2014

Food Safety Knowledge and Self-Reported Practices of Food Handlers in Jamaica

Marcia Annmarie Thelwell-Reid
Walden University

Walden University

College of Health Sciences

This is to certify that the doctoral dissertation by

Marcia Thelwell-Reid

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

Review Committee
Dr. Howard Rubin, Committee Chairperson, Public Health Faculty
Dr. Aimee Ferraro, Committee Member, Public Health Faculty
Dr. Vincent Agboto, University Reviewer, Public Health Faculty

Chief Academic Officer
Eric Riedel, Ph.D.

Walden University
2014

Abstract

Food Safety Knowledge and Self-Reported Practices of Food Handlers in Jamaica

by

Marcia Thelwell-Reid

MPH, University of the West Indies, Mona, 2003

BSc, University of the West Indies, Mona, 1996

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Health

Walden University

November 2014

Abstract

Food-borne illnesses are responsible for disease globally. One of the most important strategies for combatting food-borne diseases is the training of food handlers. Using social cognition theory as a framework, the purpose of this study was to assess the effectiveness of the mandatory training program for food handlers in a rural parish in Jamaica. A cross-sectional survey, using self-administered questionnaires, was used to assess and compare food safety knowledge and self-reported practices of food handlers trained in 2 government training programs, while using untrained food handlers as controls. Descriptive and inferential statistics such as *t* test, chi-square test, and ANOVA were used to explore relationships between training and knowledge and practice. According to study results, trained food handlers had a statistically significant higher mean knowledge score (65.61% vs. 59.0%, $p < 0.05$) and mean practice score (67.40% vs. 60.35%, $p < 0.05$) than untrained food handlers, although these scores were significantly lower than the minimum acceptable standards of 70%. Results of this study may assist policy makers in designing effective training programs for food handlers, which should ultimately lead to a safer food supply for the consuming public and a reduction in food-borne disease outbreaks in Jamaica.

Food Safety Knowledge and Self-Reported Practices of Food Handlers in Jamaica

by

Marcia Thelwell-Reid

MPH, University of the West Indies, Mona, 2003

BSc, University of the West Indies, Mona, 1996

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Health

Walden University

November 2014

Dedication

I dedicate this dissertation to my husband, Garnet, and son, Nicanor. Without your unwavering support and sacrifice throughout my 6 years at Walden, this would not have been possible. Thank you, and I love you!

Acknowledgments

I would like to acknowledge the following persons for their contribution to this research:

- My Committee Chair, Dr. Rubin for his encouragement and professional assistance throughout the process. You came on board when I lost my first Chair and you stuck to the task, encouraging me when I felt like giving up.
- Dr. Aimee Ferraro, my committee member, for her invaluable critique and advice during the proposal and final stages of the dissertation.
- The members of Westmoreland Public Health, who facilitated data collection in their food handlers' training sessions.
- My family, my tower of strength throughout this journey. You stood by me and carried some of my responsibilities when it became difficult to balance work, school, and family.
- All my friend and colleagues who, by your kind words of encouragement, have helped me to finish the journey.
- To God be the glory, great things He has done.

Table of Contents

List of Tables

Chapter 1: Introduction to the Study

Introduction

Food-borne illnesses are responsible for a high number of diseases globally. The World Health Organization (WHO, 2010) estimated that approximately 1.8 million children die each year from diarrhea, much of which is caused by consumption of contaminated food and water. Food contamination is widespread not only in developing countries, but also in developed industrialized countries. For example, in the United States, the Center for Disease Control and Prevention (CDC, 2011) estimated that the burden of food-borne illnesses is approximately 47.8 million cases, with over 128,000 hospitalizations and 3,000 deaths. This may suggest a decrease in the number of cases from the 1999 estimates of 76 million cases with 325,000 hospitalizations and 5,000 deaths (Mead et al., 1999). However, according to the CDC, the reduction in the estimates of food-borne illnesses is a result of improved surveillance over the past decade and improved ways of assessing the burden of food-borne diseases.

While there is limited surveillance of foodborne disease outbreaks in developing countries, the incidence of diarrheal diseases in these countries is indicative of the high incidence of food-borne disease outbreaks (WHO, 2007). The Caribbean Epidemiological Center (CAREC, 2006) indicated that there has been an increase in the annual incidence of foodborne illnesses, as the annual number of reported cases has moved from approximately 500 in 1981 to over 2,500 in 2005. Because reported cases of food-borne diseases represent only the “tip of the iceberg,” even in jurisdictions with

highly developed surveillance systems, the true estimates of food-borne diseases in this region far exceed the reported cases.

The social and economic burden associated with food-borne diseases worldwide is increasing. Scharff (2012) revealed that food-borne diseases cost the United States $77.7 billion. This figure represents medical costs, loss in productivity, and a calculated portion for pain and suffering (Scharff, 2012). As the food industry expands with its increased challenges related to globalization, urbanization, international travel, farming practices, environmental pollution, and emerging and reemerging pathogens, steps need to be taken to reduce food-borne disease outbreaks and curtail costs.

Eating away from home may lead to an increased risk of contracting a food-borne illness. According to Cates et al. (2009), eating away from home, especially in restaurants, is associated with a significant number of food-borne disease outbreaks in the United States. Jones and Angulo (2006) demonstrated that eating in restaurants in the United States was a risk factor for foodborne diseases. Over 70 billion meals were consumed in restaurants, four out of every 10 people in the United States ate in restaurants on a given day, and over 16% ate over five meals per week in restaurants (Jones & Angulo, 2006). Although it is not clear as to the percentage of the 48 billion episodes of food-borne illness that was related to consuming food in a restaurant, this industry has a role to play in reducing food-borne disease outbreaks. This can be achieved by addressing food handler-related risk factors in these food establishments.

The WHO (2010) identified five food handling factors associated with food-borne disease outbreaks: improper cooking, temperature abuse during food storage, cross

contamination between raw and cooked foods, poor sanitation and hygiene, and using unsafe water and raw materials. Most of these factors are directly linked to food handlers. Food handlers have been directly linked to a number of food-borne disease outbreaks (Barrabeig et al., 2010; Beatty et al., 2009; Hundy & Cameron, 2002). Food handlers are integral to the improvement of food safety. The WHO (2007) has resolved to assist in strengthening food safety systems globally through a number of interventions, one of which is the training of food handlers in safe food handling.

To reduce the risk of food-borne diseases in many jurisdictions across the world, food safety training through food handlers' training and certification programs was implemented. Some jurisdictions require mandatory training, while training in other jurisdictions is voluntary (Averett, Nazir, & Neuberger, 2011; Egan et al., 2007; Pilling et al., 2008). Most of the training programs are based on the knowledge, attitude, and practice (KAP) model (Egan et al., 2007; Worsfold et al., 2004), which is based on the premise that an increase in knowledge will translate to positive attitude and appropriate practices. While knowledge is a prerequisite for positive attitudes and practices, there are many other factors (environmental, social, cultural, belief systems, and so on) that determine whether food handling knowledge positively impacts attitudes and practices in the workplace (Seaman, 2010).

While some researchers have claimed that training of food handlers does not guarantee safe food handling practices (Clayton et al., 2002; Howes et al., 1996; Powell et al., 1997), food handlers who receive training have more knowledge about food-borne

illnesses and are inclined to be more concerned with food safety (Angelillo et al., 2000; Miraglia, 2003). More details of this discussion are provided in Chapter 2.

In the food hygiene training model, Seaman (2010) proposed that improvement in knowledge transfer may be fostered by consideration of the venue for training. Seaman proposed that food handlers trained in remote locations in courses that are highly knowledge-based are less likely to convert their knowledge into practice than those who are trained onsite with information and demonstrations that are practical and relevant to the duties to be performed. According to WHO (as cited in Chapman et al., 2011), one barrier to combating food-borne illnesses is the "generic prescriptive content and school-like delivery method used in current food safety training," as evidenced in the general training programs held in venues divorced from the workplace (p. 161). Therefore, knowledge and practices of food handlers trained in these two types of training programs should differ.

In this study, I focused on the assessment of the food safety knowledge and self-reported hygienic practices of three groups of food handlers in Jamaica: (a) untrained food service workers, (b) those who are trained in remote locations (in general food handlers' certification programs), and (c) those trained onsite (food service workers in the hotel industry). According to Rowitz (2009), the four components of an evaluation of a training program are assessment of (a) the reactions of the trainees to the program; (b) the learning that has occurred; (c) behavior changes due to the training; and (d) long-term effects of the training, such as improvement in safe food handling practices and reduction in food-borne diseases nationally (p. 505). In this evaluation, I assessed the learning that

had occurred as a result of the training and self-reported practices that may be attributed to the training. Information derived from the study will inform the health authorities of the effectiveness of the food handlers' program in improving the knowledge and practice of food handlers in Westmoreland, a rural parish in Jamaica. The study results also have the potential to influence the Ministry of Health in developing policies for food safety education and training.

In Chapter 1, I cover background information on the food handlers' training program in Jamaica; the problem statement; the purpose of the study; the research questions and hypotheses; the theoretical framework; the defined terms; and the assumptions, limitations, scope, and significance of the study.

Background of the Study

The CAREC (2006) examined trends in food-borne illnesses for the period of 1981–2005 and revealed that there was a general increase in the number of cases in the Caribbean region. The majority of the 42,973 cases were reported from four countries: Trinidad and Tobago (38%), Bahamas (34%), Jamaica (8%), and Antigua (7%). Most of the Jamaican cases were related to travelers' diarrhea and occurred prior to 1996, with the highest number of cases (1,565) occurring in 1993 (CAREC, 2006). Due to the high incidence of travelers' diarrhea in tourists to Jamaica, in 1996 the Ministry of Health initiated a program to reduce travelers' diarrhea through environmental management and training of hotel workers in safe food handling practices (Ashley, Walters, Dockery-Brown, McNab, & Ashley, 2004). This led to hotel workers being specially trained through in-house training programs. Since the implementation of that program, there has

been a reduction in reported cases of travelers' diarrhea among visitors to Jamaica (Ashley et al., 2004). Between 1996 and 2002, there was a 72% reduction in diarrhea in the tourist population (CDC, 2012).

In 1999, the Ministry of Health in Jamaica implemented a new mandatory food safety training and certification program for general food handlers guided by new Food Handling Regulations and Tourist Establishment Regulations (Ministry of Justice, n.d.). The Public Health Food Handling Regulation (1998, 2000) states, "No person, including an operator, shall be employed in, or assist in food-handling establishment unless he is the holder of a valid Food Handlers Permit" (p. 47).

Prior to 1998, the food handlers' certification program involved a venereal disease research laboratory (VDRL) blood test and a physical examination, with no education or training. Favorable results from the blood test and the physical examination would guarantee food handlers a certificate valid for 1 year. Certification was not mandatory, and many food handlers operated without certification. This new certification process involves a 1-hour lecture, a written 20-question objective-type test (an oral test for illiterates), observation of some physical features (nails and teeth), and a few health questions. A 70% score on the test is considered a "pass," and a certificate, valid for 1 year, is issued. This food handlers' training session is the main source of information for most food handlers.

There is no national standardized test on food handling and sanitation, as each local health department develops its own food handlers' test. The educational sessions are held in community health centers, public health departments, rented halls, and onsite

in large food handling establishments. These sessions are conducted by environmental health officers with training in food hygiene. These officers also inspect and approve for licensing all food handling premises covered under the regulations. In some health regions, training and testing are offered on a daily basis, while in other areas, clients have to make appointments for the days that the service is offered. In Westmoreland, 13 food handlers' sessions are conducted each month for general food handlers, and special arrangements are made for onsite training programs in large tourist establishments (R. Stephens, personal communication, June 10, 2012).

Despite an increase in the number of food handlers being certified under the new regulations and subsequent training programs, a high proportion of food poisoning outbreaks still occur. While there is limited information on the extent of food-borne disease outbreaks in Jamaica, poor food handling practice is a contributor to food-borne disease outbreaks worldwide (Clayton et al., 2002; Howes et al., 1996). A strategy to reduce the incidence of food-borne illnesses has been the improvement of food handling practices through training of food handlers.

This new training program operated within the context of the poor financial status of public health departments. Most food handlers' clinics for the general food handler's training lack the necessary resources to deliver the information and are conducted at times without the use of visual aids (multimedia and overhead projectors, models for demonstration, and so on). The conditions under which food handlers are trained (in open clinic settings) sometimes create distractions for the food handlers and affect the learning process. There is also a low literacy level among food handlers, which may

impede their assimilation of the material being presented and understanding of the tests. Oral examination scores for food handlers who are not able to read may be influenced by the examiner, as voice intonations and the questioning process may give hints to food handlers and bias the scores. Instances were found where illiterate food handlers scored much higher on the test than literate food handlers (R. Stephens, personal communication, June 10, 2012). Many food handlers are also from the small business sector, where businesses may lack the basic amenities necessary for food handlers to practice the information given, such as a three-compartment sink, towel dispensers, hot and cold water, food thermometers, hot food service facilities, and adequate personnel welfare facilities.

The hotel workers are trained under different circumstances, more approaching the ideal setting recommended by Rennie (1994), Seaman (2010), and Worsfold (2004). They are trained in-house for longer periods, usually over a number of days, addressing topics such as hazard analysis critical control points (HACCP) monitoring and assessment that are not included in the general training program. There are benefits to be derived from this type of training program, as these workers receive job-specific food safety instructions. Demonstrations can be conducted in their actual work setting, thereby improving their understanding of the instructions given. The test that is administered to these workers is also different.

Since 1999, many food service workers have been certified and recertified, but no evaluation has been conducted to ascertain the effectiveness of the current training program in preparing food handlers for practice (W. Broughton, personal communication,

November 10, 2011). The new certification program was expected to equip food handlers with the necessary knowledge and skills to handle food safely and prevent food-borne disease outbreaks. There is no published study on the role food handlers play in disease outbreaks in Jamaica since mandatory certification, and there is limited documentary evidence of the knowledge, attitude, and practices of food handlers in Jamaica (Dawes, 2001). If food handlers and their practices are considered to be the main contributors to food-borne disease outbreaks, and training is limited to 1 hour annually for most food handlers, questions remain about the level of food safety knowledge and the hygienic practices that are being displayed by food handlers in the food service industry.

Even though both groups of food handlers possess the same food handlers' certificate indicating their competence to handle food, there is no evidence that they possess comparable levels of knowledge on handling food and carrying out the same practices. There is also no evidence that either group of food handlers possesses adequate knowledge and acceptable practices that are required to handle food safely. This study provides evidence to guide the Ministry of Health in determining whether to continue with its dichotomous food safety education policy, draft a single training policy that uses either method of training, or change the training program to make it more responsive to the challenges associated with the reduction in food-borne disease outbreaks.

Problem Statement

Although researchers in many countries have found that trained food handlers are more inclined to practice safe food handling (Anding, Boleman, & Thompson, 2007; Cates et al., 2009; Park, Kwak, & Chang, 2010; Rebellato, Cholewa, Chow, & Poon, 2011; Roberts et al., 2008; York et al., 2009), no study has been conducted in Jamaica to determine if the 13-year mandatory food handlers' certification program is effective in helping food handlers to acquire the necessary knowledge and skills to handle food safely and ultimately reduce food-borne disease outbreaks. This research is needed because training of food handlers is one of the most important strategies proposed by the WHO (2007) to reduce the global burden of food-borne diseases.

Many countries have investigated the knowledge, attitude, and practices of various categories of food handlers to establish a baseline for the development of effective and relevant food handlers' training programs (Hislop & Shaw, 2009; Jianu & Chis, 2012; Martins, Hogg, & Otero, 2012; Van Tonder, Lues, & Theron, 2007). No such study has been done in Jamaica. The knowledge and practice of trained food handlers may differ from that of individuals who are untrained. In this study, I assessed the food safety knowledge and hygienic practices of food handlers trained in both government programs so that the Ministry of Health would be able to justify the continuation of the training program or propose changes to the new food safety policy being developed.

Nature of the Study

In this study, I described the food safety knowledge and hygienic practices of trained and untrained food handlers in Jamaica. The observational, cross-sectional survey method was chosen, as this is the method most frequently used by researchers in these types of studies (Chuckwuocha et al., 2009; DeBess, Pippert, Angulo, & Cieslak, 2009; Egan et al., 2007; Gomes-Neves, Araujo, Ramos, & Cardoso, 2007; Jevsnik, Hlebec, & Raspor, 2008; Santos, Noguiera, Patarata, & Mayan, 2008). It is also the most appropriate method for obtaining a snapshot of food handlers' knowledge and practice at a particular point in time.

The key study dependent variables were food safety knowledge and hygienic practices as measured by scores on a self-administered questionnaire. The independent variable was training as measured the by number of training sessions attended and type of training. Data analysis was conducted using SPSS 22.0, and analyses included measures of central tendency (mean), *t* tests, chi-square analysis, ANOVA, ANCOVA, and item analysis. Greater detail on the nature of the study is provided in Chapter 3.

A number of researchers have conducted similar studies in several regions of the world, comparing the knowledge and practice of trained and untrained food handlers. However, no such study was found for the Caribbean region in general and Jamaica in particular. Due to the lack of standardization of food handlers' certification across health regions in Jamaica, I decided to conduct the study in one health region. The Western Regional Health Authority was selected, as this region had the greatest proportion of hotel workers in Jamaica. Westmoreland was selected randomly, and, in this parish, food

handlers are categorized for training. Separate training sessions are held for first-time attendees (untrained) and those being recertified. Also, food handlers involved in the preparation and service of potentially hazardous foods are trained separately from general (low-risk) food handlers.

Research Questions

1. How knowledgeable are food handlers with respect to critical food safety factors?
2. What are the reported practices of food handlers with respect to critical food safety factors?
3. Are food handlers trained by the Ministry of Health more knowledgeable about food safety issues and report safer practices than untrained food handlers?
4. Is there a difference in knowledge and practices of food handlers trained for the tourist industry and those trained in the general program?
5. Is there a relationship between level of knowledge and self-reported practices and the number of training sessions attended?

Hypotheses

$H_0$1**:** There is no difference in the food safety knowledge of certified food handlers with respect to critical food safety factors as evidenced by scores on a test when compared to uncertified food handlers.

H_a1**:** There is a difference in the food safety knowledge with respect to critical food safety factors as evidenced by scores on a test among food handlers certified by the Ministry of Health when compared to uncertified food handlers.

$H_0$2: There is no difference in the hygienic practice scores with respect to critical food safety factors among food handlers certified by the Ministry of Health when compared to the scores of uncertified food handlers.

H_a2: There is a difference in the hygienic practice scores with respect to critical food safety factors among food handlers certified by the Ministry of Health when compared to the scores of uncertified food handlers.

$H_0$3**:** There is no difference in food safety knowledge scores between food handlers trained for the tourist industry and food handlers trained in the general program.

*H*a3: There is a difference in food safety knowledge scores between food handlers trained for the tourist industry and food handlers trained in the general program.

$H_0$4: There is no difference in hygienic practice scores between food handlers trained for the tourist industry and food handlers trained in the general program.

*H*a4: There is a difference in hygienic practice scores between food handlers trained for the tourist industry and food handlers trained in the general program**.**

$H_0$5: There is no difference in the food safety knowledge scores of trained food handlers based on number of training sessions attended.

*H*a5: There is a difference in the food safety knowledge scores of trained food handlers based on number of training sessions attended.

$H_0$6: There is no difference in the hygienic practice scores of trained food handlers based on number of training sessions attended.

*H*a6: There is a difference in the hygienic practice scores of trained food handlers based on number of training sessions attended.

Purpose of the Study

The purpose of the study was to quantitatively describe and compare food safety knowledge and self-reported hygienic practices of three groups of food handlers in a rural parish in Jamaica. I targeted food handlers trained in the two separate mandatory government food safety education programs and a group of untrained food handlers. In addition, the relationship between level of training (independent variable) and levels of knowledge and practice (dependent variables) was explored. The influences of covariates such as education, experience, job level, and formal culinary training were also explored.

Theoretical Framework

The aim of any food handlers' training program is to influence safe food handling behavior in the workplace. However, Clayton and Griffith (2008) have shown that knowledge-based training programs do not automatically translate to safe food handling in the workplace. This has led to the call for the use of behavioral science theories to help food handlers understand food hygiene behavior (Rennie, 1995). The theoretical frameworks selected for this study were social cognition theories that are used to explain how humans acquire and maintain certain behaviors. The theories selected for this research were the social cognitive theory (SCT), the theory of planned behavior (TPB), and the health belief model (HBM). According to Bandura (as cited by Cherry, 2011),

"Most human behavior is learned observationally through modeling," and the mental state of the individual, along with the physical and social environment, interact to produce an observed behavior (p. 1). There are three models of observational learning (modeling): a live model, a verbal instruction model, and a symbolic model. All three models operate in some aspects of both food safety training programs in Jamaica. A more detailed explanation of Bandura's SCT is given in Chapter 2.

According to the HBM, an individual will behave based on his/her perception of his or her susceptibility to a serious or severe threat and whether the benefits to be derived from performing the proposed behavior to minimize the threat outweigh the barriers to performing those actions (Janz & Becker, 1984). Therefore, if food handlers perceive that their hand washing behavior, for example, can put them or the customers at risk for food-borne illnesses, and the benefits of washing hands are far greater than the barriers, the hand washing behavior will occur. This theory has been tested among food handlers (Cho, Hertzman, Erdem, & Garriott, 2012), and researchers have found that there are benefits to be derived from training. More details on this theory are provided in Chapter 2.

The TPB is a social cognition theory that is frequently used in trying to understand food handling behavior (Ajzen, 1991). According to the TPB, an individual's behavior is determined by behavioral intentions, and these intentions are a function of attitudes, subjective norms, and perceived behavioral control. Researchers have demonstrated that the TPB is useful in explaining factors influencing food handlers' behaviors, such as hand hygiene (Clayton & Griffith, 2008) and general food handling

practices (Seaman & Eves, 2008). More details on the use of this theory are provided in Chapter 2.

The two training programs in Jamaica, while not stating that they are grounded in any social cognition theory, have been using the principles of the SCT in their delivery. The general food handlers' program uses mainly verbal instruction modeling, with no opportunity for practicing new behaviors. The tourism workers' training program uses both live and verbal instruction models. Onsite training also provides opportunities for workers to practice new skills under supervision to clarify misunderstandings. In this study, I compared the food hygiene knowledge and self-reported hygienic practices of food handlers to ascertain if there were differences based on type of training.

Definition of Terms

Critical food safety factors: Those factors that predispose consumers to food-borne illnesses, such as hand washing practices, temperature control, thawing and reheating of potentially hazardous foods, food from unsafe sources, cross contamination, and personal hygiene habits (WHO, 2010).

*Cross contamination***:** Indicates the "transfer of harmful substances or germs from one food product to another through direct contact, or contact with utensils, equipment, work surfaces, or employee hands or clothing" (Spokane Regional Health District, n.d., p. 1).

Food-borne illness: According to the WHO (2014), food-borne illnesses are defined as resulting from "ingestion of foodstuffs contaminated with microorganisms or chemicals" (p. 1).

Food hygiene practice: Activities carried out by food handlers to protect food from contamination and ensure a safe supply of food for consumers.

Food safety knowledge: The level of awareness of food handlers concerning food safety issues as measured by scores on a written test. Satisfactory knowledge is demonstrated with a score of 70% or over on the written test.

Potentially hazardous foods: According to the FDA Food Code (FDA, 2001), a potentially hazardous food is any natural or synthetic food that requires refrigeration due to its ability to "support the rapid growth of infectious or toxigenic microorganisms, the slower growth of the *Clostridium botulinum*, and in raw shell eggs, the growth of *Salmonella enteritidis*" (p. 2)

Temperature abuse: Occurs when potentially hazardous foods are held in the temperature danger zone of 41°F to 140°F for an extended period of time, giving rise to the possibility of bacterial growth and foodborne disease outbreak (Spokane Regional Health District, n.d.).

Trained/certified food handler: A food handler who attends and successfully completes the food safety education program offered by the Ministry of Health and is in receipt of a food handler's permit.

Training: Food safety education sessions conducted by the Ministry of Health on or off the worksite with the aim of improving knowledge and skills of food handlers.

Assumptions

The following assumptions had the potential to affect the study:

- It was assumed that the food handlers voluntarily participated in the study.

- It was assumed that the food handlers would understand the questions asked on the test, even though pretests were done with a similar population to improve clarity of the instrument.
- It was assumed that the test was an appropriate way to measure food safety knowledge and practice.
- It was assumed that the results of the study would influence policy decisions, leading to the improvement of training of food handlers.

These assumptions were necessary as (a) written consent was not required before the administration of the instruments and food handlers had the option to decline to participate and (b) low literacy levels among food workers may have impacted the level of understanding of the test items.

Scope, Delimitations, and Limitations

In this study, I focused on providing an overview of the food safety knowledge and hygienic practices of trained and untrained food handlers in Jamaica by a self-administered questionnaire. This focus was chosen because there had been no formal assessment of the food handlers' training program since its implementation. Food safety knowledge and hygienic practices should improve with training, and a comparison of knowledge and practices of trained and untrained food handlers will provide an indicator of the effectiveness of the training programs. A self-administered questionnaire was an acceptable way of assessing these variables in a literate population, reducing the possibility of interviewer bias. While there was always the possibility of guessing on

such an instrument, the presence of a “don’t know” option on the instruments and anonymity during data collection should have improved the internal validity of the study.

I concentrated on food handlers in one purposefully selected health region in Jamaica. Only literate food handlers were included in the study, as the data collection method was a self-administered questionnaire that required a level of literacy on the part of food handlers. Illiterate food handlers were excluded, as their inclusion would have required face-to-face interviews for data collection. This would have created the possibility of linking respondents with instruments, which was not the intent of the study. However, the omission of illiterate food handlers excluded their knowledge and practices from the study. Also, because an incidental sample was used, there was no way of knowing the type and number of food handlers who would attend a training session on a given day; therefore, the final sample may not have been representative of the general population of food handlers in Jamaica. These limitations prevent generalizability of the study findings beyond the food handlers in the parish of Westmoreland.

Other possible threats to validity were (a) distractions in the research setting during the administration of the test, (b) uncertainty that the test was a true measure of the “food safety knowledge” variable, and (c) inappropriate statistical tests. Measures that were implemented to minimize these threats included the control of the testing environment to minimize distractions, expert review of tests, and ensuring that statistical assumptions were not violated.

Significance

There was no previous study on the food safety knowledge and hygienic practices of food handlers trained in government training programs versus those of untrained food handlers in Jamaica. This study was important because new food safety policies were being drafted and there was no evidence as to the effectiveness of the mandatory training program that had been in place since 1999.

Even though there has been an increase in the number of trained food handlers serving food to the public, the incidence of food-borne illnesses remains high. This brings the adequacy of food handlers' training into question. Higher standards of operation are required for tourist establishments due to the high instance of travelers' diarrhea among tourists (Ashley et al., 2004). This led to the implementation of specialized food safety training for hotel workers. In this study, I determined whether food handlers trained in this program were more knowledgeable than those trained in the general program and untrained food handlers. The findings may inform decisions concerning the efficacy of the structure of both training programs for meeting the minimum standards for knowledge and practice in food hygiene in Westmoreland. This study has implications for positive social change in that it may influence policy that results in better training programs for food handlers in Westmoreland, and, by extension, Jamaica. This may ultimately lead to the serving of safer food to the public and a reduction in food-borne disease outbreaks.

Summary

Training of food handlers has been recognized by the WHO (2007) as one of the most important strategies for reducing the burden of food-borne diseases worldwide. Such training programs should equip food handlers with knowledge and practice with respect to food safety factors that are linked to disease outbreaks. Although the evidence is not conclusive that training automatically translates to improved knowledge and practice (Clayton, 2002), trained food handlers are more inclined to practice safe handling of food (Seaman, 2010). Training programs with a theoretical foundation in behavior change theories are more effective in improving knowledge and practice than those based solely on "information giving" in an environment remote from the work setting.

While many jurisdictions have mandated food handlers' training, there is a lack of evaluation of the effectiveness of these programs in achieving their objectives. Ineffective training programs constitute a waste of resources, as they have no meaningful impact on the level of food handler-related food-borne disease outbreaks. In this study, I assessed and compared knowledge and self-reported practices of food handlers who were trained in-house and in remote locations, using untrained food handlers as a control group.

Chapter 2 covers the review of the literature on food safety knowledge and hygienic practices of food handlers from different regions of the world. Chapter 2 begins with the association of food handlers with disease outbreaks and continues with a review of the literature on the effectiveness of food handlers' training, the knowledge and

practice of food handlers, and training based on social science behavior change theories. The chapter ends with literature related to the use of the cross-sectional survey as the most appropriate data collection method. Chapter 3 provides a detailed outline of the methodology. It includes the setting, the sample selected, the population, the data collection method, and details of analysis of the data. The quantitative cross-sectional study was conducted in food handlers' clinics in Westmoreland, Jamaica, and targeted trained and untrained literate food handlers who were involved in the preparation and service of potentially hazardous foods. Data were collected by a self-administered questionnaire to assess food safety knowledge and self-reported hygienic practices of food handlers. Data were analyzed using the SPSS 22.0 statistical software package. Chapter 4 includes the results of the study. In Chapter 5, I present the discussion, reflections, and recommendations for future research.

Chapter 2: Literature Review

Introduction

According to the WHO (2007), the increase in the incidence of food-borne diseases is a public health concern in both developed and developing countries. An estimated 30% of the population of industrialized countries suffers from foodborne illnesses annually (WHO, 2007). This translates to approximately 76 million cases, with 325,000 hospitalizations and 5,000 deaths each year in the United States alone (WHO, 2007). Developing countries such as Jamaica with inadequate surveillance systems are unable to accurately capture the magnitude of food-borne illnesses, but an inordinately high incidence of diarrheal diseases seems to suggest underlying food safety problems (WHO, 2007). The WHO cited training of food handlers in safe food handling as one of the most critical interventions in prevention of food-borne disease outbreaks. Researchers have linked these outbreaks to the mishandling of food and poor personal hygiene of food handlers. Therefore, from as early as 1938, there has been the call for training of food handlers (Jackson, 1954). Many jurisdictions, including Jamaica, have mandated the training of food handlers. Most training programs are based on the KAP model, which is geared toward improving knowledge and practice through information giving.

The literature is inconclusive as to the effectiveness of food handlers' training programs. In most cases, food handlers' knowledge remained low even after training, and knowledge was not always translated into practice. Many of these scholars used the survey method to determine knowledge and practice. Researchers have sought to

improve knowledge transfer by developing training programs based on social cognitive theories. Such programs have shown greater improvement in hygienic practices determined by observation and assessment of restaurant violations. The training of managers has also been associated with improved inspection scores and greater levels of food safety knowledge and practices of employees.

Training of food handlers and food establishment managers has been mandatory in Jamaica since 1999. The training, done by the Ministry of Health through its local health departments, is based on the KAP model. No formal evaluation had been done to ascertain whether the knowledge imparted to food handlers in the 1-hour training had led to improved knowledge that was retained and transferred to the food establishments. This was the focus of this research.

In the literature review, I address the role of food handlers in disease outbreaks, knowledge and practices of food handlers, and the effectiveness of training programs for food handlers, including traditional programs as well as theory-based programs. In the final section, I address the methodology that was used to assess food handlers' knowledge and practice in Jamaica.

Literature Review Strategies

The databases used for this research included CINAHL, ProQuest Central, ProQuest Nursing and Allied Health Source, Hospitality and Tourism Complete, Academic Search Complete, Medline, and Google Scholar. Search words included *food safety, food handler, food handling, food hygiene, hygiene, food poisoning, health education, food handler's education, sanitation, food, training, food-borne illnesses,*

food-borne disease outbreaks, knowledge, hygiene practices, social cognitive theories, theory of planned behavior, effectiveness of food hygiene training, restaurants, food safety methods, hand washing, surveys, food service, and *food businesses.* The articles selected for inclusion in this review were based on a number of criteria: the target population (food handlers in the food service industry), the date of publication (last 5 years), the variables studied, and the methodology used (mainly surveys and self-reported methods). Studies were not restricted to the Caribbean context, as efforts were made to include studies from several regions of the world. A few older studies were included due to their relevance to this research.

Association of Food Handlers With Food-Borne Disease Outbreaks

A number of food-borne disease outbreaks have been associated with food workers. Beatty et al. (2009) conducted epidemiological studies over a 5-week period to determine the cause of the largest *Salmonella* outbreak in Texas. The methods used included outbreak surveys, symptom surveys, cohort studies, follow-up surveys, environmental investigations, and lab analyses. Beatty et al. found that the outbreak was due to the mishandling of food by a food handler. Eleven food service employees had positive stool cultures for *Salmonella enteritidis*. This was the largest food-handler-associated outbreak in the United States, and the transmission only ended when policies were implemented to screen food handlers and exclude those with positive cultures for *Salmonella*. The limitations of the study, including low response rates and the passive reporting, prevented the determination of the original source of the outbreak.

Barrabeig et al. (2010) also demonstrated the role of an asymptomatic food handler in an outbreak associated with food-borne norovirus in Barcelona, Spain in 2005. A retrospective cohort study that targeted exposed people as well as food handlers was conducted using interviews and stool analyses. Attack rate and relative risks were calculated to determine the association between disease and food consumption. Barrabeig et al. claimed that the norovirus was present in seven stool samples, including that of an asymptomatic food handler who did not eat the implicated food but cooked and served the lunch. Infectious agents are possible in asymptomatic food handlers, which warrants the practicing of safe food handling techniques, especially handwashing, at all times.

Isara, Isah, Lofor, and Ojide (2009) studied food contamination in fast food restaurants in Nigeria and looked at the role of food handlers in food contamination. Isara et al. administered a semistructured questionnaire to collect data from 350 food handlers who were systematically selected. Other methods of data collection used included food sampling and stool analysis. Most food handlers displayed characteristics that may influence food contamination, such as a lack of training in food hygiene (52.6%), no preemployment medical examination (70.3%), and no knowledge that microbes can contaminate food (57.4%). The microbes were isolated from salads, meat pies, and fried rice, and these microbes included *B. cereus, S. aureus*, and *S. typhimurium*. These entero-pathogenic bacteria were isolated from the stool of the healthy workers. The presence of *S. aureus* in foods and in a high proportion of stools of

food handlers indicated the possibility of contamination by food handlers. There is a need for preemployment training and medical examination for food handlers.

To further demonstrate that food handlers are potential sources of food-borne infections, Andargie, Kassu, Moges, Tiruneh, and Huruy (2008) determined the prevalence of intestinal and bacterial parasites among university cafeteria food handlers and food handlers from a teacher training college in Ethiopia. Specimens from fingernails, hands, and stools were collected from 127 food handlers. This sample included all food handlers who did not take treatment for intestinal problems within the previous 3 months. A questionnaire was also used to collect demographic and hygiene data. The specimen analysis for fingernail contents revealed that 41.7% of the 127 specimens were positive for *Staphylococcus aureus*. Other pathogens found included *Klebsiella*, *Escherichia coli*, *Serratia, Citrobacter*, and *Enterobacter*. No intestinal parasites were found on fingernails. *Shigella* species was isolated from 3.1% of stool cultures. However, in a microscopic examination of stool specimens, Andargie et al. revealed that 29.1% were positive for *Ascaris lumbricoides* (18.1%). Other parasites found were *Trichuris trichuria*, hookworm, and *Giardia lamblia*. Overall, 29.1% of food handlers had intestinal parasites in their stools. The presence of fecal bacteria on the hands of food handlers and food contact surfaces may have led to outbreaks of food-borne illnesses. Training and hygiene education were recommended for food handlers in Ethiopia.

Khurana, Taneja, Thapar, Sharma, and Malla (2008) also revealed the presence of bacterial and parasitic infections in food handlers. Khurana et al. collected stool samples

from food handlers working in food service establishments over a 5-year period (2001-2006) to study the presence of entero-pathogenic bacteria and parasites. Khurana et al. found that, each year, between 1.4% and 16% of food handlers were infected with entero-pathogens, the main ones being *Giardia* and *Shigella*. The 2002 analysis yielded the maximum prevalence rate of entero-pathogenic bacteria (13.3%), and all of the food handlers were asymptomatic. Asymptomatic carriers place the consuming public at risk, as they are unaware of their infective state and may contribute to foodborne disease outbreaks. Training and monitoring are necessary to encourage all food handlers, regardless of health status, to practice safe food handling techniques.

Effectiveness of Food Handlers' Training

One strategy to reduce the growing increase in food-borne illnesses is the training of food handlers. Some jurisdictions mandate the training of food workers, while others recommend or encourage training. According to Rennie (1994), voluntary training programs may reach only those who are interested in food safety and want to behave appropriately. Mandatory training programs ensure a wider coverage of food handling personnel. Effectiveness of food hygiene training programs is generally measured by change in food safety knowledge, food hygiene practice, or food violations detected through observation/inspection. Several studies have been conducted to test the effectiveness of these training programs. These studies have yielded mixed results as to the effectiveness of training.

Egan et al. (2007) conducted a review of studies done to determine the effectiveness of food hygiene training in the commercial sector of the food industry.

Specifically, Egan et al. focused on outcome measures used by the scholars to ascertain training effectiveness. Forty six studies met the inclusion criteria. These studies spanned the period 1969-2003 and were conducted in 10 countries, with the majority being done in the United States and the United Kingdom. Sixty-five percent involved food handlers, and 24% focused on managers. Most of the researchers measured knowledge, attitude, behavior, and practices concerning food safety or food hygiene. The study designs fell into five categories: descriptive, audit, before-after, comparative-experimentalist, and randomized controlled experiment, the majority (56.5%) being descriptive.

Egan et al. (2007) evaluated the studies based on five measures: knowledge, attitude, behavior and work practice, retraining, and duration of effects. Egan et al. found that most scholars measured effectiveness of training by assessing knowledge using questionnaires or pre/posttests. The knowledge ranged from good to poor on various critical aspects of food safety. With respect to attitude, behavior, and work practice, Egan et al. revealed that, although there was a positive attitude toward food safety, this was not supported by self-reported practice, and there was a discrepancy between self-reported practice and actual behavior. There was also no correlation between knowledge test scores and premises inspection scores. Seven of the studies were rated as moderate, and of these, “four provided good evidence to support the effectiveness of food safety intervention, specifically food handler training or recertification" (Egan et al., 2007, p. 1,187). However, this training program was more effective when conducted in the workplace rather than in a remote training environment. While there is acknowledgment

that training of food handlers is critical to effective food hygiene practices, a limited number of studies have addressed the effectiveness of training.

Pilling et al. (2008) assessed the effect of mandatory training of managers and food handlers on knowledge and behaviors with respect to food safety. Three behaviors were investigated in this cross-sectional study: hand washing, thermometer use, and proper handling of food and work surfaces. The theoretical underpinning of the study was the TPB, which focuses on the contribution of behavioral antecedents to food handling behaviors. Questionnaires and observation of food preparation behaviors were the two methods used to gather data. The questionnaire was developed by the researchers and piloted for internal reliability and consistency. It focused on demographics, knowledge assessment, and assessment of the TPB. Participants were food service employees from restaurants in Kansas, Iowa, and Missouri. The 242 employees were drawn from restaurants where training was mandatory for all food handlers and from restaurants where training was only mandatory for supervisors. Pilling et al. revealed that food handlers' knowledge with respect to thermometer use and hand washing was significantly lower for food handlers for whom training was mandated than those where training was mandatory for only managers ($p < 0.001$). These food handlers also had less favorable attitudes toward food handling and work surfaces. The training of shift managers yielded similar benefits as having all food handlers trained. Having trained managers led to overall better knowledge of employees with respect to the three areas investigated. Training does not always lead to improved behaviors, but it may lead to benefits in some areas.

Averett et al. (2011) evaluated the mandatory food handlers' training program implemented by the Kansas City Health Department in 2005. This training program involved a 2-hour lecture conducted at the health department, followed by a written examination. Food handlers' training cards, valid for 3 years, were awarded to the food handlers after successful completion of the course. The evaluation was conducted by comparing rates of critical and noncritical violations of food establishments before and after the implementation of mandatory food handlers' training. Violations related to food handler behaviors were compared for the period 2001-2004 (4 years before mandatory food handlers' training) and 2005-2007 (3 years after imposition of mandatory food handlers' training). Non-food-handler-related violations were used as control violations in a quasi-experimental study design. Averett et al. found an overall significant decrease in food handler-related violations by 4.9% after the food handler training program was implemented, while control violations decreased by 24.7%. Within the subset of establishments in operation in both time periods, there was a significant decrease in food handler-related critical violations by 13.1% and control violations by 47.7%. While food handler-related and control violations decreased, there was a greater decrease in the control violations. This made it difficult to determine the level of decrease that was explained by the food handler training program. Hence, when compared to the control group, no measurable benefit was seen in food handler-related violations after training (Averett et al., 2011).

Cates et al. (2009) assessed whether the presence of certified kitchen managers improved restaurant outcomes. Kitchen managers/supervisors are classified as food

handlers, and their training and certification are mandatory in Jamaica. The researchers, who conducted the study in Iowa, assessed the relationship between the presence of a certified kitchen manager (CKM) and restaurant inspection outcomes and critical violations. Data were gathered from routine inspection records for three types of premises (restaurants serving liquor, restaurants that do not serve liquor, and taverns with food preparation) over a 2-year period (2005-2006). Approximately 4,461 establishments with 8,338 routine inspection reports were included in the study. In the results of logistic regression analysis, Cates et al. found that the presence of a CKM during inspection was protective against most critical violations ($OR = 0.82$, $p < 0.01$). The establishments were less likely to have critical violations for personnel ($OR = 0.73$, $p < 0.01$), food source and handling ($OR = 0.80$, $p < 0.01$) and ware washing ($OR = 0.82$, $p < 0.01$). The presence of a CKM did not protect against violations for food temperature and time control, specifically cold holding. The training of managers may increase their knowledge and their ability to impart this knowledge to and adequately supervise food service employees, thereby reducing critical violations that may lead to food-borne disease outbreaks.

Park et al. (2010) conducted a study among small franchise restaurants in Korea to evaluate food safety training programs for food handlers. The outcome measures used in this study were knowledge and practices of food handlers concerning food safety and food safety performance of restaurants. The theoretical foundation of this study was that hygiene education/training based on imparting knowledge alone was not sufficient to improve attitudes and practices of food handlers. Data were collected by self-

administered pre and posttraining questionnaires and food safety performance checklists for restaurant observations. Using the nonequivalent pretest posttest control group design, 12 restaurants were allocated between a training group and control group, with seven restaurants with 41 food handlers assigned to the intervention group and five restaurants with 49 food handlers assigned as controls. The training group was exposed to a 1-hour training, and posttests were administered to the two groups after 2 weeks. After the pretest, there was no significant difference in food safety knowledge between the two groups. There was a significant increase in knowledge after training for the intervention group (mean score = 17.3, $p < 0.05$), especially in areas such as personal hygiene and the handling and serving of food. There was no change in pretest/posttest scores for the control group, thereby validating the study as a good measure of the intervention effect of the training.

With respect to food handling practices, Park et al. (2010) found no significant improvement in posttest scores over pretest scores ($p > 0.05$) in the intervention group, leading to the rejection of the hypothesis that training would lead to improvement in food handlers hygiene practices. Also, training did not contribute to significant improvement in inspection scores for the intervention group, especially in areas such as handwashing, food handling practices, and checking and recording of food temperatures. The employees did not know proper hand washing procedures (average score of 1.4 points), although they stated that they washed their hands properly. There was negative correlation between knowledge and practice ($r = -0.235$, $p < 0.05$). The positive correlation between inspection sanitation scores and knowledge, though insignificant,

indicated that behavior change may be due to knowledge acquisition. The negative correlation between practices and inspection scores was not significant (r = -0.191, p > 0.05). Park et al. concluded that continuous food hygiene education program could be effective in improving knowledge and the sanitation inspection scores. The limitations for this study, however, were in the design and the analysis. There were differences between the intervention and control groups and due to loss of subjects and the resulting small sample size, the *t* test was used in the analysis instead of the paired *t* test. Further research on the effectiveness of training should include larger sample sizes and an analysis of a paired *t* test.

Roberts et al. (2008) also used a pretest/posttest experimental design to determine if knowledge and practices regarding food safety changed after training. Roberts et al. used a 54-item knowledge assessment questionnaire that focused on cross-contamination, time and temperature abuse, and poor personal hygiene of food handlers in commercial, licensed restaurants in three U.S. states. Observation was also conducted using a validated food safety observation form. After a 4-hour training session, the same questionnaire was administered and the food handlers were observed. Thirty one restaurants yielding 242 employees completed the pretest, and 160 did the training and the posttest and were observed. Roberts et al. found that training had a significant impact on hand washing knowledge ($p < 0.05$) and behavior ($p < 0.001$), but was not significant in preventing cross-contamination and time temperature abuse. An investigation of the relationship between overall behavioral scores and knowledge scores using linear regression revealed a significant positive relationship (F = 4.266, p <0.05). Food

handling practices were poor, even after training. Training can improve knowledge and practice. However, knowledge alone will not always improve behavior. Efforts should be made to target other factors that hinder or promote food safety behavior change. The study was limited by the small number of restaurants that were willing to participate in the study (response rate of 2.4%). Further studies are needed to investigate the reason for managers' unwillingness to participate in studies and also into barriers and motivators to the translation of knowledge into practice.

Rebellato et al. (2011) used a pretest/posttest design to evaluate the effect of a food handler certification program, PROTON, on the knowledge, attitudes, and practices of participants who completed the course. In the assessment, Rebellato et al. focused on three variables: hand washing, cross contamination, and temperature abuse. One thousand and forty two participants completed the pretests, and 320 completed the posttest after 1 month of completing the course. Rebellato et al. found that there was a significant increase in mean test scores from 6.3/10 (SD = 2.0) to7.6/10 (SD = 1.6) ($p <$ 0.001). Food handlers' attitudes to food hygiene remained positive, and improvements were observed also in the practice assessment, especially in the area of hand washing (over 90% on posttest) and wearing of headgear. Rebellato et al. demonstrated the benefits to be derived from food handlers' training. A number of limitations were highlighted by Rebellato et al., namely, social desirability bias resulting from self-reported practices, selection bias resulting from low response rate for the posttest, test/retest bias from the repeated administration of the instrument, and from the possibility that food handlers got assistance in completing the posttest as it was done at

home without supervision. These biases should be addressed in future studies to assess the effectiveness of training in food safety.

York et al. (2009) conducted a 2-year longitudinal study to assess and compare the effectiveness of two training initiatives: the National Restaurant Association ServSafe training program and an intervention based on the TPB. As a result of attrition, a small sample of 33 restaurant food service employees completed the study. Data were collected using a questionnaire and peak hour on-the-job observation. York et al. focused on three areas: hand washing, use of thermometer, and cleaning of food contact surfaces. Repeated measures of knowledge and practice were done at baseline, after training using ServSafe, and 1 week after the TPB intervention. The intervention, based on barriers identified from posttraining focus group interviews, involved the placing of colorful "Did you know" signs in high-traffic areas of the restaurants. York et al. found that hand washing knowledge significantly improved posttraining ($p < 0.01$) and post intervention ($p < 0.05$). However, there was no significant change in knowledge in the other variables measured. Observation revealed a significant improvement in behavior in all three areas post intervention over baseline scores ($p < 0.01$) and posttraining ($p < 0.05$). In all three areas, posttraining behavior was not significantly better than baseline. Training alone may improve knowledge, but does not improve behavior. Improvement in behavior requires an intervention that will address barriers to performing desired food safety behaviors/attitudes toward food safety practices.

Anding, Boleman, and Thompson (2007) evaluated the impact of a food safety education program by assessing self-reported changes in food safety behaviors among

food service employees. The training program-Food Safety: It's Our Business (FSIOB)-was designed to train food service workers as certified food managers and was delivered over 1 or 2 days using interactive activities, such as temperature measurement and hand washing techniques. Data were collected from 710 participants who completed the program using a mailed survey instrument that required recall of the frequency of practicing 12 safety practices critical to the prevention of foodborne illnesses. Anding et al. showed that there was significant self-reported improvement in behavior after the completion of the FSIOB program in all 12 food handling practices ($p < 0.05$). The practices assessed were cold holding of food, measurement of internal temperature, date marking of ready-to-eat potentially hazardous foods, cooling of foods, hand washing, cleaning and sanitizing of work surfaces, utensils and cutting boards, cleaning of equipment, storage of raw foods, and pest management. Large effect size was noted for measuring of internal food temperature (0.93) and using the two-step cooling process (0.80). Food workers who were certified food managers reported significantly greater changes in practices ($p < 0.05$). Food safety education programs are effective in helping to improve safe food handling practices among food workers.

Ehiri, Morris, and McEwen (1997) conducted an experimental study to ascertain the effectiveness of a food hygiene training course in Scotland. Although this is an old study, it was included in the review because of its similarity and relevance to the present study with respect to the training program being evaluated, the method used, the use of an untrained control group, and the areas of knowledge being assessed. In this study, Ehiri et al. used the Solomon 4 experimental design to create two intervention groups and two

control groups. The 188 food handlers who undertook the Royal Environmental Health Institute of Scotland (REHIS) elementary food hygiene training course was divided into two equal groups, with half receiving a pretest and posttest and the other half posttest only. The comparison group, drawn from a similar population in the locality, was comprised of 204 participants. Seventy five participants were asked to do the pretest and posttest and 129 did the posttest only. Questionnaire surveys and a 20-question pre and posttest were used to collect data on areas, such as awareness of food-borne disease agents, food storage, cross contamination, temperature control, personal hygiene practices, knowledge of high risk foods, and awareness about HACCP. Ehiri et al. showed that there was no significant impact of the pretest on the study results. Participants in the intervention group showed little improvement in knowledge when pretest and posttest scores were compared for all variables. In some instances, the comparison group performed better than the intervention group. In one instance, there was a decrease in knowledge after training with respect to times when cross contamination can occur in the food establishment (52% to 31%, $p < 0.005$). Training programs should be based on behavior change theories and use training strategies and interventions that develop skills and increase participation.

Chapman, Eversley, Fillion, McLaurin, and Powell (2010) used a communication intervention (posting of food safety information sheets in work areas and subsequent video observation) to demonstrate that food handlers' food handling practices can be positively influenced by nontraditional training methods. Nonparticipant observation was conducted at baseline in eight food preparation sites of a large international food service

company in Ontario, Canada. Forty seven food handlers were observed on their practices of hand washing and cross contamination. Food safety information sheets were then placed in five high traffic areas in the food preparation departments and changed each week for a period of 7 weeks. Postintervention video recordings were then conducted and the results compared with baseline. Chapman et al. found that the intervention contributed to significant improvement in all events observed. Hand washing attempts improved by 6.7% and correct hand washing events by 68.9%. Indirect cross-contamination was reduced by 19.6% and direct cross-contamination by 81.7% ($p < 0.05$, 95% *CI*). While there was improvement, Chapman et al. noted that risky behaviors still existed in these establishments. Hence, the risk of food-borne disease transmission via food workers can be effectively reduced if other methods (theory-based training and organizational change) are used along with interventions.

Training Based on Social Cognitive Theories

As traditional training methods have failed to produce the desired food handling behavior changes in food handlers, researchers have advocated using social cognitive theories and models to help food handlers understand behaviors. Such theories include Bandura's Social Cognitive Theory - SCT (Cherry, 2011), the theory of reasoned action (Ajzen & Fishbein 1980), the Theory of Planned Behaviour - TPB (Ajzen, 1991), and the Health Belief Model - HBM (Janz & Becker, 1984).

Social Cognitive Theory

The main theoretical framework selected for the food safety education study in Jamaica was Bandura's SCT. According to Bandura (as cited in Cherry, 2011), "Most

human behavior is learned observationally through modeling: by observing others, one forms an idea of how new behaviors are performed, and on later occasions, this coded information serves as a guide for action" (Introduction section, para. 1). According to SCT, people learn from others through observation, imitation, and modeling; the individual's mental states are essential to the learning process, and people can learn new things without demonstrating a change in behavior. Behavior change is dependent on the environment; hence, human behavior is a continuous interaction between personal (cognitive) factors, those behaviors, and environmental factors.

There are three basic models of observational learning (modeling): (a) a live model-an individual demonstrating or acting out a behavior, (b) a verbal instruction model-description and explanation of behaviors, and (c) a symbolic model-real or fictional characters displaying behavior in films, books, or online media (Bandura as cited in Cherry, 2011). An individual's mental state, which is described as intrinsic reinforcement, can influence learning and behavior change. Examples include pride, satisfaction, and a sense of accomplishment. When new information is acquired, there needs to be an environment conducive to practice for the individual to translate learning into behavior change. Observational learning involves four steps: paying attention, retaining information, reproducing the information in the form of behavior performance, and motivation to imitate the modeled behavior, in which reinforcement and punishment can play a role. Food safety education sessions based on the SCT should be interactive, using repetition and audiovisuals to aid retention, provide opportunities for the reproduction of the modeled behaviors, and use incentives (certification and special

awards) to provide motivation. While learning is usually assessed through a written test, permanent behavior change will not result if the work environments do not provide opportunities for the food handlers to practice the new behaviors.

Theory of Planned Behavior

Ajzen (1985, 1991) developed the TPB and postulated that the most important factor that precedes a behavior is the intention to perform the behavior. This behavioral intention is determined by the extent to which the individual perceives that he or she can exercise control over the behavior (Glanz, Rimer, & Lewis, 2002, p. 74). Perceived behavioral control is determined by personal beliefs about how difficult or easy it is to perform the behavior. Other factors determining behavioral intentions are subjective norms surrounding the performance of the behavior and the individual's attitude to the behavior. Subjective norm is an individual's perception of whether significant others think that the behavior should be performed. If perceived behavioral control is a determinant of behavior, then knowledge of the factors that impede or facilitate behavioral control is instrumental in developing interventions targeting behavior change.

Seaman and Eves (2008) looked at food hygiene training in small- to medium-sized care settings using the TPB. Questionnaires based on the TPB, along with in-depth interviews with food handlers and the managers, were used to gather data from 155 food handlers and 10 managers in care settings such as nurseries, day care centers, preschools, respite units, and residential homes. Seaman and Eves evaluated the impact of different factors on the intentions of food handlers to handle food safely and found that subjective norms (other people's opinions) had the greatest influence on food handlers' behavioral

intention to perform safe food handling practices at all times ($\beta = 0.55$, $p \leq 0.001$), while attitude did not have a significant influence. Also, training significantly influenced the subjective norms of food handlers. Trained food handlers were more concerned about what others thought of their behavior in the workplace. Training, however, did not influence intentions to perform safe food handling practices on all occasions. Untrained food handlers displayed a positive attitude towards training and most managers did not provide support for untrained food handlers. Managerial training in food safety and subsequent in-house training and support for food handlers may reduce the risk of food-borne disease outbreaks in care settings.

Clayton and Griffith (2008) investigated the efficacy of an extended TPB model for predicting hand hygiene practices of caterers in food handling establishments in South Wales, United Kingdom. The extended model included aspects of the HBM and the TPB incorporated in a Hand Hygiene Instrument (HHI). One hundred and fifteen (115) food handlers from 29 food businesses participated in the study. Data were collected by observation and completion of the HHI. Food handlers were observed on three different occasions and then were asked to complete the instrument that targeted beliefs about the outcomes of carrying out hand hygiene actions, perceived behavioral controls, and perceived susceptibility to, and severity of, food-borne illnesses among patrons that may be derived from their hand hygiene actions. Clayton and Griffith found that the TPB was a good model in predicting hand hygiene malpractices as it explained 34% of the variance ($p < 0.05$). The model also explained 24% of the variance in intentions. Significant predictors of hand hygiene malpractices were attitudes, subjective norms, descriptive

norms, perceived behavioral control, and intention. Although a large percent of the variance remains unexplained, training programs based solely on information giving cannot improve food handling practices. There needs to be a clear understanding of the factors influencing behavior change within the individuals and within the environment where these behaviors are practiced.

Health Belief Model

The HBM was developed in the 1950s by a group of social psychologists in the United States to explain and predict health behaviors (Glanz et al., 2002, p. 46). According to the HBM, an individual will be inclined to take action if he or she perceives him or herself to be susceptible to an adverse or severe situation and that the benefits of taking action will outweigh the cost or barriers. HBM theorists also identified two other constructs: "cues to action" that will spur the individual into action and self-efficacy, which is the individual's perceived ability to do something about the situation.

Cho et al. (2012) used the six constructs of the HBM (perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy) to investigate Latino(a) food handlers' attitude to food safety and possible predictors of food safety behaviors. Two hundred and ninety seven eligible restaurant employees participated in the study that was conducted across several U.S. states by completing a self-administered questionnaire. Cho et al. found that food safety knowledge was a significant predictor of three constructs of the HBM: perceived severity of food safety action ($\beta = 0.20$, $p = 0.01$), perceived susceptibility to food-borne illnesses ($\beta = 0.23$, $p = 0.01$), and food safety knowledge also reduced perceived barriers to

performing safe food handling practices (β = -0.23, p = 0.001). However, food handling behavior was not affected by any of these three constructs. The only factor that affected food handling behavior was perceived benefit of safe food handling actions such as "increased management satisfaction" (β = 0.17, p = 0.05). While one drawback in this study was self-reported practices that led to the possibility of social desirability bias, the findings support the need for the continued provision of training for food handlers. The training methods may have to be reconsidered to address the needs of the learners.

Knowledge, Attitude, and Practice Model

While it is recognized that theory-based training programs are more likely to yield better results, many jurisdictions have continued to use the traditional methods of training based on the KAP model, which has a focus on information giving. According to the KAP model, an individual's behavior is dependent on his or her knowledge and the provision of knowledge will directly lead to a change in attitude and practice (Rennie, 1995). Even though a lack of knowledge on the part of food handlers has contributed to the prevalence of food-borne diseases (WHO, 2000), and training and education are essential in supplying this knowledge, it does not automatically translate to safe food handling practices (Clayton & Griffith, 2008). It is important that research be conducted to ascertain the level of knowledge of food handlers concerning safe food handling practices and the actual practices that take place in the work environment so that relevant and effective food training programs can be planned. Some scholars have addressed only one variable (knowledge or practice), while others have combined knowledge, attitude,

and practices as variables of interest. In this review, I addressed the variables separately and in combination.

Food Handlers' Food Safety Knowledge

Many studies have been conducted in different countries to assess food handlers' food safety knowledge on areas such as hand washing, temperature control, cross contamination, food storage, and some aspects of food microbiology. Hislop and Shaw (2009) conducted a study in Edmonton, Canada to determine the food safety knowledge of food handlers in the food service industry. Knowledge was assessed by using standardized, self-administered questionnaire distributed by environmental health officers during site inspection. Both certified and noncertified food handlers were included in the study to determine if a relationship existed between length of time since certification and food hygiene knowledge, or between number of years of experience in the food industry and food safety knowledge. Six hundred and thirty food handlers participated in this study. A score of less than 50% was considered a failure by the researchers. Scores were also cut off at 70%, which is minimum score set by the health authorities in Edmonton for certification. Hislop and Shaw found that, of the certified food handlers, 68% had training of 5 years and under. Also, 98% achieved scores higher than 50% and 94% had scores higher than 70%. Food handlers training (certified food handler) was significantly associated with passing at the 50% ($p = 0.007$) or 70% ($p = 0.015$) cutoff points. However, length of time since training had no significant influence on the passing scores of certified food handlers ($p = 0.821$) or noncertified food handlers ($p = 0.543$), neither at the 50th or 70th percentile. There was, however, a significant difference of failure rates

between certified and noncertified food handlers as the failure rates for the noncertified were between two to five times that of the certified food handler. The highest failure rates were for those with over 10 years of experience. Training had a positive impact on food safety knowledge and recertification was necessary at intervals as knowledge retention decreased with passage of time.

Jianu and Chis (2012) used a cross-sectional quantitative study to determine food hygiene knowledge level of food handlers working in Romanian small- and medium-sized companies and also to provide baseline data for training programs for food handlers in Romania. Structured, self-administered questionnaires were used to elicit information on demographics and level of knowledge concerning food poisoning, cross-contamination, time temperature control, and personal hygiene. The 211 participants were drawn from the meat industry, dairies, bakeries, catering, and retail trades that had implemented the HACCP system. Although 46 companies met the criteria, 33 companies (72% response rate) participated. From the findings, there was no significant difference in level of food handlers' knowledge based on gender, age, or professional experience. However, knowledge levels were significantly greater based on educational levels, with food handlers with higher education achieving higher knowledge scores (F= 3.779, p = 0.011). There were also significant differences in knowledge scores of the three categories of food handlers, with production staff scoring highest and retail staff lowest (F= 38.107, p =0.022). Production staff displayed significantly higher levels of knowledge on food poisoning, cross-contamination and sanitation, time temperature control, and personal hygiene. However, there was a low-level of knowledge on some

areas. Jianu and Chis concluded that the low level of knowledge of some of these trained food handlers indicate the need for retraining of food handlers using different methodologies from the knowledge-based programs that were used to train food handlers. Training methods should concentrate on the needs of the food handlers.

Martins et al. (2012) conducted a study to assess food hygiene knowledge of food handlers employed to a catering company in Portugal. In a cross-sectional study, Martins et al. used a self-administered questionnaire to collect data from 102 food handlers on critical food safety areas such as temperature control, personal hygiene, surface and utensils hygiene, contamination/high risk foods, and food storage. Statistical analysis was done using SPSS and Martins et al. found that the average score was 56.5%, with scores ranging from 87% to just over 4%. Specific questions relating to knowledge of areas that can have food safety impact were analyzed. Knowledge level scores for temperature control questions were significantly lower than the average score for the full questionnaire ($p < 0.001$). Temperature control is vital in controlling microbial growth in food (Jay, Loessner, & Golden, 2005) and improper holding temperatures have been linked to food-borne disease outbreaks. Food handlers' knowledge was also significantly lower than the full questionnaire on the issue of contamination/high-risk foods ($p < 0.001$). Food handlers believed that contamination could be identified by organoleptic means. There was also a low-level of knowledge demonstrated for foodborne pathogens. On the other hand, knowledge level was high for surface and utensils hygiene and food storage. Experience and education had statistically significant effects on the results, as advanced schooling ($p < 0.05$) and length of years of the company ($p < 0.05$) were related

to higher scores on overall performance. These food handlers lacked knowledge on vital aspects of food safety and recommended that this should be addressed through training designed to address health needs and which incorporates a hands-on approach.

Food safety knowledge levels of food handlers may be influenced by language barriers and training methodologies used in training food handlers drawn from populations where English is not the main language. Panchal, Liu, and Dworkin (2012) outlined the results of a survey to assess baseline food safety knowledge of 508 food handlers in 125 restaurants in Chicago. A 58-question survey was used to collect information on food safety knowledge, behavior, and food hygiene practices of food handlers, along with demographic data. English was the primary language for 53% of the respondents, and 39% had no formal training in food safety. The mean knowledge score was 71%. However, food handlers with training scored higher than those without training (76% versus 63%, $p < 0.05$). Both groups (English and non-English food handlers) performed poorly in questions related to the temperature danger zone; however, English-speaking food handlers responded correctly more often (16% versus 5%, $p < 0.05$). Also, English speakers were more likely to respond positively to hygiene practice questions such as hand washing. The main gaps in food handlers' knowledge were in areas, such as cooking, holding temperatures, and hygiene practices. These findings were consistent with other studies conducted in the United States, such as DeBess et al. (2009) who conducted a similar study in Oregon.

Food Hygiene Practices of Food Handlers

Researchers have used two main methods to assess food handling practices: self-reported questionnaires and observation.

Self-Reported Studies

Green et al. (2005) conducted a study among food service facility workers at nine Foodborne Active Surveillance Network (FoodNet) sites to determine the self-reported prevalence of safe and unsafe food handling practices and other factors that may have influenced these practices. Using results from the 486 eligible respondents to the FoodNet population survey, data were collected on four food handling practices related to the transmission of foodborne illnesses: hand washing, use of gloves when handling ready-to-eat foods, temperature assessment of prepared foods, and working in food preparation areas when ill with vomiting or diarrhea. Green et al. found that 40% of workers handling ready-to-eat foods wore gloves and changed gloves on an average 15.6 times during an 8 hour shift (n = 127,*CI* [12.1, 19.1]). Food service workers washed hands on an average 15.7 times during the same time interval (n = 420, 95% *CI* [14.0, 17.4]). Seventy-one percent of workers who handled both raw and ready-to-eat foods reported that they always washed hands, and 67% change gloves between touching foods to avoid cross contamination. Forty-seven percent of respondents used thermometers to check internal temperatures of food, and 5% reported that they worked while ill with vomiting or diarrhea. Age, restaurant type, and work responsibilities significantly impacted differences in food handling practices. Generally, FoodNet respondents reported risky food handling practices, which increased the risk of cross contamination

and the potential for food-borne disease outbreak. One weakness of the study was that self-reported data are susceptible to response/social desirability bias-individuals reporting desirable behavior rather than the actual behavior. More information is needed to determine the relationship among the variables of management responsibility, age, experience, food safety knowledge, and food handling practices.

Van Tonder et al. (2007) studied the personal and general hygiene practices and level of training of food handlers in retail outlets in South Africa. Data were collected from 50 randomly selected food handlers from 35 food outlets using interviewer-administered questionnaires. Van Tonder et al. found that most food handlers reported a satisfactory level of food handling practices such as washing hands after visiting the toilet or before each shift (100%), wearing and frequently changing protective clothing such as gloves (82%), never suffered cough or diarrhea on the job (92%), reported illness to management (82%), and cleaning work contact surfaces (92%). Eighty-four percent of respondents were trained. This may account for the high level of responses and supports the hypothesis that effective training of food handlers should be a part of food control activities in order to prevent food-borne disease outbreaks.

In this Jamaican study, I used a similar self-reported methodology to determine food handling practices of food handlers. While there is an inherent weakness in using self-reported data (response bias), steps can be taken to strengthen the method (for example, using anonymity in data collection). When doing surveys on behavior or practice in a large population, the collection of self-reported data is more feasible than

observation. I also addressed the gaps in the previous studies by determining the relationship between demographic variables and food handling knowledge and practice.

Observational Studies

Some researchers have used observational studies to determine food handling practices. Observations are more reliable means of collecting practice data as employees tend to overestimate their actual behaviors, thereby introducing social desirability bias (Clayton & Griffith, 2004). On this premise, Clayton and Griffith (2004) observed food safety practices in 29 catering establishments in Wales using notational analysis. A total of 115 food handlers, all of whom had received some form of food hygiene training, participated in the study. Each food handler was observed on three separate occasions performing over 270 actions. The areas of observation focused on hand hygiene practices, cleaning of food contact surfaces and equipment, washing of utensils, and use of different utensils for preparing raw and ready-to-eat foods.

Clayton and Griffith (2004) found that hand hygiene malpractice is more frequent than the other two food hygiene behaviors observed. Correct hand hygiene practice was observed on only 31% of the required occasions and were not attempted on most of the required occasions, such as after touching potentially contaminated surfaces, after touching hair and face, and after handling potentially contaminated food. Two major hand hygiene errors were observed: failure to use soap and failure to dry hands. With respect to cleaning of food contact surfaces, 31% of caterers carried out this action adequately 33% of the time and failed to attempt cleaning in 60% of the required times. Adequate washing of utensils and use of different utensils were observed more frequently

than correct hand hygiene and cleaning actions. Appropriate utensils were used and adequately washed on 91% of occasions observed. Training was not effective in ensuring safe food handling practices with respect to hand hygiene and cleaning of work surfaces. All food handlers in the study were trained /certified. There needs to be a change in training strategies, focusing more on effective methodologies that will ensure the transfer of knowledge into practice, rather than the present emphasis on knowledge dissemination and certification.

Lubran et al. (2010) also conducted an observational study to examine the behavior of food employees in deli departments in nine stores in Maryland and Virginia and to ascertain the level of compliance with the Food Code. A notational analysis observation protocol focusing on hand washing and the cleaning of equipment, utensils and surfaces was used to collect data from 33 employees; 25 from chain stores, and eight from independent stores. Lubran et al. found that all employees used gloves on all occasions when handling ready-to-eat foods. However, hand washing was observed in 17% of recommended times at the independent stores. The majority of times hands were washed were when gloves were changed. Food employees cleaned and sanitized food contact surfaces 100% of the recommended times. The information gained from this study improved the understanding of food handling practices in delis and can be used to improve the quality of food offered by these establishments. The major limitation of this study was the use of one observer. This limited ability to obtain a reliability estimate of the study. A complete study of Food Code compliance was not possible due to the inability of the observer to capture all the activities of food handlers. Also, this small

convenience sample from one region reduces the generalizability of the study results. Preplanned, announced visits may also have led to food handlers behaving abnormally (Hawthorne effect). A larger study is needed with multiple trained observers to improve reliability of the results.

An increase in diversity is reflected in the restaurant industry as more ethnic restaurants are being established. Roberts et al. (2011) conducted a U.S.-based study to determine safety practices per the Food Code in ethnic and nonethnic restaurants in Kansas. Four hundred and twenty four ethnic and 500 nonethnic restaurants constituted the sample, and these were further classified as independent or chain restaurants. A data collection form was developed to capture violation information from inspection reports done over a 1-year period (2007-2008). Independent ethnic restaurants had the highest number of critical (4.52 ± 2.85) and noncritical (2.84 ± 2.85) violations ($p < 0.001$). Critical violations are more likely to contribute to foodborne illnesses. Independent restaurants also had a greater number of violations than chain restaurants. The violations were directly related to food handling practices, such as time and temperature abuse, personal hygiene, and cross-contamination. Independent ethnic restaurants also had a greater number of annual inspections (2.29 ± 1.63) ($p < 0.001$), indicating the presence of food safety problems within these facilities. While Roberts et al. did not explore the knowledge of food handlers with respect to food hygiene or the Food Code, improved knowledge and culturally relevant training should improve food safety practices and reduce food violations.

The nature of this study precluded the use of observation as the preferred method for collecting practice data. Food handlers were not interviewed on the job; data were collected at the training sessions. Food handlers at training sessions came from diverse food establishments across a wide geographic location; it was not feasible to provide observers at these numerous establishments to observe their practices. Also, observation was only performed on a limited number of variables within a particular time, while self-reported data can capture more information on more variables.

Food Safety Knowledge and Practices

Researchers have evaluated both food safety knowledge and practices among food handlers in various food service settings in many countries across the world. In Slovenia, Jevsnik et al. (2008) conducted a study to assess food safety knowledge and practices among three groups of food handlers in 2005. Self-administered questionnaires were used to gather data from 386 food handlers working in production, catering, and retail units. Most of the respondents were females working in the retail food business with lower than a high school education. Comparative analyses were done on employees' responses to knowledge and practice questions, responses to opinion of food safety, and responses to work satisfaction. Jevsnik et al. found that there was no significant difference among the three groups of employees with respect to knowledge and practice. There was an inadequate knowledge of food handlers about microbiological hazards, correct temperature for hot holding, use of organoleptic methods to detect food contamination, and risks involved with handling food while experiencing health problems.

Chuckwuocha et al. (2009) conducted a study to determine knowledge, attitude, and practices of food handlers in food sanitation in South Africa. The study was based on the premise that education, training, and examination are key components in ensuring that food handlers are proficient and knowledgeable about food safety. This cross-sectional, quantitative study involved food handlers drawn from the registry of the municipal council. Questionnaires, developed and pretested by the researchers, and inspection forms were used to gather data from 430 food handlers. Chuckwuocha et al. found significant differences of knowledge ($X^2 = 4.6$, $P < .05$) and practice ($X^2 = 5.1$, $P < 0.05$) between trained and untrained food handlers. No difference in attitude was observed. Significant potential influencing factors were type of premises (food stalls) and level of education (secondary). Food handlers who were not trained, like those working in food stalls, had a four times higher odds of having poor knowledge. Most food handlers had a low-level of education, which may have contributed to a lack of understanding of training material. Although attitude was good towards some practices, especially hand washing, food handlers should receive training in the principles of food safety namely personal hygiene, temperature control, cross-contamination, and microbial growth and survival.

Santos et al. (2008) also looked at the knowledge levels of food handlers and their self-reported behavior towards food safety in Portuguese school canteens. The theoretical framework for this study was the KAP model, which states that provision of information will lead to desired behavioral changes. An interviewer- administered questionnaire that collected data on sociodemographic characteristics, knowledge of food

hygiene, self-reported behaviors towards safe food handling, and personal health and hygiene was administered to 124 food handlers from 32 school canteens. Santos et al. revealed that food handlers' knowledge was high regarding personal hygiene and cross-contamination, but little was known about pathogens and the risk of contamination between raw and cooked foods. The weakest area of knowledge was temperature control. Trained food handlers had a significantly higher knowledge score than the untrained ($p < 0.000$). Although the behavior score was high, workload had a significant impact on behavior ($X^2 = 13.9$, $p < 0.001$) in that, at peak periods, food handlers did not practice desired behaviors. Education levels significantly impacted scores for hygiene behavior ($X^2 = 10.7$, $p < 0.01$). Generally, there was a great variation in the level of knowledge of food handlers, and Santos et al. concluded that this could be improved through training and motivation. There was no relationship between knowledge and self-reported behavior ($r = 0.09$, $p > 0.05$). The use of a face-to-face interview may have led to participants reporting intended or correct behavior instead of actual behavior or practice. Further study is needed to assess whether education and knowledge influenced changes in work practice.

In a cross-sectional survey, Hertzman and Barrash (2007) investigated food safety knowledge and practices of catering employees in the southwestern U.S. city of Las Vegas. This analysis was done using a 20-question food safety survey and a checklist to guide the observation of food handlers' activities. Hertzman and Barrash targeted social caterers and restaurants, hotels, and casinos that offered catering services in Las Vegas. A convenience snowball sample of 23 catering events was selected, and 81 surveys were

completed. Over 30% of employees scored below 70% of the survey, with limited knowledge on adequate cooking temperature, proper equipment use, proper holding temperature, and personal hygiene. Employees of independent operations scored significantly higher than those of corporate operations ($p = 0.009$ at the 0.005 alpha level). Most observed violations were with respect to personal hygiene (specifically lack of proper hand washing), followed by holding of prepared food at the correct temperature. The actions of employees were not in keeping with food safety knowledge expressed on the survey, as they failed to follow the proper food handling procedures they identified. Food safety knowledge may not automatically translate into safe practices. One limitation of the study was the inability to generalize the findings due to the nonrandom sampling methodology resulting from a lack of cooperation from caterers. Also, the presence of observers may have introduced bias into the study as food workers may endeavor to perform according to expectations (the Hawthorne effect). Hertzman and Barrash did not establish prior knowledge and were unable to determine if prior knowledge or training had an influence on knowledge on practice. Also the discrepancy between knowledge and practice needs to be investigated.

Gomes-Neves et al. (2007) used a cross-sectional quantitative study to compare food safety knowledge and practices in three food handling groups in Portugal: food handlers from small independent food businesses, first-year university students, and third- and fourth-year students at the University of Porto who were enrolled in courses with a public health background. Data were collected using self-administered questionnaires that covered key food safety knowledge and practice issues. The 79 food

handlers had a week to respond, while 152 students completed their instruments during one class session. Gomes-Neves et al. found that the knowledge level of food handlers was significantly lower than the two groups of students, with a mean score of 55% (food handlers), 66% (first-year students) and a 77% (third- and fourth-year students; $p < 0.0001$). With respect to practice, the food handlers scored significantly higher than the students ($p < 0.05$). Item analysis revealed that food handlers had generally poor knowledge on microbiological hazards and other key aspects of food safety required for the protection of the public from foodborne illnesses. This may be due to the generally low educational level of food handlers. Food hygiene training should be a legal requirement and form part of a comprehensive food safety management program. The small sample size limited the generalizability of the findings. However, there is a need to improve training for not only food handlers, but also public health professionals (those in veterinary and human medicine) who can assist in the training and evaluation of food handlers in the future.

DeBess et al. (2009) also assessed food handlers in Oregon to determine their knowledge and practices with respect to food hygiene and to ascertain possible gaps in education and training. This cross-sectional quantitative survey consisted of a 28-question self-administered questionnaire completed by food handlers from 67 (from a possible 1265) randomly selected restaurants. In a survey, DeBess et al. sought information on knowledge of food-borne illnesses and prevention, food hygiene, food handling practices, and demographics. Four hundred and seven food handlers from food service, fast food, self-serve, and buffet dining restaurants in two Oregon counties were

included in the study. The average survey score was 68%, 2% below the pass rate of 70% for Oregon. Forty-eight percent of food handlers scored below 70%. There were significantly higher scores in food handlers who were certified (69% compared to 63%, $p < 0.001$), had tertiary education (73% versus 64%, $p < 0.001$) and were in management positions at (74% versus 67%, $p < 0.001$). Generally, the questions concerning food contamination and sanitation averaged about 70%, while those on food safety and personal hygiene averaged below 70%. Food handlers demonstrated limited knowledge about food safety. One of the most significant measures to reduce food-borne disease spread is good kitchen hygiene practices, and this can be improved through the training of food handlers.

Tokuc, Ekluku, Berberoglu, Bilge, and Dedeler (2009) investigated knowledge, attitudes, and practices of food service staff regarding food hygiene in hospitals in Turkey using a self-administered questionnaire administered by a face-to-face interview. Tokuc et al. collected demographic data, along with information on knowledge about food hygiene, foodborne diseases, attitudes about prevention of foodborne diseases, and practices with regards to the prevention of food contamination. Twenty three food service workers from three hospitals participated. Tokuc et al. showed that there was a general lack of knowledge regarding correct holding temperature of food (41% incorrect responses), foodborne pathogens (41% incorrect responses), and refrigeration temperatures (27% incorrect responses). Attitude to food hygiene, especially hand washing, was good as 95% of respondents believed it was important to wash hands to reduce the risk of contamination. However, practice was not consistent with attitudes as

hand washing and glove use to prevent cross contamination were not frequently practiced. None of the 73 respondents ever attended a food hygiene course. Tokuc et al. indicated an immediate need for training of hospital food service workers using educational strategies that will not only produce certificated individuals, but using theory-based models that improve both knowledge and practice (Tokuc et al., 2009).

Buccheri, Mammina, Giammanco, Giammanco, and La Guardia (2010) also investigated knowledge, attitudes, and practices of food service staff in nursing homes and long-term care facilities for the elderly in Italy. Ten nursing homes and one long-term care facility with a total of 502 respondents were included in the study that used a self-administered questionnaire. Buccheri et al. found that most respondents (80.3%) had some form of food hygiene training. Knowledge assessment revealed that knowledge level was high regarding glove use to prevent food-borne disease transmission and the risks of food poisoning associated with advanced food preparation and reheating of food. However, respondents had limited knowledge of storage temperatures (hot and cold) for ready-to-eat foods (82%) and of high risk foods associated with food-borne illnesses (24.2%). Attitudes were positive regarding safe food storage, temperature control, and glove use. However, the results were not good for attitude to thawing and refreezing, as over 15% believed that thawed food should be refrozen. Despite the positive attitude to food hygiene, self-reported behavior showed a number of unsafe food hygiene practices, such as thawing foods at room temperature (91.4%) and using the same utensils for raw and cooked foods (34.1%). Education level was significantly related to higher food hygiene knowledge and shorter length of service associated with unsafe food hygiene

practices. Training was significantly positively associated with food handlers' knowledge, attitudes, and practices, indicating that training had a positive influence on the number of correct answers given by respondents. Although the study results were limited by small study population and low response rate for knowledge assessment, Buccheri et al. demonstrated a need for more information for food handlers in long-term care facilities regarding food hygiene through effective training programs.

Bas, Ersun, and Kivanc (2007) evaluated the food hygiene knowledge, attitudes, and practices of food handlers in food businesses in Turkey. Seven hundred and sixty four food handlers from 109 food business (hospital food services, catering companies, school food services, hotels, kebab houses, takeaways, and restaurants) participated in the study. Data were collected using two questionnaires, one on knowledge and the other on attitudes and practices. The knowledge questionnaire focused on high-risk food groups, cleaning, temperature control, cross contamination, personal hygiene, and food poisoning, as well as demographic information from the respondents. In the knowledge questionnaire, Bas et al. revealed that food safety knowledge was poor, with a mean food safety score of 43.4 ± 16.3%. Knowledge was lowest in the area of time temperature control and hand washing practices. Approximately 48% of food handlers were not trained, and knowledge level was significantly higher for trained food handlers (45.8 ± 17.6) than for the untrained (40.8 ± 14.3; $p < 0.05$). Food handlers' knowledge was also higher in hospital and school food handlers than among food handlers from the other food businesses. While food safety attitudes were generally positive (79% and over), food safety practice scores were averaging 48.4 ± 8.8%. Practice scores were significantly

higher for the trained food handlers ($p < 0.05$), and caters and school food service workers had higher scores than restaurants and hotels. Due to the lack of knowledge and poor food handling practices by food handlers in food businesses in Turkey, emphasis should be placed on food hygiene training before employment and continuous training during employment.

Use of Surveys in Food Handlers' Assessment

The majority of studies reviewed employed the survey method, using self-administered questionnaires to determine food safety knowledge levels and self-reported hygiene practices of food handlers with respect to food hygiene (Bas et al., 2006; Buccheri et al., 2010' Chukwuocha et al., 2009; DeBess et al., 2009; Gomes-Neves et al., 2007; Jevsnik et al., 2008; Tokuc et al., 2009). Redmond and Griffith (2003), in comparing and evaluating consumer food safety studies, stated that survey was a common method used by researchers to measure general food safety and hygiene knowledge, understanding of food safety issues, food safety attitudes, and self-reported practices. Redmond and Griffith found that using this method was advantageous in that knowledge determination was straightforward, and the information gleaned is an accurate description of the issue being investigated. The accurate determination of knowledge is imperative for the development of effective training programs and also for the evaluation of the effectiveness of existing programs (Redmond & Griffith, 2003).

The survey method was appropriate for the Jamaican study as no prior research had been done in the area, and there is need to determine food safety knowledge and practices from a wide cross-section of food handlers who had been trained by the health

authorities. The information gleaned will determine the effectiveness of existing government training programs and help to shape new training programs, if they are deemed to be necessary.

Two studies were found to be relevant to this study and they guided the study development. One study was by Gomes-Neves et al. (2007) who used a self-administered questionnaire design to evaluate knowledge and practice in three relevant groups in Portugal. Gomes-Neves et al. granted me permission to use the instrument and it formed a part of the instrument used in the Jamaican study. In this study, I compared knowledge and self-reported practices of three groups of food handlers in Jamaica, two groups trained in different government training programs (in-house and health department based), and one untrained (control) group. Gomes-Neves et al. used a chi square test to demonstrate that there was a significant difference in the proportion of correct answers in each group. The one-way ANOVA was done to demonstrate that there was a significant difference in the mean score of participants within each group at the 0.05 level of significance. Descriptive statistics were used to describe the demographic characteristic of the three groups.

Santos et al. (2008) study focused on knowledge level and self-reported behaviors of food handlers in school canteens in Portugal. Santos et al. addressed similar variables (knowledge, practice, sociodemography, and training). Santos et al. also used one-way ANOVA to test the differences in the means of food handlers' knowledge and practice scores as a function of sociodemographics and training. Santos et al. granted me permission to use the instrument.

Literature Related to Differing Methodologies

Determining the effectiveness of training through the assessment of food safety knowledge and food handling practices among food handlers has been conducted using different methodologies. One method used was meta-analysis, or the combination of various studies, as in Egan et al. (2007). Egan et al. analyzed 46 studies, mainly descriptive, to assess attitude, knowledge, behavior, and practice using questionnaires or pre-posttests. Of these, only four provided evidence to support the effectiveness of food handler training and recertification (Egan et al., 2007). A meta-analysis was not appropriate for the Jamaican study as there were no published studies on the effectiveness of training of food handlers in this jurisdiction.

Another method that was used was observation. However, this is only applicable when assessing food handling practices (Clayton & Griffith, 2004; Lubran et al, 2010). While this method may be more reliable than self-reporting, as it eliminates social desirability bias, observation is human-resource intensive. This limits the number of subjects that can be studied in a given time period. There is also the possibility of bias as the presence of observers may influence food handlers' behavior, leading to the Hawthorne effect (Clayton & Griffith, 2004; Hertzman & Barrash, 2007).

Interviews were also used to elicit information on food handlers' knowledge and practice (Santos et al., 2008; Walker et al., 2003). While this was a useful methodology in low literacy situations, the use of a face-to-face interview may lead participants to report intended or correct behavior instead of actual behavior or practice. This method is also labor-intensive and the results may be influenced by interviewer bias.

Summary

The purpose of the literature review was to develop the theoretical basis and justification for the study, which assessed the effectiveness of the food handlers' training program through an assessment of the food safety knowledge and hygiene practices of food handlers in Jamaica. The review provided information on the key areas of the study, namely food handling knowledge, hygiene practices, and effectiveness of food hygiene training program. I also demonstrated that there was a need for this this study because there was no published research on trained food handlers' knowledge and practices in the Caribbean region and specifically, Jamaica.

There was a link between food handlers and food-borne disease outbreaks (Andargie et al., 2008; Beatty et al., 2009; Isara et al., 2009). Training was an important strategy for addressing the problem (WHO, 2007). Training programs based on the KAP (giving information and certifying individuals) were most often used (Egan et al., 2007), but these programs were not as effective as theory-based programs (Clayton & Griffith, 2008) or intervention-type training programs (Chapman et al., 2010). Planning of effective training programs require the establishment of baseline information on knowledge and practices of food handlers. The baseline of knowledge may be determined by questionnaires (Gomes-Neves et al., 2008; Santos et al., 2007), or observation (Clayton & Griffith, 2002) or both (Pilling et al., 2008). Generally, food handlers' knowledge of safe food handling practices is low, and even where it is high, it is not readily translated into practice. Use of social cognitive theories in designing

research and planning training programs (Seaman & Eves, 2008) can help in gaining a better understanding of food handlers' behaviors.

The literature search also helped in determining the appropriate methodology for the study. The main method used by researchers was the cross-sectional survey method, using self-administered questionnaires to determine knowledge and self-reported practices/behaviors. The authors used univariate and bivariate analyses to describe the variables and test relationships between the variables (knowledge, practice, training, and demographics). These analyses were effective in describing knowledge and practice and answering the research question concerning the relationship between training and food safety knowledge and food hygiene practices of food handlers. In Chapter 3, I present the research design.

Chapter 3: Research Method

Introduction

The study design was a quantitative, cross-sectional, causal-comparative study on the effectiveness of the mandatory food safety training program in Jamaica. I compared the food hygiene knowledge and self-reported hygienic practices of trained and untrained food handlers with respect to critical food safety factors and against established food safety practices. Critical food safety factors that are food handler-related included those factors that predisposed consumers to food-borne illnesses, such as hand washing practices, temperature control, thawing and reheating of potentially hazardous foods, cross contamination, and personal hygiene habits.

In this chapter, I provide details of the research design and rationale for selecting the design. Also, the methodology for conducting the study, inclusive of the population and sample selection, recruitment, and data collection procedures, is outlined. Details on instrumentation and operationalization of constructs and data analysis are provided. The chapter ends with threats to validity of the study and ethical procedures.

Research Design and Rationale

The survey is the most widely used method to determine food safety knowledge and self-reported food handling practices of food workers (DeBess et al., 2009; Gomes-Neves et al., 2007; Jevsnik et al., 2008; Santos et al., 2008). The cross-sectional approach was used because it allows for the observation and description of a sample of any population at a particular point in time (Babbie, 2010, p. 106). The causal-comparative design was used to understand the cause and effect between variables in a

nonexperimental setting, as the cause and effects had already taken place and were being examined after the fact (ex post facto; Wiersma, 2000, p. 158). This allowed for the simultaneous comparison of two or more groups based on the independent variable(s). In this study, I compared three groups of food handlers on the basis of training (independent variable), and the effects of interest that were measured were food hygiene knowledge and self-reported hygienic practices. The purpose of the study was to determine whether food handlers trained in either of the government's mandatory training programs were more knowledgeable and reported safer food handling practices than untrained food handlers in Jamaica. I also determined whether food handlers' knowledge and practice improved with the number of training sessions attended. I focused on knowledge with respect to critical food safety factors that were food handler-related and had been linked to food-borne disease outbreaks. These factors are hand washing, temperature control, cross contamination, thawing and reheating of foods, and personal hygiene habits.

Food handlers in Jamaica are trained under two separate programs: one program for general food handlers and the other for food handlers employed in the tourism/hotel industry. These training programs differ on the basis of number of hours, educational environment (one done on-site and the other at a health facility that is far removed from the working environment), and training methodology. I attempted to determine whether the type of training had an effect on the level of knowledge and the self-reported practices of food handlers. The untrained food handlers in both settings were used as controls. The use of a control group strengthened the study, as the comparison of the

results from the trained groups with the control group helped to explain the effects of the training on the knowledge and practice of the trained food handlers.

To determine knowledge and self-reported practice, a self-administered questionnaire was administered to food handlers attending training facilities for certification or recertification. Food handlers being trained for the first time were classified as untrained. The surveys were administered before the start of the training sessions so that the responses would not be influenced by new information presented in the training. I was present to clarify any questions that the food handlers had when answering the questions. This required a considerable amount of time to complete the surveys, as food handlers' training sessions were held with varying frequencies in various localities within each parish/region. For example, training may be done once monthly, twice monthly, once weekly, or as the need arises, in which case, individuals would be given appointments.

Setting and Sample

Setting

Since 1998, the local health department in each parish in Jamaica has conducted food handlers' training sessions in keeping with the requirements of the Food Handling and Tourist Establishment Regulations. All food handlers are required to be trained before employment in the food trade. However, there is no standardized training program, and each health department develops its own training materials and assessment tests with guidance from a regional food safety officer. There is no consistency in the material delivered across health regions/parishes or in the methods used, making it

difficult to assess the national program on the basis of the knowledge and practices of food handlers. Therefore, one region was selected to conduct this study.

Population

The participants in the study were food handlers who registered for training for certification or recertification in one parish in the Western Region in Jamaica. This region is composed of four parishes: Hanover, Westmoreland, St. James, and Trelawny. The parish selected randomly for the study was Westmoreland. The major hotels where in-house training sessions are conducted are located in this region in Jamaica. Therefore, it was possible to obtain a large enough sample size to detect a significant difference in knowledge and practice in the three groups of food handlers, if that difference existed, thereby increasing the power of the study and reducing the probability of a Type II error (accepting the null hypothesis when the alternate is true).

Westmoreland certified and recertified approximately 7,000 general food handlers annually and approximately 1,600 tourist establishment food handlers (R. Stephens, personal communication, May 4, 2012). In Westmoreland, there was a separate training session for first-time applicants (the control group), and food service workers were trained separately from general food handlers, such as food shop operators, itinerant vendors, and bar operators.

Sample Size

The sample size was calculated using G*Power 3 (Faul, Erdfelder, & Buchner, 2007), a free statistical power analysis program found online. A minimum sample size was calculated for each group of food handlers in the parish to arrive at a composite

sample representative of the food handlers in the parish of Westmoreland. This software allowed for the calculation of sample size based on a statistical test. Using the two-group independent means statistical *t* test, the parameters of alpha = 0.05, effect size of 0.2, power $(1 - \beta)$ of 0.80, and two-tailed test were inputted into the calculator. The two-tailed test compared differences between the mean knowledge and practice scores of trained and untrained food handlers and between regular food handlers and those trained for the tourism sector. This resulted in a sample size of 394 for each group and a total sample size of 1,182. The Westmoreland Health Department trained 7,000 regular food handlers and 1,600 tourist establishment food handlers annually. Recruitment continued at the training sites until the sample size was achieved.

Sampling and Sampling Procedure

A purposive, comprehensive sample was used. According to Babbie (2010), a *purposive* or *judgmental sample* is a nonrandom sample in which the units of observation are selected based on the "researcher's judgment about which ones will be most useful or representative" (p. 193). There was no sample frame of food handlers attending training from which a random sample could be drawn. There was no way of ascertaining the number of each category of food handler that would be attending any of the training sites for certification or recertification on any given day. Therefore, all qualified food handlers who were present on any day selected for data collection were included in the study until the sample size for each category was reached. The sample consisted of 1,109 food handlers drawn from hotel workers (391), trained food handlers (394), and untrained food handlers (324). A *qualified food handler*, for the purpose of this study, was one

who prepared and handled potentially hazardous foods and was literate (able to complete the self-administered questionnaire). Food handlers who were unable to read were excluded because they were unable to complete the self-administered test and would have required the services of readers or interviewers. Interviewer administration of the instrument would have served to increase the inherent social desirability bias in self-reported studies. To reduce this bias and strengthen the reliability of the study, self-completed questionnaires that were anonymous were recommended. Food handlers such as bar operators, grocery shop attendants, cashiers, and all other food handlers not directly involved in serving ready-to-eat, potentially hazardous foods were excluded also. In this jurisdiction, these food handlers were classified as general food handlers for training purposes.

The sampling procedure was termed comprehensive, as every unit of observation (qualified food handler) was included in the sample (Wiersma, 2000, p. 285). Participants were invited to participate in the study, and the purpose was clearly outlined. They were also assured that their participation would be voluntary and responses confidential, with no penalty for nonparticipation. All those who indicated their willingness to participate were included in the study. To reduce social desirability bias, which is a threat to external validity, food handlers remained anonymous. Therefore, signed consent forms were not required, as this would have defeated the purpose of anonymity. Instead, an information sheet was attached to the data collection instrument that outlined all of the details of a consent form, except that there was no signature requirement.

Procedures for Recruitment, Participation, and Data Collection

To prepare for the study, I wrote to the director of health promotion and protection and the director of environmental health in the Ministry of Health, outlining the study and requesting permission to use the food handlers trained in the government clinics and hotels as participants in the research. Meetings were arranged with these individuals, and Mr. Broughton and Dr. Copeland granted permission to conduct the research at the sites indicated (personal communication, November 24, 2011). Subsequently, a letter was sent to these individuals requesting their permission in writing. Visits were then made to the local health department, and meetings were conducted with the parish food safety officers in order to outline the purpose of the research and request their cooperation. The food safety officers supplied information on training schedules and the population of food handlers, which was used to determine sample size and the procedure for data collection.

Westmoreland has five training sites for general food handlers' training, and 13 sessions are conducted monthly. All five sites were included in the study. Over a 3-month period (January-April 2014), all training sites were visited and all qualified food handlers were recruited to participate in the study. Information sheets outlining the purpose of the study, noting the voluntary nature of participation, and assuring confidentiality of the data were presented to all participants who gave verbal consent to participate before the surveys were presented to them for completion.

The food handlers participated by completing the self-administered data collection instruments. The instruments were used to collect demographic data, as well

as data on food hygiene knowledge and self-reported hygienic practices. Demographic data included age, gender, years of experience in the food industry, educational level, position in the organization, and number of training sessions attended. The knowledge and practice aspects of the instrument focused on five areas: cross contamination, hand washing, temperature control, thawing and reheating of food, and hygienic practices.

All participants were supplied with the questionnaire and were given time to complete the questionnaire before the start of the training sessions. Data collection started at 8:00 a.m., 1 hour before registration began for the training sessions. Hence, all participants had the opportunity to complete the instruments before the training sessions began, without extending their stay at the training facility. Data collection after the session would have influenced the responses through the fresh information presented, thereby distorting the findings of the study. Also, because the untrained food handlers were used as controls, these individuals were only available before their first training session. No corresponding was allowed during the data collection session. I emphasized that no name should be written on the questionnaires, and I was present to clarify any question that any food handler had. I collected all questionnaires as soon as they were completed. Each instrument took, on average, 30 minutes to complete. Participants remained anonymous and were only identifiable by their demographic profiles. All questionnaires were assigned a number. When the last food handler had completed the instrument, I thanked everyone for participating.

Instrumentation

The final instrument that was used for this study was developed from sections of three validated instruments on food handlers' food safety knowledge and hygienic practices. Permission was granted by the authors of these studies to use their data collection instruments in my research in Jamaica (see Appendices A-C). The first instrument was from Buccheri et al. (2010), who studied knowledge, attitude, and self-reported practices of food handlers in nursing homes in Italy. The section that assessed practice was used from this instrument, as it addressed the practices that were most relevant to this research. Buccheri et al. reported that this self-administered questionnaire was "based on questionnaires previously used and validated in studies done in Italy and other countries" (p. 1368). Five previous researchers who used the instrument were cited.

The second instrument was from Santos et al. (2008), who looked at knowledge levels and self-reported behaviors of food workers in schools in Portugal using a structured questionnaire. The knowledge assessment section of the instrument was used in this study. This instrument assessed knowledge on the relevant aspects of food safety, such as personal hygiene, cross contamination, temperature control, and hygienic habits and was designed for a low-literacy population, similar to food handlers in the Jamaican context. Santos et al. stated that the questionnaire was based on existing food safety literature and had been pretested with food handlers from a similar environment.

The third instrument came from DeBess et al. (2009), who studied knowledge and practice of food handlers in Oregon. While the two other instruments were used in nonEnglish-speaking populations and different cultures, the Oregon study was conducted

with a population that was closer, geographically and culturally, to Jamaica. Also, the questions were derived from the test used by Oregon's food handlers' certification program. The sample for this study was drawn from food handlers registered in the national certification program. The demographics section, along with some knowledge and practice questions, was used from this instrument.

There were no published reliability or validity values for any of the three studies. However , some degree of validity was suggested, as questions were drawn from authentic sources such as Codex Alimentarius and Fight Bac™ (Santos et al., 2008) and a statewide food handlers' test that had been used repeatedly to assess food handlers' knowledge and practice (Debess et al., 2009). Buccheri et al. (2010) stated that the instrument was a validated one that was used repeatedly in similar studies in more than one country.

The final instrument (see Appendix D) was pretested in a sample of food handlers drawn from food handlers' clinics and hotels in another health region in Jamaica. This was done to assess clarity, comprehension, and time needed to complete the instrument. No changes were made to the instrument after the pretest. The data from the pretest were not used in the study.

Operationalization

Variables

Training. The independent variable was training, and this was defined as attendance at food safety education training sessions conducted by the Ministry of Health. This variable was measured by the number of sessions attended (0, 1, 2, 3, etc.),

and this could be verified by the notation in the food handlers' certificate. Each time a food handler attends a session and his or her permit is renewed, a note is made in the card that is held by the food handler. Untrained food handlers were scored as having "0" training sessions. This was captured in the sociodemographic section of the instrument.

Food safety knowledge. This variable was measured by scores on the self-administered questionnaire. Food handlers are expected to achieve a score of 70% or over to be certified to handle food in Jamaica. The knowledge section of the questionnaire was used to obtain information on critical food safety factors, such as food-borne diseases, personal health and hygiene, cross-contamination, and temperature control. Each of these food safety factors was a subheading on the instrument, under which a number of relevant statements were made. Each statement had three possible responses: *agree*, *disagree*, and *don't know*. The don't know response was included to dissuade food handlers from guessing and introduce bias in the study. Two points were awarded for each correct answer and 0 points for don't know and incorrect responses. An example of a knowledge item was "Cooked foods do not have microbes." The food handler was asked to indicate an agreement, disagreement, or lack of knowledge for this item by placing a tick in the appropriate column. Knowledge was measured by 40 questions, giving rise to a total possible score of 80. Scores were calculated as a percentage of 80, and scores of 70% and over were classified as satisfactory.

Hygienic practices. These were self-reported actions by food handlers that could contribute to or prevent food-borne disease outbreaks. These practices were linked to food handling and personal health and hygiene. Practices were determined from

responses to 20 questions about appropriate or inappropriate actions in the food preparation environment. Responses to these questions were *always*, *sometimes*, and *never*. Correct responses were given a score of 2, sometimes responses (indicating that the correct action was performed sometimes) were given a score of 1, and incorrect responses were scored as zero. An example of a statement in this section on food handling practices was "Do you thaw frozen food at room temperature?" The response that would indicate acceptable food handling practice was never, and this would be allotted a score of 2; sometimes was scored as 1; and always was given a score of zero. For the section on personal health and hygiene, an example of a question was "Do you go to work if you are ill?" Two additional questions that required participants to fill in the blanks were also included. The total possible mark for this section was 44.

Sociodemographics. One section of the instrument was used to collect data on the sociodemographic characteristics of the sample. Items included were age, gender, educational level, number of training sessions attended, job title, years of experience in the food industry, number of years since first certification, and whether or not the food handler had received formal training in food preparation (attended culinary school). For the latter, the food handler was asked, "Have you had 6 months or more formal training in food preparation, such as classes at HEART or cooking/catering school?"

Data Analysis Plan

Statistical analyses were performed with SPSS 22.0 for Windows. Deductive coding, which occurred independently of the responses to the questions, was used for the analysis of the quantitative data. Range and consistency checks provided by the

statistical software were used to clean the data and identify values that were out of range or inconsistent. In self-administered questionnaires, response bias is possible. Checks for response bias were done during data analysis by comparing responders to a question with non-responders to see if there was a significant difference in the responses to questions. If there was a difference in the two groups, response bias existed.

The data analysis plan is presented according to the research questions and associated hypotheses. In the introductory section of the presentation of findings, univariate descriptive statistics was used to summarize the independent demographic variables, including age, gender, education, years of experience, job level, number of training sessions attended, and presence or absence of formal food preparation training.

1. How knowledgeable are food handlers with respect to critical food safety factors?

Univariate descriptive statistics was used to answer Research Question 1. Using SPSS version 22.0, the raw data for food handlers' knowledge was summarized according to critical food safety factors (transmission of food-borne diseases, personal health and hygiene, contamination/cross contamination, and temperature control), and sectional scores for each factor, along with overall scores, was presented for the three groups of food handlers. Knowledge was categorized as adequate knowledge for scores 70% and above, and as inadequate knowledge for scores under 70%. Frequency tables, graphs, and measures of central tendency were used to present the findings.

One sample *t* test was used to test whether the mean score of food handlers was 70% or over. Test scores were analyzed and compared to the expected score of 70% that

was considered as satisfactory for certification. Alpha was set at 0.05 with a confidence interval of 95%.

Item analysis was conducted to determine if there were content areas where knowledge level was particularly high or low for all categories of food handlers. This may have implication for policy and future training of food handlers.

2. What are the reported practices of food handlers with respect to critical food safety factors?

Research Question 2 was answered by summarizing the scores for the practice section of the questionnaire. In the measures of central tendency, I found the level of food handling practices of the three groups of food handlers and determined the percentage of food handlers with satisfactory and unsatisfactory hygienic practices. Practice was classified as satisfactory for scores over 28 (from a possible 40) and unsatisfactory for scores under 28. Item analysis was also done to determine areas of strengths and weaknesses in the practices of each group of food handler.

3. Are food handlers trained by the Ministry of Health more knowledgeable about food safety issues and report safer hygienic practices than untrained food handlers?

$H_0$1**:** There is no difference in the food safety knowledge of certified food handlers with respect to critical food safety factors as evidenced by scores on a test when compared to uncertified food handlers.

H_a1: There is a difference in the food safety knowledge with respect to critical food safety factors as evidenced by scores on a test among food handlers certified by the Ministry of Health when compared to uncertified food handlers.

$H_0 2$: There is no difference in the hygienic practice scores with respect to critical food safety factors among food handlers certified by the Ministry of Health when compared to the scores of uncertified food handlers.

$H_a 2$: There is a difference in the hygienic practice scores with respect to critical food safety factors among food handlers certified by the Ministry of Health when compared to the scores of uncertified food handlers.

To test the null hypotheses that there were no differences in food hygiene knowledge and self-reported hygienic practices between trained and untrained food handlers, the two sample *t* test for independent means was used. Food handlers were classified as trained (those being recertified) and untrained (first-timers). The two sample *t* test for independent means was ideal for evaluating the difference in means between two groups, assuming that the conditions of random sampling/unknown population standard deviation and normal distribution or a large population (> 30) were met. Assessment of normality was done by constructing a histogram of test scores and observing the shape. However, the *t* test can still be used if the departure from normality is not too extreme (Triola, 2011).

4. Is there a difference in the knowledge and practices of food handlers trained for the tourist industry and food handlers trained to serve the general population?

$H_0$3: There is no difference in the food safety knowledge scores between food handlers trained for the tourist industry and food handlers trained in the general program.

*H*a3: There is a difference in the food safety knowledge scores between food handlers trained for the tourist industry and food handlers trained in the general program.

$H_0$4: There is no difference in the hygienic practice scores between food handlers trained for the tourist industry and food handlers trained in the general program.

*H*a4: There is a difference in the hygienic practice scores between food handlers trained for the tourist industry and food handlers trained in the general program.

The null hypotheses that there were no differences in food hygiene knowledge and hygienic practices between the two groups of government-trained food handlers were tested using the independent two sample *t* test. The mean knowledge and practice scores were used in the analysis. ANOVA was also be used to investigate if there was a difference in the knowledge and practices among the three groups of food handlers: the untrained food handlers, food handlers trained in the general training program, and those trained for the tourist industry.

5. Is there a relationship between the level of knowledge and self-reported practices of food handlers and the number of training sessions attended?

$H_0$5: There is no difference in the food safety knowledge scores of trained food handlers based on number of training sessions attended.

*H*a5: There is a difference in the food safety knowledge scores of trained food handlers based on number of training sessions attended.

$H_0$6: There is no difference in the hygienic practice scores of trained food handlers based on number of training sessions attended.

*H*a6: There is a difference in the hygienic practice scores of trained food handlers based on number of training sessions attended.

ANOVA was used to determine if there was a difference in the level of knowledge and self-reported practices of food handlers based on number of training sessions attended. Food handlers were grouped as untrained (T0), first recertification (T1), second recertification (T2), third recertification (T3), and so on. While ANOVA may allow for the rejection of the null hypothesis (equality of means), indicating that there is a difference between the groups, it does not tell where the differences are. This was achieved by performing posthoc pair wise comparisons using Tukey's honestly significant difference (HSD) test.

Additional Analyses

The chi-square test was performed to assess if an association existed between independent sociodemographic variables (such as training, education, gender, job level, and food handling experience) and knowledge and practice of three groups of food handlers. The chi-square test would indicate that a relationship existed, but not the strength of the relationship.

An ANCOVA was also used to test for differences between groups on the test, resulting from the presence of covariates. This analysis is useful when the groups are not randomly assigned and there is a need to control for any initial difference between the groups. Possible covariates were formal food preparation training, years of experience,

job level (supervisor, manager, kitchen staff), and education. These factors could influence the level of knowledge and practices of food handlers independent of the training offered by the Ministry of Health.

A multiple regression model was used to investigate and predict the probability of a demographic variable influencing adequate or inadequate knowledge and satisfactory/unsatisfactory self-reported practices. Variables such as age, education, experience (years), job level, formal training, and job site were included in the multiple regression model to determine their influence on knowledge and practice.

According to Triola (2011), when nonrandom sampling methods are used, it is possible that "no method of statistics can be used to find a useful estimate of a population mean" (p. 348). Because a nonrandom convenience sample was used, it may not be possible to estimate the mean knowledge and practice scores of the population of food handlers in Westmoreland. Findings, therefore, cannot be generalized.

Threats to Validity

External validity relates to the extent to which the findings from the study can be generalized to food handlers outside of the sample. For nonrandom samples (as was the case of this study), there was limited scope for generalization to food handlers in Jamaica. Due to the unavailability of a sample frame for this study, the sample of food handlers included all eligible food handlers attending the training programs for certification or recertification purposes in a randomly selected parish from a nonrandomly selected health region. The findings will only be applicable to the parish studied. There are set times each month for training for the various categories of food handlers. To improve on

the possibility of generalizing to the parish of Westmoreland, the months (time periods) for the study was randomly selected. This sample of food handlers should be representative of the population of food handlers in the parish.

The method used to measure knowledge and practice could also be a threat to external validity. Self-reporting of practices may lead to social desirability bias, in that food handlers, recognizing that they were a part of a study, may report on the ideal or acceptable hygienic practices rather than their actual practices. To minimize this, food handlers remained anonymous and were only identified by a number. This should create a sense of security for respondents and may influence them to be truthful.

An internally valid study is one that measures the true changes in the dependent variables (knowledge and practice) resulting from the independent variable (training). Guessing is always possible on a written test, and this may distort the true measure of food safety knowledge. To minimize guessing, a "don't know" option was included in the list of responses for each question. Also, statistical analyses (ANCOVA) and the use of a control group (untrained food handlers) controlled for confounders to more accurately determine if there was a difference in knowledge and practice as a result of training.

Because there were no published reliability or validity measures for the data collection instrument, there were possible threats to construct validity. Even though these instruments were used in previous studies, there was no indication that the type and wording of the questions were good measures of the construct of knowledge. Food safety experts in Jamaica reviewed the questionnaire before final preparation for administration.

According to Trochim (2006), threats to conclusion validity are those factors that could influence a wrong conclusion about the research, either concluding that there was a relationship between the variables when there was none or that there was no relationship where one existed. One objective of this research was to establish if there was a relationship between training and knowledge and practices of food handlers. One threat to conclusion validity in this study may be related to random irrelevancies in the research setting. Food handlers' tests were usually administered in an open setting with distractions from other activities that may be taking place at the location. This could affect the accuracy of the responses, giving rise to the conclusion that there was no difference in knowledge between the trained and untrained food handler. Another threat to conclusion validity was related to the match between the distribution of the data and the appropriate statistical tests. A wrong assumption about the normal distribution of the data could lead to wrong statistical tests and subsequent incorrect conclusions. To minimize these threats to conclusion validity, efforts were made to conduct the tests in areas with minimal distractions and ensuring that assumptions of statistical tests were not violated.

Ethical Procedures

Verbal permission was given by the relevant directors in the Ministry of Health to conduct the study at government food handlers' certification clinics and hotels where in-house training programs were conducted. Approval for the research was sought from the Walden University Internal Review Board and the Ministry of Health's Ethics Committee before the start of data collection. The Ministry of Health gave written consent to

conduct the study (see Appendix F) and the Ethics Committee Approval # 2013/18 was received on October 23, 2013 (see Appendix G). Walden University approval number for the study is 01-15-14-0043979 (see Appendix D).

Due to the fact that the respondents remained anonymous and their involvement in the study was limited to the completion of a survey with no identifying mark, a signed consent form was not required. Instead, participants were given an information sheet requesting their participation and explaining the purpose of the study, the intended use of the information given, and instructions for completing the instrument. They were also assured of the confidentiality of their responses and their right to refuse to participate without penalty. Questionnaires were only issued to those indicating their willingness to participate in the study after reading the information sheet.

The data collected were presented as aggregates, and no individual was identified in the results. Data will be stored on my personal computer and backed up on an external hard drive. No one else will have access to the raw data. The questionnaires will be safely stored for a period of no less than 10 years. If the results of the study influenced food safety policy changes, the instruments will be archived after 10 years.

Summary of Research Design

In this study, I used a cross-sectional survey design to collect data using a self-administered questionnaire from food handlers in Westmoreland, Jamaica. In Chapter 3, I outlined the research design and setting for the study. I also gave details on the population of study, sampling procedure, data collection instruments, operationalization of variables, and the data analysis plan. The chapter ended with details on the threats to

validity and ethical consideration for participants. Details of the results are presented in Chapter 4.

Chapter 4: Results

Introduction

The purpose of Chapter 4 is to report the results of the analyses conducted on the data gathered from food handlers in Westmoreland, Jamaica. The objective of the study was to conduct a comparative analysis of food handlers' food safety knowledge and self-reported hygienic practices to determine if the mandatory training of food handlers by the government agency was effective in improving knowledge and practices of trained food handlers over untrained food handlers. The results are summarized and presented according to research questions and hypotheses. This chapter also includes sample demographics and additional analyses conducted to determine relationships between dependent and independent variables.

Sample Characteristics

The sample consisted of 1,109 food handlers drawn from hotel workers (391), trained food handlers (394), and untrained food handlers (324), representing an estimated 5% and 24% of trained and hotel workers, respectively. Based on estimated sample size, there was a 100% response rate for trained food handlers and an 83% response rate for untrained food handlers. Data were collected over a 4-month period, January-April 2014. Data analysis using SPSS version 22.0 displayed descriptive statistics that indicated that the distribution of food handlers was negatively skewed, with skewness of -0.749 (SE = 0.073) and kurtosis of 0.407 (SE = 0.147). Shapiro–Wilk statistics 0.961 ($p < 0.05$) indicated nonnormality of the distribution; however, with a large sample size (1,109) and skewness and kurtosis between -1.0 and +1.0, parametric tests can be performed (Diehr &

Lumley, 2002). Parametric tests were used to test hypotheses and answer research questions, details of which are presented in this chapter.

Sample Demographics

Table 1

Demographics of Food Handlers (N = 1,109)

Characteristics of food handlers	Hotel workers (*N* = 391)	Trained food handlers (*N* = 394)	Untrained food handlers (*N* = 324)	Total (*N* = 1,109)
Age group (yrs)				
<= 21	30 (7.7%)	48 (12.2%)	83 (25.6%)	161 (14.5%)
21–35	258 (66.0%)	154 (39.1%)	111 (34.3%)	523 (47.2%)
36–50	55 (14.1%)	125 (31.7%)	82 (25.3%)	262 (23.6%)
> 50	3 (0.8%)	45 (11.4%)	30 (9.3%)	78 (7.0%)
Missing	45 (11.5%)	22 (5.6%)	18 (5.6%)	85 (7.7%)
Gender				
Male	177 (45.3%)	87 (22.1%)	116 (35.8%)	380 (34.3%)
Female	210 (53.2%)	305 (77.4%)	206 (63.6%)	721 (65.0%)
Missing	4 (1.0%)	2 (0.5%)	2 (0.6%)	8 (0.7%)
Highest level of education				
Primary	12 (3.1%)	37 (9.4%)	15 (4.6%)	64 (5.8%)
Secondary	196 (50.1%)	242 (61.4%)	177 (54.6%)	615 (55.5%)
College	60 (15.3%)	32 (8.1%)	74 (22.8%)	166 (15.0%)
Skill training	116 (29.7%)	64 (16.2%)	47 (14.5%)	227 (20.5%)
None	1 (0.3%)	5 (1.3%)	3 (0.9%)	9 (0.8%)
Other	0 (0%)	3 (0.8%)	1 (0.3%)	4 (0.4%)
Missing	6 (1.5%)	11 (2.8%)	7 (2.2%)	24 (2.2%)
Years worked in food industry				
<1	38 (9.7%)	63 (16%	95 (29.3%)	196 (17.7%)
1–5	215 (55.0%)	203 (51.5%)	54 (16.7%)	472 (42.6%)
6–10	56 (14.3%)	29 (7.4%)	2 (0.6%)	87 (7.8%)
> 10	24 (6.1%)	26 (6.6%)	3 (0.9%)	53 (4.8%)
Missing	58 (14.8%)	73 (18.5%)	170 (52.5%)	301 (27.1%)
Current employment position				
Food worker	286 (73.1%)	182 (46.2%)	104 (32.1%)	572 (51.6%)
Supervisor	35 (9.0%)	29 (7.4%)	12 (3.7%)	76 (6.9%)
Manager	14 (3.6%)	35 (8.9%)	4 (1.2%)	53 (4.8%)
Administrative	8 (2.0%)	11 (2.8%)	19 (5.9%)	38 (3.4%)
None of above	39 (10.0%)	93 (23.6%)	149 (46.0%)	281 (25.3%)
Missing	9 (2.3%)	44 (11.2%)	36 (11.1%)	89 (8.0%)
Previous training session attended				
1–2	114 (29.2%)	130 (33.0%)	0 (0%)	244 (22.0%)
3–5	109 (27.9%)	124 (31.5%)	0 (%)	233 (21.0%)
> 5	84 (21.5%)	72 (18.3%)	0 (0%)	156 (14.1%
Missing	84 (21.5%)	68 (17.3%)	324 (100%)	476 (42.9%)
Formal training				
Yes	160 (40.9%)	115 (29.2%)	63 (19.4%)	338 (30.5%)
No	200 (51.2%)	242 (61.4%)	237 (73.1%)	679 (61.2%)
Missing	31 (7.9%)	37 (9.4%)	24 (7.4%)	92 (8.3%)

As shown in Table 1, 1,109 food handlers were interviewed: 391 hotel workers, 394 regularly trained food handlers, and 324 untrained food handlers. The 21-35 age group accounted for the largest proportion of the sample (47%), followed by the 31-50 age group (23.6%) and the under-21 age group (14.5%). Seven percent of food handlers surveyed were over 50 years of age. With respect to gender distribution, women dominated (65%) and the men accounted for 34%. The majority of food handlers (55%) had attained secondary level education; 15% had tertiary education, 6% did not go beyond primary/elementary education, and 1% had no formal education. A large proportion of food handlers had been employed in the food service industry between 1-5 years (43%), and 18% had less than 1 year of service. Five percent of food handlers had been employed for over 10 years. Most of the food handlers (52%) were currently employed as food workers, and approximately 12% were employed in management or supervisory positions. Of the 633 food handlers (57% of sample) who indicated that they had attended previous food handlers' training sessions, 22% were attending the first or second recertification training, 21% were coming for the third through fifth session, and 14% had received more than five training sessions. Over 61% of food handlers had received no formal training in food preparation.

Results

Research Question 1: How knowledgeable are food handlers with respect to critical food safety factors?

Univariate descriptive statistics and one sample *t* test were used to answer Research Question 1. Food handlers' knowledge was summarized according to four

critical food safety factors: transmission of food-borne diseases, personal health and hygiene, contamination/cross-contamination, and temperature control. Knowledge scores under 70% were classified as inadequate knowledge and scores over 70% were classified as adequate knowledge.

Food Handlers' Knowledge Scores

The mean knowledge score of all food handlers in the sample (n = 1,109) was 63.70% (SD = 14.95), with scores ranging from 10% to 95%. The hotel workers had a higher mean score (68.92%, SD = 11.9) than the other trained food handlers (62.33%, SD = 15.7) and the untrained food handlers (59.06%, SD = 15.5; see Table 2).

Table 2

Mean Knowledge Scores of Categories of Food Handlers (N = 1,109)

Category of food handler	Mean score (%)	*SD*	Max score	Min score
Hotel worker	68.92	11.93	95.00	15.00
Trained food handler	62.33	15.67	92.5	10.00
Untrained food handler	59.06	15.46	90.00	12.5

A one-sample t test allows a researcher to test whether a sample mean of a normally distributed interval dependent variable differs significantly from an established or predetermined value. Although the sample was not normally distributed and would dictate the use of nonparametric tests, the sample size was large; hence, the t test was appropriate (Diehr & Lumley, 2002). A one-sample t test was conducted on the knowledge scores of all food handlers to evaluate whether the mean was significantly different from 70%, which is the minimum acceptable score set by the Ministry of Health

for passing the food handlers' test. The sample mean of 63.70% (*SD* = 14.95) was significantly lower than 70% by 6.30%, *t*(1108) = -14.036, *p* = 000, 95% *CI* [- 7.18, 5.42]; see Table 3. Generally, food handlers' knowledge was significantly lower than the minimum acceptable score of 70%.

Table 3

One Sample t-Test Analysis of Mean Score of Food Handlers (N = 1,109)

One-sample test						
	Test value = 70					
					95% confidence interval of the difference	
	t	*df*	Sig. (2-tailed)	Mean difference	Lower	Upper
Knowledge score of food handlers	-14.036	1108	.000	-6.30072	-7.1815	-5.4199

A one-sample *t* test was also conducted on the mean knowledge score of each category of food handler to determine if their means were significantly different from 70%. Table 4 shows that, for hotel workers, the mean score of 68.92% was not significantly different from 70%, *t*(390) = - 1.781, *p* = 0.76 at an alpha level of 0.05, *CI* [- 2.26, 0.11]. However, the mean scores for trained and untrained food handlers were significantly lower than 70% by 7.67% and 10.94%, respectively. For the trained food handler, *t*(393) = - 9.72, *p* < 0.001, *CI* [- 9.22, - 6.11], and for the untrained food handler, *t*(323) = - 12.74, *p* = 0.000, *CI* [- 12.63, - 9.25].

Table 5 outlines the overall assessment of knowledge of the three groups of food handlers. Approximately 58% of the sample displayed inadequate knowledge by failing to achieve 70% on the test, while 42% demonstrated adequate knowledge. When

analyzed by category of food handler, 58% of hotel workers passed the test, while 62% of trained food handlers and 71% of untrained food handlers failed the test.

Table 4

One Sample t-Test Analysis for Three Groups of Food Handlers (N = 1,109)

One-sample test							
		Test value = 70					
						95% confidence interval of the difference	
Category of food handler		*t*	*df*	Sig. (2-tailed)	Mean difference	Lower	Upper
Hotel worker	Knowledge score of food handlers	-1.781	390	.076	-1.07417	-2.2603	.1119
Trained food handler	Knowledge score of food handlers	-9.719	393	.000	-7.67132	-9.2231	-6.1195
Untrained food handler	Knowledge score of food handlers	-12.736	323	.000	-10.94136	-12.6315	-9.2512

Table 5

Distribution of Food Handlers by Knowledge Assessment (N = 1,109)

Category of food handler	Knowledge assessment		
	Inadequate knowledge	Adequate knowledge	Total
Hotel worker	165 (42.2%)	226 (57.8%)	391
Trained food handler	243 (61.7%)	151 (38.3%)	394
Untrained food handler	231 (71.3%)	93 (28.7%)	324
Total	639 (57.6%)	470 (42.4%)	1109

When each critical food safety factor was analyzed, the mean scores for food-borne diseases, personal health and hygiene, contamination/cross-contamination, and temperature control were 55.62 (*SD* = 20.85), 75.40 (*SD* = 16.51), 76.51 (*SD* = 22.38), and 51.44 (*SD* = 23.42), respectively (see Table 6). In an analysis of knowledge of food safety factors by categories of food handlers, I found that all three categories of food handlers scored high on personal health and hygiene and cross-contamination factors and low on knowledge of transmission of food-borne diseases and temperature control (see Table 7).

Table 6

Mean Scores for Critical Food Safety Factors (N = 1,109)

Critical food safety factor	Mean	Std. deviation
Food borne diseases	55.62	20.846
Personal health and hygiene	75.40	16.51
Cross-contamination	76.51	22.38
Temperature control	51.44	23.42

Table 7

Distribution of Mean Critical Food Safety Factors Scores by Category of Food Handler (N = 1,109)

	Category of food handlers		
Critical food safety factor	Hotel worker (%)	Trained (%)	Untrained (%)
Food borne diseases	60.61	53.66	51.98
Personal health and hygiene	79.10	74.82	71.64
Cross-contamination	81.33	74.75	72.84
Temperature control	58.80	50.30	43.95

The food handlers' knowledge of critical food safety factors is described in Table 8 as a percentage of correct, incorrect, and *don't know* responses. The weakest factor was temperature control with a mean of 51% correct answers, and the strongest factor was cross-contamination with a mean of 76.5% of correct answers (see Table 6). With regard to the transmission of food-borne diseases, food handlers stated that one can tell if a food is dangerous to eat by its look, smell, or taste (76.2%); that cooked foods do not contain microbes (39.9%); and that foods served cold do not have to be disinfected (33.1%). Only 43.8% of food handlers knew that it was normal for fresh chicken to have *Salmonella*; 23.5% gave an incorrect answer, and 32.6% did not know.

Table 8

Frequency (%) of Correct, Incorrect, and Don't Know Answers on Knowledge of Critical Food Safety Practices (N = 1,109)

Question	Corr %	Incorr %	DK %
Transmission of foodborne diseases			
Fresh eggs can have *Salmonella*	52.8	18.4	28.9
Fresh meat always has microbes on the surface	55.5	16.5	28.0
Canned foods may have harmful microbes	67.6	11.3	21.1
Healthy people can cause illness by carrying germs to food	69.3	18.8	11.9
It is normal for fresh chicken to have *Salmonella*	43.8	23.5	32.6
Lettuce and other raw vegetables might have harmful microbes	68.6	15.1	16.2
Foods served cold (salads) do not have to be disinfected	48.0	33.1	18.9
Cooked foods do not have microbes	38.5	39.9	21.6
Foods prepared too long in advance might give microbes time to grow	76.0	11.2	12.8
You can tell if a food is dangerous to eat by its look, smell, or taste	18.5	76.2	5.3
The HIV virus can be spread through food	72.9	16.8	10.3
Cholera can be spread through food	56.0	21.8	22.2
Personal health and hygiene			
Hands can be washed with water alone after handling raw meat	91.5	7.0	1.4
You can prepare food with a wound on the hand if the wound is covered with a bandage	64.7	29.9	5.4
After washing, hands may be dried with a kitchen towel	55.3	40.7	4.1
It is not necessary to wash hands to handle food that is already cooked	82.1	14.9	3.0
After using the toilet, we should always wash hands with soap and water	96.7	1.6	1.7
When wearing gloves, you can handle cooked foods after handling raw meat	88.2	6.7	5.1
Hands should be properly washed after sneezing or blowing your nose	93.5	4.3	2.2
When you leave the kitchen and go outside, you should change the footwear	42.3	42.4	12.4
After using the bathroom, hands can be washed in the kitchen sink	93.1	3.1	3.1
Wearing gloves while handling food protects the food service staff from infection	43.6	42.3	14.1
Contamination/Cross-Contamination			
Food-borne disease can result from storing raw meat and cooked foods in the same refrigerator	68.3	18.7	13.1
Foods prepared with many steps increase the handling and possibility of contamination of the food	58.5	18.2	23.2
Foods can be contaminated with microbes by coming in contact with unsafe foods	87.3	3.4	9.3
Food preparation surfaces can contaminate foods	81.3	6.4	12.3
Ready to eat foods (e.g., vegetables) can be prepared on the same cutting board that was used to prepare meat	89.7	5.7	4.6
Soap and water can be used to kill all harmful microbes on cutting boards after preparation of raw meat	59.2	32.9	7.9
Prepared or ready-to-eat foods are stored on the top shelf in a refrigerator that also stores raw food	77.0	13.5	9.5
Cutting boards, meat slicers and knives should be sanitized after each use	91.0	2.9	6.1
Temperature control			
Foods that need to be kept hot should be at 60°C or above	62.0	10.6	27.3
Leftovers should be reheated to a minimum temperature of 75°C	51.3	16.5	32.2
Microbes may grow because prepared food was left at room temperature for a long period	76.4	7.1	16.5
Cooked foods might be safely stored in the refrigerator at 5°C	18.9	52.8	28.2
Foods should be slowly cooled at room temperature before storage in the refrigerator	13.3	74.8	11.9
Refrigeration kills all the bacteria that might cause food-borne illnesses	68.3	15.4	16.2
Microbes responsible for food-borne illnesses grow well at room temperature	61.8	10.2	28.0
Frozen foods should be thawed on the counter or in the sink	46.9	40.7	12.4
After thawing, meat might be held for 5 hours at room temperature	63.6	11.7	24.7
Foods stored at 40°C are being held in the temperature danger zone	52.0	12.7	35.3

In the area of personal health and hygiene, the majority of food handlers gave the correct answers for most statements. However, over 40% of food handlers gave incorrect answers to the following statements: “After washing, hands may be dried with a kitchen towel” (40.7%); “when you leave the kitchen and go outside, you should change the footwear”(42.4%); and that wearing gloves while handling food protects the food service staff from infection” (42.3%). Thirty percent felt that food can be prepared with a wound on the hand if the wound is covered with a bandage

With respect to contamination/cross-contamination, 32.9% of food handlers felt that soap and water alone could be used to kill microbes on a cutting board after preparation of raw meats, and 23.2% did not know whether foods prepared with multiple steps increased the handling and possibility of contamination of the food. Ninety-one percent of food handlers agreed that cutting boards, meat slicers, and knives should be sanitized after each use and disagreed with the statement that ready-to-eat foods could be prepared on the same cutting board that was used to prepare meat.

The critical food safety factor of temperature control had the lowest proportion of correct answers. Incorrect answers were given for the following statements by a large proportion of food handlers: “foods should be slowly cooled at room temperature before storage in the refrigerator” (74.8%); “Cooked foods might be safely stored in the refrigerator at 5°C” (52.8%); and “frozen foods should be thawed on the counter or in the sink” (40.7%). Of note are the following areas for which food handlers indicated don’t know: “Foods stored at 40°C is being held in the temperature danger zone” (35.3%); “Microbes responsible for food-borne illnesses grow well at room temperature” (28%);

"Leftovers should be reheated to a minimum temperature of 75°C" (32%); "Foods that need to be kept hot should be at 60°C or above" (27.3%); and "After thawing, meat might be held for 5 hours at room temperature" (24.7%).

Research Question 2: What are the reported practices of food handlers with respect to critical food safety factors?

Research Question 2 was answered by summarizing the scores of the practice section of the questionnaire, which consisted of 22 questions. The mean practice score was 65.34% (*SD* = 19.10) with scores ranging from 0-98. A score of 70% and above was considered as satisfactory and less than 70% as unsatisfactory. Table 9 shows that 50% of the sample reported satisfactory practices and 50% reported unsatisfactory practices.

Table 9

Practice Assessment of Food Handlers (N = 1,109)

Assessment	Frequency	%
Unsatisfactory practice	555	50.0
Satisfactory practice	554	50.0
Total	1109	100.0

Table 10 shows that the trained food handlers (hotel workers and those trained in the regular program) showed similar results for satisfactory practice scores (39%) and unsatisfactory scores (31%). Untrained food handlers achieved higher unsatisfactory practice scores (38%) and lower satisfactory practice scores (21%) than trained food handlers.

Table 10

Practice Assessment of Food Handlers by Category (N = 1,109)

Category of food handler	Practice results		Total
	Unsatisfactory practice	Satisfactory practice	
Hotel worker	173 (31.2%)	218 (39.4%)	391(35.2%)
Trained food handler	173 (31.2%)	221 (39.8%)	394 (35.5%)
Untrained food handler	209 (37.6%)	115 (20.8%)	324 (29.2%)
Total	555(50.0%)	554 (50.0%)	1109 (100%)

Table 11 displays the frequency of responses to the first 20 food hygiene practice questions. Thirty-three percent never used a thermometer to check food temperature, 73% always or sometimes thawed frozen foods at room temperature, 72% used a handkerchief or rag (always or sometimes) when suffering from a cold, and 57% always or sometimes used a kitchen towel to dry utensils. Some satisfactory practices were reported by a majority of food handlers: 71 % never wore jewelry when serving food, 72% did not come to work with fever or diarrhea, 76% used separate utensils for raw and cooked foods, and 75% checked expiry dates of all products.

Table 11

Frequency of Responses (%) to Food Hygiene Practice Questions (N = 1,109)

Food handling practices	Always	Sometimes	Never
1. Do you wash your hands before touching unwrapped raw food?	65.4	28.8	1.3
2. Do you wash your hands after touching unwrapped raw foods?	79.9	14.2	0.5
3. Do you wash your hands before touching cooked foods?	78.0	16.7	0.3
4. Do you wash your hands after touching cooked foods?	68.5	23.8	0.5
5. Do you use separate utensils when preparing raw and cooked foods?	75.7	15.7	1.9
6. Do you thaw frozen foods at room temperature?	30.1	43.0	15.2
7. Do you check the expiry dates of all products?	75.0	16.8	2.1
8. Do you use a thermometer to check temperature?	26.1	29.9	33.0
9. Do you use gloves when serving unwrapped foods?	28.1	36.2	24.1
10. Do you wash your hands before using gloves?	47.7	28.1	14.7
11. Do you wash your hands after using gloves?	7.06	16.0	5.0
12. Do you wear an apron or uniform when serving food?	60.8	20.0	9.9
13. Do come to work when ill a fever, upset stomach or diarrhea?	2.3	16.8	72.2
14. Do you use a handkerchief or rag when suffering from a cold?	50.8	21.4	17.0
15. Do you wear a hat or head covering when serving food?	66.5	17.1	8.1
16. Do you wear jewelry when serving food?	5.1	15.7	70.8
17. Do you disinfect cutting boards after each use?	74.7	11.5	4.8
18. Do you use kitchen towels to dry utensils?	27.5	30.1	33.4
19. Do you sanitize utensils after washing them?	58.7	23.0	8.3
20. Do you have separate shoes for use in the food establishment?	44.1	23.1	20.6

Note. The difference between total score and 100% is accounted for by missing data.

The majority of food handlers reported satisfactory practices with respect to hand washing questions in that 78% of food handlers washed hands before touching cooked foods and 65.4% before touching unwrapped raw foods. Eighty-one percent always or sometimes sanitized utensils after washing them.

There were two open-ended questions on the questionnaire. In the first question, I asked food handlers to state what they used to sanitize utensils. Table 12 shows the responses. Over 35% of the sample did not answer this question. The most common responses were commercial sanitizers (18%) and bleach (19%). Fourteen percent stated that soap was used as a sanitizer.

Table 12

Distribution of Items Used to Sanitize Utensils (N = 1109)

Sanitizing item	Frequency	Percent
Sanitizer	199	17.9
Hot water	107	9.6
Bleach	208	18.8
Soap	153	13.8
Other	44	4.0
Don't Know	1	0.1
Missing	397	35.8
Total	1109	100.0

In the second open-ended question, I asked food handlers "For how long do you wash your hands?" The hoped-for response of "20 seconds" was stated by 58 or 5.2% of the sample (See Table 13). Time periods of < 20 seconds were stated by 2.9% of food handlers. The vast majority (55%) gave time periods of over 20 seconds, ranging from 1 minute to 30 minutes. Four hundred and five food handlers (36.5%) did not answer that question.

Table 13

Distribution of Responses Concerning Length of Time Used to Wash Hands (N =1,109)

Period of time	Frequency	Percent
< 20 seconds	32	2.9
20 seconds	58	5.2
> 20 seconds	614	55.4
Missing	405	36.5
Total	**1109**	**100.0**

Research Question 3: Are food handlers trained by the Ministry of Health more knowledgeable and report safer hygiene practices than untrained food handlers?

$H_0$1: There is no difference in the food safety knowledge of certified food handlers with respect to critical food safety factors as evidenced by scores on a test when compared to uncertified food handlers.

H_a1: There is a difference in the food safety knowledge with respect to critical food safety factors as evidenced by scores on a test among food handlers certified by the Ministry of Health when compared to uncertified food handlers.

This null hypothesis was tested with the two-sample *t* test for independent means. An independent sample *t* test is appropriate when it is necessary to compare the means of a normally distributed interval dependent variable (knowledge/practice) for two independent groups (trained and untrained food handlers) (Laerd, n.d.). Food handlers trained by the Ministry of Health (hotel workers and food handlers being recertified) were classified as trained food handlers, and food handlers attending training for the first time were classified as untrained. Table 14 shows that there were 324 untrained food handlers and 785 trained food handlers in the sample. The mean knowledge score of the

sample of food handlers (n = 1109) was 63.70% (SD = 14.95). However, when categorized into trained and untrained categories, the mean knowledge score of trained food handlers was 65.61% (SD = 14.30) and that of untrained food handlers was 59.06 (SD = 15.46; see Table 15). Therefore the null hypothesis was rejected as there was a difference in food safety knowledge between trained and untrained food handlers.

Table 14

Distribution of Trained and Untrained Food Handlers (N = 1,109)

Training classification	Frequency	Percent
Untrained	324	29.2
Trained	785	70.8
Total	1109	100.0

Table 15

Mean Knowledge Score of Trained and Untrained Food Handlers (N = 1,109)

Training classification	*N*	Mean	Std. deviation	Std. error of mean
Untrained	324	65.6146	14.30485	0.51069
Trained	785	59.0586	15.46372	0.85910
Total	1109	63.6993	14.94892	0.44889

Bivariate Analysis

The results of the two-sample t test for independent means are shown in Table 16. The Levene's test for equality of variance was significant (p = 0.02); hence, the equal variances not assumed test results were used. The results showed that there was a statistically significant difference between mean knowledge scores of trained and untrained food handlers, $t(562.665) = -6.556$, $p < 0.001$, 95% CI [- 8.52, - 4.59] at the

0.05 alpha level. The mean difference was – 6.56 with a 95% *CI* [-8.45 and -4.66]. Trained food handlers had a statistically significant higher mean knowledge score (65.61) than untrained food handlers (59.06).

When the mean knowledge score of each category of trained food handlers was compared to the mean score of the untrained food handler, the results were as outlined in Tables 17 and 18. There were 394 regular trained food handlers and 324 untrained food handlers, with mean knowledge scores of 62.33 (*SD* = 15.66) and 59.06 (*SD* = 15.46) respectively. The Levene's Test was not significant ($p = 0.918$), so the test result for equal variances assumed was used, which indicated that there was a statistically significant difference in the mean knowledge scores of regularly trained food handlers and untrained food handlers, $t(716) = -2.80$, $p = 0.005$, 95% *CI* [- 5.56, - 0.98] at the 0.05 alpha level. The mean difference was – 3.27%, and regularly trained food handlers had a statistically significant higher mean knowledge than untrained food handlers.

Table 16

Independent Sample t-Test for Knowledge Scores for Trained and Untrained Food Handlers (N = 1,109)

		t Test for equality of means						
		t	*df*	Sig. (2-tailed)	Mean difference	Std. error difference	95% Confidence interval of the difference	
							Lower	Upper
Knowledge score of food handlers	Equal variances not assumed	-6.560	562.665	.000	-6.55601	.99942	-8.5191	-4.5929

The mean knowledge score for hotel workers was 68.93 (*SD* = 11.93) and 59.06 (*SD* = 15.46) for untrained food handlers. The Levene's Test was significant ($p < 0.001$) and the equal variances not assumed test was used. Table 18 shows the result of the *t* test and indicated that there was a significant difference in the mean knowledge score of hotel workers when compared to the untrained food handler, $t(599.39) = -9.399$, $p < 0.001$, 95% *CI* [-11.93, -7.80] at the 0.05 level. The mean difference in knowledge scores was -9.87. Hotel workers had significantly higher mean scores than untrained food handlers.

Table 17

Independent Sample t-Test for Knowledge Scores of Regular Trained and Untrained Food Handlers (N = 718)

		t Test for equality of means						
		t	*df*	Sig. (2-tailed)	Mean difference	Std. Error difference	95% Confidence interval of the difference	
							Lower	Upper
Knowledge score of food handlers	Equal variances assumed	-2.799	716	.005	-3.27	1.168	-5.56	-0.98

Table 18

Independent Sample t-Test for Knowledge Scores of Hotel Workers and Untrained Food Handlers (N = 715)

		t Test for equality of means						
		t	*df*	Sig. (2-tailed)	Mean difference	Std. error difference	95% Confidence interval of the difference	
							Lower	Upper
Knowledge score of food handlers	Equal variances not assumed	-9.399	599.39	.000	-9.87	1.050	-11.93	-7.80

$H_0$2: There is no difference in the hygienic practice scores with respect to critical food safety factors among food handlers certified by the Ministry of Health when compared to the scores of uncertified food handlers.

H_a2: There is a difference in the hygienic practice scores with respect to critical food safety factors among food handlers certified by the Ministry of Health when compared to the scores of uncertified food handlers.

This null hypothesis was tested using the two-sample independent *t* test. The mean practice score of trained food handlers (*n* = 785) was 67.40% (*SD* = 18.80), and the mean practice score of the untrained food handlers was 60.35% (*SD* = 18.93). When the *t* test was performed, the results from the equal variances assumed test indicated that there was a statistically significant difference in mean practice scores for trained and untrained food handlers, $t(1107) = -5.67$, $p < 0.001$, 95% *CI* [-9.49, -4.60] at the 0.05 level (see Table 19). The mean difference was -7.05, and trained and certified food handlers achieved significantly higher practice scores than untrained food handlers.

Table 19

Independent Sample t-test for Practice Scores of Trained and Untrained Food Handlers (N = 1,109)

		t Test for equality of means						
		t	*df*	Sig. (2-tailed)	Mean difference	Std. error difference	95% Confidence interval of the difference	
							Lower	Upper
Practice score of food handlers	Equal variances assumed	-5.668	1107	.000	-7.05	1.244	-9.49	--4.61

Mean practice scores for both categories of trained food handlers were also compared individually with the mean practice score of untrained food handlers using the independent sample *t* test. The results are outlined in Tables 20 and 21. Hotel workers (*n* = 391) and regularly trained food handlers (*n* = 394) had mean practice scores of 68.26% (*SD* = 18.22) and 66.54% (*SD* = 19.35) respectively. The results of the *t*-test indicated that mean practice scores were significantly higher for hotel workers than for untrained food handlers, *t*(713) = -5.679, *p* = 0.000, 95% *CI* [-10.65, -5.18] at the 0.05 level. The mean difference in practice scores was -7.91.

Table 20

Independent Sample t-Test for Practice Scores of Hotel Workers and Untrained Food Handlers (N = 715)

		T Test for Equality of Means						
		t	*df*	Sig. (2-tailed)	Mean difference	Std. error difference	95% Confidence Interval of the difference	
							Lower	Upper
Practice score of food handlers	Equal variances assumed	-5.679	713	.000	-7.911	1.393	-10.65	--5.18

Table 21 shows the result of the independent sample *t*-test comparing the mean practice scores of regularly trained food handlers and untrained food handlers. The regularly trained food handlers achieved significantly higher practice scores than untrained food handlers, *t*(716) = -4.313, *p* = 0.000, 95% *CI* [-9.02, -3.38] at the 0.05 level. The mean difference in practice scores was -6.197%. The null hypothesis was therefore rejected and the alternate hypothesis accepted.

Table 21

Independent Sample t-Test for Practice Scores of Regular Food Handlers and Untrained Food Handlers (N = 718)

		t Test for equality of means						
		t	*df*	Sig. (2-tailed)	Mean difference	Std. error difference	95% Confidence interval of the difference	
							Lower	Upper
Practice score of food handlers	Equal variances assumed	-4.313	716	.000	-6.197	1. 437	-9.02	--3.38

Research Question 4: Is there a difference in knowledge and practices of food handlers trained in the tourist industry and food handlers trained to serve the general population?

$H_0$3: There is no difference in the food safety knowledge scores between food handlers trained for the tourist industry and food handlers trained in the general program

*H*a3: There is a difference in the food safety knowledge scores between food handlers trained for the tourist industry and food handlers trained in the general program

$H_0$4: There is no difference in the hygienic practice scores between food handlers trained for the tourist industry and food handlers trained in the general program.

*H*a4: There is a difference in the hygienic practice scores between food handlers trained for the tourist industry and food handlers trained in the general program.

To test the null hypotheses, the two-sample independent *t* test was again used to compare mean knowledge and practice scores of regularly trained food handlers and hotel workers. The results are summarized in Tables 22 and 23. The mean knowledge score of

hotel workers (*n* = 391) was 68.92% (*SD* = 11.93), and the mean knowledge score of regular food handlers (*n* = 394) was 62.33% (*SD* = 15.67).

Table 22

Independent Sample t Test for Knowledge Scores of Hotel Workers and Regular Trained Food Handlers (N=785)

		t-Test for equality of means						
		t	*df*	Sig. (2-tailed)	Mean difference	Std. Error difference	95% Confidence interval of the difference	
							Lower	Upper
Knowledge score of food handlers	Equal variances not assumed	-6.641	733.899	.000	-6.60	0.993	-8.55	-4.65

The results of the independent sample *t* test, using equal variances not assumed, indicate that the mean knowledge score of hotel workers was significantly higher than the mean knowledge score of regularly trained food handlers, $t(733.899) = -6.641$, $p < 0.001$, 95% *CI* [-8.55, -4.65] at the 0.05 alpha level. The mean difference was -6.60. The null hypothesis is therefore rejected in favor of the alternate hypothesis as there was a statistically significant difference between the food safety knowledge of the two groups of trained food handlers.

The mean practice score for regular food handlers (*n* = 394) was 66.54 (*SD* = 19.35) and for hotel workers (*n* = 391) was 68.26 (*SD* = 18.22). Independent *t* test, equal variances assumed produced results that are summarized in Table 23. There was no statistically significant difference in the mean practice scores of hotel workers and

regularly trained food handlers, $t(783) = -1.278$, $p = 0.202$, 95% *CI* [-4.35, -0.92] at the 0.05 alpha level. The null hypothesis is therefore accepted.

Table 23

Independent Sample t-Test for Practice Scores of Regular Food Handlers and Hotel Workers (N = 785)

		t-Test for equality of means						
		t	*df*	Sig. (2-tailed)	Mean difference	Std. error difference	95% Confidence interval of the difference	
							Lower	Upper
Practice score of food handlers	Equal variances assumed	-1.278	783	.202	-1.714	1. 341	-4.35	--0.92

Research Question 5: Is there a relationship between the level of knowledge and self-reported practices of food handlers and the number of training sessions attended?

$H_0$5: There is no difference in the food safety knowledge scores of trained food handlers based on number of training sessions attended.

*H*a5: There is a difference in the food safety knowledge scores of trained food handlers based on number of training sessions attended.

ANOVA was used to determine if there was a difference in the level of knowledge of food handlers based on number of training sessions attended. An ANOVA is used when there is a categorical independent variable (eg., training sessions attended) with two or more categories (i.e., T0, T1, T2, T3) and a normally distributed interval dependent variable (knowledge and practice), and there is need to test for differences in the means of the dependent variable broken down by the levels of the independent

variable (Laerd, n,d,). The number of previous training sessions for food handlers was coded as "T1" for those attending 1-2 sessions; those attending 3- 5 sessions were coded as "T2"; and those over five previous sessions as "T3." First-timers (untrained food handlers) were coded as having "T0" training sessions. The summary statistics are captured in Table 24.

Table 24

Frequency of Number of Sessions Attended by Food Handlers (N=1109)

Training Sessions	Frequency	Percent
T0	323	29.1
T1	244	22.0
T2	233	21.0
T3	156	14.1
Missing	153	13.8
Total	1109	100.0

One hundred and fifty three respondents did not answer this question on the instrument, and these were labeled as missing data. Descriptive statistics and ANOVA results are summarized in Tables 25 and 26.

Table 25

Descriptive Statistics of Knowledge Score of Food Handlers by Number of Previous Training Sessions Attended (N=1,109)

Descriptive

Knowledge score of food handlers

	N	Mean	Std. deviation	Std. error	95% Confidence interval for mean		Minimum	Maximum
					Lower Bound	Upper Bound		
T1	244	64.4877	13.73971	.87959	62.7551	66.2203	15.00	95.00
T2	233	66.5236	12.70040	.83203	64.8843	68.1629	17.50	90.00
T3	156	68.6699	13.84657	1.10861	66.4799	70.8598	17.50	95.00
T0	323	59.1331	15.42939	.85851	57.4441	60.8221	12.50	90.00
Missing	153	62.7124	17.24186	1.39392	59.9585	65.4664	10.00	90.00
Total	**1109**	**63.6993**	**14.94892**	**.44889**	**62.8185**	**64.5801**	**10.00**	**95.00**

Table 26

ANOVA for Knowledge Score of Food Handlers by Number of Training Sessions (N = 1,109)

ANOVA

Knowledge score of food handlers

	Sum of Squares	*df*	Mean Square	*F*	Sig.
Between groups	12748.006	4	3187.001	14.981	.000
Within groups	234856.954	1104	212.733		
Total	247604.959	1108			

The mean knowledge score of food handlers varied significantly based on the number of training sessions attended as determined by one-way ANOVA F (4,1104) = 14.98, $p < 0.001$). In order to determine where the difference lies with respect to the

number of sessions attended, a Tukey posthoc test was done. The results are summarized in a Table 27. The posthoc test revealed that the mean knowledge scores were significantly higher for food handlers being recertified (T1 = 64.49±13.74, $p < 0.001$; T2 = 66.52±12.70, $p < 0.001$; T3 = 68.67±13.85, $p < 0.001$) when compared to untrained food handlers (T0 = 59.13±15.43). There was also a statistically significant difference in the knowledge scores between T1 and T3 ($p < 0.05$). There was no significant difference in the mean knowledge scores of T1 ($p > 0.05$) and T3 ($p > 0.05$) when compared to T2 food handlers. Knowledge increased significantly as the number of training sessions increased. The null hypothesis is therefore rejected.

Table 27

Tukey Posthoc Results for Mean Knowledge Score of Food Handlers Based on Training Sessions (N = 1,109)

Multiple Comparisons

Dependent variable: Knowledge score of food handlers

(I) Number of previous training sessions	(J) Number of previous training sessions	Mean difference (I-J)	Std. error	Sig.	95% Confidence interval	
					Lower bound	Upper bound
T1	T2	-2.03590	1.33599	.547	-5.6862	1.6144
	T3	-4.18217*	1.49517	.042	-8.2674	-.0969
	T0	5.35458*	1.23712	.000	1.9744	8.7348
T2	T1	2.03590	1.33599	.547	-1.6144	5.6862
	T3	-2.14627	1.50887	.613	-6.2689	1.9764
	T0	7.39048*	1.25365	.000	3.9652	10.8158
T3	T1	4.18217*	1.49517	.042	.0969	8.2674
	T2	2.14627	1.50887	.613	-1.9764	6.2689
	T0	9.53674*	1.42207	.000	5.6512	13.4223
T0	T1	-5.35458*	1.23712	.000	-8.7348	-1.9744
	T2	-7.39048*	1.25365	.000	-10.8158	-3.9652
	T3	-9.53674*	1.42207	.000	-13.4223	-5.6512

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

$H_0$6: There is no difference in the hygienic practice scores of trained food handlers based on number of training sessions attended.

*H*a6: There is a difference in the hygienic practice scores of trained food handlers based on number of training sessions attended.

One way ANOVA was also used to determine if there was a difference in hygienic practices based on the number of training sessions attended. Descriptive statistics and ANOVA results are displayed in Tables 28 and 29.

Table 28

Descriptive Statistics of Practice Score of Food Handlers by Number of Previous Training Sessions Attended (N=1109)

	Practice percentage							
	N	Mean	Std. deviation	Std. error	95% Confidence interval for mean		Minimum	Maximum
					Lower bound	Upper bound		
T1	244	66.49	17.556	1.124	64.27	68.70	0	93
T2	233	67.58	19.548	1.281	65.05	70.10	0	93
T3	156	70.32	16.880	1.351	67.65	72.99	0	98
T0	323	60.29	18.937	1.054	58.22	62.37	0	91
Missing	153	65.66	21.066	1.703	62.29	69.02	0	93
Total	1109	65.34	19.101	.574	64.21	66.46	0	98

Table 29

ANOVA for Practice Score of Food Handlers in Training Sessions (N = 1,109)

ANOVA					
Practice percentage					
	Sum of squares	*df*	Mean square	*F*	Sig.
Between groups	13600.203	4	3400.051	9.609	.000
Within groups	390639.517	1104	353.840		
Total	404239.720	1108			

The mean practice score of food handlers varied significantly based on the number of training sessions attended as determined by one-way ANOVA F (4,1104) = 9.609, $p < 0.001$). Mean scores increased as the number of training sessions increased. Posthoc tests were conducted to determine where the difference lay with respect to training sessions attended. The Tukey posthoc test results, as shown in Table 30, revealed that the mean practice scores for untrained food handlers (T0) of 60.29 ± 18.94% was significantly lower than the mean practice scores for all other categories of trained food handlers (TI = 66.49 ±17.56%, $p < 0.001$; T2 = 67.58 ± 19.55%, $p < 0.001$, and T3 = 70.32 ± 16.88, $p < 0.001$). However, there was no significant difference in practice scores among T1, T2, or T3 food handlers. The number of sessions attended did not significantly increase practice scores for trained food handlers. The null hypothesis is therefore accepted.

Table 30

Tukey Posthoc Results for Mean Practice Score of Food Handlers Based on Training Sessions (1,109)

Multiple Comparisons

Dependent variable: Practice percentage

	(I) Number of previous training sessions	(J) Number of previous training sessions	Mean difference (I-J)	Std. error	Sig.	95% Confidence interval	
						Lower bound	Upper bound
Tukey HSD	T1	T2	-1.090	1.723	.970	-5.80	3.62
		T3	-3.837	1.928	.272	-9.11	1.43
		T0	6.192*	1.596	.001	1.83	10.55
	T2	T1	1.090	1.723	.970	-3.62	5.80
		T3	-2.746	1.946	.620	-8.06	2.57
		T0	7.283*	1.617	.000	2.87	11.70
	T3	T1	3.837	1.928	.272	-1.43	9.11
		T2	2.746	1.946	.620	-2.57	8.06
		T0	10.029*	1.834	.000	5.02	15.04
	T0	T1	-6.192*	1.596	.001	-10.55	-1.83
		T2	-7.283*	1.617	.000	-11.70	-2.87
		T3	-10.029*	1.834	.000	-15.04	-5.02

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

Additional Analyses

Chi-Square Test

A chi-square test is appropriate when there is a need to determine if a relationship exists between categorical variables, assuming that the value for each cell is five or higher. A chi-square test was done to determine if an association existed between independent sociodemographic variables (such as training, education, gender, job level, food handling experience) and adequacy of knowledge and practice of food handlers. The distribution of adequate and inadequate knowledge scores of food handlers by sociodemographic variables are summarized in Table 31. A majority of food handlers (57.6%) displayed inadequate knowledge (< 70%), and 42.4% displayed an adequate knowledge of food safety factors.

The results of the Chi-square analysis between the categorical variables of knowledge (coded as satisfactory for scores over 70% and unsatisfactory for scores less than 70%) and the sociodemographic variables are summarized in Table 32. The results indicated that all five sociodemographic variables of gender (χ^2 (2) = 8.212, $p < 0.05$), education (χ^2(6)= 37.036, $p < 0.001$), job position (χ^2 (5) = 27.48, $p < 0.001$), training (χ^2 (4) = 48.053, $p < 0.001$), and experience in the food industry (χ^2 (4) = 51.975, $p < 0.01$] were significantly associated with knowledge level of food handlers.

Table 31

Summary of Knowledge Level of Food Handlers by Sociodemographic Variables (N = 1,109)

Sociodemographic variables	Inadequate knowledge (%)	Adequate knowledge (%)	Total (*N* = 1,109)
Gender			
Male	206 (18.6)	174 (15.7)	380 (34.3)
Female	425 (38.3)	296 (26.7)	721 (65)
Missing	8 (0.7)	0 (0)	8 (0.7)
Total	639 (57.6)	470 (42.4)	1109 (100)
Highest level of education			
Primary	45 (4.1)	19 (1.7)	64 (5.8)
Secondary	383 (34.5)	232 (20.9)	615 (55.5)
College	73 (6.6)	93 (8.4)	166 (15.0)
Skill training	110 (9.9)	117 (10.6)	227 (20.5)
None	6 (0.5)	3 (0.3)	9 (0.8)
Other	2 (0.2)	2 (0.2)	4 (0.4)
Missing	20 (1.8)	4 (0.4)	24 (2.2)
Total	639 (57.6)	470 (42.4)	1109 (100)
Years worked in food industry			
<1	129 (11.6)	67 (6.0)	196 (17.7)
1 – 5	255 (23.0)	217 (19.6)	472 (42.6)
6 – 10	36 (3.2)	51 (4.6)	87 (7.8)
> 10	14 (1.3)	39 (3.5)	53 (4.8)
Missing	205 (18.5)	96 (8.7)	301 (27.1)
Total	639 (57.6)	470 (42.4)	1109 (100)
Current employment position			
Food worker	313 (28.2)	259 (23.4)	572 (51.6)
Supervisor	36 (3.2)	40 (3.6)	76 (6.9)
Manager	23 (2.1)	30 (2.7)	53 (4.8)
Administrative	21 (3.3)	17 (3.6)	38 (3.4)
None of above	177 (16.0)	104 (9.4)	281 25.3)
Missing	69 (6.2)	20 (1.8)	89 (8.0)
Total	639 (57.6)	470 (42.4)	1109 (100)
Previous training session attended			
T1	140 (12.6)	104 (9.4)	244 (22.0)
T2	121 (10.9)	112 (10.1)	233 (21.0)
T3	62 (5.6)	94 (8.5)	156 (14.1)
T0	230 (20.7)	93 (8.4)	323 (29.1)
Missing	86 (7.8)	67 (6.0)	153 (13.8)
Total	639 (57.6)	470 (42.4)	1109 (100)

Table 32

Summary of Chi-Square Analysis Results for Knowledge Level of Food Handlers by Sociodemographic Variables (N = 1,109)

Socio-demographic variables	Pearson Chi-Square			Symmetric measures		
	Value	*df*	Asymp. Sig (2-sided)	Phi	Cramer V	Strength of association
Gender	8.212	2	0.016	0.086	0.086	Very weak
Education	37.036	6	0.000	0.183	0.183	Weak
Job position	27.48	5	0.000	0.157	0.157	Weak
Training	48.053	4	0.000	0.208	0.208	Moderate
Experience	51.975	4	0.000	0.216	0.216	Moderate

Phi and Cramer V statistics indicate that the strength of the association ranged from very weak for gender to moderate for training and experience (see Table 32). Gender had a very weak effect on knowledge scores, education and job position had weak effects, and training and experience had moderate effects on knowledge scores.

The distribution of satisfactory and unsatisfactory hygienic practices of food handlers based on sociodemographic variables is summarized in Table 33. There was an even distribution of satisfactory and unsatisfactory practices. The results of chi-square analysis of practices based on sociodemographic variables revealed that all variables: gender (χ^2 (2) = 9.425, $p < 0.05$), education (χ^2(6) = 14.527, $p < 0.05$), job position (χ^2 (5)

= 27.183, $p < 0.001$), training (χ^2 (2) = 29.286, $p < 0.001$), and experience in the food industry (χ^2 (4) = 39.796, $p < 0.001$) were significantly associated with practices scores of food handlers. Symmetric measures indicate very weak associations for gender and education and weak associations for job position, training, and experience (see Table 34).

Table 33

Summary of Practices of Food Handlers by Sociodemographic Variables (N = 1,109)

Sociodemographic variables	Unsatisfactory practices	Satisfactory practices	Total (*n* = 1,109)
Gender			
Male	168	212	380
Female	381	340	721
Missing	6	2	8
Total	555 (50%)	554 (50%)	1109 (100)
Highest level of education			
Primary	32	32	64
Secondary	303	312	615
College	102	64	166
Skill training	101	126	227
None	2	7	9
Other	2	2	4
Missing	13	11	24
Total	555 (50%)	554 (50%)	1109 (100)
Years worked in food industry			
<1	80	116	196
1 – 5	227	245	472
6 – 10	33	54	87
> 10	21	32	53
Missing	194	107	301
Total	555 (50%)	554 (50%)	1109 (100)
Current employment position			
Food worker	259	313	572
Supervisor	34	42	76
Manager	20	33	53
Administrative	22	16	38
None of above	159	122	281
Missing	61	28	89
Total	259(45%)	313(55%)	572
Previous training session attended			
T1	116	128	244
T2	98	135	233
T3	61	95	156
T0	209	114	323
Missing	71	82	153
Total	555 (50%)	554 (50%)	1109 (100)

Table 34

Summary of Chi-Square Analysis Results for Practices of Food Handlers by Sociodemographic Variables (N = 1,109)

Sociodemographic variables	Pearson Chi-Square			Symmetric measures		
	Value	*df*	Asymp. Sig (2-sided)	Phi	Cramer V	Strength of association
Gender	9.425	2	0.009	0.092	0.092	Very weak
Education	14.527	6	0.024	0.114	0.114	Very Weak
Job Position	27.183	5	0.000	0.157	0.157	Weak
Training	29.286	2	.000	0.196	0.196	Weak
Experience	39.796	4	0.000	0.189	0.189	Weak

ANCOVA

ANCOVA is appropriate when it is necessary to neutralize the effects of non-interacting variables in the analysis (Laerd, n.d.). An ANCOVA was used to test for the knowledge difference between trained and untrained food handlers on the test that may have resulted from the presence of covariates. Possible covariates were formal food preparation training, years of experience, job level (supervisor, manager, kitchen staff),

and education. These factors could have influenced the level of knowledge and practices of food handlers independent of the training offered by the Ministry of Health.

Before ANCOVA analysis was done, the interaction effect between training and each possible covariate was assessed to rule out the violation of the regression homogeneity assumption. The *F* test result of the product term of training and the four possible covariates are as follows:

- Educational level: $F_{\text{training*education}}$ (1, 1105) = 0.031, $p = 0.86$
- Job level: $F_{\text{training*job level}}$ (1, 1105) = 6.039, $p = 0.014$
- Experience: $F_{\text{training*experience}}$ (1, 1105) = 6.454, $p = 0.011$
- Formal Training: $F_{\text{training*formal training}}$ (1, 1105) = 1.41, $p = 0.235$

Interaction effect was detected between the variables of training and experience ($p = 0.011$) and also between training and job level ($p = 0.014$) as the test results were significant at the 0.05 alpha level. These violated the assumption of regression homogeneity and were omitted from ANCOVA analysis (Laerd, n.d.). The analysis was done with education and formal training in food preparation as possible covariates. The results are shown in Table 35.

Table 35

ANCOVA Analysis Output for Effect of Training on Knowledge of Food Handlers in the Presence of Education Level and Formal Training as Covariates (N = 1,108)

Tests of Between-Subjects Effects

Dependent variable: Knowledge score of food handlers

Source	Type III sum of squares	*df*	Mean square	*F*	Sig.	Partial Eta Squared
Corrected model	17103.923[a]	3	5701.308	27.332	.000	.069
Intercept	3187702.775	1	3187702.775	15281.543	.000	.933
Formal Train	2771.607	1	2771.607	13.287	.000	.012
Education	2873.297	1	2873.297	13.774	.000	.012
Train_Cat	10063.511	1	10063.511	48.244	.000	.042
Error	230501.036	1105	208.598			
Total	4747481.250	1109				
Corrected Total	247604.959	1108				

Note. a. R Squared = .069 (Adjusted R Squared = .067)

Table 35 shows that training significantly affected mean knowledge scores, even when covariates of education and prior food preparation training are controlled for, F (1, 1105) = 48.244, $p < 0.001$ at the 0.05 alpha level. Partial Eta Squared indicates that 4% of the variation in knowledge scores may be explained by food handlers training conducted by the Ministry of Health.

ANCOVA analysis was also used to test for differences in practice scores that may result from the presence of the same covariates: education, job level, experience, and formal training in food preparation. Tests were also performed to rule out the presence of interaction which would violate the assumption of regression homogeneity. The results were as follows:

- Educational level: $F_{\text{training*education}}$ (1, 1105) = 0.025, p = 0.875
- Job level: $F_{\text{training*job level}}$ (1, 1105) = 1.276, p = 0.259

- Experience: $F_{\text{training*experience}}$ (1, 1105) = 0.170, p = 0.680
- Formal Training: $F_{\text{training*formal training}}$ (1, 1105) = 0.203, p = 0.652

All interaction tests were not significant; hence, the assumption of regression homogeneity was not violated, and all four covariates were entered into the ANCOVA analysis. The results are outlined in Table 36, which showed that training significantly affected practice scores even when covariates are controlled for F (1, 1103) = 13.945, p < 0.001. Partial Eta Squared indicated that 1.2% of the variation in practice scores may be explained by food handlers training.

Logistic Regression

A multiple logistic regression analysis is an appropriate tool for determining the effect of each independent variable on the outcome variable when controlling for other variables also associated with the outcome (IDRE, n.d.). Several predictor (independent) variables such as age, education, experience (years), job level, formal training, and job site were entered in a multiple logistic regression model to predict the dichotomous outcome variable of knowledge measured as adequate and inadequate. Each of these independent variables may be associated with the level of knowledge of food handlers.

I found that in the baseline model, without the predictor variables entered in the model, 57.6% of food handlers would have inadequate knowledge. I also found that all variables would be strong predictors of inadequate knowledge (p < 0.05).

Table 36

ANCOVA Analysis Output for Effect of Training on Practice of Food Handlers in the Presence of Education Level, Formal Training, Job Level and Experience as Covariates (N = 1,108)

Tests of Between-Subjects Effects

Dependent Variable: Practice percentage

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.	Partial Eta Squared
Corrected Model	19808.650[a]	5	3961.730	11.367	.000	.049
Intercept	2341418.863	1	2341418.863	6717.940	.000	.859
Education	40.080	1	40.080	.115	.735	.000
Experience	5161.754	1	5161.754	14.810	.000	.013
Job level	875.607	1	875.607	2.512	.113	.002
Formal Train	272.798	1	272.798	.783	.377	.001
Train_Cat	4860.443	1	4860.443	13.945	.000	.012
Error	384431.070	1103	348.532			
Total	5138522.727	1109				
Corrected Total	404239.720	1108				

a. R Squared = .049 (Adjusted R Squared = .045)

The omnibus tests of model coefficients was used to check that the new model (with predictor variables included) was an improvement over the baseline model, by using chi-square tests to see if there was a significant difference between the baseline model and the new model. When predictor variables were entered into the model, the omnibus test of model coefficients showed that χ^2 (24) = 142.122, $p < 0.001$), indicating that the model was significant and would adequately predict the outcome variable of knowledge, measured as adequate and inadequate knowledge. A Nagelkerke R Square of 0.162 indicated that 16.2% of the variance in the knowledge scores was explained by the predictors (See Table 37).

Table 37

Omnibus Test of Model Coefficients and Model Summary (N = 1,109)

Omnibus Tests of Model Coefficients				
		Chi-square	*df*	Sig.
Step 1	Step	142.122	24	.000
	Block	142.122	24	.000
	Model	142.122	24	.000

Model Summary			
Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	1369.424	.120	.162

The Hosmer & Lemeshow Test of the goodness of fit had a *p*-value of 0.408 (see Table 38). Being greater than 0.05, this *p*-value meant that the model would be a significant predictor of knowledge. The classification table showed that the model was able to correctly classify the outcome of inadequate or adequate knowledge in 66% of the cases compared to the 57.6% in the baseline model. The model with the predictor (independent) variables included is an improvement over the baseline model.

Table 38

Hosmer and Lemeshow Test Results and Classification Table (N = 1,109)

Hosmer and Lemeshow Test					
Step		Chi-square	*df*		Sig.
1		8.269	8		.408
Classification Table					
	Observed		Predicted		
			Knowledge Result		Percentage Correct
			Inadequate knowledge	Adequate knowledge	
Step 1	Knowledge Result	Inadequate knowledge	506	133	79.2
		Adequate knowledge	240	230	48.9
	Overall Percentage				66.4

Odds ratios are presented in Table 39. Ratios greater than 1 indicate the likelihood of the predictors predicting the outcome variable of knowledge. The most significant predictors of knowledge were college education ($OR = 4.7$, $p < 0.05$), skills training ($OR = 3.2$, $p < 0.05$), formal training in food preparation ($OR = 1.87$, $p < 0.05$), experience over 10 years ($OR = 3.95$, $p < 0.05$), and management position ($OR = 2.47$, $p < 0.05$).

Tables 39

Logistic Regression Between Knowledge and Predictor Variables of Age, Education, Experience, Job Level, Formal Training, and Job Site (N = 1,109)

Variables in the Equation

							95% C.I. for EXP(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1[a]	Age			11.837	4	.019			
	<21	-.629	.310	4.119	1	.042	.533	.290	.979
	22 - 35	.004	.258	.000	1	.987	1.004	.606	1.666
	36 - 50	.006	.276	.001	1	.982	1.006	.586	1.727
	>50	.380	.352	1.170	1	.279	1.463	.734	2.914
	Education			26.955	6	.000			
	Primary	.140	.651	.046	1	.830	1.150	.321	4.121
	Secondary	.807	.582	1.925	1	.165	2.241	.717	7.006
	College	1.557	.600	6.728	1	.009	4.747	1.463	15.398
	Skills Tr.	1.175	.593	3.928	1	.047	3.239	1.013	10.357
	None	.528	.953	.307	1	.580	1.695	.262	10.980
	Other	1.727	1.166	2.195	1	.138	5.626	.572	55.282
	Experience			19.045	4	.001			
	<1 yr	-.039	.220	.032	1	.859	.962	.625	1.479
	1- 5 yrs	.266	.188	2.013	1	.156	1.305	.903	1.886
	6 – 10 yrs	.706	.279	6.400	1	.011	2.026	1.172	3.500
	>10 yrs	1.374	.376	13.353	1	.000	3.952	1.891	8.260
	Job Pos.			5.328	5	.377			
	Food wkr	.539	.305	3.129	1	.077	1.714	.943	3.115
	supervisor	.684	.375	3.339	1	.068	1.983	.951	4.132
	Manager	.903	.423	4.554	1	.033	2.466	1.076	5.652
	Administ.	.463	.458	1.021	1	.312	1.588	.647	3.897
	None	.506	.310	2.667	1	.102	1.659	.904	3.046
	Formal Tr.			13.576	2	.001			
	Yes	.628	.293	4.599	1	.032	1.873	1.055	3.324
	No								1.846
		.074	.275	.073	1	.787	1.077	.629	*Table*
									Continues
	Job site			10.469	3	.015			
	Hazard	.380	.195	3.798	1	.051	1.462	.998	2.142

Non-haz.	-.255	.252	1.031	1	.310	.775	.473	1.268
Both haz. Non-haz.	.544	.428	1.612	1	.204	1.722	.744	3.986
Constant	-2.404	.639	14.163	1	.000	.090		

Note. Variable(s) entered on step 1: DEMO1, DEMO3, DEMO4, DEMO6, DEMO9, DEMO5.

Summary

In Chapter 4, I presented data to answer five research questions on the effect of the mandatory food handlers' training by the Ministry of Health on knowledge and practice scores of food handlers. Comparisons were made between food handlers trained in the regular training program and hotel workers. Untrained food handlers were used as controls. Univariate, bivariate, and multivariate statistical analyses were used to analyze the data.

I found that the mean knowledge score for the sample of 1109 food handlers was 63.70%, 6.3% below the minimum level set by the Ministry of Health for passing the food handlers test. Overall, 42% of the sample passed the test. However, when analyzed by categories of food handlers, hotel workers (M = 69%) had higher mean knowledge scores than regularly trained (M = 62%) and untrained (M = 59%) food handlers. The greatest failure rate was among the untrained food handlers in which 71% failed to achieve 70%.

Knowledge assessment was based on four critical food safety factors: food-borne diseases, personal health and hygiene, contamination/cross contamination, and temperature control. Food handlers had higher mean scores for cross-contamination and personal health and hygiene and lowest on temperature control. Food handlers demonstrated limited knowledge in several areas of each food safety factor.

With respect to self-reported practices, there was an equal distribution of satisfactory and unsatisfactory practices. Trained food handlers reported safer practices than untrained food handlers. According to independent *t* test analyses, the mean differences in knowledge and practices were significant. When both categories of trained food handlers were compared on knowledge and practice, the mean knowledge score for hotel workers was significantly higher than that of the other trained food handlers. However, there was no statistically significant difference in practice scores between these two groups.

ANOVA was used to determine if the number of training sessions was related to knowledge and practice scores. I found that the mean knowledge score increased significantly with the number of training sessions attended. An increase in the number of training sessions significantly increased practice scores of trained food handlers over untrained food handlers, but it did not significantly increase practice scores for trained food handlers. A summary of the results of hypothesis testing is presented in Table 40.

Additional analyses such as Chi square tests, analysis of covariance, and multiple logistic regression were conducted. Chi square tests revealed that demographic variables, such as gender, education, job position, formal training, and experience in the food industry were significantly associated with knowledge and practice levels of food handlers, with associations varying from very weak to moderate. When covariates were controlled for using ANCOVA, I found that 4% of the variations in knowledge and 1.2% of variations in practice could be explained by food handlers' training. Results from a logistic regression model indicated that college education, experience over 10 years,

formal training in food preparation, and management positions in food premises were significant predictors of satisfactory knowledge.

Table 40

Summary of Research Findings

Research question	Null hypothesis	Statistical test	Null hypothesis decision
Are food handlers trained by the Ministry of Health more knowledgeable about food safety issues and report safer hygienic practices than untrained food handlers?	$H_0$1: There is no difference in food safety knowledge of certified food handlers with respect to critical food safety factors as evidenced by scores on a test when compared to uncertified food handlers.	two sample *t* test for independent means	Rejected
	$H_0$2: There is no difference in hygienic practice scores with respect to critical food safety factors among food handlers certified by the Ministry of Health when compared to the scores of uncertified food handlers.	two sample t test for independent means	Rejected
Is there a difference in knowledge and practices of food handlers trained in the tourist industry and food handlers trained to serve the general population?	$H_0$3: There is no difference in food safety knowledge scores between food handlers trained for the tourist industry and food handlers trained in the general program	two sample t test for independent means	Rejected
	$H_0$4: There is no difference in hygienic practice scores between food handlers trained for the tourist industry and food handlers trained in the general program.	two sample t test for independent means	Did Not Reject
Is there a relationship between the level of knowledge and self-reported practices of food handlers and the number of training sessions attended?	$H_0$5: There is no difference in food safety knowledge scores of trained food handlers based on number of training sessions attended.	ANOVA	Rejected
	$H_0$6: There is no difference in hygienic practice scores of trained food handlers based on number of training sessions attended.	ANOVA	Did Not Reject

In Chapter 5, I discuss the interpretation of the results outlined in Chapter 4, especially as they relate to the research questions and hypotheses.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The WHO (2010) identified five key food handling factors associated with food-borne disease outbreaks: (a) improper cooking, (b) temperature abuse during food storage, (c) cross contamination between raw and cooked foods, (d) poor sanitation and hygiene, and (e) using unsafe water and raw materials. The WHO (2010) indicated that four out of these five factors were directly linked to food handlers. Food handlers have been directly linked to a number of food-borne disease outbreaks (Barrabeig et al., 2010; Beatty et al., 2009). Consequently, training of food handlers is one of the most important strategies proposed by the WHO (2007) to reduce the global burden of food-borne diseases.

While some researchers have concluded that the training of food handlers does not guarantee safe food handling practices (Clayton et al., 2002), food handlers who received training were more knowledgeable about food safety issues and were inclined to be more concerned with food safety than untrained food handlers (Angelillo et al., 2000; Miraglia, 2003). A high incidence of travelers' diarrhea in Jamaica in the 1990s served as a catalyst for the enactment of new food handling regulations for both tourism workers and regular food handlers. Included in these regulations was the mandatory training and certification of all food handlers. Food handlers in the hotel industry were trained onsite in a more comprehensive training program and were assessed with different instruments from the other trained food handlers. There had been no formal assessment of the effectiveness of either of these training programs since their inception in 1999. There

was also no evidence that the knowledge and practice of trained food handlers differed from that of individuals who were untrained, and there was no evidence indicating whether the food handlers trained in the regular program differed in knowledge and practice from those trained in the hotel workers' program.

I conducted this study to determine if the mandatory food handlers' certification program was effective in helping food handlers to acquire the necessary knowledge and skills to handle food safely. It is hoped that the results of the study will be used to improve the training programs for food handlers and reduce the burden of food-borne disease outbreaks attributable to poor food handling practices. The purpose of the study was to quantitatively describe and compare food safety knowledge and self-reported hygienic practices of trained food handlers in a rural parish in Jamaica, using untrained food handlers as a control group. In addition, the relationship between the level of training (independent variable) and levels of knowledge and practice (dependent variables) were explored.

A self-administered questionnaire was used to collect data to answer five research questions: (a) How knowledgeable are food handlers with respect to critical food safety factors? (b) What are the reported practices of food handlers with respect to critical food safety factors? (c) Are food handlers trained by the Ministry of Health more knowledgeable about food safety issues and do they report safer practices than untrained food handlers? (d) Is there a difference in knowledge and practices of food handlers trained for the tourist industry and those trained in the general program? (e) Is there a relationship between level of knowledge and self-reported practices and the number of

training sessions attended? Univariate, bivariate, and multivariate statistical analyses were used to analyze the data.

Summary of Findings

The mean knowledge score of the sample of food handlers was 63.70%, a significant 6.3% below the 70% minimum passing score set by the Ministry of Health. Overall, 42% of the sample passed the test. When analyzed by categories of food handlers, hotel workers had a higher mean knowledge scores (M = 69%) than regularly trained (M = 62%) and untrained (M = 59%) food handlers. The greatest failure rate was among the untrained food handlers, as 71% failed to achieve the minimum acceptable score of 70%. Trained food handlers reported safer practices than untrained food handlers, but there was no statistically significant difference in reported practices for the two groups of trained food handlers, or those trained in the hotel industry and the regular trained food handlers. The mean knowledge score also increased significantly with the number of training sessions attended. Training also increased practice scores of trained food handlers over untrained food handlers.

Demographic variables, such as gender, education, job position, formal training, and experience in the food industry, were significantly associated with knowledge and practice levels in food handlers. When covariates were controlled for, a small variation in knowledge (4%) and practice (1.2%) could be explained by food handlers' training. According to logistic regression, college education, experience over 10 years, and management positions in food premises were significant predictors of satisfactory knowledge.

Food Handlers and Critical Food Safety Factors

The mean knowledge score for the food handlers in the sample was 63.7%, which was significantly lower than the minimum standard of 70%, with only 42% of the sample achieving a score of 70% or above. I found a generally low level of food safety knowledge for food handlers; food handlers worldwide generally display a limited level of knowledge on food safety issues (Bas et al., 2007; Buccheri et al., 2010; Chuckwuocha, 2009; DeBess et al., 2009; Gomez-Neves, 2007; Jevsnik et al., 2008; Jianu & Chris, 2012; Martins et al., 2012; Santos et al., 2008; Tokuc et al., 2009). This finding, however, deviates from the findings of Hislop and Shaw (2009), who found that 94% of the certified and noncertified food handlers surveyed scored higher than the 70% score.

The generally low level of knowledge of the Jamaican food handlers may be attributed to two factors: (a) the educational level of the respondents, as confirmed by Chuckwuocha (2009) and Buccheri et al. (2010), and (b) the highly knowledge-based, lecture-type of training program that allows for minimal participation of the participants. Only 15% of all food handlers attained higher than a secondary-level education, and only 30% (mainly hotel workers) had formal training in food preparation. Jianu and Chris (2012) concluded that the low level of knowledge of trained food handlers indicated the need for retraining using different methodologies from the highly knowledge-based programs that are presently being used to train them.

When analyzed by categories, the mean knowledge score of hotel workers (68.92%) was not significantly different from 70%. The mean knowledge scores of the

regular trained food handlers (62.33%) and the untrained food handlers (59.06%) were significantly lower than the 70% pass level. While 58% of hotel workers passed the test (scored higher than 70%), only 38% of regular trained food handlers and 29% of untrained food handlers passed the test. Training had a positive effect on the knowledge level of food handlers, even though the knowledge was below minimum acceptable standards.

The difference in knowledge levels among the categories of food handlers may be influenced by the work environment. According to chi-square analysis, job experience had a moderate yet significant effect on knowledge level (χ^2 (4) = 51.975, p = 0.000). Workers with hands-on experience in ideal food handling settings, such as hotels, with trained supervisors tend to demonstrate a higher knowledge of food safety issues because experience contributes to knowledge. Jianu and Chris (2012) demonstrated that production and catering staff who were directly involved in food preparation exhibited a greater knowledge of food safety than retail staff. Pilling et al. (2008) also found that having trained managers/supervisors (as in hotels and large restaurants) led to overall better food safety knowledge levels for food service employees. Food handlers operating in small food service facilities would not normally have the opportunity to observe many food safety procedures, such as temperature control, effective washing and sanitization of utensils, and HACCP mechanisms. Hence, their level of knowledge would be limited to the food handlers' training sessions attended, and the information would soon be forgotten if the work environment did not facilitate the transfer of knowledge.

All categories of food handlers displayed higher knowledge levels for personal hygiene and contamination/cross-contamination factors, but scored low on knowledge of food-borne diseases and temperature control. Similar results were found by Martins et al. (2012), Gomez-Neves et al. (2007), Bas et al. (2007), Jevsnik et al. (2008), Chuckwuocha, (2009), and Tokuc et al. (2009). With respect to knowledge of food-borne diseases, the majority of food handlers (62%) did not know that cooked foods could have microbes. Seventy-six percent of food handlers stated that they could detect dangerous foods by organoleptic methods (look, taste, and smell). Other researchers had similar concerns (Gomez-Neves et al., 2007; Jevsnik et al., 2008; Martins et al., 2012). This finding is worrying, especially when coupled with the finding that approximately 50% of food handlers in the present study were not able to identify egg and poultry as the main sources of the common food borne pathogen, *Salmonella*. This same lack of this type of knowledge was reported by Santos (2008) and Martins et al. (2012). Numerous scholars have identified food handlers as potential sources of food-borne pathogens (Andargie et al., 2008; Barrabeig et al., 2010; Isara et al., 2009) and have linked food handlers with food-borne disease outbreaks. Beatty et al. (2009) conducted a study on the largest *Salmonella* outbreak in Texas and found that it was due to the mishandling of food by a food handler. Food handlers in the Beatty et al. study needed to be more aware of the risks associated with food-borne microorganisms and their role in the dissemination of these microbes. Inadequate knowledge of microbial characteristics may lead to dangerous practices, which may compromise the health of the consuming public. In contrast to the low levels of knowledge in these areas that may indicate the potential

for risky behaviors, food handlers in this study showed a relatively high level of awareness of risks associated with consumption of raw vegetables (69%), human carriers of disease (69%), and preparing foods too long in advance (76%).

According to Medieros et al. (as cited in Santos et al., 2008), food safety experts concluded that hand washing is the single most important factor in preventing food-borne disease outbreaks. The findings from this study concurred with findings from previous studies (Bas et al., 2007; Santos et al., 2008; Tokuc et al., 2009) that there was a reasonably high level of knowledge on hand washing after handling raw meat (91%), after using the toilet (97%), after sneezing or blowing nose (94%) and, washing with soap in the bathroom rather than in the kitchen sink (93%). Whether this knowledge is translated to safe, observable practices in the workplace is unknown. However, there is concern for the high percentage (55%) of food handlers who expressed that kitchen towels may be used to dry hands after washing. Kitchen towels are generally used for wiping surfaces and are potential sources of contamination for washed hands. This information should be emphasized during training sessions.

There is a cause for concern for the responses expressed to the statements on the wearing of gloves. Over 50% of food handlers in this study stated that they wore gloves to protect themselves from infection and over 10% would handle cooked foods after handling raw meat if they were wearing gloves. Santos et al. (2008), one of the main studies used in the development of this Jamaican study, expressed similar concerns based on the findings of their Portugal study. The wearing of gloves seemed to impart a false sense of security to food handlers and may contribute to risky food handling practices.

Gloves are potential sources of contamination and the importance of frequent changing of single-use gloves cannot be overemphasized in food handlers' training sessions.

Food handlers in this study demonstrated a relatively high level of knowledge for contamination/cross-contamination; even untrained food handlers averaged over 70% in this area. These findings are similar to that of Santos et al. (2008), although the latter study had higher mean scores. However, 40% of food handlers stated that soap and water alone could be used to kill microbes on cutting boards after preparation of raw meats. This indicated a lack of knowledge of correct sanitization/disinfection procedures in food establishments and a lack of clarity between washing and sanitization. This deduction was derived from the fact that 91% of food handlers knew that cutting boards should be sanitized after each use. Also, when asked to report on their practice of sanitization of utensils, 14% said they used soap and water to carry out sanitization. Sanitization and cleaning of food contact surfaces are critical to the reduction in food contamination and food-borne disease outbreaks. Every effort should be made to clarify these issues in food handlers' training programs.

According to the WHO (2010), poor temperature control or temperature abuse was a key factor in food-borne disease outbreaks worldwide as it led to the proliferation of microbial hazards. Hence, training of food handlers in temperature control was one of the key factors in reducing the disease burden. Food handlers' level of knowledge in this study was weakest in the area of temperature control, averaging only 51% for the sample and dropping to as low as 44% for untrained food handlers. Temperature control was also the weakest area for the Portugal study (Santos et al., 2008) and other studies such as

Tokuc (2009), Jevsnik (2008), and Martins et al. (2012). There was a general lack of knowledge for adequate hot and cold holding temperatures, conditions for thawing frozen foods, preparation of food for refrigeration, and the danger associated with holding foods for long periods at ambient temperatures.

One possible factor contributing to the low level of knowledge for temperature control is the lack of temperature measuring devices in food handling establishments. Over 33% of food handlers expressed that they had never used a thermometer when self-reported practices were assessed. Therefore, assessment of adequacy of heat or cold was determined by sensory means, like sticking the hand in the refrigerator or in the oven. Another possible contributory factor to the low level of knowledge for temperature control is the lack of demonstrations in food handlers' training sessions. According to Bandura's SCT (Cherry, 2011), people learn through observation, imitation, and modeling, and the environment needs to be conducive to the practicing of the newly-learnt behavior. Merely stating correct temperatures for food control during training sessions (as that which obtains in the Jamaican setting), will not lead to improved knowledge or practice, if food handlers have never seen a thermometer. Training sessions should incorporate more hands-on or practical experiences to facilitate learning. Anding et al. (2007) demonstrated that food handlers' training that used interactive activities such as temperature measurement and hand washing techniques produced significant improvements in food safety knowledge and practices in these areas.

Reported Practices of Food Handlers With Respect to Critical Food Safety Factors

The mean practice score for this study was 65.34%, with scores ranging from 0 – 98%. Half of the sample of food handlers reported satisfactory practices (scoring over 70%), and the other half reported unsatisfactory practices. However, when assessed by categories of food handlers, the trained food handlers (hotel workers and those trained in the regular program) had higher satisfactory practice scores and lower unsatisfactory practice scores that untrained food handlers. This is consistent with the findings of Debess (2009) and Gomez-Neves (2007) and demonstrates that training improves self-reported practices of food handlers. Although there were areas where the number of reported appropriate actions was outstanding, there were some instances in this study where food handlers reported risky practices, similar to those found by Green et al. (2005), Vantonder et al. (2007), and Buccheri et al. (2010). Seventy-three percent of food handlers always or sometimes thawed foods at room temperature. The possible result of this practice is high bacterial load in the raw food and the likelihood of contamination of utensils and food contact surfaces. The danger is further compounded by the lack of understanding of microbial activity in foods and proper cleaning/sanitization techniques for food utensils and equipment. When added to the fact that 57% of food handlers reported that they always or sometimes used kitchen towels to dry food service utensils and 41% suggested that hands can be dried with a kitchen towel after washing, there is an increased possibility of gross contamination of prepared foods and consequent food-borne disease outbreaks. Training programs must emphasize the danger of these practices.

Using a rag or towel to a wipe nose when suffering from a cold, as was reported by 72% of food handlers, is a potential source of contamination of hands and ready-to-eat foods in food establishments. Andargie et al. (2008) conducted a study in Ethiopia and found *Staphylococcus aureus* in fingernail specimens from 41.7% of the food handlers in the study and concluded that this level of hand contamination could lead to food-borne disease outbreaks, especially if coupled with a lack of knowledge of the role of pathogens in food-borne disease outbreaks and temperature abuse.

Although knowledge level was high with respect to instances when hands should be washed, when asked for how long hands should be washed, only 5.2% of the sample knew that it was for a minimum of 20 seconds. Some responses were so far off (for example, half an hour) that it clearly demonstrated a lack of knowledge and poor practices in this area. Demonstrations in hand washing during training should improve knowledge and practice in this area.

Some reported practices were commendable; these included no jewelry wearing on the job (71%), not reporting to work with a fever or diarrhea (72%), using separate utensils for raw and cooked foods (76%), and checking expiry dates of all products (75%). One weakness of this study was a lack of observation to ascertain if reported practices were in keeping with actual behavior on the job. Scholars have found these to be inconsistent, like Hertzman and Barrash (2007). Favorable self-reported practices may be a demonstration of knowledge rather than actual practices, as is possible in any self-reported study, where a potential social desirability bias exists. Respondents will tend to report known acceptable behaviors rather than actual behaviors, even when steps

are taken to reduce such bias. Future researchers should seek to fill this gap by observing food handlers on the job.

Food Handlers Trained by the Ministry of Health

According to bivariate analysis, trained food handlers had a statistically significant higher mean knowledge score (65.61% vs 59.0%) and mean practice score (67.40% vs 60.35%) than untrained food handlers. When each category of trained food handler was compared with the untrained food handler, I found that knowledge and practice scores were significantly higher for both hotel workers and regular food handlers. However, the mean knowledge difference for the hotel worker (-9.87%) over the untrained was three times that of the regular food handler (-3.27%). Training does have a positive impact on knowledge and practice and support similar findings from Buccheri et al. (2010), Bas et al. (2007), Debess et al. (2009), Santos et al. (2008), Chuckwuocha et al. (2009), and Rebellato et al. (2011).

Even after training, the average practice scores remained below the 70% minimum acceptable level. This supports the findings of other researchers (Roberts et al., 2008) and builds on the body of evidence that training does not automatically translate into safer practices (Clayton & Griffiths, 2008; Ehri et al., 1997). The least effective training model for knowledge transfer is the KAP model, which assumes that the provision of knowledge will directly lead to a change in attitude and practice (Rennie, 1995). Food handlers' training in Jamaica is based on the KAP model. This model alone will merely produce certificated individuals who are still lacking the necessary skills to safely handle food. Even though training and education were prerequisites for safe food

handling, training alone does not guarantee safe practices (Park et al., 2010). Other factors that influence behavior change must be considered and incorporated into the training program.

Knowledge and Practices of Food Handlers Trained in the Tourist Industry

The mean knowledge score of hotel workers (68.92%) was significantly higher than that of the other trained food handlers (62.33%) in the study, even though knowledge levels were below the satisfactory level of 70% for both groups. This finding may be attributed to the type of work environment, presence of managers trained in food safety in hotels, formal food hygiene training for many hotel workers, and the difference in training methodology for both types of food handlers. Work environments, such as hotel kitchens, with modern equipment and HACCP monitoring will create a supportive environment for workers to acquire new knowledge and reinforce information received during training. This position is supported by Jianu and Chris (2010). Other trained food handlers generally operate in environments devoid of these amenities and were therefore at a disadvantage.

The presence of trained managers in food establishments leads to greater knowledge of employees with respect food safety issues (Cates et al., 2009; Pilling et al., 2008). Pilling et al. (2008) concluded that having trained managers yielded similar results with respect to food safety knowledge, as having all food handlers trained. Training of hotel managers and food and beverage managers is mandatory in Jamaica. According to Cates et al. (2009), the training of managers will increase their knowledge and their ability to impart this knowledge to food service employees. Managers trained

in food safety are not usually present in smaller food handling establishments; hence, these food handlers were not afforded the opportunity for continued learning between training sessions.

Another explanation for the difference in knowledge scores is that many food handlers in the hotel industry received formal food hygiene training before employment. Over 30% of the sample had training outside of the food handlers' training sessions and these were mainly hotel workers. This formal training would expose them to more information than that which was supplied by the 1-hour food handlers' training and would contribute to their greater level of knowledge on food safety issues.

Another possible contributing factor to the difference in knowledge score for the two groups of trained food handlers is the method of training. Hotel workers are trained onsite, in comfortable, air-conditioned training rooms devoid of external disturbances. This setting is the ideal training setting recommended by Seaman (2010), Worsfold (2004), and Rennie (1994). Also, Egan et al. (2007) conducted a review of studies to determine the effectiveness of food handlers' training and found that training programs were more effective when conducted onsite. Other food handlers are not afforded this luxury and are trained in rented halls or health centers where other health services are being offered concurrently. These activities create distractions and affect the learning process. The length of time for training and the information imparted during training are also different. Training sessions for hotel workers are usually over 2 hours, while training for the regular food handlers lasts between 45 minutes and 1 hour. Information

on areas such as HACCP were included in the hotel workers' training, but not in the training of the regular food handlers.

With respect to practice, there was no statistically significant difference in the mean practice scores of both groups of trained food handlers (68.26% and 66.54%). This could be due to the fact that practice was determined by self-reports, and food handlers may have reported desirable behaviors rather than actual behaviors. Further research using observation is needed to accurately determine practices of food handlers.

Even after training, knowledge and practice scores remained low for both groups of trained food handlers. Roberts et al., (2008) had similar results in the U.S.- based study. This has implications for the training program of the Ministry of Health. The KAP model being used is not effective in improving the knowledge and skills of food handlers to minimum acceptable standards. Food handlers' training programs are more effective when based on theories of behavior change and when they incorporate interactive learning methodologies and planned food safety interventions (Anding et al., 2007; Chapman et al., 2010; Clayton & Griffith, 2008; Ehiri et al., 1997; Seaman & Eves, 2008; York et al., 2009). Therefore, even though hotel workers experienced the ideal training and working conditions that should translate into improved knowledge, their knowledge level remained low. This may be due to the method used to impart food safety information to food handlers, the content of the training module, and the ability of food handlers to understand the materials presented (Seaman, 2010)..

These findings align with the conclusion of Jianu and Chris (2012) and Martins et al. (2012) that the low level of knowledge of trained food handlers indicates the need for

retraining using different methodologies from the highly knowledge-based programs that are presently used to train food handlers. Effective training programs should target the needs of the food handlers and this can only be determined through research that establishes a baseline/foundation for planning such training programs. With respect to the content of the training module, I did not assess its adequacy to cover the areas assessed on the questionnaires. Further research is needed to determine if training content is adequate in supplying information on the key areas of food safety identified by the WHO (2010). This study will provide baseline information for the planning and implementation of the food handlers' training program in Westmoreland, Jamaica.

Level of Knowledge and Self-reported Practices of Food Handlers Based on Training

There was a statistically significant increase in the mean knowledge score of food handlers as the number of training sessions increased. According to the chi-square analysis, training had a moderately significant effect on the knowledge level of food handlers. This finding adds to the body of knowledge that supports continuous training and the recertification of food handlers (DeBess, 2009; Hislop & Shaw, 2009; Park et al., 2010). However, other evidence-based and theory-based strategies are necessary to improve the knowledge level of food handlers to at least minimum acceptable levels.

With respect to practice, I found that the mean practice score of untrained food handlers was significantly lower than the scores of trained food handlers. However, the number of sessions attended did not significantly increase the practice scores for trained food handlers. Training is beneficial in improving practice scores, especially for the

"new" food handler, but will not significantly alter self-reported practice scores for trained food handlers after the first certification. This may be due to the possibility that self-reported practices are merely expression of knowledge of acceptable practices rather than actual practices. To support this point, Averett et al. (2011) assessed food handlers' practices after a 2-hour training and found that training did not significantly affect food handlers' practice as measured by the number of food-handler related violations in restaurants. Research is needed to determine the factors that are barriers to safe food handling practices in the workplace and the steps taken to address these during training and monitoring (York et al., 2009).

Knowledge and Practice of Food Handlers in Relation to Theoretical Foundation

The main theoretical framework for this study was Bandura's Social Cognitive Theory (SCT), which stated that people learn through observation, imitation, and modeling, and that people can learn new things without exhibiting a change in behavior (Cherry, 2011). The findings support the SCT in that there was a significant difference in mean knowledge score between trained and untrained food handlers (65.61% vs 59.06%), and also between the two categories of trained food handlers (68.92% vs 62,33%). Knowledge level improved with training. However, this knowledge was not translated into practice as the findings revealed that practice did not improve with training among the trained food handlers.

It was also observed that although food safety knowledge improved, the level was still below the minimum standard of 70% set by the Ministry of Health. To improve knowledge level, food safety training sessions based on the SCT should be interactive,

using visuals to aid retention, and provide opportunities for reproduction of the modeled behavior (such as return demonstrations). While the training sessions in Westmoreland were observed to be somewhat interactive (level of interaction varied with the session leader), visual aids were sometimes poor and no opportunity was provided for modeling the desired behaviors to correct any errors or misconceptions that trainees may have. This method of training, coupled with a predominantly non-supportive work environment, may help to explain the generally low level of knowledge and self-reported practices among trained food handlers.

The literature demonstrated that food hygiene practices can be improved if training programs are designed with a theoretical background such as the Theory of Planned Behavior (TPB), as demonstrated by Clayton & Griffith (2008). The Health Belief Model and Theory of Reasoned Action (TRA) were not good explanatory models for this study as the study did not assess attitudes or behavioral intentions of food handlers.

Study Limitations

The data collected were limited to food handlers' training sites in Westmoreland. This does not give an accurate representation of food handlers' knowledge and practice in Jamaica, thereby limiting the generalizability of the findings. Future scholars should include data from all of the parishes to derive a more accurate representation of the variables in the Jamaican population. Because this was a nonrandom, cross-sectional study, I captured only a snapshot of the variables in the population at a particular point in time (Babbie, 2010), between January and April, 2014. This excluded the population of

food handlers who would have attended for training over the next 8 months, which may be significantly different from the population surveyed. Future studies should capture data over a longer period of time, using random methods where possible.

Practice data were self-reported and this had the potential for response or social desirability bias. Individuals with correct information concerning any practice may report what was known rather than what was being practiced. Improvement in practice data would come from the actual observation of food handling practices in the work environment. Although there are potential biases in using observations, for example, the Hawthorne effect (individual's behavior being influenced by the presence of the observer), this additional information would supplement the reported behavior and ascertain if there was a discord between the reported and the actual behavior.

Another limitation was the omission of illiterate food handlers from the study based on the data collection method used. A number of food handlers were challenged in this area, and their omission has resulted in the omission of valuable data from the study. Therefore, this study may be affected by selection bias.

Recommendations for Action

I found that the mandatory training of food handlers, though beneficial, was ineffective in improving food safety knowledge and skills to minimum acceptable standards. Currently, all health regions develop and deliver their own training programs and assessment tests for food handlers. There is no standardized training curriculum or test. It is, therefore, recommended that the Ministry of Health draft new food handlers' training guidelines that would include the Ministry of Health relinquishing its role in the

training of food handlers and retaining its licensing/certification role. Food handlers should be trained by an approved agency/institution with competency in curriculum development and knowledge assessment. Training should be modular, focusing on the critical areas as identified by the WHO. The National Restaurant Association ServSafe training program in the United States (www.servsafe.com) could serve as a template for the development of the local training program. Training would be conducted over a number of sessions, rather than in one hour. A certificate would be awarded at the successful completion of the course. Managers'/supervisors' training should be separate from the regular food handlers' training and should provide in-depth food safety information that will assist managers in protecting customers' health and improving employee performance. Currently, managers and food handlers are trained and certified in the same training sessions.

The Ministry of Health should retain its present role in the issuing of permits. Trained food handlers should present their certificate, pay the necessary fees, be interviewed, and receive a permit to handle food for a period of time to be determined by the Ministry of Health. If the Ministry of Health chooses to retain the training responsibilities, I recommend that a standardized curriculum for the training of all food handlers be developed by the Food Safety Unit of the Environmental Health Division, under the consultancy of a curriculum specialist. Such curriculum should address the gaps in knowledge identified by this research, as well as future research into the adequacy of current training materials.

I am also recommending that the Ministry of Health consider an online/electronic option for food handlers' training. A large proportion of the population has access to computers, smart phones, tablets, and other electronic devices that can be used to deliver training material. This type of training will improve knowledge retention because it uses audio-visual delivery methods and it also allows for the interaction of the trainee with the material at their own convenience. The National Restaurant Association ServSafe training program (www.servsafe.com) is an example of this proposed training method.

New training policies should be clear on the assessment of illiterate food handlers. Currently, many food handlers are unable to read and are administered the food handlers' test orally. However, this methodology has the potential for bias, as the result can be influenced by the method of questioning. Even if questions were answered correctly and the food handlers' cards issued, the food handler would still be unable to translate into practice those areas that require reading, such as temperature measurement, washing and sanitization of utensils, reading of labels, and so on. Special training programs must be developed for this special group, incorporating more use of symbols and hands-on experience, if they are going to be allowed to continue to handle and serve food to the public.

The results of this study will be first shared with the local health department in which the study was done (Westmoreland Health Department) and the Western Regional Health Authority through a research document summary that will highlight the major findings. Meetings will be arranged with directors/policy-makers at the Ministry of Health to share findings and explore feasibility of recommendations. The findings will

also be shared at research/international public health conferences hosted by the Ministry of Health and the University of Technology, Jamaica. Efforts will be made to publish the findings in at least one peer-reviewed journal, such as the *Journal of Arts, Science and Technology* (JAST) published by the University of Technology, the *Journal of Food Control*, the *International Journal of Environmental Health*, the *Journal of Food Safety*, and *Journal of Food Protection*.

Recommendations for Further Study

I found that there is a need for further research in a number of areas touching on food handlers' training in Jamaica. There is need to investigate the level of knowledge of food handlers in Jamaica, not just in one rural parish. This will provide more reliable data on which to ground a new food handlers' training policy. Also, a study of the knowledge and practices of illiterate food handlers, using face-to-face interviews, is of utmost importance if an effective training program is to be developed for these food handlers. These food handlers were not included in the present study.

More information is also needed on the actual, rather than self-reported, practices of food handlers. This can be achieved through observations conducted in the workplace. In this study, I did not assess the content of the current training program. In the future, research should be done to determine if the course content meets minimum standard for food handlers' training, as outlined by the WHO (2010). This will help the Ministry of Health in determining whether to retain the responsibilities of training of food handlers or to divest it to an agency or institution with the requisite competences. The knowledge and attitudes of the current trainers should also be investigated. The success of any food

handlers' training program depends, to some extent, on the trainers. If the Ministry decides to continue to do the actual training of food handlers, the trainers must possess the attitude and aptitude to effectively deliver the training program.

Significance of Findings and Social Change Implications

The levels of knowledge and hygienic practices of food handlers in Westmoreland were below minimum acceptable standards. However, there was evidence that training was beneficial, as trained food handlers achieved higher mean scores than untrained food handlers. I found that hotel workers were more knowledgeable on food safety issues than regular trained food handlers. The mandatory training of food handlers conducted by the Ministry of Health is effective in improving food handlers' food safety knowledge, which is a prerequisite for safe food handling and ultimate reduction in food-borne disease outbreaks (WHO, 2010). The training offered to hotel workers was superior to the training program for the general food handlers in improving knowledge and practice based on research findings. Ashley et al. (2004) found that the mandatory training of hotel workers was effective in reducing the incidence of traveler's diarrhea among tourists in Jamaica.

The results have implications for food safety policy changes in the parish of Westmoreland and, by extension, the Ministry of Health. The training programs for both categories of food handlers can be improved by developing a standardized training curriculum that focuses on the four main food handler-related areas identified by the WHO-food-borne diseases, personal health and hygiene, contamination/cross contamination, and temperature control. Training methodologies should also incorporate

more practical and return demonstrations, simulations, and visuals to increase the retention of knowledge of food handlers, especially in a low-literacy population. Also, further research is needed to determine the weaknesses/knowledge gaps of the present training materials to guide the development of new training materials that will meet the needs of food handlers. While training significantly improved the practice scores for trained food handlers over untrained food handlers, there was no significant difference in the practice scores of trained food handlers based on training sessions attended. This added to the body of knowledge that improved knowledge does not automatically translate into practice. Coupled with new training methodologies, the public health department should ensure that certified food handling establishments provide the workers with the supportive environment to practice the skills learnt. Only then can the public be assured that the trained food handler is adequately equipped with the knowledge and skills to serve safe food to the public.

Summary

The aim of the study was to compare the knowledge and self-reported practices of two groups of trained food handlers in Jamaica, using untrained food handlers as controls. Food handlers have been linked to a number of food-borne disease outbreaks. This contributes to the annual global burden of food-borne diseases. The WHO (2010) proposed that all food handlers should be trained, as this was an effective means of reducing the number of food-handler related outbreaks. Jamaica, having experienced its share of food-related outbreaks, implemented mandatory training of food handlers since 1999, supported by new food handling regulations.

In this study, the first formal evaluation of the training program, I found that training was associated with the improved knowledge and practice of trained food handlers. However, the majority of food handlers who were certified by the Ministry of Health, having scored 70% or more and passed the local test, failed to achieve a passing grade on this test that focused on the critical areas identified by the WHO. The knowledge levels were particularly weak for temperature control and food-borne diseases, crucial areas for the prevention of food-borne disease outbreaks.

Significant changes are needed for the food handlers' training program. The changes are needed for both course content and training methodology. These changes must be evidence-based and supported by policy changes and enforcement of regulations. Equipping food handlers with the knowledge and skills to safely handle and serve food, and encouraging behavior change with supportive work environments and legislations, will ultimately lead to a reduction in food-borne disease outbreaks associated with poor food handling practices in Jamaica.

References

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Development Processes, 50,* 179–211. doi:10.1016/0749-5978(91)90020-T

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior*. Englewood Cliffs, NJ: Prentice Hall.

Andargie, G., Kassu, A., Moges, F., Tiruneh, M., & Huruy, K. (2008). Prevalence of bacteria and intestinal parasites among food handlers in Gondar Town, Northwest Ethiopia. *Journal of Health, Population & Nutrition, 26*(4), 451–455. doi:10.3329/jhpn.v26i4.1887

Anding, J., Boleman, C., & Thompson, B. (2007). Self-reported changes in food safety behaviors among food service employees: Impact of a retail food safety education program. *Journal of Food Science Education, 6*, 72-76.

Ashley, D., Walters, C., Dockery-Brown, C., McNab, A., & Ashley, D. E. (2004). Interventions to prevent and control food-borne diseases associated with a reduction in traveler's diarrhea in tourists in Jamaica. *Journal of Travel Medicine, 11*(6), 364-369.

Averett, E., Nazir, N., & Neuberger, J. (2011). Evaluation of a local health department's food handler training program. *Journal of Environmental Health, 73*(6), 65–69.

Babbie, E. (2010). *The practice of social research* (12th ed.). Belmont, CA: Wadsworth, Cengage Learning.

Barrabeig, I., Rovira, A., Buesa, J., Bartolome, R., Pinto, R., Prellezo, H., & Dominguez, A. (2010). Foodborne norovirus outbreak: The role of an asymptomatic food

handler. *Biomed Central Infectious Diseases, 10*, 269-275. doi:10.1186/1471-2334-10-269

Bas, M., Ersun, A., & Kivanc, G. (2006).The evaluation of food hygiene knowledge, attitudes, and practices of food handlers in food businesses in Turkey. *Food Control, 17*, 317-322. doi:10.1016/j.foodcont.2004.11.006

Beatty, M., Chevy G., Shupe-RickSecker, K., Bannister, E., Toyota, A., Lancaster, K ... Braden, C. (2009). Large salmonella enteritis outbreak with prolonged transmission attributed to an infected food handler, Texas, 2002. *Epidemiological Infection, 137*, 417-427.

Buccheri, C., Mammina, C., Giammanco, S., Giammanco, M., & LaGuardia, M. (2010). Knowledge, attitudes and self-reported practices of food service staff in nursing homes and long term care facilities. *Food Control, 21,* 1367-1373. doi:10.1016/j.foodcont.2010.04.010

Caribbean Epidemiological Center. (2006). Food-borne illnesses. Retrieved from http://www.carec.net/pdf/mobidityreview/8.%20Food-borne.pdf

Cates, S., Muth, M., Karns, S., Penne, M., Stone, C., Harrison, J., & Radke, V. (2009). Certified kitchen managers: Do they improve inspection outcomes? *Journal of Food Protection, 72*(2), 384–391.

Centers for Disease Control and Prevention. (2001). CDC estimates of food-borne illnesses in the United States. Retrieved from http://www.cdc.gov /foodborneburden/PDFs/FACTSHEET_D_DIFFERENCES.pdf

Centers for Disease Control and Prevention. (2012). Travelers' health: The Caribbean. Retrieved from http://wwwnc.cdc.gov/travel/yellowbook/2012/chapter-4-select-destinations/the-caribbean.htm

Chapman, B., Eversley, T., Fillion, K., McLaurin, T., & Powell, D. (2010). Assessment of food safety practices of food service food handlers (risk assessment data): Testing a communication intervention (Evaluation of tools). *Journal of Food Protection, 7*(6), 1101–1107.

Chapman, B., McLaurin, T., & Powell, D. (2011). Food safety infosheets. *British Food Journal, 113*(2), 160–186.

Cherry, K. (2011). Social learning theory: An overview of Bandura's social learning theory. Retrieved from http://psychology.about.com/od/developmentalpsychology/a/sociallearning.htm

Cho, S., Hertzman, J., Erdem, M., & Garriott, P. (2012). A food safety belief model for Latino(a) employees in food service. *Journal of Hospitality and Tourism Research, 20* (10), 1-19. doi:10.1177/1096348012436378

Chuckwuocha, U. M., Dozie, I. N. S., Amadi, A. N., Nwankwo, B. O., Ukaga, C. N., Aguwa, O. C., … Nwoke, E. A. (2009). Knowledge, attitude and practices of food handlers in food sanitation in a Metropolis in south eastern Nigeria. *East African Journal of Public Health, 6*(3), 243-246.

Clayton, D., & Griffith, C. (2004). Observation of food safety practices in catering using notational analysis. *British Food Journal, 106,* 211–227. doi:10.1108/00070700410528790

Clayton, D., & Griffith, C. (2008). Efficacy of an extended theory of planned behavior model for predicting caterers' hand hygiene practices. *International Journal of Environmental Health Research, 18*(2), 83-98.

DeBess, E., Pippert, E., Angulo, F., & Cieslak, P. (2009).Food handler assessment in Oregon. *Foodborne Pathogens and Disease, 6*(3), 329-335. doi: 10.1089/fpd.2008.0102.

Diehr, P., & Lumley, T. (2002). The importance of normality assumption in large public health data sets. *Annual Review of Public Health, 23,* 151-169. doi: 10.1146/annurev.publheath.23.100901.140546

Egan, M., Raats, M., Grubb, S., Eves, A., Lumbers, M., Dean. M., & Adams, M. (2007). A review of food safety and food hygiene training studies in the commercial sector. *Food Control, 18*, 1180-1190.

Ehiri, J., Morris, G., & McEwen, J. (1997). Evaluation of a food hygiene course in Scotland. *Food Control, 8*(3), 137–141. doi:10.1016/S0956-7135(97)00005-4

Faul, F., Erdfelder, E., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and medical sciences. *Behavior Research Methods, 39*(2), 175–191. Retrieved from http://www.psycho.uni-duesseldorf.de/abteilungen/aap/gpower3/download-and-register/Dokumente/GPower3-BRM-Paper.pdf

Food and Drug Administration. (2001). Evaluation and definition of potentially hazardous foods. Retrieved from

http://www.fda.gov/Food/ScienceResearch/ResearchAreas/SafePracticesforFoodProcesses/ucm094143.htm

Glanz, K., Rimer, B., & Lewis, F. (2002). *Health behavior and health education: Theory, research and practice* (3rd ed.). San Francisco, CA: Jossey-Bass

Gomes-Neves, E., Araujo, A., Ramos, E., & Cardoso, C. (2007). Food handling: Comparative analysis of general knowledge and practice in three relevant groups in Portugal. *Food Control, 18,* 707–712. doi:10.1016/j.foodcont.2006.03.005

Green, L., Selman, C., Banerjee, J., Marcus, R., Medus, C., Angulo, F., … EHS-Net Working Group. (2005). Food service workers' self-reported food preparation practices: An EHS-Net study. *International Journal of Environmental Health, 208,* 27–35.

Hertzman, J., & Barrash, D. (2007). An assessment of food safety knowledge and practices of catering employees. *British Food Journal, 109*(7), 562-576. doi: 10.1108/00070700710761545

Hislop, N., & Shaw, K. (2009). Food safety knowledge retention study. *Journal of Food Protection, 72*(2), 431-435.

Isara, A., Isah, E., Lofor, P., & Ojide, C. (2010). Food contamination in fast food restaurants in Benin City, Edo State, Nigeria: Implications for food hygiene and safety. *Public Health, 124,* 467–471. doi:10.1016/j.puhe.2010.03.028

Institute for Digital Research and Education (n.d.). Statistical tests in SPSS. Retrieved from http://www.ats.ucla.edu/stat/spss/whatstat/whatstat.htm

Janz, N., & Becker, M. (1984). The health belief model: A decade later. *Health Education and Behavior, 11*(1), 1–47. doi:10.1177/109019818401100101

Jay, J., Loessner, M., & Golden , D. (2005). *Modern food microbiology* (7th ed.). New York, NY: Springer.

Jevsnik, M., Hlebec, V., & Raspor, P. (2008). Food safety knowledge and practices among food handlers in Slovenia. *Food Control, 19*, 110 –1118. doi:10.1016/j.foodcont.2007.11.010

Jianu, C., & Chis, C. (2012). Study on the hygiene knowledge of food handlers working in small and medium-sized companies in Western Romania. *Food Control, 26*, 151-156. doi:10.1016.foodcont.2012.01.023

Jones, T., & Angulo, F. (2006). Eating in restaurants: A risk factor for foodborne diseases? *Clinical Infectious Disease, 43*, 1324–1328.

Kassa, H. (2001). An outbreak of Norwalk-like viral gastroenteritis in a frequently penalized food service operation: A case for mandatory training of food handlers in food safety and hygiene. *Journal of Environmental Health, 64*(5), 9–12.

Khurana, S., Taneja, N., Thapar, R., Sharma, M., & Malla, N. (2008). Intestinal bacterial and parasitic infections among food handlers in a tertiary care hospital of North India. *Tropical Gastroenterology, 29*(4), 207–209.

Laerd (n.d). Independent *t* test using SPSS. Retrieved from https://statistics.laerd.com/spss-tutorials/independent-t-test-using-spss-statistics.php

Leard (n.d). One-way ANOVA in SPSS. Retrieved from https://statistics.laerd.com/spss-tutorials/one-way-anova-using-spss-statistics.php

Laerd (n.d.). ANCOVA in SPSS. Retrieved from https://statistics.laerd.com/spss-tutorials/ancova-using-spss-statistics.php

Lubran, M., Pouillot, R., Bohm, S., Calvey, E. M., Meng, J., & Dennis, S. (2010). Observational study of food safety practices in retail deli departments. *Journal of Food Protection, 73*(10), 1849-1857.

Martins, R., Hogg, T., & Otero, J. (2012). Food handlers' knowledge on food hygiene: The case of a catering company in Portugal. *Food Control*, *23*, 184–190.

Mead, P. S., Slutsker, L., Dietz, V., McCaig, L. F., Bresee, J. S., Shapiro, C.,…Tauxe, R. V. (1999). Food-related illness and death in the United States. *Emerging Infectious Disease, 5*, 607-625. doi:10.3201/eid0505.990502

Ministry of Justice. (n.d.) The Public Health Act. Retrieved from http://www.moj.gov.jm/sites/default/files/laws/Public%20Health%20Act%20Regulations_0.pdf

Panchal, P., Liu, L., & Dworkin, M. (2012). Food safety knowledge is lower among Spanish-speaking than among English-speaking food handlers in Chicago. *Food Protection Trends*, *32*(1), 16–25.

Park, S., Kwak, T., & Chang, H. (2010). Evaluation of the food safety training for food handlers in restaurant operations. *Nutrition Research and Practice, 4*(1), 58-68. doi:10.4162/nrp.2010.4.1.58

Pilling, V., Brannon, L., Shanklin, C., Roberts, K., Barrett, B., & Howells, A. (2008). Food safety training requirements and food handlers' knowledge and behaviors. *Food Protection Trends, 28*(3), 192-200.

Public Health Act. (1985). Retrieved from http://www.moj.gov.jm/sites/default/files/laws/Public%20Health%20Act%20Regulations_0.pdf

Rebellato, S., Cholewa, S., Chow, J., & Poon, D. (2012). Impact of PROTON: A food handler certification course on food handlers' knowledge, attitudes and behaviors. *Journal of Food Safety, 32*, 129–133.

Redwood, E., & Griffith, C. (2003). A comparison and evaluation of research methods used in consumer food safety studies. *International Journal of Consumer Studies, 27* (1), 17-33.

Rennie, D. (1994). Evaluation of food hygiene education. *British Food Journal, 96*(11), 20 – 25. doi:10.1108/00070709410074650

Rennie, D. M. (1995). Health education models and food hygiene education. *Journal of Royal Society of health, 115*, 75–79. doi:10.1177/146642409511500203

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

Rowitz, L. (2009). *Public health leadership: Putting principles into practice* (2nd ed.). Sudbury, MA: Jones and Bartlett.

Santos, M., Noguiera, J.R., Patarata, L., & Mayan.O. (2008).Knowledge levels of food handlers in Portuguese school canteens and their self-reported behavior towards food safety. *International Journal of Environmental Health Research, 18*(6), 387-401. doi:10.1080/09603120802100212

Scharff, R. L. (2012). Economic burden from health losses due to foodborne illnesses in the United States. *Journal of Food Protection, 75*(1), 123–131. doi:10.4315/0362-028X.JFP-11-058

Seaman, P., & Eves, A. (2008).Food hygiene training in small to medium-sized care settings. *International Journal of Environmental Health Research, 18*(5), 367-374. doi:10.1080/09603120802272193.

Seaman, P. (2010). Food hygiene training: Introducing the food hygiene training model. *Journal of Food Control, 21*, 381–387. doi:10.1016/j.foodcont.2009.08.005

ServSafe National Restaurant Association. Retrieve from http://www.servsafe.com/home

Spokane Regional Health District. (n.d.).Food safety definitions. Retrieved from http://www.srhd.org/inspections/definitions.asp

Tokuc, B., Ekluku, G., Berberoglu, U., Bilge, E., & Dedeler, H. (2009). Knowledge, attitudes and self-reported practices of food service staff regarding food hygiene in Edirne, Turkey. *Food Control, 20*, 565-568. doi:10.1016/j.foodcont.2008.08.013

Triola, M. (2011). *Essentials of statistics*. (4^{th} ed.). Boston, MA: Addison-Wesley.

Van Tonder, I., Lues, J., & Theron, M. (2007). The personal and general hygiene practices of food handlers in the delicatessen sections of retail outlets in South Africa. *Journal of Environmental Health, 70*(4), 33–38.

Wiersma, W. (2000). *Research methods in education: An introduction.* (7th ed.). Boston, MA: Pearson Education Company.

World Health Organization. (2000).*Foodborne disease: A focus for health education*. Geneve, Switzerland: World Health Organization.

World Health Organization (2010). Food safety. Retrieved from http://www.who.int/foodsafety/consumer/5keys/en/

World Health Organization. (2014). Foodborne diseases. Retrieved from http://www.who.int/topics/foodborne_diseases/en/

Worsfold, D., Groffith, C., & Worsfold, P. (2004). A survey of environmental health officers' views of food hygiene training. *British Food Journal, 106*(1), 51–64.

York, V., Brannon, L., Shanklin, C., Roberts, K., Howells, A., & Barrett, E. (2009). Food service employees benefit from interventions targeting barriers to food safety. *Journal of the American Dietetic Association, 109,* 1576–1581.

Appendix A: Permission to Use Research Instrument (1)

From: Casuccio [mailto:alessandra.casuccio@unipa.it]
Sent: Monday, March 12, 2012 6:55 AM
To: [redacted]
Subject: Re: Permission to use research instrument

Dear Dr. Marcia Thelwell-Reid,
I send you in attachment a copy of the questionnaire employed in my survey.
Unfortunately, it is a material in Italian language, but I hope you can adapt to your needs.
best regards,
Alessandra Casuccio

From: Marcia Reid
Sent: Wednesday, March 07, 2012 11:08 PM
To: [redacted]
Subject: Permission to use research instrument

Dear Allessandra Cassucio,
My name is Marcia Thelwell-Reid, a PhD student at Walden University. I live in Jamaica and my dissertation will focus on the knowledge and practices of food handlers in Jamaica. MY literature review led me to your article, "Knowledge, attitudes and self-reported practices of food service staff in nursinhg homes and long term care facilities" which has a similar focus as my dissertation. I am requesting permission to use your data collection instrument in my research. If my request is favorably considered, please email a copy of the instrument to: [redacted]. I can assure you that it will be used for no other purpose. Thank you.

Regards,
Marcia Thelwell-Reid

Appendix B: Permission to Use Research Instrument (2)

Hi Marcia,

Please do use the instrument, and make please give us credit for developing the instrument.

good luck and hope your project goes well in Jamaica.

Emilio

From: Marcia Thelwell-Reid [mailto:[redacted]]
Sent: Wednesday, March 07, 2012 2:26 PM
To: [redacted]
Subject: Permission to use research instrument

Dear Emelio E. DeBess,

Good day. I am a student of the Walden University, pursuing a PhD in Public Health with my dissertation focusing on food handlers knowledge and self-reported practices in Jamaica. In my literature review, I was impressed by your article in the Foodborne Pathogens and Disease Journal (2009) entitled Food Handler Assessment in Oregon. I would like to use your instrument to repeat this study in Jamaica. Is it possible that I may be granted permission to do so? If yes, what is the procedure for accessing this instrument? An early reply will be greatly appreciated.

Regards,

Marcia Thelwell-Reid

Appendix C: Permission to Use Research Instrument (3)

Dear Marcia
Sorry for the delay in sending the questionnaire but have been very busy with work and doctoral thesis. I hope it will be useful, I can clarify any questions adicinal and of course then I would have knowledge the results of its study.
Best regards, Maria José santos

_____

De: Marcia Thelwell-Reid [redacted]
Enviado: segunda-feira, 16 de Abril de 2012 5:07
Para: Maria José De Oliveira Santos
Assunto: Re: Permission to use survey instrument

Dear Maia-Jose De Oliviera Santos,
Good day. This email is a follow-up to one sent earlier requesting permission to use your research insrument to repeat your study in Jamaica. I noted that you were willing to allow me to use the instrument but it was not yet translated. Could you send it to me by email and I would arrange for its translation? I need to start working on my methodology chapter to present to my chair. Your assistance will be greatly appreciated.

Regards,

Marcia Thelwell-Reid

_____

From: Maria José De Oliveira Santos <[redacted]>
To: Marcia Thelwell-Reid <[redacted]>
Cc: Maria José De Oliveira Santos <[redacted]>
Sent: Friday, February 10, 2012 6:38 AM
Subject: RE: Permission to use survey instrument

Dear Marcia
Thank you for your contact.
The questionnaire used in my thesis is published in Portuguese and has not yet been translated to English. However if you are willing to wait a while, I can make the translation to send him.

Best regards, Maria José Santos

De: Marcia Thelwell-Reid [mailto:[redacted]]
Enviada: terça-feira, 31 de Janeiro de 2012 3:36
Para: Maria José De Oliveira Santos
Assunto: Permission to use survey instrument

Dear Maria-Jose Santos,

Good day. I am a student of the Walden University, pursuing a PhD in Public Health with my dissertation focusing on food handlers knowledge and self-reported practices in Jamaica. In my literature review, I was impressed by your article in the International Journal of Environmental Health Research (2008) on knowledge levels and self-reported behaviors of food handlers in school canteens in Portugal. I would like to use your instrument to repeat this study in Jamaica. Is it possible that I may be granted permission to do so? If yes, what is the procedure for accessing this instrument? An early reply will be greatly appreciated.

Regards,

Marcia Thelwell-Reid

Appendix D: Consent Form Sheet

A COMPARATIVE ANALYSIS OF FOOD SAFETY KNOWLEDGE AND SELF-REPORTED PRACTICES OF THREE GROUPS OF FOOD HANDLERS IN JAMAICA: HOW EFFECTIVE IS THE MANDATORY TRAINING?

CONSENT FORM/INFORMATION SHEET

Dear Food Handler,
You are invited to take part in a research study of food handlers' knowledge and practices. The researcher is inviting literate food handlers who handle prepared foods to be in the study. This form is part of a process called "informed consent" to allow you to understand this study before deciding whether to take part. This study is being conducted by a researcher named Marcia Thelwell-Reid at Walden University.

Background Information:
The purpose of this study is to determine food hygiene knowledge and self-reported practices of food handlers trained by the Westmoreland Health Department to determine if the training is effective.

Procedures:

If you agree to be in this study, you will be asked to:

- Complete one questionnaire without talking to anyone. This should take about 30 minutes.
- Return completed questionnaire to the researcher.
- Direct any questions you have to the researcher.
- Not write your name on the questionnaire.

Here are some sample questions:
The HIV virus can be spread through food. ( ) agree ( ) disagree ( ) don't know
Food preparation surfaces can contaminate food ( ) agree ( ) disagree ( ) don't know

Voluntary Nature of the Study:
This study is voluntary. Everyone will respect your decision of whether or not you choose to be in the study. No one at the food handlers' clinic or the health department will treat you differently if you decide not to be in the study. If you decide to join the study now, you can still change your mind later. You may stop at any time.

Risks and Benefits of Being in the Study:

Being in this type of study involves some risk of the minor discomforts that can be encountered in daily life, such as stress related to completing the questionnaire because

you may not know some of the answers. Being in this study would not pose risk to your safety or wellbeing. However, the benefit you will derive form participation in this study is better training in the future that will equip you to serve safer food to the public.

Payment:

After completing the questionnaire, light refreshment will be served.

Privacy:

Any information you provide will be kept anonymous. The researcher will not use your personal information for any purposes outside of this research project. Also, the researcher will not include your name or anything else that could identify you in the study reports. Data will be kept secure by storing paper questionnaires in locked filing cabinets and in electronic form on password protected computers. Data will be kept for a period of at least 5 years, as required by the university.

Contacts and Questions:

You may ask any questions you have now. Or if you have questions later, you may contact the researcher via telephone at [redacted] or email at mthelwellreid@yahoo.com. If you want to talk privately about your rights as a participant, you can call:
Prof. Owen Morgan, Chairman, Advisory Panel on Ethics & Medico-Legal Affairs,

PH: [redacted], or you may contact Dr. Leilani Endicott. She

is the Walden University representative who can discuss this with you. Her phone

number is 001-612-312-1210

Walden University's approval number for this study is 01-15-14-0043979 and it expires on **January 14, 2015.**

Statement of Consent:
I have read the above information and I feel I understand the study well enough to make a decision about my involvement. By returning a completed survey, I understand that I am agreeing to the terms described above.

QUESTIONNAIRE FOR THE ASSESSMENT OF FOOD HANDLERS' KNOWLEDGE

INSTRUCTION: Please place a tick under the appropriate column to indicate whether you **agree** with, **disagree** with, or **don't know** each of the following statements.

Transmission of food-borne diseases	Agree	Disagree	Don't know
1. Fresh eggs can have Salmonella			
2. Fresh meat always has microbes on the surface			
3. Canned foods may have harmful microbes			
4. Healthy people can cause illness by carrying germs to food			
5. It is normal for fresh chicken to have Salmonella			
6. Lettuce and other raw vegetables might have harmful microbes			
7. Foods served cold (salads) do not have to be disinfected			
8. Cooked foods do not have microbes			
9. Foods prepared too long in advance might give microbes time to grow			
10. You can tell if a food is dangerous to eat by its look, smell or taste			
11. The HIV virus can be spread through food			
12. Cholera can be spread through food			

Personal Health and Hygiene	Agree	Disagree	Don't know
1. Hands can be washed with water alone after handling raw meat			
2. You can prepare food with a wound on the hand if the wound is covered with a bandage			
3. After washing, hands may be dried with a kitchen towel			
4. It is not necessary to wash hands to handle food that is already cooked			
5. After using the toilet, we should always wash hands with soap and water			
6. When wearing gloves, you can handle cooked foods after handling raw meat			
7. Hands should be properly washed after sneezing or blowing your nose			
8. When you leave the kitchen and go outside, you should change the footwear			
9. After using the bathroom, hands can be washed in the kitchen sink			
10. Wearing gloves while handling food protects the food service staff from infection			
Contamination/Cross-contamination	**Agree**	**Disagree**	**Don't know**
1. Food-borne disease can result from storing raw meat and cooked foods in the same refrigerator			
2. Foods prepared with many steps increases the handling and possibility of contamination of the food			
3. Foods can be contaminated with microbes by coming in contact with unsafe foods			
4. Food preparation surfaces can contaminate foods			
5. Ready to eat foods (eg. Vegetables) can be prepared on the same cutting board that was used to prepare meat			
6. Soap and water can be used to kill all harmful microbes on cutting boards after preparation of raw meat			
7. Prepared or ready-to-eat foods are stored on the top shelf in a refrigerator that also stores raw food			
8. Cutting boards, meat slicers and knives should be sanitized after each use			

Temperature Control	Agree	Disagree	Don't know
1. Foods that need to be kept hot should be at 60°C or above			
2. Leftovers should be reheated to a minimum temperature of 75°C			
3. Microbes may grow because prepared food was left at room temperature for a long period			
4. Cooked foods might be safely stored in the refrigerator at 5°C			
5. Foods should be slowly cooled at room temperature before storage in the refrigerator			
6. Refrigeration kills all the bacteria that might cause food-borne illnesses			
7. Microbes responsible for food-borne illnesses grow well at room temperature			
8. Frozen foods should be thawed on the counter or in the sink			
9. After thawing, meat might be held for 5 hours at room temperature			
10. Foods stored at 40°C is being held in the temperature danger zone			

QUESTIONNAIRE FOR THE ASSESSMENT OF FOOD HANDLERS' HYGIENE PRACTICES

INSTRUCTION: Please place a tick under the appropriate column to indicate whether you carry out these activities **always, sometimes or never.**

Food handling practices	Always	Sometimes	Never
1. Do you wash your hands before touching unwrapped raw food?			
2. Do you wash your hands after touching unwrapped raw foods?			
3. Do you wash your hands before touching cooked foods?			
4. Do you wash your hands after touching cooked foods?			
5. Do you use separate utensils when preparing raw and cooked foods?			
6. Do you thaw frozen foods at room temperature?			
7. Do you check the expiry dates of all products?			
8. Do you use a thermometer to check temperature?			
9. Do you use gloves when serving unwrapped foods?			
10. Do you wash your hands before using gloves?			
11. Do you wash your hands after using gloves?			
12. Do you wear an apron or uniform when serving food?			
13. Do come to work when ill a fever, upset stomach or diarrhea?			
14. Do you use a handkerchief or rag when suffering from a cold?			
15. Do you wear a hat or head covering when serving food?			
16. Do you wear jewelry when serving food?			
17. Do you disinfect cutting boards after each use?			
18. Do you use kitchen towels to dry utensils?			
19. Do you sanitize utensils after washing them?			
20. Do you have separate shoes for use in the food establishment?			

1. What do you use to sanitize utensils?

_____

2. For how long do you wash your hands

_____

These questions seek to find out some things about you.

1. What is your age? _____
2. What is your sex ?
    a. Male
    b. Female
3. What is the highest level of school you completed?
    a. Primary or elementary school
    b. High or secondary school
    c. College or university
    d. Skills training
    e. None
    f. Other _____
4. How long have you worked in food handling/food service _____ (Months or years) Circle one.
5. In what type of food handling facility are you employed or hope to be employed in?

    _____

6. What is your present position?
    a. Food worker
    b. Supervisor
    c. Manager
    d. Administrative
    e. None of the above
7. Is this your first food handlers' training session?
    a. Yes
    b. No. How many training sessions have you attended before?

        _____

8. Have you had six months or more of formal training in food preparation such as classes at HEART or cooking/catering school?
    a. Yes
    b. No

Appendix E: Letter Requesting Permission to Conduct Study

Marcia Thelwell-Reid
School of Public Health & Health Technology
[redacted]

Dr. Kevin Harvey
Director, Health Promotion and Protection
[redacted]

Dear Dr. Harvey:

I am currently pursuing Doctoral studies at Walden University in the USA and I am at the dissertation stage. The topic of the research is *"**A Comparative Analysis of Current Food Safety Knowledge and Self-reported Food Hygiene Practices of Three Groups of Food Handlers in Jamaica: How Effective is the Mandatory Training?*** The three groups of food handlers will be drawn from the parish of Westmoreland; one group of general food handlers, one group of tourist establishment workers, and a group of untrained food handlers as controls.

In November 2011, a meeting was held with Dr. Copeland (then Director of HP&P) and Mr. Broughton and verbal permission was given for the research to be conducted in the food handlers' clinics. I am now seeking Institutional Review Board Approval (Walden University) and approval from the Ethics Committee of the Ministry of Health. The IRB requires written consent from the MOH for the conduct of the study and also an indication that the study was approved by the Ethics Committee.

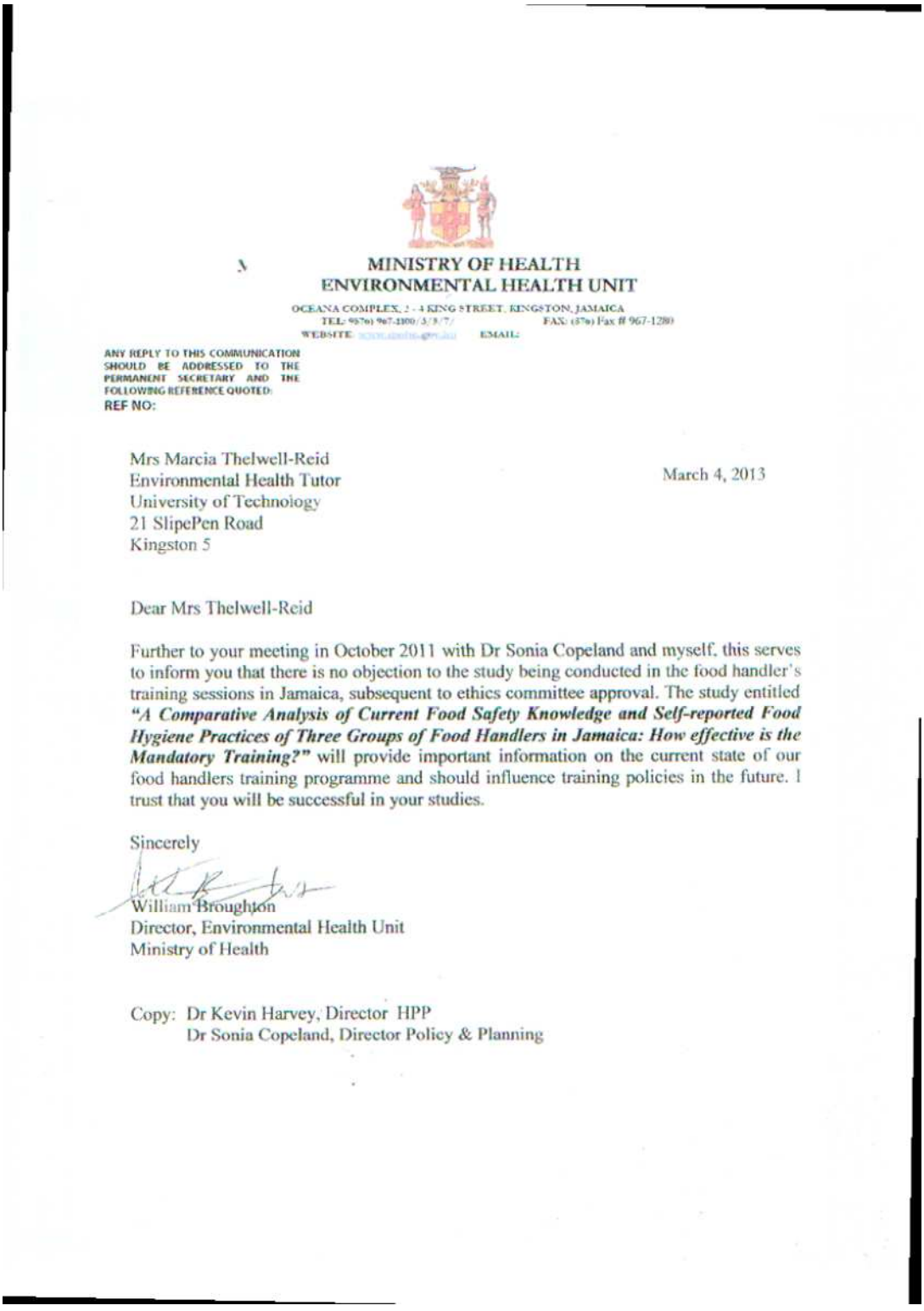
I have attached copies of the Prospectus and the proposed instrument. I am therefore asking you to grant permission (in writing) for the study to be done in the clinics. A letter will also be sent to the Regional Technical Director (Western Region) seeking her permission for the study to be done in the Western Region. I am not sure if you are the one to forward the request to the Ethics Committee or if there are particular forms to be completed by me. Please inform me of the correct procedure. I am anticipating an early favorable response.

Sincerely,

Marcia Thelwell-Reid, MPH, BSc.
Lecturer

cc: Mr. William Broughton, Director, Environmental Health Services.

Appendix F: Ministry of Health Approval



MINISTRY OF HEALTH
ENVIRONMENTAL HEALTH UNIT

OCEANA COMPLEX, 2 - 4 KING STREET, KINGSTON, JAMAICA
TEL: (876) 967-1300/3/8/7/ FAX: (876) Fax # 967-1280
WEBSITE: EMAIL:

ANY REPLY TO THIS COMMUNICATION SHOULD BE ADDRESSED TO THE PERMANENT SECRETARY AND THE FOLLOWING REFERENCE QUOTED:
REF NO:

Mrs Marcia Thelwell-Reid
Environmental Health Tutor
University of Technology
21 SlipePen Road
Kingston 5

March 4, 2013

Dear Mrs Thelwell-Reid

Further to your meeting in October 2011 with Dr Sonia Copeland and myself, this serves to inform you that there is no objection to the study being conducted in the food handler's training sessions in Jamaica, subsequent to ethics committee approval. The study entitled ***"A Comparative Analysis of Current Food Safety Knowledge and Self-reported Food Hygiene Practices of Three Groups of Food Handlers in Jamaica: How effective is the Mandatory Training?"*** will provide important information on the current state of our food handlers training programme and should influence training policies in the future. I trust that you will be successful in your studies.

Sincerely

William Broughton
Director, Environmental Health Unit
Ministry of Health

Copy: Dr Kevin Harvey, Director HPP
Dr Sonia Copeland, Director Policy & Planning

Appendix G: Ministry of Health Approval (2)

MINISTRY OF HEALTH
STANDARDS & REGULATION DIVISION
OCEANA COMPLEX, 2- 4 KING STREET, KINGSTON, JAMAICA
TEL: (876) 967-1100/3/5/7; 948-4106 FAX: (876)-557 8629
WEBSITE: EMAIL:

ANY REPLY TO THIS COMMUNICATION SHOULD BE ADDRESSED TO THE PERMANENT SECRETARY AND THE FOLLOWING REFERENCE QUOTED

Reference: No. S&R/ERP/17

October 23, 2012

Mrs. Marcia Thelwell-Reid
47 McKenzie Close
May Pen P.O.
Clarendon

Dear Mrs. Thelwell-Reid

Approval of Project: 2013/18 – A Comparative Analysis of Current Food Safety Knowledge & Self-reported Food Hygiene Practices of Three Groups of Food Handlers in Jamaica: How Effective is the Mandatory Training?

This serves to inform you that the Advisory Panel on Ethics and Medico-Legal Affairs in the Ministry of Health has reviewed and approved the above-captioned Study. The Study has been assigned the number **2013/18.**

Please keep the Ministry updated regarding the progress and submit a summary of the results and conclusions at the end of the Study.

We wish you every success in future endeavours.

Yours sincerely

Prof. Owen Morgan
Chairman
Advisory Panel on Ethics and Medico-Legal Affairs

Curriculum Vitae

Marcia Thelwell-Reid

Career Summary

My 30 years career in the field of public health began in 1983 as a public health inspector in the parish of Clarendon. Of this period, I spent 20 years lecturing and developing public health courses in the then West Indies School of Public Health and now at the University of Technology, Jamaica. For two years I worked as the Senior Health Education Officer in the Ministry of Health with special responsibility for school health and development of educational materials for the healthy lifestyle program.

Summary of qualifications

Dec. 2008 PhD in Public Health (Candidate - ABD)

Nov. 2005 Post-Graduate Diploma in Education

Nov. 2003 Master of Public Health

Nov. 1996 B.Sc. in Management Studies (1st Class Hons.)

Nov. 1990 Diploma in Community Health/Education

Aug. 1988 Diploma in Meats and Other Foods

Aug. 1983 Diploma in Public Health Inspection

Education

Dec. 2008 – Present Walden University - USA
Doctor of Philosophy in Public Health

May 2004 – Aug. 2005 University of Technology, Jamaica
Post-Graduate Diploma in Education

Sept 2001 – July 2003 University of the West Indies - Mona
Master of Public Health

Sept. 1993 – Aug. 1996 University of the West Indies – Mona

B. Sc. In Management Studies

- Victoria Mutual Scholarship (1995)

Jan. 89 – March 1990 University of the West Indies – Mona

Diploma in Community Health (Health Education)

April – Aug. 1988 West Indies School of Public Health

Diploma in Meat & Other Foods Inspection

Sept 1981 – Aug. 1984 West Indies School of Public Health

Diploma in Public Health Inspection

Professional Experience

2003 – present Lecturer, UTECH

As a lecturer, I have reviewed and developed syllabi for modules in undergraduate and post graduate courses of study. I am also involved in the preparation of students for research, health promotion and environmental health management. A part of my responsibility is to guide students in preparing research papers at the Bachelors and Masters levels, and supervising students on the field who are conducting research. Part-time teaching is also done at nursing training institutions namely, Portmore Community College and Victoria Jubilee Hospital School of Midwifery. Since 2008, I have been pursuing doctoral studies in the field of public health. The PhD dissertation, which is in the final stage, will focus on the knowledge and practices of food handlers in Jamaica and the implications for social change.

2001 - 2003 Senior Health Education Officer

During this two-year contractual employment, I was responsible for the development and production of educational materials on all aspects of health and the drafting and implementation of the "Healthy Lifestyle in Schools" program that came out of the Health Promotion and Protection Division. As the school health specialist, I had the opportunity of traveling to Barbados to sign, on behalf of the Ministry of Health, the charter for the establishment of the Caribbean Network of Health Promoting Schools.

During this period, I conducted a research on the level of physical activity among senior citizens in a rural parish in Jamaica. The findings were presented at a conference in Geneva in 2003.

1990 – 2000 Community Health Tutor

As a tutor, I lectured at the basic and post basic levels to Public Health Inspection and Nursing students in various areas of public health. I also taught in other institutions such as the School of Physiotherapy (U.W.I.), and the Victoria Jubilee Hospital School of Midwifery. I also participated in the development of training courses for other health workers such as the Community health workers (Westmoreland) and Inspectors at Western Parks and Markets.

1983 – 1990 Public Health Inspector (PHI)

During this time, I discharged all the duties attached to the post including meat and other foods inspection, health education, community organization, organization of food handler's clinics, and so on. I also participated in short courses on Family Planning, Assessment of Land Development Applications and Teaching Skills workshops.

While working as a PHI, research projects were conducted in communities to determine health problems and a KAP study was done among food vendors in May Pen on food handling practices and the implications for a health education programme.

Professional Memberships

- APHA (student membership)
- A registered Public Health Inspector
- A member of Golden Key International Honour Society

Awards Received

- Winning poster presentation at the 2nd International Public Health Conference in June 2012.
- Victoria Mutual Building Society Scholarship (1995)
- First Place for Overall Academic Achievement (W.I.S.P.H.) – 1982, 1983, 1984.

References

These can be provided upon request