*yebo*	
No/*cha*	

38. Are there enough cleaning tools to clean the kitchen e.g. broom, mop, cloths, sponge, etc?
Anele yini amathuluzi okuhlanza ikhishi njengemishanelo, imophu, izindwangu zezitsha, izimpontshi, njalo?

Yes/*yebo*	
No/*cha*	

39. How often is the preparation area cleaned? (Mark all relevant options)
Ihlanzwa kangaki indawo yokulungisela ukudla? Khetha konke okulungelekile

During preparation/ *ngenkathi kulungiswa ukudla*	1
After the food is ready/*emva kokuba ukudla kulungile*	2
After the work is finished/ *uma sekuphele umsebenzi*	3

40. Are the work areas ever sanitised?
Iyasetshenziswa yini imithi yokubulala amagciwane?

Yes/*yebo*	
No/*cha*	

41. If yes, how often? (Select one)
Uma kuyebo, kangaki? Khetha okukodwa

Frequently/ *njalo*	1
Daily/ *njalo ngosuku*	2
Weekly/ *njalo ngesonto*	3
Seldom/ *akujwayelekile*	4

42. How often is frying oil changed from the deep fat fryer?
Kungabe ashintshwa kangaki amafutha okushisa emshinini wokushisa?

Frequently during the day/ *njalo ngosuku*	1
Daily/ *nsuku zonke*	2
Weekly/ *ngamasonto*	3
Seldom/ *akujwayelekile*	4

Annexure H

OBSERVATION CHECKLIST

OBSERVATION	YES	NO	N/A	COMMENTS
GENERAL / MANAGEMENT				
1. Is there a menu?				

2. Is there evidence of monitoring procedures?				
3. Is there evidence of policies and procedures? (ask)				
4. Is there service learning agreement between DUT & the vendors?				
RECEIVING				
5. Is the delivery date written onto the product?				
6. Are the delivery temperatures checked?				
7. If yes how?				
STORAGE				
8. Is the perishable food stored in a cold room/fridge/freezer?				
Is the non-perishable foods stored in a separate room?				
9. Are cleaning items stored with food?				
10. Are the storage areas kept locked?				
11. Are there adequate light in the storage areas?				
12. Are there adequate space in the storage areas?				
13. Is the food stored in original packaging?				
14. Are the products clearly labeled?				
15. Are there expiry dates on food items?				
16. Have some food passed the expiry dates?				
17. If products are transferred to storage containers, is the expiry date recorded?				
18. Are any foods that are past their expiry date used?				
19. Are all containers covered?				
20. Is any of the food old or stale?				
21. Is there any evidence of decay in the fresh produce?				
22. Are the storage areas clean?				
23. Are the storage areas neatly arranged?				
24. Is any food stored directly on the floor?				
25. Is refrigerated storage available				
26. If yes, is the refrigerated storage in working order?				
27. Is the stock sheet kept? (ask)				
28. Is the old stock of food used before the new stock (FIFO)? (ask)				
29. Is there any evidence pest (rodents/insects) infestation?				
30. Are there any unpleasant odours in the storage area?				
FOOD PREPARATION				
31. Is there adequate space for foodpreparation?				
32. Is there adequate space for serving / portioning?				
33. Are recipes available?				
34. Are the recipes standardized?				
35. Are there adequate food preparation utensils?				
36. What fuel source is used for cooking? (e.g. wood, gas, electricity)				
37. Is the internal temperature of the food checked?				
38. Is there easy availability to water for cooking?				
HOLDING				
39. Is the food served immediately following cooking?				
40. How long is the food held between cooking and serving?				
41. Is the food kept warm at this time?				
42. If yes, how is the food kept warm?				
43. If yes, is the internal temperature checked?				

SERVING				
44. Are there adequate food serving utensils?				
45. Are there adequate eating utensils?				
46. Are the portion sizes standardized?				
WASTE				
47. Is all the prepared / cooked food served?				
48. If not, is the left-over food stored properly				
49. Is the internal temperature of reheated food checked? (ask)				
50. Do the students finish their food?				
51. Is there any plate waste/ food thrown away?				
52. Is there a designated rubbish bin?				
53. Are the dust bins covered?				
54. Are the dust bins clean?				
55. Is there waste lying outside the dustbins?				
HYGIENE				
56. Are the kitchens utensils clean?				
57. Is the kitchen equipment clean?				
58. Are there correct cleaning chemicals available?				
59. Are there adequate cleaning supplies e.g. cloths, scourers, etc?				
60.Are the work areas clean?				
61. Is the area cleaned frequently during preparation?				
62. Is the area sanitized following food preparation?				
63. Is there water available for cleaning?				
64. Do the food handlers wash their hands regularly				
65. Is there water available for the food handlers to wash their hands?				
66. Is there soap available for hand washing?				
67. Are the food handler's overalls/ clothes clean?				
68. Do the servers wash their hands before serving?				
69. Do the students wash their hands before eating?				
70. Is cooked food kept separately from raw food items?				

Do you have any questions/comments/suggestions?

_____

_____

_____

FIELD WORKERS TRAINING MANUAL

FOOD HYGIENE AND SAFETY PRACTICES OF FOOD HANDLERS AT TUCK SHOPS IN SECONDARY/HIGH SCHOOLS IN UMLAZI

BY: KAITE DLOMO

MASTERS OF APPLIED SCIENCE IN FOOD AND NUTRITION

INTRODUCTION

1. Purpose of the study

The aim of this study is to ascertain food hygiene practices, food safety knowledge and practices of food handlers' working in various secondary school tuck shops situated in Umlazi Township, Durban. The study also aims to determine the microbial levels present within the tuck shop environment and the food handlers involved in food preparation.

2. Summary of the study

The research will be conducted in South Africa (SA) in the province of KwaZulu Natal (KZN), city of Durban and region of Umlazi. The study will be observational, analytical and descriptive. The sample will comprise of tuck shop food handlers and owners from various secondary schools in Umlazi. The sample size is 18 randomly selected schools, all of the food handlers involved in food preparation and the tuck shop owners included as participants. The collection of data will be done at each of the tuck shops of the selected secondary schools. An information letter explaining the purpose of the study will be provided and a consent form will be completed by the participants prior to participation.

Data will be collected through the completion of a managers demographic and food handling practices and Food handlers' food handling and hygiene practices questionnaire, an observational food handling and practices checklist and microbial swab tests taken from food handlers and from the surface areas where food is prepared.

3. Objectives of the training session

- To provide understanding about the study to the field workers

- To clarify the role of a fieldworker and the responsibilities
- To enforce the ethical behavior of a field worker
- To provide with sufficient information about the study
- To develop communication skills

4. Field Worker

4.1 What is a Field Worker?

Field workers are research workers who are in direct interaction with the target population or group. The primarily task of the field worker is to educate and collect data through the use of questionnaires, interviews and observation Green and Baxen (2002:319). The field worker is expected to understand the study very well in order to be able to respond to participant's questions.

4.2 Roles of a Field worker may include,

- Communicating to participants about the study
- Mobilization
- Follow up of participants
- Conducting interviews
- Ensuring quality data is widely recognized
- Ensure privacy and confidentiality in participants responses
- Give adequate information
- Handle questions well
- Carry out relatively simple data collection (Developing world bioethics 2013: 1-3).

5. Consent Forms

All participants should sign a consent form prior to participation or completing the questionnaire. The researcher will communicate with the participants and sign consent forms then the field workers can start with data collection.

6. Behaviour

6.1 How should I behave?

6.1.1 Friendliness: The field worker should always make a comfortable environment for the participant in order for the participant to feel relaxed and confident.

6.1.2 Respect: the respondent should be treated with respect at all times. Be greeted with respect, ask questions in a respectful manner and thank the respondent for participation.

6.1.3 Patience: Some respondents might take long to answer questions or require the question to be repeated numerous times. But, the interviewer should be patient at all times.

6.1.4 Enthusiastic and excited: the field worker must be excited and enthusiastic about doing the research, must know grasp a lot of information to feel more confident.

6.1.5 Appearance: The field worker must always be wearing comfortable clothes and look neat. It is advisable for the field worker to wear comfortable jeans, a department t shirt, which will be provided by the researcher and tekkies or comfortable shoes.

7. Conducting the Interview

7.1 How do I interview the participant?

7.1.1 The type of interview that will be conducted is a structured standardized interview. There are set of questions arranged in the questionnaire in order to avoid variation in the questions. The respondent will be answering based on the questions asked by the field worker. The interview will be conducted on a one on one basis, between the field worker and the participant. The interviewer should have a good understanding about the objective of the study and the information in order to be able to answer questions asked by the participants.

7.1.2 The interviewer should avoid startling potential participants and running up to them, pulling out questionnaires for interviews because one should keep in mind most people are sensitive towards outsiders and often feel there is something wrong or the business in being investigated etc. so, it is best to blend in with the environment and make the respondents relaxed Agriculture and consumer protection (2007: 2-3).

7.2 How do I begin?

7.2.1 Greet the participant politely and introduce yourself.

7.2.2 Explain briefly to the participant about the purpose of the study and benefit of the study to the respondent so that the respondent will also be relaxed and be confident throughout the interview.

7.2.3 Inform the respondent about the confidentiality of the interview and that no information will be given away into public, officials or anyone.

7.3 How do I conduct the interview?

7.3.1 Interview the participant by reading out the questions listed in the questionnaire and recording all information obtained makes sure to collect as much information as you can from the respondent especially on questions that need elaboration.

7.3.2 Ask the questions in the order that they appear on the questionnaire. If the respondent refuses to answer the question, record the lack of response and go on to the next question.

7.3.4 Do not lead the respondents. Do not try to influence the respondents answer by suggesting answers or asking them if they meant a particular answer.

7.3.5 Always keep on a neutral and friendly facial expression. Never discourage or show the respondent that the answer given was wrong or unexpected and try not to give your own opinions.

7.3.6 The spaces allocated for response in the questionnaires is very minimal, its either a tack or elaborate. Please try to summarize all the information given for that question without disappointing the respondent by saying you think the information given is enough.

7.3.7 The field worker should be able to control the interview by maintaining the conversation to a specific topic or question. Some respondents might end up branching off to irrelevant answers but try to bring them back by asking them the question again or the next one.

7.3.8the respondent might require a bit more time to think about the question, give them time to do so but it is too long maybe you can introduce the question again to remind them.

7.4 How do I end the interview?

7.4.1 Inform the participant that the interview is completed.

7.4.2 Reassure her about the confidentiality of the interview conducted.

7.4.3 Thank him/her for participation and time consumed.

8. Food Handlers Questionnaire

The aim of this questionnaire is to determine the knowledge of the food handlers with regards to hygiene and food safety practices.

Below is an example of a food handler's questionnaire. Most of the questions are close ended questions meaning that the questions only require a one word answer which will be completed

in the blank blocks provided on the right hand side of each question. The questionnaire is in two languages, English and IsiZulu which is the participant's language of proficiency.

GENERAL/ OKUJWAYELEKILE:

27. How many cooks/ food handlers are working at this Tuck shops?
    Bangaki abapheki abasebenza kuleli khishi?

Number/ Inombolo	

28. How long have you been a cook/ food handler for? Record the number of years and months.
    Usunesikhathi esingakanani usebenza njengompheki? Bhala iminyaka nezinyanga

Years/Iminyaka	
Months/Izinyanga	

29. Do you have previous experience in food service?
    Unalo ulwazi ngaphambilini lokusebenza ngokudla?

Yes/*Yebo*	
No/*Cha*	

30. Is there a menu?
    Likhona yini iphepha elibhalwe ukudla ngokulandelana kwakho?

Yes/*Yebo*	
No/*Cha*	

There are questions that will be open ended questions eg. (Question 6) below. Those questions need more data gathering or elaboration from the participant. **Please make sure to collect as much as you can for this section.**

FOOD STORAGE/ *INDAWO YOKUGCINA UKUDLA*

31. Are the expiry dates checked on the foods?

Niyakuqikelela ukubheka imibhalo emaphaketheni okudla eshoyo ukuthi ngabe ukudla konakele yini?

Yes/*Yebo*	
No/*Cha*	

32. If the expiry date on the food packaging is 20 August2014, what does this mean? (take a sample and show it to the cook / food handler)

Uma usuku lokonakala ephakethenil okudla lingumhlaka 20 August 2014, kusho ukuthini?

(thatha isampula utshengise umpheki)

…….

…….

9. <u>Managers Questionnaire</u>

The aim of this questionnaire is to ascertain the knowledge of tuck shop managers with regards to hygiene, food safety, staff trainings etc.

Please refer to section 1 below. This question requires the manager to list the top 5 food items that are mostly purchased by students every day. On the right have side block, the food items need to be ranked in percentages and should all add up to a 100%.

SECTION 1 – GENERAL /MANAGEMENT

List the three most important products/services your business sells in order of highest sales to lowest sales:

	What do you sell? **(List in order of importance)**	**Approximate % of total sales**
	e.g. Vetkoek 60 %	60%
1.		
2.		
3.		
4.		
5.		
	Total	**100%**

Please refer to question 18 below. This type of question only requires the participant to tick the appropriate answer where ever it says other (please specify), the participant should write the answer which was not found on the list and elaborate on it for better understanding.

18. Have you received training regarding the following? (Answer all options)

18.1	Menu planning	Y	N
18.2	Food preparation	Y	N
18.3	Prevention of food contamination	Y	N
18.4	Prevention of cross-contamination of food	Y	N
18.5	Illness in the workplace	Y	N
18.6	Injury in the workplace	Y	N
18.7	First aid	Y	N
18.8	Personal hygiene	Y	N
18.9	Hand washing	Y	N
18.10	Other (please specify)	Y	N

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5 April 2019

To whom it may concern

Dissertation written by Ms Kaite Dlomo

This letter confirms that I have edited the Dissertation: **Food Hygiene and Safety Practices of Food Handlers at Secondary School Tuck Shops in Umlazi, Durban, South Africa** written by Ms Kaite Dlomo for linguistic and grammatical correctness.

I am a qualified editor and proof reader.

Michael Vermeer
Editor/Proofreader

082 093 4347

mike.vermeer3@gmail.com

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