AN ASSESSMENT OF MOBILE FOOD FACILITIES HANDLER

KNOWLEDGE

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Bernardo Rivera

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Approval Date
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DEDICATION

The thesis is dedicated to my mother, brother and sister. Additionally I would like to dedicate my thesis to Elizabeth Pozzebon, Jenny Quintana, Gloria Estolano, Vivian Nelson, Norman Fujimoto, Dina Ellorin, Muriel Galsim, Joel Wright, Omar Garcia and others who help me finish this project.
ABSTRACT OF THE THESIS

An Assessment of Mobile Food Facilities Handler Knowledge

by
Bernardo Rivera

Master of Public Health with a Concentration in
Environmental Health
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The popularity of mobile food facilities has steadily grown over the last few years. Safe food management practices are essential in food operations since employee knowledge can reduce mishandling of food that can cause foodborne illnesses. Food safety education is associated with a decrease in risky food handling practices by food workers. This study was conducted to evaluate mobile food facility service workers food safety knowledge and the association with behavior that has the potential to cause foodborne illness. Twelve hundred and eighty-two voluntary surveys of worker knowledge resulted in a significantly higher mean score (64%) for restaurant food workers than for five hundred and thirty-nine mobile food facility service workers (60%), surveys taken in Spanish (50%) had lower mean scores than English surveys scores (64%) and men (60%) scored higher than women (57%). No food handling education (54% & 64%) had the lowest mean score and the 3 hour food handler card (58% & 67%) had the lowest mean score when compared to other food handler training. Limitations to the study were that it was on a voluntary basis to take survey and the survey was not performed at random.
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CHAPTER 1

INTRODUCTION AND OBJECTIVES

Customer demand for food at convenient locations has resulted in the production of food inside mobile kitchens. The first company specializing in mobile food service in San Diego County is Moody’s Lunch Service that has been established since the 1926 (Moody’s The Original Food Truck, 2013). Traditionally mobile food units have been visualized as hot dog carts and beverage carts. Since the mid 1990’s mobile food facilities have started reinventing their menu and concocting a variety of gourmet food items. This caused cooking equipment traditionally seen in the brick and mortar restaurants, such as brick wood fire pizza oven, deep fryers, flat grills and a stand-alone refrigerator to appear inside these mobile units. These changes allowed the creation of gourmet items and resulted in loyal crowd followings for specialty mobile food facilities which use social media like Twitter and Facebook to post business hours and locations. It was estimated that 630 million dollars was spent on food at mobile food facilities in the year 2011 (Berstein, 2011).

This innovative food preparation has also brought concerns about food safety. Food is a major vehicle for the transmission of disease. From 1990 to 2000, documented food illnesses associated with Mexican, Italian or Asian ingredients increased from 3% to 10% because of the microbial profile that each cuisine type encompassed (Niode, Bruhn, & Simonne, 2011). The most common bacteria associated with food borne illness is Salmonella, which is often transmitted via infected workers or through handling of chicken products (Hedican et al., 2010). Mishandling of food can cause cross-contamination, such as the contamination of onions with hepatitis A due to poor practices by food worker’s (Dentinger et al., 2001). There are a variety of methods for the transmission, including pathogen transmission via improper storage of food, obtaining food from unapproved sources and contaminated equipment.

Worker knowledge is an important tool in the prevention of disease transmission. Risky behaviors exhibited by food service workers, such as maintaining food at unsafe temperatures, cross-contamination, poor hygiene and working while ill are common factors
in the epidemiological analysis of outbreak data (Niode et al., 2011). Food service workers are trained in food safety topics to minimize the occurrence of these behaviors. A behavior that is attributed to insufficient food safety knowledge is improper hand washing and it has been correlated to laziness (Todd et al., 2010). However, food safety knowledge and translating this knowledge into practice has not been shown to go hand and hand (Park, Kwak, & Chang, 2010).

A grading system is an informational tool that consumers can use to make safe dining choices. Consumers can see at a glance if a restaurant is in compliance with state health and safety codes. Consumers place sanitation and price as the top priority when choosing a food establishment (Park et al., 2010). The grading system began in San Diego County in the 1950’s to inform consumers of sanitary compliance at the places they chose to dine out (County of San Diego Department of Environmental Health Food & Housing Division [County of San Diego DEHFHD], 2007). Checking grades at food facilities helps consumers make an informed decision and can reduce their risk of foodborne illness. While it helps the public in general, it is especially important for immune-compromised individuals, such as pregnant women, infants, the elderly, and those who are ill or taking certain medications, as they have a higher risk of foodborne illness (Lund & O’Brien, 2011).

Grading of restaurants and mobile food facilities is not a state law requirement, so it is not used by all jurisdictions in California. Those jurisdictions with a grading system have amended their local ordinances to adopt it. In 2010, Los Angeles County began the implementation of the A, B and C grading system for mobile food facilities, starting a multi-year implementation project to issue grade cards to more than 10,000 merchants who perform limited food preparation and full food preparation at mobile food facilities (Lin II, 2010). In 2012, San Diego County San Diego County started devising their own mobile food facility grading program and passed county ordinance in March 5, 2013, extending its restaurant grading system to mobile food facilities (County of San Diego, 2013).

State law requires that all employees who handle open food in restaurants have food safety training in California. San Diego had an existing food handler program before state law went into effect, therefore the local program remains in effect providing three ways in which food handlers can achieve compliance. They can obtain a food safety manager’s certification, a food handler card or an in-house food handler test administered by a Certified
Food Safety Manager at their place of work. San Diego County has set a minimum passing score of 80% for both the in-house food handler test and tests administered as part of the 3-hr classroom training offered by food safety schools. During the inspection, Environmental Health Specialists review training documentation, to verify that all food service workers have completed adequate training for the type of work they perform at a food facility. Some local schools offer online training approved by the County, combined with a proctored exam.

Food handler training is used as a tool to prevent and correct existing conditions at food facilities that have the potential to cause foodborne outbreaks. Human error has been implicated in 97% of foodborne illness outbreaks. Providing continuous training on safe food handling training is of utmost priority to reduce the incidence of errors made by employees when preparing food. Continual safe food handling training is of utmost priority to reduce the incidence of employee errors when preparing food. As an example, Irish food workers, when surveyed, were not as familiar with Campylobacter, a leading cause of bacterial gastroenteritis in Ireland, as they were with Salmonella, E.coli 0157 and Listeria monocytogenes (Bolton, Meally, Blair, McDowell, & Cowan, 2008). However, food safety knowledge did not lead to placing knowledge into practice (Bolton et al., 2008). Combined, lack of knowledge and lack of application of food safety principles can increase the incidence of risky behavior.

Non-English speakers have been shown to earn lower scores in food safety tests. An internal food handler survey administered in restaurants demonstrated that Spanish speakers had lower scores compared to English speakers; only 3.4% of them answered all questions correctly, whereas English speakers earned much higher scores (Degraw, 2003). In Oregon, the mean score in a food handler survey had of Spanish speaking Hispanics was 54%, which was 18% lower than Non-Hispanic whites (DeBess, Pippert, Angulo, & Cieslak, 2009). Specialized training must be developed to assist non-native speakers to comprehend the significance of proper food safety behaviors while preparing food for the public. Based on a food handler survey conducted in 2003, the Food and Housing Division in San Diego County developed a Spanish Operator’s Guide and outreach materials to educate non-native speakers (County of San Diego DEHFHD, 2007).

Mobile food facilities have similar infractions to restaurants because of the use of similar equipment. Common violations cited during the inspection of 1,100 mobile food
facilities in San Diego were improper refrigeration food, employee hand hygiene, the lack of 
employee training and contamination of food surfaces (Weisberg, 2012). In Houston, Texas 
the most common violation cited was improper holding of potentially hazardous food and 
equipment conditions. Infractions are mapped in a Google map program showing location 
and conditions during the inspection (Batchgeo.com, 2012). San Diego County is finishing 
online inspection reporting and the system has been online since March 5, 2013 (County of San 
Diego, 2013). Health department inspection violations and reporting vary across counties 
and states depending on how departments are funded (Weisberg, 2012).

The Center for Disease Control and Prevention has categorized the top five risky 
behaviors that contribute to food borne illness. They are defined as improper holding of 
potentially hazardous food, poor hygiene, inadequate cooking, contaminated equipment and 
food from unsafe sources. Increased food safety knowledge in food workers working in 
mobile food facilities should result in lower incidences of risky behavior. A survey was 
conducted with same six question survey in 2003 with 1282 samples and the results showed 
an average score of 64% (Degraw, 2003) Therefore, the average score for food safety 
knowledge questions in mobile food facilities should be at 64%.

Environmental Health Specialist in the Specialist Inspection Unit (SIU) collected data 
analyzed during routine inspection of mobile food facilities during the period of July of 2012 
to March of 2013. The workload during the inspections and the voluntary nature of the 
survey limited the number of participants. Some of the survey questions were from the in-
house food handler card test and food handler class; therefore, some questions were familiar 
to food employees. The survey was only conducted in the San Diego County area and may 
not represent results from other regions because mobile food facility operators differ between 
jurisdictions.

A total of 539 employee surveys were collected from 349 mobile food facilities. The 
thesis had the following objectives:

1. Compare the six questions food handler test average score from 2003 study to test 
average of mobile food facility scores.

2. Compare the Spanish survey mean score versus English survey mean score.

3. Compare the Center for Disease Control and Prevention foodborne illness risk 
factors observed versus food handler knowledge score.
4. Compare the Center for Disease Control and Prevention food borne illness risk factors observed versus type of food safety course taken by individual.

5. Compare the Center for Disease Control risk factors observed versus years of experience in the food industry.

6. Compare the differences in different types of food safety training.
CHAPTER 2

REVIEW OF LITERATURE

Disease outbreaks related to food consumption are of great concern, principally because of the health effects to consumers, but also because of the costs associated with such incidents. An outbreak can cost a company millions of dollars in recalled product, loss of business, damage to their reputation, and the cost of lawsuits and settling damages with consumers affected by the tainted food product. Jack in the Box reported a loss of 160 million dollars for the 18 months following the initial implication of *E. coli* in undercooked hamburger patties served at their restaurants (MarlerClarck Attorneys at Law L.L.P. P.S, 2012). Monetary losses aside, there may be serious consequences to consumers, who may temporary, permanent or even fatal have health effects from the consumption of the food product. There were 171 individuals hospitalized with symptoms of diarrhea, and xx of them developed hemolytic uremic syndrome (HUS) due to the consumption of undercooked hamburgers from Jack in the Box. Three individuals died in the state of Washington and one person died in California (MarlerClarck Attorneys at Law L.L.P. P.S, 2012). Health care from an incident like this can incur in health costs that can range in the millions, depending on the treatment and care needs of the affected individual. William Marler represented a nine-year-old Seattle girl who recovered after suffering complications that included kidney failure. Jack in the Box settled a lawsuit with her family for $15.6 million. The Jack in the Box outbreak was the result of not applying the company’s food safety knowledge that requires cooking hamburger patties to a minimum internal temperature of 157°F (MarlerClarck Attorneys at Law L.L.P. P.S, 2012). California law now requires all comminuted beef to be cooked to a minimum temperature of 158°F (California Association of Environmental Health Administrators [CAEHA], 2011)

TRACKING OF FOODBORNE ILLNESS

Pulse net is used to monitor food borne causing pathogens via ten sites throughout the United States. It monitors the incidence of Campylobacter, Listeria, Shiga toxin-producing *Escherichia coli* O157 (STEC O157), Salmonella, Shigella, Vibrio, Yersinia and
Cryptosporidium. Pulse net is divided up into 8 regions and there are 29 participating sites where samples are analyzed and uploaded into data base (Centers for Disease Control and Prevention, 2012). The agency has limitations because it relies on laboratory diagnosis, laboratory practices and food borne illnesses. The agency has limitations because foodborne illness is not always reported and finding cannot be generalized to the entire United States population because disease demographics differ from regions (Center for Disease Control and Prevention, 2012).

There are other systems of monitoring foodborne illness throughout the world. The World Health Organization suggests using Disability-Adjusted Life Years (DALY) as a metric to express the public health effect of food borne illness. This process is a risk-based approach to determining food borne illness in Greece. The study used available surveillance data, hospital statistics from 1996 through 2006, and literature (Gkogka, Reij, Havelaar, Zwietering, & Gorris, 2011). Disability-Adjusted Life Years metric system additionally accounts for severe outcomes and sequelae of this disease (Gkogka et al., 2011). The authors account for under reporting, food attribution, the quality of incidence data and value choices for the formula, which can affect the outcome of values (Gkogka et al., 2011).

**Susceptible Populations**

Young children, the elderly and those who are immune-compromised are populations susceptible to illness caused by mishandling of food. Factors that contribute to the population vulnerability are a recent organ transplant, HIV, stress, cirrhosis, age, pregnancy, nutritional deficiency and ingestion of fatty foods (Lund & O’Brien, 2011). It is recommended that these susceptible populations do not consume undercooked seafood or eggs, deli or hot dog meats that have not been reheated prior to consumption, unpasteurized milk or cheeses, raw sprouts, or unwashed vegetables. Susceptible consumers should be educated on food safety and be encouraged to select lower risk foods such as cooked versus raw sprouts (Lund & O’Brien, 2011). Operators of mobile food facilities should consider advising consumers when a food has been associated with foodborne illnesses or place an advisory notice if food is not fully cooked (CAEHA, 2011).

Consumers typically perceive themselves as being knowledgeable about food safety. A survey conducted in the state of Gujarat, India showed the following percentages of
disease recognition in 300 consumers: cholera 60.3%, typhoid 30.3%, jaundice 47%, gastroenteritis 19.7%, amebiosis 13.3% and food poisoning 57.7% (Gurudasani & Sheth, 2009). The results of the study also indicated that mature adults aged 65 years and older required further education by food safety advocates in specific subject areas to combat maladaptive food handling behaviors (Gurudasani & Sheth, 2009). This is because older consumer behaviors may include consumption of unsafe food. Currently, due to information available online, the radio, television and magazines, consumers are more aware of food safety related issues. The communication of food facility operators with their consumers is of utmost priority to improve food choices and handling practices for the further reduction of foodborne illnesses (Gurudasani & Sheth, 2009).

**FOOD SAFETY CERTIFICATION AND TEST**

There are three options in San Diego County to satisfy the food safety training requirement. The first option is having a qualified member of the staff provide training and test employees at food facility; the two other options are administered by food handler schools or instructors approved and audited by San Diego County to ensure training includes all the required food safety topics (County of San Diego DEHFHD, 2012a). The first option is the in-house training exam administered at a business, typically by their food safety manager who holds a valid food safety certification. This food handler test is valid for three years at the facility where it was administered (County of San Diego DEHFHD, 2010). The second option is to complete a three-hour classroom training followed by a test. Participants that obtain a minimum test score of 80% are issued a San Diego County Food Handler Card, which is valid for three years at any food establishment throughout San Diego County. The third training option is the food safety certification; this is an eight hour course that can be taken in a classroom or online and requires a minimum passing grade of 75%. The food safety certification is valid for five years (ServSafe, 2008). Currently there are four State approved providers for this certification that operate in San Diego County: ServSafe / National Restaurant Association Educational Foundation, Experior Assessments, also known as Thompson Prometrics, 360training.com Inc. and the National Registry of Food Safety Professionals (County of San Diego DEHFHD, 2012a).
**FOOD INSPECTIONS**

The Department of Environmental Health in San Diego County has an inspection frequency of three times per year for occupied mobile food facilities (County of San Diego DEHFHD, 2013). Food safety inspections in California are conducted by Registered Environmental Health Specialists who are trained to reduce the incidence of risky food handling behaviors and mitigate risk factors observed during a site inspection (CAEHA, 2011). Facility Managers are encouraged to use inspection reports as a training tool to educate staff. Risk factors cited on inspection reports should be reviewed with food workers to reduce the occurrence of repeat violations. The person in charge of the facility is encouraged to develop an open flow of communication with their area Registered Environmental Health Specialist so they can ask and get answers to any questions related to risk factors for foodborne illness and how to prevent risky food handling behaviors.

More frequent inspections have been shown to improve sanitation at restaurants. It has been shown that an inspection frequency of a year or greater results in poor sanitation scores, while a frequency of two, four or six inspections a year results in a lower number of violations identified during inspection. (Campbell et al., 1998). The research paper, “Effectiveness of Public Health Interventions in Food Safety: A Systematic Review”, reviewed a total of 168 studies during the months of January and February of 1997. Five studies were used to identify the minimum number of inspections required to see no significant change in inspection score from written literature. No studies were evaluated that involved hazard analysis critical control point (HACCP)-based inspections due to the lack of available documentation of such studies. The quality of study is minimal because no real-time inspections were conducted to quantify sanitation score change or food service worker behavior change correlated to frequency of inspections.

**EDUCATION IN SAFE FOOD HANDLING**

A food hygiene system must have an understanding of deficiencies and attributes in the system to provide effective training to all types of food operators. It was found that 20% of cooks had no formal training in food preparation or hygiene (Bolton et al., 2008). Another significant factor noted was that less than 50% of individuals recognized *Bacillus cereus* (47.5%), *Campylobacter* (41.5%) and *Clostridium perfringens* (41.5%) in a survey (Bolton et
al., 2008) that sampled 200 establishments at random over four providences of Ireland. The questionnaire contained 44 questions, covering seven major areas: demographics, training, food storage and delivery, food handling, personal hygiene/cleaning, food preparation, and knowledge of foodborne pathogens. This extensive study demonstrated all the areas that food safety educators need to emphasize, including other food borne pathogens; it also promoted formal training to all food service workers. The study did not specify who was asked to take the survey in establishments nor did it specify dates taken.

A study in the state of Oregon sampled 407 food handlers and they included both, employees with and without food handler cards. The resulting average test score was 68% (DeBess et al., 2009). Employees with food handler cards scored five points higher on a food safety and prevention survey compared to employees who did not have food handler cards (DeBess et al., 2009). The study demonstrated that employees with food handler cards have a higher potential to decrease the incidence of food borne illness because they have the potential to participate in safe food handling behavior.

To overcome training barriers, the trainer must consider a number of factors, such as the country of origin, religion, years of experience and food worker’s pre-conceived food handler habits when providing training. A religious magazine published a food safety article that instructed readers to hold potentially hazardous food at 45°F, keep hot food at 140°F and wash produce prior to consumption (Watch Tower Bible & Tract Society of New York, 2012). Some cultures leave food unrefrigerated because it is common practice in their country. Examples of ethnic foods typically seen in the temperature danger zone are siopao, marinated pork slowly cooked in a gyro machine, and Japanese sushi rice. Ultimately, a food safety educator must make food safety a pleasant learning experience that overcomes obstacles to food safety knowledge to ensure the development of positive attitudes and behaviors.

Mobile food facilities have specific menus due to their limited capacity to produce food. Regulations may differ from brick and mortar restaurants because restaurants are in a fixed location; they have a restroom available are hard-plumbed to sewer, water, gas, and electricity. Food safety training should be tailored to the type of food produced in a mobile food facility to account for the physical differences, capacity limitations and location of food preparation. This can be an effective method in implementing food safety knowledge to food
workers (Park et al., 2010) through repetitive training and re-enforcement of specific sanitation goals. A written standard operating procedure can re-enforces these practices because it is a living document developed by a mobile food facility operator specifically for their business operation; this document is used to train staff, describes where food is produced, equipment is being sanitized, and the location where food and food related items are stored (County of San Diego DEHFHD, 2012b).

Trained management can improve food inspection scores and result in improved microbiological quality of food. Trained management has a trickling effect to the food handlers under their management, as their food safety training is transmitted to their employees. Food handlers were also affected by management by improving hand washing habits, proper use of thermometer and positive behavioral antecedents. This improvement may be the result of the trained manager feeling obligated to train food workers underneath their supervision. Contrary to the training of management, when required food training was administered to service workers it did not result in improved knowledge and behavior antecedents (Pilling et al., 2009).

**FOODBORNE ILLNESS RISK FACTORS IDENTIFIED BY THE CENTERS FOR DISEASE CONTROL AND PREVENTION**

The Centers for Disease Control and Prevention (CDC) have identified five behaviors that contribute foodborne illness. The five behaviors are improper food storage, poor hygiene, improper cooking temperatures, contaminated equipment and food from unapproved sources. The CDC conducts surveillance, investigates outbreaks, conducts research, identifies prevention measures and provides consumer education to reduce the incidence of foodborne disease (Centers for Disease Control and Prevention, 2007). It is estimated that 20% of foodborne illnesses results from food workers transmitting a disease causing agent to the food while handling (Sumner et al., 2011). It was identified that 15% of all food borne illness was due to the consumption of contaminated fish (Rakowaski, 2012). Consequently known pathogens caused 25% of food borne illness and 75% is caused by unknown agents (Ciment, 1999).

Food pathogens have an optimal range where microorganisms can reproduce; this range has been defined as the danger zone. The danger zone may differ between states and the federal requirements. The temperature range may change due to the enactment of new
health and safety laws, or when science demonstrates through research different growth
temperatures for pathogens found in food. At the federal level, the Food and Safety and
Inspection Service identified the danger zone between 41°F to 139°F (United States
Department of Agriculture, 2012).

In the State of California, potentially hazardous food is defined as having a ph above
4.6 or a water activity above 0.86 in the State of California (CAEHA, 2011). Other factors
that influence the food’s potential to cause foodborne illness are: the type of food, acidity,
time, temperature, oxygen and moisture (FAT TOM), which can result in the rapid
reproduction of pathogens (National Restaurant Association Education Foundation, 2002).
Improper refrigeration can produce favorable conditions for microbial growth. Potentially
hazardous foods that consumers recognized are beef, chicken, dairy products and cooked
foods that contained comminuted meat products. Produce such as alfalfa, radish sprouts,
lettuce, carrots, spinach, unpasteurized apple cider, berries and melon can be considered
potentially hazardous food because it exhibits the characteristic that can support microbial
growth when the produce has been subjected to temperature abuse. *E. coli* grew significantly
on fresh cut water melon at temperature of 77°F versus no growth at temperature of 41°F
(Abadias, Alegre, Oliveira, Altisent, & Vinas, 2012). The most effective control for
foodborne illness outbreak is to monitor food temperature control and have effective
infection control procedures for *Campylobacter spp.*, *Salmonella*, *Norovirus*, *Clostridium
Perfrigens* and *E. coli* (Greig, Lee, & Harris, 2011).

Inhibition of bacterial and virus transmission in food can be achieved by cooking
food at adequate temperatures. Improper cooking can result in the survival of *Salmonella
species*, which is the most common food borne illness bacteria associated in food outbreaks
(Silva & Gibbs, 2012). An article review of methods used to control *E. coli 0157:H7* in food
stated that pasteurizing milk to 162°F deactivates this bacterium and other pathogens
(Chauret, 2011). Cooking mussels at 140°F, 149°F, 159°F and 167°F showed that the
optimal cooking internal temperature is between 185-194°F, sustained for one minute to
inactivate the Hepatitis A virus (Harlow, Oudit, Hughes, & Mattison, 2011). The numbers of
*Salmonella species* and *E. coli*, microorganisms in catfish and tilapia, can significantly be
reduced (from 55.5±2.8 to 4.2±0.09 for *E. coli* and from 51.4±2.2 to 3.8±.8 for *Salmonella*
when the cooking temperature is raised from 140°F to 149°F (Rakowaski, 2012). Proper
cooking of food is one of the primary tools methods to reduce the incidence of a food borne illness in the food service industry.

Proper cooking of food includes reheating of potentially hazardous food at appropriate temperatures. Proper reheating food that has been cooked and then chilled to temperatures below 41°F has is essential to ensure all remaining food borne causing bacteria and spores are inactivated. Improper reheating of raw frozen breaded chicken nuggets and chicken strips by the consumers who purchased product was assumed to be the cause of food borne illness outbreaks in Australia and Canada. The investigation determined that the manufacturer must reach the coldest point of product and then process the product to a minimum cooking temperature of 158°F for 91 seconds or above this set standard to ensure proper pasteurization of food (Filipa & Gibbs, 2011). Consumers do not usually cook packaged food to temperatures above 165°F. The purchaser of product must follow the procedures set by manufacturer or reheat product to 165°F (CAEHA, 2011). It is of vital importance to verify temperatures with an accurate probe thermometer.

Ill employees have been linked to multiple foodborne illness outbreaks. A literature review of possible scenarios of norovirus outbreaks has shown a strong implication of food workers in the transmission of norovirus via person to person and also through food (Dreyfuss, 2009). This is due to asymptomatic workers that return to work when they recover from their gastro-intestinal symptoms, but continue shedding and spreading virus particles (Dreyfuss, 2009). In a confirmed norovirus outbreak in Japan, norovirus was present in symptomatic workers at a rate of 73%, and at a rate of 7% in asymptomatic workers. (Dreyfuss, 2009).

An effective intervention to prevent food borne illness when symptomatic and asymptomatic workers returned to work is to exclude or limit them to work on non-food contact surfaces. In Texas, 617 individuals became ill in 42 states after consuming a sauce made by a food handler who was diagnosed with *Salmonella enteritidis* (Beatty et al., 2009). Eleven food workers were implicated in the outbreak, confirmed by stool cultures positive for *Salmonella enteritidis* positive (Beatty et al., 2009). Worker exclusion or limiting a worker to non-food preparation activities is imperative to reduce or eliminate the spread of disease.

Cross-contamination of equipment has been linked to the transmission of disease. Disinfection of equipment is crucial to eliminating pathogens. Chlorine, quaternary
ammonium and iodine are approved disinfects for multiuse equipment in California (CAEHA, 2002). An article reviewed current technologies to reduce infection *E. coli 0157:H7* and demonstrated that chlorine levels of 50 to 200ppm reduce *E. coli 0157:H7* (Chauret, 2011). Appropriate levels must be used to inactive pathogens because they can form a biofilm that produces extracellular polysaccharides on stainless steel. Frequent cleaning can produce biofilm and desiccative colonies which can survive for 28 days on stainless steel (Chauret, 2011). The cleaning of equipment at adequate concentrations and intervals may reduce the incidence of cross-contamination on food contact surfaces, therefore reducing the likelihood of bacterial growth.

Food from approved sources is key to limiting food borne illness. Obtaining food from approved sources ensures that it was produced in a facility that has met the minimum sanitation standards (CAEHA, 2002). Spices that have met FDA requirements have shown *E. coli 0157:H7* at levels below detection, which is essential for food safety (Chauret, 2011). Approved manufacturing of food is also key to ensure we have an approved source. The Food and Drug Branch of the California Department of Public Health stated that incorrect vacuum packing of raw fish can produce toxins in *Clostridium botulinum* and *Staphylococcus aureus*, as well as produce histamines due to temperature abuse of the fish (United States Department of Health & Human Services, Food & Drug Branch, Center for Food Safety and Applied Nutrition, 2006). Hence, purchasing food from approved vendors reduces the likelihood of a food borne illness.

**EMPLOYEE HABITS AND HYGIENE**

An employee work history can lay down the principal foundations for basic safe food handling practices because management may reinforce unsafe food handling practices. Jack in the Box food staff were undercooking hamburger patties under the required internal temperature of 157°F because it was making the hamburger patty doughy (Marler Clark Attorneys at Law L.L.P. P.S, 2012). As a result of the investigation of a Salmonella outbreak that resulted in 399 consumers becoming sick and Peanut Corporation of America was cited for rodent droppings and bugs at their factory (Stark, 2013). By not correcting unsafe behaviors and preventing risk factors, management was promoting an environment of unsafe food handling practices for employees.
Employee’s preconceived notions may influence safe food handling habits and hygiene. A study that focused on the PRECEDE-PROCEED model, cited that approximately 64% of workers perceived “no risk” of someone contracting food poisoning from their business, even though all the establishments in the sample prepared high risk foods. There was no difference in risk perception between trained and untrained individuals (Mithcell, Fraser, & Bearon, 2007). Additionally, 18% of food handlers perceived that they would be late in serving meals if they engaged in appropriate food handling practices (Mithcell et al., 2007). It is essential to speak to staff on an individual basis to find the communication and learning style the individual learns best for the individual to comprehend food safety. Lastly, it is imperative that the connection between the unsafe food handling action conducted by the food service staff and the impact on the consumer is linked to demonstrate the consequences associated with poor food handling.

The stress level in food service workers can reduce their auditory attention and focus when performing food preparation. This reduction is associated with the time constraints under which a worker has to provide service to customer and ensure food is made in a timely manner. Male workers with less than five years of experience showed a 73.68% incidence of stress compared to a 13.79% from the control group. Male workers with less than five years of experience also developed physical signs of stress at a rate of 57.89%, as compared to a rate of 15.79% from the control group (de Melo Guerra Ribas et al., 2010). Increased stress levels may hinder auditory and attention spans and can consequently lead to storing food improperly, accidently modifying recipes, and cause changes to the food delivery system (de Melo Guerra Ribas et al., 2010). Only 67 male workers were examined in a hospital setting, since there were not sufficient female participants for study.

Proper hand washing has been known to decrease the transmission of disease. It was reported that one third of individuals who knew the importance of hand washing did not actually wash their hands (Bolton, 2008). A study of ten Middle Eastern cuisine mobile food facilities in New York cited 50% percent of the food vendors using gloves incorrectly. It addressed a lack of hand washing because none of the vendors observed washed their hands or changed gloves in 20 minutes. The study correlated results to another study performed in 2001, where 254 mobile food operators were involved and no hand washing was observed after selling food or handling money (Burt, Volel, & Finkel, 2003). Improper hand washing
is associated with the transmission of *Salmonella, E. coli, Hepatitis A* and *Staphylococcus aureus*.

Pre-conceived employee behaviors regarding safe food handling practices prevent increased knowledge from translating into safe food handling practices (Bolton et al., 2008). Fifty mobile food facility operators were surveyed at the region of Moka and Flacq. Food vendors in the region predominately wash utensils on site with 42% of vendors using water and soap. Prevention of contamination was only observed in 52% operators at this region. Among 36% of female operators, 42% had nail polish which causes hand washing to be performed incorrectly (Lues, Rasephei, Venter, & Theron, 2006). Even though food vendors know the procedures to follow, the vendors do not prevent contamination from food or food related equipment.

Cross-contamination of multi-use surfaces can be prevented by employee behavior. A study found that color-coded cutting boards were in used in 82.5% of the 200 catering business in Ireland. Color coding equipment is a preventive measure used to minimize cross-contamination with supplemental training to train staff on how recognize color for the type of use. Staff washed the equipment with water 0.5% of the time, with water and detergent 7.5% of the time, and with a bleach disinfectant 8% of the time. A color coded system for a cutting knife was used in 25% of business in the survey. Employees acknowledge rinsing knife with hot water, detergent and a bleach disinfectant solution 100% of the time in survey. One fifth do not have equipment that is color coded to specific task and can result in the spread of *E. coli 0157* because of lack of color coded equipment (Bolton, 2008).

Improving employee behavior through a food handling course can increase safe food handling practices. A Pre and Post test survey conducted from October 2008 through October 2010 showed an increase in food safety knowledge scores from 63% to 76%, when the survey was done a month after taking a food safety course. Duplicate surveys were obtained form 320 participants from the initial 1042. This is a positive indicator that food safety behaviors such as proper hand washing and handling of food were more likely to be accepted by the 320 individuals who did post test (Rebellato, Cholewa, Chow, & Poon, 2012). Therefore food service staff is more likely to perform appropriate food handling techniques when appropriately trained.
SOCIAL MEDIA / RESTAURANTS OPPOSED

There are approximately 200 food trucks in the Los Angeles area using social media technologies (Gelt, 2011). Facebook and twitter has created a following for mobile food facilities that facilitates the service of mass crowds in short periods of time. Customers can wait up to an hour for food at mobile food facilities sites (Lin II, 2010). Schools are using mobile lunch truck fundraisers at school properties via twitter and face book to raise funds for scholarships and school equipment (Jennings, 2011). Gourmet trucks can have up to 2,500 followers if they are promoted correctly. Start up cost to launch a gourmet truck can range from $15,000 dollars and to $20,000 dollars (Gelt, 2011).

The limited food capacity in mobile food facilities creates limitations which the brick and mortar restaurants typically do not have because of storage space, food production area, availability of restrooms, and water supply. Mobile food facilities limited food capacity requires operator’s to have a commissary where the operator replenish product (CAEHA, 2011). City ordinance can limit the time and the locations where a mobile food facility can conduct business. In the City of Vista, mobile food facilities cannot operate beyond 6 p.m. and if found operating it is a criminal offense (Klawnon & Gaona, 2004).

Restaurant owners are opposed to mobile food facilities because it creates choices for consumers. Owners feel that mobile food facilities have lower overhead cost than convention restaurants. Restaurant owners also criticize the menu price because mobile food facilities menu prices are lower. Additionally, many restaurant owners are against lunch trucks because they may take up parking spaces used for their business (Guy, Fitzpatrick, & Morris, 2012). Lastly, restaurants owners want a grading system for fair competition because the menu on mobile food facility maybe similar to menu in restaurants. A grading system has been proposed and implemented in San Diego County (County of San Diego, 2013).

DEFINITIONS

A mobile food facility is designated with the prefix FB and is assigned a numerical number of 15, 16, 19, 22 and 23. The numerical number is designated based on food production type. A FB15 is an occupied mobile food facility that can prepare open potentially hazardous food and has been known as a “Lunch Truck”. A FB16 is a motorized vehicle that holds packaged potentially hazardous food that has been prepared and packaged
at an approved commissary. A FB19 is a motorized or non-motorized cart which sells packaged potentially hazardous food and unpacked non-potentially hazardous food. A FB22 is a cart that sells food for immediate sale and is limited to coffee drinks, blended smoothies, crepes, hot dogs and pretzels. A FB23 is a satellite mobile food facility that is similar to the FB22, but the main difference is it has additional carts adjacent to main cart (County of San Diego DEHFHD, 2013).
CHAPTER 3

METHODS

STUDY LOCATION

There are approximately 2300 mobile food facilities in the San Diego County Area. Surveys were taken through the San Diego County region at mobile food facilities location of business, lunch truck events and temporary food events (County of San Diego, 2013). The data used in this thesis was collected by Registered Environmental Health Specialists during the period of June, 2012 to March, 2013 at inspection sites. Mobile food facilities food workers that were tested operated occupied mobile food facilities, coffee carts, hot dog carts, crepe carts, pretzel carts, cookie carts, ice cream vehicles, hot ready to eat packaged food in commissary vehicles and blended drink carts. The surveyed locations were chosen by the inspection frequency of the mobile food facility. There were 539 surveys completed by workers at 349 mobile food facilities.

ADMINISTRATION OF QUESTIONNAIRE

Food service employees at these establishments were assessed for food handler knowledge with a questionnaire. Upon arrival, food service workers were asked if they were willing to take a survey before, during or after inspection of mobile food facility. Employees who volunteered to take questionnaire where given a survey and there was no time limit on the completion of survey. The questionnaire had ten food safety questions pertaining to mobile food facilities and scenario questions implicated in causing food borne illness. Six of the ten questions were surveyed previously at restaurants. The average score of survey was 64% (Degraw, 2003). Questions 7 through 10 were specific questions for mobile food facilities for food protection and were not assessed in the 2003 survey.

QUESTIONNAIRE

Each question was designed to test food handler’s knowledge for behaviors that may cause a food borne illness. The questions described scenarios that are linked to the the Center for Disease Control five causes that are associated with food borne illness. Questions 1 and 2
focused on potentially hazardous food cold and hot holding requirements when a food is ready to eat or being held for future processing. Question 3 focused on employee hygiene and hand washing after cross contamination activities. Questions 4 focused on proper cooking of ground beef to an adequate cooked temperature of 157°F. Question 5 focused on where approved sources of food can be obtained for mobile food facilities. Question 6 focused on cross-contamination of equipment because it tested the proper method of sanitizing multi-use utensils. Question 7 focused on employee hygiene, cross contamination of food storage and the proper use of hand sink. Questions 8 focused on cross contamination and employee hygiene due to the ability of cold and hot running water for proper hand washing and utensil sanitization. Question 9 focused on where food production should be conducted because of mobile food facilities are allowed to produce food only inside permitted occupied mobile food units or on permitted carts and in an approved commissary. Question 10 focused on cooling potentially hazardous food at a mobile food facility. A mobile food facility is required to discard all potentially hazardous food held at or above 135°F at the end of day because they do not have the equipment or the capacity to properly cool potentially hazardous food at or below 41°F within six hours (CAEHA, 2011).

Additional demographics collected were location of sample, date sampled, sex of food worker, type of worker, years of experience and age.

**OBSERVATIONAL QUESTIONNAIRE**

The observational questionnaire was completed by a Registered Environmental Health specialist who conducted the inspection and the survey. The infractions that were observed in the inspection of the mobile food facility were associated with the Center for Disease Control food borne illness risk factors and noted on survey of volunteer (See Appendix). Also, the type of food safety training of volunteer and the food production designation for mobile food facility were documented on survey.

**STATISTICAL ANALYSIS**

The data was reviewed and verified to be exempt in accordance with SDSU’s Assurance and federal requirements pertaining to human subjects within the Code of Federal Regulations (45CFR46.101) (Graduate and Research Affairs, Division of Research Affairs, San Diego State University, 2013). Collected surveys were graded, numbered and entered in
Microsoft Excel. Microsoft Excel analysis tool pack was used to obtained mean, standard deviation, variance, mode, minimum score, maximum score, create tables and graphs. IBM SPSS software Mann Whitney U test was used to compute the nonparametric Wilcoxon signed-rank test for Mobile Food Facility Food Handler Validation Survey 2013 scores to Food Handler Validation Survey 2003 scores and for the Mobile Food Facility Food Handler Validation 2013 Spanish survey scores to English surveys scores (Alcaraz, 2009). Kruskal–Wallis one-way analysis of variance was also used on IBM SPSS software to compare the various types of training (Alcaraz, 2009).
CHAPTER 4

RESULTS

Table 1 presents a summary of demographics of the 539 voluntary surveys collected for this study. There were 216 males and 283 females who supplied gender information with an average age for male of (40 ± 15) and for females of (36 ± 12). Years of experience averaged 8 years and did not differ between Spanish and English speaking participants (Table 1). The highest scores, though not significant were by individuals who operated stationary limited mobile food facilities (73%), Lunch Trucks (69%) and the lowest by those in fully packaged or no hazardous food mobile facilities (54%) (Table 1).

Table 2 shows a summary scores obtained in this study versus the same survey administered to restaurant workers in 2003 (Degraw, 2003). The mean scores for mobile food facilities were lower than the Food Handler Validation Survey (60% versus 64%). Questions 7 through 10 were not tested in 2003 study. The (93% & 94%, p < .05) highest percentage answered in both study was the question that pertained to proper hand washing after changing tasks (Question 2). Question number 7, asked about proper use of a hand sink also had a high score (93%). Knowledge of the correct cooking temperature for ground beef had the lowest scores in both studies (10% vs. 12%).

Table 2 also shows a breakdown from questions 1 through 10 from sampled population. Volunteers who took survey answered 72% correctly for proper cold potentially hazardous food and 38% correctly for hot potentially hazardous food. There were 501 (93%) food handlers who answered that a hand washing sink can only be used to wash hands. There were 501 (93%) food handlers who answered that hands should be washed after using restroom, smoking and handling raw meats. There were 54 (10%) food handlers who know that ground beef should be cooked to a minimum internal temperature of 157°F compared to 21% (113) who know to cook to a minimum internal temperature ground beef below 157°F and 61% (340) who know to cook to minimum internal temperature above 165°F. Lastly, questions #1, #2, #4, #5, #6 and #10 are not meeting the 80% passing score that Department of Environmental Health Food and Housing Division has implemented.
Table 1. Summary of Demographics and Scores for Mobile Food Facilities

<table>
<thead>
<tr>
<th></th>
<th>N (%)</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Responded</strong></td>
<td>539 (100%)</td>
<td></td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td>499 (93%)</td>
<td>38 ± 13</td>
</tr>
<tr>
<td>Male</td>
<td>214 (43%)</td>
<td>40 ± 15</td>
</tr>
<tr>
<td>Female</td>
<td>276 (55%)</td>
<td>37 ± 12</td>
</tr>
<tr>
<td><strong>Years of Experience</strong></td>
<td>491 (91%)</td>
<td>8 ± 9</td>
</tr>
<tr>
<td>English</td>
<td>327 (67%)</td>
<td>8 ± 9</td>
</tr>
<tr>
<td>Spanish</td>
<td>168 (34%)</td>
<td>9 ± 8</td>
</tr>
<tr>
<td><strong>Mean Score</strong></td>
<td>539 (100%)</td>
<td>60% ± 21</td>
</tr>
<tr>
<td><strong>Type of Mobile Food Facility</strong></td>
<td>537 (99%)</td>
<td></td>
</tr>
<tr>
<td>Lunch Truck (FB15)</td>
<td>310 (58%)</td>
<td>60% ± 21</td>
</tr>
<tr>
<td>Fully Packaged Mobile Food Facility (FB16)</td>
<td>14 (0%)</td>
<td>50% ± 24</td>
</tr>
<tr>
<td>No Potentially Hazardous Food Mobile Food Facility (FB19)</td>
<td>15 (0%)</td>
<td>43% ± 20</td>
</tr>
<tr>
<td>Limited Mobile Food Facility (FB22)</td>
<td>158 (29%)</td>
<td>59% ± 19</td>
</tr>
<tr>
<td>Stationary Limited Mobile Food Facility (FB23)</td>
<td>40 (7%)</td>
<td>65% ± 16</td>
</tr>
</tbody>
</table>

Figure 1 shows the proportion of the Center for Disease Control risk factors observed at mobile food facilities. The risk factor that had the highest prevalence rate in the mobile food facility inspections was temperature control for potentially hazardous food with a rate of 26.3%. The lowest prevalence rate was inadequate cooking with a rate of 0.6%. There were no risk factors observed at 54.4% of mobile food facilities sampled.

Table 3 and Table 4 illustrates the Center for Disease Control did not exceed more than three from surveyors. Overall results for questions 1-6 and questions 1-10 show that an increase in mean survey score is associated with a lower incidence of risk factors observed in mobile food facility. In English surveys, a decrease in survey mean score resulted in an increase of risk factors observed. In Spanish surveys, an increase in survey mean score resulted in an increase of risk factors observed. Lastly, English surveys had higher mean
Table 2. Summary Data of Survey Questions

<table>
<thead>
<tr>
<th></th>
<th>Mobile Food Facility Food Handler Validation Survey 2013 (This Study)</th>
<th>Food Handler Validation Survey 2003 (Previous Study*)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Overall Scores Surveys</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Correct for Questions 1-6*</td>
<td>60² ± 21</td>
<td>64 ± 19</td>
</tr>
<tr>
<td>% Correct for Questions 1-10</td>
<td>69 ± 17</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>% Correct for Questions 1</td>
<td>72</td>
<td>77</td>
</tr>
<tr>
<td>% Correct for Questions 2</td>
<td>38</td>
<td>56</td>
</tr>
<tr>
<td>% Correct for Questions 3</td>
<td>93</td>
<td>94</td>
</tr>
<tr>
<td>% Correct for Questions 4</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>% Correct for Questions 5</td>
<td>76</td>
<td>74</td>
</tr>
<tr>
<td>% Correct for Questions 6</td>
<td>68</td>
<td>71</td>
</tr>
<tr>
<td>% Correct for Questions 7</td>
<td>93</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>% Correct for Questions 8</td>
<td>81</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>% Correct for Questions 9</td>
<td>88</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>% Correct for Questions 10</td>
<td>56</td>
<td>Not Applicable</td>
</tr>
</tbody>
</table>


bPercent correct higher than Spanish respondents

* P < .05

scores than Spanish surveys for questions 1-6 (64% vs. 50%, p < .05) and questions 1-10 (73% vs. 60%, p < .05).

The highest mean score was registered from the volunteers who had an in-house food handler test (73% ± 12, p < .05). The group who had the lowest number of risk factors (2) was the volunteers who had a Food Safety Certification. The lowest mean survey scores from individuals who had training were from the food service workers who had a 3 hour food handler card (58% ± 20, p < .05). The next lowest group was the individuals who had no food handler training available.
Figure 1. Center for disease control risk factors observed at 349 mobile food facilities.

Table 3. Summary Statistical Analysis of Center for Disease Control Risk Factors

<table>
<thead>
<tr>
<th>Number of Risk Factors (SD)</th>
<th>N (%)</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>Overall Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall</strong></td>
<td>539 (100%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Correct Questions 1-6</td>
<td></td>
<td>60 ± 21</td>
<td>61 ± 21</td>
<td>58 ± 19</td>
<td>51 ± 17</td>
<td>60 ± 21</td>
</tr>
<tr>
<td>% Correct Questions 1-10</td>
<td></td>
<td>69 ± 19</td>
<td>70 ± 16</td>
<td>67 ± 17</td>
<td>65 ± 9</td>
<td>69 ± 17</td>
</tr>
<tr>
<td><strong>English</strong></td>
<td></td>
<td>65 ± 20</td>
<td>64 ± 20</td>
<td>62 ± 17</td>
<td>67 ± 17</td>
<td>64* ± 17</td>
</tr>
<tr>
<td><strong>Spanish</strong></td>
<td></td>
<td>45 ± 27</td>
<td>55 ± 21</td>
<td>54 ± 21</td>
<td>48 ± 15</td>
<td>50 ± 23</td>
</tr>
</tbody>
</table>

% Correct Questions 1-10

| English                   | 174 (32%) | 73 ± 13 | 74 ± 13 | 70 ± 15 | 70 ± 10 | 73* ± 13 |
| Spanish                   | 365 (68%) | 56 ± 26 | 64 ± 19 | 64 ± 18 | 64 ± 9 | 60 ± 22 |

Food Safety Training 538 (100%

| Food Safety Certification | 220 (49%) |       |       |       |       |       |
| % Correct Questions 1-6    |       | 63 ± 17 | 60 ± 20 | 63 ± 15 | 0    | 64 ± 20 |
| % Correct Questions 1-10   |       | 74 ± 10 | 71 ± 14 | 72 ± 13 | 0    | 72 ± 17 |

3 Hour Food Handler Card 138 (29%)

| % Correct Questions 1-6    |       | 57 ± 21 | 63 ± 19 | 58 ± 16 | 49 ± 15 | 58 ± 20 |
| % Correct Questions 1-10   |       | 67 ± 18 | 71 ± 13 | 65 ± 15 | 64 ± 1 | 67 ± 16 |

Note. No Facilities sampled had more than three Center for Disease Control risk factors observed.

*p < .05
Table 4. Continuation of Summary Statistical Analysis of Center for Disease Control Risk Factors

<table>
<thead>
<tr>
<th>Food Safety Training</th>
<th>N (%)</th>
<th>Number of Risk Factors (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>In-house Food Handler Course</td>
<td>86 (17%)</td>
<td>64 ± 20</td>
</tr>
<tr>
<td>% Correct Questions 1-6</td>
<td></td>
<td>71 ± 18</td>
</tr>
<tr>
<td>% Correct Questions 1-10</td>
<td></td>
<td>66 ± 18</td>
</tr>
<tr>
<td>No Food Handler Education</td>
<td>80 (16%)</td>
<td>58 ± 21</td>
</tr>
<tr>
<td>% Correct Questions 1-6</td>
<td></td>
<td>66 ± 18</td>
</tr>
<tr>
<td>% Correct Questions 1-10</td>
<td></td>
<td>38 ± 25</td>
</tr>
<tr>
<td>No Food Handler Education Required</td>
<td>14 (3%)</td>
<td>46 ± 28</td>
</tr>
<tr>
<td>Years of Experience</td>
<td>491 (100%)</td>
<td>323 (67%)</td>
</tr>
<tr>
<td>English</td>
<td></td>
<td>168 (34%)</td>
</tr>
</tbody>
</table>
CHAPTER 5

DISCUSSION

This study found that stationary limited food preparation mobile food facilities (FB23) had higher mean scores than occupied mobile food facilities (FB15). A contributing factor that may have caused higher mean scores is employee turnover rate and training course taken. Limited food preparation mobile food facilities (FB22) had the lowest mean scores among groups who assembled food (Table 1). Food service worker at (FB22) may not handle meat products or potentially hazardous food that may have translated into lower scores on survey on answers that involve knowing proper temperature holding for potentially hazardous food. Creating a curriculum that is tailored for a mobile food facility operator may increase food safety knowledge survey scores, since current food safety curriculum is tailored to restaurant operators.

Additionally, volunteers who took surveys at mobile food facilities scored lower than the volunteers who took survey at restaurants establishments (Table 2). There are many factors that may influence lower survey scores in food safety knowledge when comparing restaurants to mobile food facilities such as employee turnover rate, lower number of employees than in a conventional restaurant, limited menu, limited food preparation capacity, food storage space, food safety promotion at the business, employee training, business concentration at the time of survey and how long the establishment has been open for business. Furthermore, food service workers work load can cause stress on a food handler that can reduce safe food handling practices because it reduces auditory and the focus of an employee (de Melo Guerra Ribas et al., 2010).

The volunteers who took the Spanish survey scored lower than volunteers who took the English survey (Table 3). External factors that can influence lower scores are ethnic background, religious back ground, the food safety educator and translation of food safety topics into different languages which all can potentially result in lower food safety scores.

In general, as mobile food facility scores increased the Center for Disease Control risk factors decreased in the inspections (Table 3). The Spanish survey mean scores
indicated that as food safety knowledge increased there was an increased in Center for Disease Control risk factors (Table 3). This contradicts the common conception which correlates food safety knowledge with lowering of risk factors that are associated with food borne diseases. This suggests that increased knowledge does not translate into safe food handling practices because of preconceived employee behaviors regarding safe food handling practices (Bolton et al., 2008).

There was an FDA study in 2000 that described and determined risk factor rate that were associated with food borne illness (FDA Retail Food Program Steering Committee, 2000). The Center for Disease Control risk factors observed at mobile food facilities in this study (26.3%) is lower than the risk factors observed in the FDA study. The FDA study indicated that in full service restaurants and fast food restaurants out of compliance observation rate for improper temperature control of potentially hazardous food was 49% and 63% (FDA Retail Food Program Steering Committee, 2000). This lower rate may be attributed to a lower number of hot holding equipment, refrigerator units, food storage space, number of employees employed, a limited menu in mobile food facilities and outreach conducted by the Department of Environmental Health Food and Housing Division. There were no other studies found who analyzed the out of compliance rate for food borne illness risk factors for mobile food facilities.

The Center for Disease Control also reported that poor personal hygiene of food workers was the second most commonly reported practice that contributed to food borne disease outbreaks (FDA Retail Food Program Steering Committee, 2000). Volunteers who took survey answered proper hand washing 93% correctly and 93% correctly the approved use of a hand sink. Full service restaurants and fast food restaurants observed rate for poor personal hygiene out of compliance was 36.6% and 53.4% (FDA Retail Food Program Steering Committee, 2000). A lower rate was observed in mobile food facilities (19.5%). Lack of hand washing among mobile food operators after selling food or handling money has been observed in a previous study (Burt et al., 2003).

The contamination of equipment observation rate in mobile food facilities is lower at mobile food facilities (18.6 %) than fast food restaurant (43.6%; FDA Retail Food Program Steering Committee, 2000). Volunteers who took survey answered 67% correctly for proper sanitization and 81% answered correctly for hot water availability in mobile food facilities.
This lower observation rate may be attributed to less equipment used in food preparation, most food sold is for immediate service with minimal process and not all mobile food facilities are required to have a warewashing sink (CAEHA, 2002).

The cooking temperature question for ground beef had the lowest scores. Survey volunteers answered 10% correctly on survey (Table 2). This may be attributed to a low score because most mobile food facility operators do not handle ground beef because their menu is limited. On the Food Handler Training Validation Survey 2003, 12% of the food handlers who worked in restaurants answered this question correctly (Degraw, 2003). There was 2% lower prevalence rate in mobile food that may be attributed to mobile food facilities do not handle various types of meats, not all mobile food facilities cook meats, most foods sold are already fully cooked, food is reheated for immediate service or Environmental Health Specialist did not observe active cooking. Survey volunteers answered incorrectly that ground meat should be cooked to 165°F (63%) when the correct answer should have been 157°F (10%). Food handlers in the Food Handler Training Validation Survey 2003 answered incorrectly (66%) that ground beef should be cooked to 165°F (Degraw, 2003). This concludes that most food handlers felt that 165°F is the “gold standard” to cook or reheat any type of food that requires cooking.

When comparing food safety certification training to the in-house food handler training at mobile food facilities, one can presume that the in-house food handler training is sufficient and food handlers that take this training have similar food safety knowledge retention. This is because the in-house food handlers mean scores were similar to the food safety certification mean for questions 1-10 (72% vs.73%). To further verify this presumption, a further survey would need to be conducted.

The three hour training for the food handler training was lower than the food safety certification training group and the in-house food handler group for questions 1-6 (58%) and
for questions 1-10 (67%) on surveys. Possible explanations for low survey scores are food safety trainers include not following San Diego County food safety outline to be taught in food handler classes, not enough emphasis in food safety relevance to prevention of food borne illness in class, and the teaching method used and overcoming preconceived student knowledge to accept food safety training. Further analyses must be conducted such as a pre and post test after a 3 hour food handler class, a food safety training retention study of the 3 hour course, trainer evaluations and food safety school audits.
CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

Safe food handling practices are essential to reducing food borne illness in establishments providing food to the public. The rule of thumb has been that food safety knowledge leads to increase knowledge and the reduction of Center for Disease Control risk factors that are associated with food borne illness. Mobile food facilities food service worker scored lower (60%) than restaurant food service workers did in previous study (64%). Additional outreach should be conducted to Spanish speaking food service worker because it was showed that Spanish speaking participants (50% & 60%) were lower than English speaking participants (64% & 74%). There was also a decrease in survey mean score as the Center for Disease Control risk factors increased (Table 3). Food service workers with no food safety training (35% & 41%) had the lowest mean score when compared to food service workers who had training (Table 4). The in-house food handler test (62% & 73%) was an effective source of food handler training for food service workers because it had a similar mean score to food service workers who had a food safety certification (64% & 72%). The lowest scored among food handler training was from individuals who took the 3 hour food handler training and had the 3 hour food handler card (58% & 67%).

Food safety training should be specific to mobile food facilities. Mobile food facilities food handlers scored lower than food handlers in restaurant. Improvements to food safety training courses for mobile food facilities should focus on holding temperature requirements for potentially hazardous food, cooling of potentially hazardous food, where food preparation is to be conducted, use of hand sink, sanitization of equipment in warewashing sink, food storage, commissary use, hot water requirements, water supply, wastewater discharge, development of written operational procedures, restroom requirements and equipment requirements. This is because of score results being lower than 80% of Department of Environmental Health Food and Housing Division passing score. Also there are physical differences from a conventional restaurant to a mobile food facility, hence the food safety instructor must be familiar with differences to properly present safe food
handling topics to food handlers to reduce Center for Disease Control risk factors and food borne illness.

A standard food safety trainer’s manual for the 3 hour food handler course is recommended to increase food safety knowledge for food handlers who take this course. The manual should contain learning objectives, common preconceived behaviors from participants that the food safety instructor should overcome during class, standard food safety questions when presenting course, standard handouts to be handed out in class and a standard power point presentation. Food safety educators are recommended to use different types of audio and visual aids to increase the importance of food safety (Gurudasani & Sheth, 2009). This will facilitate future studies when evaluating food safety knowledge for food handlers at mobile food facilities and restaurants. The future evaluations of food safety trainers should consists of a pre and post test to assess food handler knowledge, evaluations for food safety trainer’s effectiveness in teaching food safety topics and geographically mapping scores to increase training efforts to areas in need of food safety outreach in the San Diego County area.

Food safety outreach should be offered for mobile food facilities and food safety instructors. Workshops for new and for future mobile food operators should be offered to present food safety topics, food safety requirements, structural requirements, equipment requirements and other governmental agencies operator may have to consult with when operating a mobile food facility. Continual education for food safety instructors should be offered to maintain and improve teaching and technical skills. Providing easily readable outreach material without acronyms may facilitate uptake of knowledge for the food handler when presenting basic food safety topics. Translating food safety training information and outreach into different languages, such as Chinese and Vietnamese may improve learning uptake of food safety topics from food service workers.

The reduction of the top three Center for Disease Control risk factors noted in the Mobile Food Facilities Validation Survey 2013 may be addressed by requiring engineering barriers. Requiring an air flow diagram of the interior for customs refrigerators to ensure it is designed properly. An accessible and easily readable gauge for refrigeration coolant may help identify service for the customs refrigerator in mobile food facility. A section in the written operational procedures should document when the refrigeration system was serviced
and by the service personnel. Sizing the electric generator installed in the mobile food facility may ensure the refrigerators and electric hot holding equipment have adequate supply of electricity to reduce temperature infractions (Farley, 2013). Another engineering barrier to reduce Center for Disease Control risk factors is requiring a preparation sink to wash produce in a safe and effective way inside mobile food facilities. This may require increasing the size requirement of potable water and waste water tank. Lastly, advance training for Environmental Health Specialists to educate operators and reduce Center for Disease Control risk factors is essential. Advance training should consists of touring a manufacturing plant where mobile food facilities are manufactured, taking a course in air conditioning to become familiar on how a refrigerator motor works, taking a course in mechanical ventilation and in fire safety.
REFERENCES


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APPENDIX

2012 MOBILE FOOD FACILITY FOOD HANDLER PROGRAM TRAINING VALIDATION SURVEY
2012 Mobile Food Handler Training Program Validation Survey

Questions:

1. Choose the proper cold-storage temperature for meat, poultry, and seafood:
   a. 32°F
   b. 41°F
   c. 59°F
   d. 65°F

2. What is the minimum hot-holding temperature for perishable foods?
   a. 135°F
   b. 140°F
   c. 150°F
   d. 160°F

3. Hands should be washed after:
   a. Using the toilet
   b. Smoking
   c. Handling raw meat products
   d. All of the above

4. What is the minimum cooking temperature of hamburgers and other ground meats?
   a. 120°F
   b. 141°F
   c. 165°F
   d. 157°F

5. Which of the following would be true of food from an approved source?
   a. Sanitary condition
   b. Safe, non-toxic ingredients
   c. Labeled in English
   d. All of the above

6. What is the correct order of manual dish washing steps?
   a. Rinse-air dry-wash-sanitize
   b. Wash-sanitize-rinse-air dry
   c. Wash-rinse-sanitize-air dry
   d. Sanitize-rinse-wash-air dry

7. Hand wash station can be used:
   a. Only for hand washing.
   b. As a preparation sink.
   c. For equipment storage.
   d. For food storage.
8. What must the operator do when a mobile food facility does not have water or hot water at least to 110 °F?
   a. Keep open because we have gloves.
   b. Closed until water or hot water is restored.
   c. Fill water tank at the end of business day.
   d. Hot water is not required to be available at all times.

9. Food can be prepared or packaged at:
   a. Home.
   b. On table outside the permitted mobile food facility.
   c. Unpermitted restaurant.
   d. Approved commissary.

10. At the end of business day, foods kept in hot holding equipment at or above 135 F should be:
    a. Rapidly cooled to 41°F.
    b. Taken home.
    c. Discarded.
    d. Stored at commissary.

Circle Sex: Male / Female
Circle type of Employee: Manager / Food Worker / Owner
Years in Industry: _______ Age: _______

FOR FHD STAFF USE ONLY:
Type of food handler training:
1. In-house______ 2. FH card______ 3. FS Certified______ 4. No Available______ 5. Not Applicable______

Circle Mobile Food Facility Type: (B15, B16, B19, B22, B23) Date Sampled: _______
Location of address: _____________________________

Center for Disease Control Major Risk Factors

<table>
<thead>
<tr>
<th>Violation</th>
<th>Check Box If Observed at Inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Improper holding temperatures</td>
<td>☐</td>
</tr>
<tr>
<td>2. Poor personal hygiene</td>
<td>☐</td>
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<tr>
<td>3. Inadequate cooking</td>
<td>☐</td>
</tr>
<tr>
<td>4. Contaminated equipment</td>
<td>☐</td>
</tr>
<tr>
<td>5. Food from an unsafe source</td>
<td>☐</td>
</tr>
<tr>
<td>6. No violations observed</td>
<td>☐</td>
</tr>
</tbody>
</table>

Score for Questions 1-6: _______  Score for Questions 1-10: _______