Influence of Demographic Characteristics, Delivery Methods, and Self-Reported Evaluations on Food Safety Knowledge after ServSafe™ Training in Minnesota (2010-2011)

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Dedication

I would like to dedicate this research paper to my parents who have been my source of inspiration, drive, discipline, and to all that I have achieved.

Thank you for your endless love and support.

Abstract

Food safety is a growing concern in the United States. Foodborne outbreaks related to the food service industry are especially of concern as Americans continue to patronize such businesses in increasing numbers. As many of the root causes of foodborne illness outbreaks have been traced to worker illness and poor food handling practices, knowledge and training is essential to ensure foods are served safely. ServSafe™ is the most widely utilized food safety-training course in the United States. Originally, it was an instructor-led training offered in class but in the last few years, it has been offered through on-line training as well. Numerous studies have documented comparable outcomes from web-based and traditional classroom instruction. Because of its prevalence, we were interested to evaluate the effectiveness of on-line training in comparison to in-class training.

The purpose of this study was to examine influence of demographic characteristics and delivery methods on food safety knowledge using on-line and in-class training scores. In addition, we also examined self-reported evaluations after ServSafe™ training in Minnesota in 2010 and 2011.

Based on data gathered, when comparing the on-line to in-class mode of training, there was no significant difference (at p-value of 0.05) between in-class and on-line instruction with respect to total exam scores and 10 domains, except in the "Temperature Measuring Devices" (D5) content area. On-line participants appeared to perform better in that area (D5) with an average score of 90% compared to in-class participants with average score of 83%. Participants' performance in different locations (cities) did not

show a significant difference with respect to total exam score and 10 domains. No significant interaction (p-value at 0.05%) was noticed between mode of training (on-line and in-class) and cities where participants took the training when we looked at all cities combined. However, when mode of instruction was considered in every single city, a significant difference was noticed. Participants in St.Paul showed better performance in in-class training (93%) than in on-line training (88%) in “Monitoring Food Personnel” (D4) content area. Participants in Rochester performed better in in-class (98%) compared to on-line training (93%) in “Training Employees” (D10). There was no in-class training in Andover and Grand Marais and no on-line training in Grand Rapids. Thus, there was not sufficient data to be able to compare the mode of instruction in those cities. There was no interaction between mode of training and gender; meaning that effect of on-line and in-class training did not vary by gender. However, an interaction was noticed between males and females in St.Cloud, Marshall, Bemidji, and Little Falls (p-value at 5%).

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Introduction

Food safety is a major issue that the food industry needs to address. Food safety is crucial because food-borne illness not only food industry and economy overall, $7.7 to $23 billion per year (Council for Agricultural Science and Technology, 1995; Martin et al., 1999). CDC estimates that each year roughly 1 in 6 Americans (or 48 million people) gets sick, 128,000 are hospitalized, and 3,000 die of foodborne diseases (CDC, 2011). According to FDA (2008), contributing factors in foodborne illness outbreaks are: 1). Unsafe Sources, 2). Poor Personal Hygiene, 3). Inadequate Cooking, 4). Improper Holding/Time and Temperature, and 5). Contaminated Equipment/Protection from Contamination.

Current evidence suggests that a substantial number of foodborne illnesses occur through poor food handling practices involving food workers (CDC, 2013). In a comprehensive summary of foodborne outbreaks caused by food handlers, 94% (767 of 816) are caused by infected food handlers, and 73 are directly linked to workers failure to wash hands (Todd et al., (2007a).

Food handlers are of particular concern as they are less likely than workers in other high-risk occupations, such as health care and day care workers, to exclude themselves from work if they become ill (Thomas et al., 2006). As many of the root causes of foodborne illness outbreaks have been traced to worker illness and poor food handling practices, this segment of the population requires education about food safety, proper food handling practices and the importance of hand washing to avoid spreading

infectious diseases while at work (McIntyre et al., 2013).

Food workers play a critical role in ensuring food safety in food service where they can introduce a food safety hazard at any point during the food production process. Thus, knowledge, and training are significantly important and essential to ensure that they practice correct way of handling food (Martins, Hogg, & Otero. 2012).

ServSafe™ Manager Certification is the most widely utilized food safety training program in the U.S. it is accredited by the American National Standards Institute (ANSI)-Conference for Food Protection (CFP) and is coordinated through National Restaurant Association (NRA). The ServSafe™ examination is based on guidelines put in place by the American Educational Research Association, the American Psychological Association, and the National Council for Measurement in Education. Group of food safety experts and regulators develop a Certified Food Manager course and exam based on the most recent FDA Food Code, food safety research, and food sanitation training.

The State of Minnesota Department of Health requires that most food establishments have a Certified Food Manager employed at their facility. Completion of the ServSafe™ course and successful completion of the exam will qualify a person to apply for a State of Minnesota Food Manager Certificate, which is valid for a three year period.

The purpose of this study was to examine influence of demographic characteristics, delivery methods, and self-reported evaluations of ServSafe™ training. Utilizing the data collected in 2010 and 2011, this research had the following objectives:

Part 1

1. To determine the influence of demographic (gender and location) on the practice of food safety by the participants.
2. To compare on-line training to in-class training on food safety knowledge.

Part 2

1. To examine the effectiveness of ServSafe™ training using self-reported evaluations.
2. To examine the influence of demographics on self-reported food safety knowledge.

Literature Review

I. Food Service Relationship to Food-borne Illness

The National Restaurant Association (NRA, 2011) is projecting sales to be $604 billion in 2011, which accounts for approximately 4% of the gross domestic product for the U.S (Neal, Binkley, & Henroid, 2012). This means that 12.8 million employees in the U.S. serve over 70 billion meals at 960,000 commercial establishments each year (NRA, 2011). These findings are significant because increase in dollars being spent at restaurants is directly proportional to the increased risk of contracting a foodborne disease transmitted by unknowledgeable food handlers (Cotterchio et al., 1998).

On a typical day, 44% of adults in the United States eat at a restaurant (NRA, 2001; Bender et al., 1999; Putnam & Allshouse, 1997). Of a mean 550 foodborne disease outbreaks reported to the Centers for Disease Control and Prevention each year from 1993 through 1997, more than 40% were attributed to commercial food establishments (Olsen et al., 2000). Restaurants served more than 70 billion meals in the United States in 2005. Of all the money spent on food in the United States, 47% is spent in restaurants, and the food service industry employs more than 9% of the nation's workforce (National Restaurant Association, 2005). Four in 10 Americans eat in restaurants on any given day, and 1 in 6 eats more than 5 meals per week in restaurants (Garman, Jones, & Kennedy, 2002). CDC estimates that each year roughly 1 in 6 Americans (or 48 million people) gets sick, 128,000 are hospitalized, and 3,000 die of foodborne diseases (CDC, 2011). From 1998 to 2004, an average of ~1290 foodborne disease outbreaks each year

(involving an average of ~25, 600 ill people each year) were reported to the Centers for Disease Control and Prevention (CDC) [4:7]. Of the 9040 foodborne disease outbreaks that were reported to the CDC from 1998 to 2004 (CDC, 2006), 4675 (52%) were associated with restaurants or delicatessens including cafeterias and hotels.

In addition to eating out more, Americans have also made changes in the foods they eat. People are eating more "heart-healthy" and "cancer-preventing" foods. In 1970, each American ate about 175 pounds of fresh fruits and vegetables per year. By 1995, the number rose to about 220 pounds per person (Putnam & Allshouse, 1997; Bender et al., 1999). From 1990 to 1996, fresh produce was the single leading carrier of food-borne disease in the state of Minnesota. Thirty percent of the outbreaks were attributed to fruits and vegetables. Since fresh produce is not usually cooked before consumption, it is susceptible to contamination anywhere and anytime--from field to plate, and a majority of the time the contamination occurs through mishandling by foodservice employees.

In Minnesota, most viral gastroenteritis outbreaks have been traced back to foodservice employees (Bender et al., 1999). This could be due to the fact that most foodservice employees do not have access to health benefits, including sick leave, and therefore commonly work when they are ill. In addition, foodservice employees are usually young, uneducated and tend to stay in a position for less than a year. They also tend to carry enteric diseases and have poor personnel hygiene (Bender et al., 1999).

In a study conducted by Reid et al. (1988) 93% of the outbreaks implicated foodservice employees who were or had been ill at the time of the incident. Eighty-nine percent (Reid et al., 1988; Guzewich & Ross, 1999) of the outbreaks occurred at food

service establishments, such as restaurants, cafeterias and catered functions. The majority of foods involved in the outbreaks included sandwiches, salads, and miscellaneous hot items. Foods such as sandwiches and salads often involve intensive hand contact during preparation and are not cooked prior to consumption.

II. Incidences of Food-borne Illness

Foodborne agents cause an estimated 48 million illnesses annually in the United States, including 9.4 million illnesses from known pathogens (Scallan et al., 2011, 17, 1-15; Scallan et al. 2011, 17, 16-22). CDC collects data on foodborne disease outbreaks submitted from all states and territories through the Foodborne Disease Outbreak Surveillance System. During 2008, the most recent year for which data are finalized, 1,034 foodborne disease outbreaks were reported, which resulted in 23,152 cases of illness, 1,276 hospitalizations, and 22 deaths. Among the 479 outbreaks with a laboratory-confirmed single etiologic agent reported, norovirus was the most common, accounting for 49% of outbreaks and 46% of illnesses. Salmonella was the second most common, accounting for 23% of outbreaks and 31% of illnesses. Among the 218 outbreaks attributed to a food vehicle with ingredients from only one of 17 defined food commodities, the top commodities to which outbreaks were attributed were poultry (15%), beef (14%), and finfish (14%), whereas the top commodities to which outbreak-related illnesses were attributed were fruits and nuts (24%), vine-stalk vegetables (23%), and beef (13%) (C).

According to CDC 2011 report (CDC, 2011, 60 (35), 1197-202), among the 868 outbreaks with a known single setting where food was consumed, 52% resulted from

food consumed in a restaurant or deli, 15% in a private home, and the remainder in other locations

In 2004, the Minnesota Department of Health (MDH) Acute Disease Investigation and Control Section identified a total of 108 outbreaks of gastroenteritis involving at least 3,553 cases of illness.

III. Cost of food-borne illness

Food safety is an important issue concerning the food industry. Food safety training is crucial because foodborne illness not only causes many needless illnesses and deaths, but also costs consumers, the food industry and the economy overall $7.7 to $23 billion per year (Council for Agricultural Science and Technology, 1995; Martin et al., 1999). Food-borne illness also increases health care costs (Campbell et al., 1998; Guzewich & Ross, 1999). CDC estimates that each year roughly 1 in 6 Americans (or 48 million people) gets sick, 128,000 are hospitalized, and 3,000 die of foodborne diseases (CDC, 2011).

In a study conducted by Hoffman, Batz, & Morris Jr. (2012), they estimated the annual cost of illness and quality-adjusted life year (QALY) loss in the United States caused by 14 of the 31 major foodborne pathogens reported on by Scallan et al. 2011, (17), 7-15, based on their incidence estimates of foodborne illness in the United States. These 14 pathogens account for 95 % of illnesses and hospitalizations and 98 % of deaths due to identifiable pathogens estimated by Scallan et al. Based on their findings, they estimated that these 14 pathogens cause $14.0 billion (ranging from $4.4 billion to $33.0 billion) in cost of illness and a loss of 61,000 QALYs (ranging from 19,000 to 145,000

QALYs) per year. They concluded that about 90% of this loss is caused by five pathogens: nontyphoidal Salmonella enterica ($3.3 billion; 17,000 QALYs), Campylobacter spp. ($1.7 billion; 13,300 QALYs), Listeria monocytogenes ($2.6 billion; 9,400 QALYs), Toxoplasma gondii ($3 billion; 11,000 QALYs), and norovirus ($2 billion; 5,000 QALYs)

Another study conducted by Scharff (2012) based on CDC 2011 estimate of foodborne illnesses in the United States, utilized two models to estimate total health related cost. Based on the basic model, which includes economic estimates for medical costs, productivity losses, and illness-related mortality, he estimated that the total annual cost would be $51 billion. The enhanced model replaces the productivity loss estimate with a more inclusive suffering, pain, and functional disability measure based on monetized quality-adjusted life year estimates. Based on this model, he estimated the total cost to be $77.7 billion per year.

IV. Cause of Illness

About 75% of foodborne outbreaks are due to contamination of food in foodservice facilities. In 2008, the U.S. Food and Drug Administration's (FDA) National Retail Food Team conducted a study to measure the occurrence of practices and behaviors commonly identified by the Centers for Disease Control and Prevention (CDC) as contributing factors in foodborne illness outbreaks (FDA, 2009). These factors herein referred to as foodborne illness risk factors are: 1). Unsafe Sources, 2). Poor Personal Hygiene, 3). Inadequate Cooking, 4). Improper Holding/Time and Temperature, 5). Contaminated Equipment/Protection from Contamination

According to CDC (2013) Surveillance for Foodborne Disease Outbreaks 2009-2010 report, Public health officials from all 50 states, the District of Columbia, and Puerto Rico reported 1,527 outbreaks, including 675 in 2009 and 852 in 2010. For the period 2009–2010, the median average annual rate of foodborne outbreaks among states was 3.2 per 1 million populations. A food vehicle was reported for 653 (43%) outbreaks; in 299 (46%) of these outbreaks the vehicle could be assigned to one of the 17 predefined commodities. The commodities most commonly implicated were beef, with 39 outbreaks (13%), followed by dairy and fish with 37 (13%) each, and poultry with 33 (11%). Among the 766 outbreaks with a known single setting where food was consumed, 48% were caused by food consumed in a restaurant or deli, and 21% were caused by food consumed in a private home.

The Food Marketing Institute (Collins, 1997) stated that the organisms that cause foodborne illnesses are found throughout nature and that mishandling and poor refrigeration are responsible for most contamination. The causes were cross-contamination of cooked foods with raw foods, contaminated utensils or serving plates, poor hygiene of food handlers and time or temperature abuse (Collins, 1997; Physicians Committee for Responsible Medicine, 1998). After workers touch food with unclean hands, improper holding temperatures may facilitate the growth of bacteria in the food. Other important areas that need to be mentioned in the prevention of foodborne illness are that ill workers should be banned from the workplace and food workers should use gloves or some other sort of barrier to prevent direct contact of hands with foods that will be served uncooked (Guzewich & Ross, 1999).

According to the CDC, contaminated hands may be the main route of contamination for enteric viruses (LeBaron et al., 1990; Guzewich & Ross, 1999). Most often the foods involved are ready-to-eat foods or food contaminated after cooking (Centers for Disease Control, 1990, 39(14): 228-232; Guzewich & Ross, 1999). Microbes can originate from the environment, foodservice personnel, origination of the food, or the food itself (Brockman et al 1990; Guzewich & Ross, 1999). Also, food workers may be exposed to pathogens due to the handling of raw animal products (Paulson, 1994; Coates, et al. 1987; Guzewich & Ross, 1999). The number of cells on an employee's hands is thought to be directly related to the chance of transferring pathogens to food products (Restaino & Wind, 1990; Guzewich & Ross, 1999).

It is well known that handling cooked products or ready-to-eat foods with bare hands is one of the major hazards of cooked foods and ready-to-eat foods (Bryan, 1995; Guzewich & Ross, 1999). Restaurants that prepare large volumes of ready-to-eat products should not allow ill workers to prepare food. Also, managers should supervise and train food workers on appropriate food preparation techniques and hygiene practices (Hedberg et al., 1992; Guzewich & Ross, 1999). It has been suggested that keeping employees out of work for 48-72 hours after symptoms have ended may help to control Norwalk-like virus outbreaks and prevent new illness from occurring (Parashar et al., 1998; Guzewich & Ross, 1999).

V. Risk Factors

The Food and Drug Administration's (FDA) National Retail Food Team conducted the third phase of a three-phase, 10-year study to measure the occurrence of practices and

behaviors commonly identified by the Centers for Disease Control and Prevention (CDC) as contributing factors in foodborne illness outbreaks in 2008. These so called Risk factors are:

1. Food from Unsafe Sources
2. Poor Personal Hygiene
3. Inadequate Cooking
4. Improper Holding/Time and Temperature
5. . Contaminated Equipment/Protection from Contamination

According to the FDA report on the Occurrence of Foodborne Illness Risk Factors in Selected Institutional Foodservice, Restaurant, and Retail Food Store Facility Types (FDA, 2009), the Out of Compliance percentages remained high for data items related to the following risk factors:

1. Improper Holding/Time and Temperature
2. Poor Personal Hygiene
3. Contaminated Equipment/Protection from Contamination

For the improper holding/time and temperature risk factor, the high percent Out of Compliance values were most commonly associated with improper cold holding of potentially hazardous food (PHF)/time-temperature control for safety (TCS) food and inadequate date marking of refrigerated, ready-to-eat PHF/TCS Food.

Within the poor personal hygiene risk factor, the proper, adequate handwashing data item had the highest percent Out of Compliance value for every facility type. Percent Out of Compliance values for proper, adequate handwashing ranged from approximately 18% for meat departments to approximately 76% for full service restaurants.

Of the data items related to the contaminated equipment/protection from contamination risk factor, improper cleaning and sanitizing of food-contact surfaces before use was the item most commonly observed to be Out of Compliance in eight out of the nine facility types. Percent Out of Compliance values for this data item ranged from 18% in seafood departments to 64% in full service restaurants.

According to the FDA Database of Foodborne Illness Risk Factors released in 2004, the greatest risk factors found in 900 institutional food service establishments, restaurants and retail food stores were:

1. Contaminated equipment/cross contamination
2. Poor personal hygiene
3. Foods from unsafe sources
4. Inadequate cooking

The study recorded the percent of observations found out of compliance for each risk factor. For full service restaurants the following risks were found to be out of compliance: 63.8% improper holding/times and temperatures; 41.7% poor personal hygiene; 37.3% protection from contamination; 30.6% other/chemical; 15.8% - inadequate cooking and 13% food from unsafe sources.

In the category of "poor personal hygiene" the following observations were made: only 72.7% had used proper and adequate hand washing; 57% prevention of hand contamination; 34% good hygienic practices; 23.2% had a hand washing facility, convenient/accessible; and 22.2% had hand and washing facility, cleaner/dry device available.

In the category of "contaminated equipment/protection from contamination" the following observations were made: 56.6% of surfaces/utensils were cleaned/sanitized; 46.9% had RAW/RTE food separated; 35.4% of food was protected from environmental contamination; 25.5% of raw animal foods were separated from cooked; and in only 6.1% of facilities was food not re-served.

According to a study by Green et al. (2005) food employees reported commonly using 'risky food preparation practices'. These risky behaviors included: 1) not always wearing gloves while touching ready-to-eat (RTE) food (60%); 2) not always washing their hands between handling raw meat and RTE food (23%); 3) not always changing their gloves between handling raw meat and RTE food (33%); 4) not using a thermometer to check food temperatures (53%) and 5) worked while sick with vomiting or diarrhea (5%).

VI. Employee Training

Foodborne illness significantly affects consumers in the United States. According to The Centers for Disease Control and Prevention (CDC), an estimated 9.4 million incidences of foodborne illnesses occur each year, with 55,961 hospitalizations and 1,351 deaths (Scallan et al., 2011, 17, 1-15). Current evidence suggests that a substantial number of foodborne illnesses occur through poor food handling practices involving food workers (CDC, 2013, 62 (03), 41-47). Food workers play a critical role in ensuring food safety in foodservice where they can introduce a food safety hazard at any point during the food production process. Thus, knowledge, and training are significantly important and essential to ensure that they practice correct way of handling food (Martins, Hogg, &

Otero. 2012). In a comprehensive summary of foodborne outbreaks caused by food handlers, 94% (767 of 816) are caused by infected food handlers, and 73 are directly linked to workers failure to wash hands (Todd et al., (2007a).

A synthesis of enumerated documented reports of food handler related outbreaks from around the world between 2000 and early 2006 documents 233 outbreaks resulting in 16,028 cases of food poisoning, the majority in restaurants and catering facilities (Greig et al., 2007). The root causes of these outbreaks were traced to poor food handling practices, such as cross contamination of raw and cooked products, slow cooling and inadequate refrigeration of foods, and poor worker hygiene such as failure to wash hands when handling ready-to-eat foods (Todd et al., 2007a).

Food handlers are of particular concern as they are less likely than workers in other high-risk occupations, such as health care and day care workers, to exclude themselves from work if they become ill (Thomas et al., 2006). As many of the root causes of foodborne illness outbreaks have been traced to worker illness and poor food handling practices, this segment of the population requires education about food safety, proper food handling practices and the importance of hand washing to avoid spreading infectious diseases while at work (McIntyre et al., 2013). Educating food handlers to prevent foodborne illness is an important objective for industry and government.

Employees are often not trained in the proper handling of food. They especially lack training in storing and holding foods at proper temperatures, personal hygiene and sanitary procedures in the kitchen (Burch & Sawyer, 1991; Manning & Snider, 1993; Wyatt, 1979; Almanza & Nesmith, 2004). It has been found that there have been more foodborne outbreaks due to foodservice employees since consumption of foods in

restaurants has increased (Cotterchio et al., 1998; Almanza & Nesmith, 2004).

The CDC evaluated all reported cases of foodborne illness in the U.S. between 1993 and 1997 and found more than 90 percent were a result of improper food handling practices, which involved coming to work when sick, bare hand contact and time and temperature abuse (CDC, 2010). In examining factors that have led to foodborne diseases in the U.S., Howes et al. found that improper food handler practices in both food service establishments and consumer homes accounted for approximately 97 percent of foodborne illnesses (Howes et al., 1996).

One of the most important procedures that retail food establishments (RFEs) can implement to decrease the chance of foodborne illness is training employees on proper food handling practices. In addition, establishments need to take into consideration the best way to train employees so that this knowledge translates not only into practice but also into changes in behavior (Neal, Binkley, & Henroid, 2012).

The lack of food safety training seen in foodservice employees these days is due to the rapid growth of the restaurant industry along with lack of workers and literacy issues among these workers (Colorado State University Cooperative Extension, 2001; Almanza & Nesmith, 2004). Many of these workers are hastily and inadequately trained resulting in unsafe handling procedures that may lead to cross-contamination, enumeration of organisms due to unsafe temperatures, and spread of disease through lack of personal hygiene. Appropriate training of these employees is very important; however the effectiveness of this training is seldom verified or measured (Almanza & Nesmith, 2004).

According to Clingman (1976), problems identified regarding training of foodservice employees are:

1. Employees (especially long-time employees) resent being told how to do their jobs by young kids with no foodservice experience.
2. Most employees have at the most a high school education resulting in slower understanding and learning of food safety principles.
3. Food safety training is usually done quickly over a short period of time (a few quick classes over a few days). This training is rarely reinforced through training on-the-job.
4. Managers, at times, think that training classes are sufficient by themselves. Therefore, these managers failed to reinforce principles learned in class.
5. The restaurant industry has a large turnover rate that, at times, makes justifying training employees difficult.

In a study conducted by Green & Selman, 2005, food workers' self-reported food safety practices and beliefs about factors that impacted their ability to prepare food safely were analyzed. Based on their findings, time pressure and structural environments, including equipment and resources, were the two most identified factors that impacted their ability to engage in safe food preparation practices. Clayton and Griffith (2005) reported similar findings. Their findings included time pressure, education and training, inadequate staffing, sink accessibility, and management role as some of the barriers for safe food practices.

Therefore, in order to reduce food-borne illness it is crucial to gain understanding of the interaction of prevailing food safety beliefs, knowledge and practices of food handlers

(WHO, 1988; Clayton et al., 2002). Although workers that received training were more likely than their untrained counterparts to carry out food safety practices, 61% them admitted that they did not always practice food safety (Clayton et al., 2002).

Food safety training needs to take into consideration the factors that are keeping foodservice employees from implementing food safety practices. Simply giving individuals' food safety knowledge and thereby certifying them in food safety does not guarantee behavior change (Ehiri et al. 1997; Clayton et al., 2002). Food hygiene training needs to embody the concept of risk in order to emphasize to food handlers, especially those in managerial role, the level of risk associated with their business. Food employees would be more likely to implement food safety practices if they were provided with resources and systems to help them implement these practices. Food safety training is more effective if managers encourage employees and the overall culture of the business is conducive to the preparation of safe food (Hennum et al., 1983; West, 1992; Crowther et al., 1993; Sprenger, 1999; Clayton et al., 2002).

VII. Manager Training

Food safety is an important public health issue in the U.S. Eating at restaurants and other food service facilities increasingly has been associated with food borne disease outbreaks. Prevention of foodborne illnesses is one of the primary responsibilities of the food service industry (Cushman, Shankin, & Niehoff, 2001). Managers play an important role to ensure the safety of food prepared and served to the customers.

A qualitative study by Green and Selman (2005) reported that management played a significant role in the extent to which food workers engage in safe food

preparation practices. Clayton & Griffith, (2002), argued that effective resources and management systems must be in place in order to have an effective safe food preparation practices.

Food safety training and certification of food mangers has been used as a method for reducing food safety violations at food service facilities (Kassa et al., 2010). Routine inspections of food service facilities long have been employed as regulatory tools to enforce sanitary codes and reduce the risk of food borne outbreaks (Luby, Jones, & Horan, 1993; Irwin et al. 1989). In addition to enforcing regulatory inspection programs, many health departments try to ensure appropriate food safety practices through the use of mandatory or voluntary food safety and hygiene training and certification programs for food personnel (Kassa et al., 2010). However, the literature is inconclusive about the effectiveness of such training programs for improving food safety and protecting consumer health (Kassa et al., 2010).

Kassa et al. (2010) reported that restaurants in Toledo, Ohio with trained and certified food mangers had significantly higher visual inspections scores than restaurants without trained and certified food managers.

Cotterchio et al. evaluated the effectiveness of a food manager training and certification program to increase compliance with sanitary codes in Boston (Cotterchio et al., 1998). Their study clearly showed a significant improvement in mean inspection scores in restaurants after training managers compared to restaurants not receiving this training. They also found a significant decrease in critical violations in restaurants with trained managers compared to restaurants without trained managers one year after training, but after two years there were deficiencies in some critical food safety elements

in both types of restaurants. Training had limited long term impact in some important critical food safety elements.

Contterchio et al. (1998), used the sanitary inspection records to compare pre-and post-training inspection scores for 94 restaurants falling into three groups: a mandatory, voluntary and control groups in Boston. They showed that the mean inspection scores for the mandatory and voluntary groups increased by 14.7 and 7.5 points respectively from baseline to one year post-intervention and was maintained at the two-year follow-up. The scores for the control group remained constant, suggesting that the improvements in the other two groups have been due to the training program. They also found that the average number of critical violations for the intervention restaurants had decreased significantly one year post-intervention. However, deficiencies were noted in all three groups with respect to food holding temperatures, equipment and utensil sanitizing procedures, and the presence of insects and rodents after two years past training.

Clayton & Griffith, argued that the success of programs to increase food safety depends on the management systems since they are the ones to enable and encourage food workers to implement safe food practices.

According to a study by Martin et al. (1999), two months after a training program, participants were surveyed regarding changes in safe handling practices that could be attributed to their participation in the training program. A total of 77 of 187 participants returned the survey for a response rate of 41%. Six safe food-handling activities were positively impacted as a result of participation in the training program. The percentage that responded, "plan to do and do because of program" ranged from 11.7% to 75% for the six practices. In addition, over half of the respondents indicated that they had

conducted an employee-training program in their establishment as a result of attending the training. The training benefited 438 employees in 35 establishments.

Similarly, mixed results have been reported in other studies conducted outside of the United States. One study conducted in Ireland concluded that better general formal training in food safety and hygiene practices was not significantly linked to better food safety practices (Bolton et al. 2008). Two studies conducted in the United Kingdom also concluded that food safety training and certification did not significantly improve hygiene standards of food premises (Powell, Attwell, & Massey, 1997; Ehiri, Morris, & McEween, 1997).

A study conducted by Kassa et al. (2010), to examine the effect of food manger training on reducing food safety violations. They examined food inspection reports from the Toledo/Lucas County Health Department (Ohio) from March 2005 through February 2006 and reported that Food service facilities with certified personnel had significantly fewer critical violations than food service facilities without certified personnel ($P \leq 0.05$). Another study reported that restaurants with certified kitchen managers had reduced critical violations significantly in comparison to restaurants without certified kitchen managers (Cates, Muth, Karns et al., 2009).

According to FDA data base (2009), presence of a Certified Food Protection Manager is positively correlated to the overall IN Compliance percentages in certain facility types, especially in delis, full service restaurants, seafood departments, and produce departments. Poor personal hygiene, improper holding/time and temperature, and contaminate equipment/protection from contamination appear to be the risk factors for which the presence of a certified manager had the most positive correlation.

It is believed by some that food safety training and certification improves sanitation and inspection scores especially in businesses generally receiving poor scores (Cotterchio et al., 1998; Almaza & Nesmith, 2004).

In the past, food safety has been maintained through employee training and restaurant inspections. Restaurant inspections are still important, however, focus has now moved to management training. It is thought that once managers are trained they will then train their employees and enforce food safety regulations at their place of business (Palmer et al., 1975; Pohlit & Bliss, 1973; FDA, 1975; Cook & Casey, 1979).

Many barriers that consistently reported by food workers for safe food practices such as time pressure, inadequate staffing, and structural environment are heavily influenced by managers. They can emphasis the importance of food safety, ensure adequate staffing to meet the demand, provide required equipment needed to prepare food safely, make food workers accountable for their failure of unsafe food preparation practices, and ensure proper food safety training of the food handlers (Green & Selman, 2005).

Penniger and Rodman (1984) stated that the benefits of food safety management training are:

1. Managers attain greater knowledge of food safety.
2. Team develops a sense of pride.
3. Better communication between manager and inspector.
4. Managers with food safety certification are more employable.
5. Inspection scores improve.
6. Fewer inspections are needed.

7. Less time is needed for inspection

In 1971, the National Conference on Food Protection recommended all persons engaged in food handling especially owners, operators, or managers should demonstrate that they have knowledge of safe food service establishment sanitation and food handling practices (Baker, 1982).

It is nearly impossible to measure the effectiveness of food safety training upon the incidence of foodborne outbreaks. Even the CDC must make estimates of foodborne disease because of the deficient reporting and tracking system currently in place. Therefore, to determine the success of food safety training it may be better to see what practices have been implemented and if employees have been trained as a result of the manager's training (Pettitt & Goldmon, 2000). In their study, the following were some of the improvements reported by food managers as a result of training:

1. Increased hand washing
2. Increased accuracy and frequency of temperature checks
3. Stored food off the floor
4. Posted signs to help employees take temperatures and wash hands
5. Changed procedures for storing leftovers
6. Marked spray bottles carefully regarding contents
7. Checked the sanitizer mixture for proper strength
8. Increased cleaning procedures throughout the establishment

Other changes reported by Pettitt & Goldmon were formation of operation food safety teams; more open communication with employees about what was expected of

them; development of a HACCP program; and reports of employee training sessions resulting from the manager's training.

According to a study conducted by Allwood et al. (2004), employees were more likely to be able to demonstrate proper hand washing procedures when the Person in Charge (PIC) was a certified food manager. The study found that only 52% of the PICs could describe the hand washing procedure outline in the Food Code, and only 48% of the workers could demonstrate code-compliant hand washing. PICs that were manager certified were more likely to be able to describe the hand washing procedure outlined in the Food Code. Also, 77% of PICs who were state certified food managers described the need to use a fingernail brush compared with 38% of uncertified PICs (Allwood et al., 2004).

The study also found that hand -washing facilities were more likely to be fully equipped (nail brush available) in the establishments where a certified food manager was the PIC during the survey. In addition, the study found that employees were more likely to be able to correctly perform hand- washing techniques when several methods were used to teach hand washing. In fact, the ability to correctly wash their hands seemed to increase with the number of methods used to teach hand washing. These findings reinforced the long-held belief that appropriate food safety education can help improve food safety performance in retail establishments (Allwood et al., 2004; Campbell et al., 1998; Cotterchio et al., 1998; Mathias et al., 1995).

Food safety classes also give employees the opportunity to interact with inspectors outside of the inspection setting. This gives the food worker a feeling that the inspector is working with them instead of against them (Pettitt & Goldmon, 2000). A

helping consultative role by technically competent environmental health personnel as a follow-up to the training sessions is an important adjunct to the instruction and provides for a follow-through that most foodservice managers need (Palmer et al., 1975).

It is assumed by most, that turnover in grocery stores is extremely high. In fact, a 100% turnover rate is often quoted (Wilson, 1978; Wyatt, 1979). Seventy-four percent of grocery workers surveyed said they had worked in the industry for more than 10 years; however, 80.6% of those surveyed were managers or owners (Wyatt, 1979). It may be true that employees in this industry do change jobs frequently and even change companies, but it seems as though they tend to stay in the retail food industry. This gives more justification to the training of these individuals. Of those surveyed, 76.6% agreed that there was a need for food safety training and they felt that most employees should undergo training, not just the managerial staff (Wyatt, 1979).

In addition, the turnover of convenience store employees also seems to be low enough to justify sanitation training. In a study conducted by Burch and Sawyer (1991), 83% of managers indicated that retail food marketing was their career choice and the mean time for hourly employees to have worked in this area was 3.7 years.

In a study conducted by Wright & Feun (1986), training courses appeared to increase the knowledge of managers, however, the managers did not seem to share this knowledge with their employees. Wyatt (1979) surveyed 219 managers and owners of retail food markets to determine their practices, knowledge, opinions and experience regarding procedures for foodservice sanitation and food safety. The managers were found to lack basic food safety knowledge although training material was available. (Wrisley, 1985; NIFI, 1985; Burch & Sawyer, 1991).

Additionally, Marth (1977) reported on a study of the short term and long-term effects on the food handling practices of employees working under a trained manager. A positive correlation was noted between the length of time since the manager was trained and the incidence of poor food handling practices by his/her employees.

Cotterchio et al. (1998) found that manager certification training programs can have a positive effect on the sanitary conditions of restaurants, especially those with initially low baseline inspection scores. In addition, they found that manager training can result in sustained improvement in sanitary conditions of public establishments and offers the potential to reduce the incidence of food-borne illness.

A study by Green et al. (2005) found that safe food handling practices were associated with the age of the food worker, work responsibilities, and the type of restaurant the participant worked in. Another study conducted in British Columbia, Canada (Mclntyre et al., 2012), showed that knowledge scores were significantly higher in trained food handlers compared with untrained ones. Although, data also demonstrated knowledge scores significantly decreased in FOODSAFE trained workers over a 15 year post-certification, they still scored higher compared to untrained food workers. Supervisory status and years of experience resulted in improved knowledge scores in both trained and untrained groups, but increasing age resulted in improved knowledge scores in only the untrained groups. They also argued that food handlers place of employment and level of education were associated with significantly higher knowledge scores. Food handlers with FOODSAFE training showed significantly better hand washing practices and attitudes. These findings could be interpreted to mean that workers with more responsibilities (associated with older age) such as management

or food preparation receive more training in food safety and are applying that training. It also supports a need for recertification of trained food workers and education of untrained food workers.

VIII. Training and Behavior Changes

Training employees on food safety practices has been shown to be one of the most important programs that food service establishments can implement. However, results also provide evidence that traditional approaches used to educate and train employees may not be particularly effective, and new behavior-based approaches that include food safety education as part of the culture of the organization need to be developed (Neal, Binkley, & Henroid, 2012).

Researchers have found that training does not necessarily cause change in behavior. It can be part of the solution, but they are not the solution by themselves (Maister, 2001). Several studies have found that workers do not always engage in safe food practices even if they demonstrate knowledge of safe food preparation (Clayton et al., 2002; Howes et al., 1996; Manning and Snider, 1993). This gap between knowledge and practice is due to inadequate training provided by food companies (Howes et al., 1996). In order to be successful, food safety intervention programs need to address the full range of factors that impact food preparation behaviors (Green and Selman, 2005).

Executive-development programs concluded that companies should expect no dramatic change in the behavior of people sent to such programs. For management as a whole, training produces only minor changes (Kirkpatrick, 1996). Employees may be satisfied with their training and have enjoyed the experience; however they would have a

difficult time proving that the program caused long-term changes in their behavior (Kirkpatrick, 1996).

Training is meant to improve an employee's performance. However, most of the training they receive is not under realistic conditions with the chaos and stressors of real life. In a study by Green and Selman, 2005, time pressure and structural environment, including equipment and resources were the two most identified barriers to perform safe food practices. Other studies also reported the same barriers such as shortage of time, inadequate staffing, sink accessibility, availability of properly working equipment, management concern for food safety, and education (Clayton and Griffith, 2002).

Kirkpatrick, 1996 argued that for training to be successful, the rewards need to be clear. These rewards could be monetary, verbal, or tied to movement within the company. Training also needs to be based on sound research. Training needs to be more real-world, so employees can learn from their past mistakes and accomplishments.

Motivation is an important step in training; every employee needs to know that they play a vital role in food safety. It is important to link 'hygiene conscience' with 'product safety' from the very beginning. Remembering that in fact most food poisonings are caused by simple ignorance – ignorance about correct time/temperature correlations, personal hygiene, and bacterial survival mechanisms, etc (Engel, 1998).

Some researchers have shifted their attention to food safety culture and suggest that behavior-based system that focuses on the processes as well as people is essential for an effective safe food practices. They state that food safety systems and practices have to be shared by every one in the organization not just management with communication as an integral part (Ball, Willcock, & Colwell, 2010; Griffith, 2006; Guldenmund, 2000;

Yiannas, 2008). Food safety culture focus is on proper food handling practices as a way of do thing compared to food safety training goal that to improve food handlers' compliance with food safety guidelines (Griffith, Livesey, & Clayton, 2010; Yiannas, 2008).

According to Yiannas, what we know and what we believe is of little consequences. It is what we do that is important. He views the food safety culture as how and what the employees think about food safety in an organization. Employees will learn the behaviors because they are part of the organization. It is management responsibility to change the food safety behaviors their employees so those behaviors are a permanent fixture in the organization.

Griffith, Livesey, & Clayton 2010, perceived food safety culture as a contributing risk factor that can increase the likelihood of a food born illness. According to their study, there are six indicators of safety culture that may be applied to food safety: leadership, management systems, communication, commitment, environment and risk awareness, perception and risk taking behavior.

Neal, Binkley, & Henroid conducted a study to assess food safety practices contributing to food safety culture in food service operation. According to their findings, the two most important factors for developing a food safety culture in food service operations are management commitment and worker food safety behavior. They argued that food service employees not only want consistency within the organization, but accountability by management. Management needs to set the example and also champion the food safety cause. Employees rely on the food safety knowledge of management to whom they look for support. Based on their findings, food service operators should

continue to focus their efforts and commitment on food safety and, during the hiring process, screen for employees who have a strong work ethic and who take responsibility for their own actions. By creating a work environment that encourages good food safety behavior, food service operations can create a strong food safety culture and in turn reduce the risk of foodborne illness outbreaks (Neal, Binkley, & Henroid, 2012).

As stated by Griffith, Livesey, & Clayton 2010, food safety culture needs to improve the actual food handling performances by employees by integrating knowledge with values, behaviors and beliefs. Food safety culture needs to be a shared attitude by all employees, especially new employees who tend to follow the "dominant behaviors" found in the organization.

Inspections alone cannot guarantee prevention of food borne outbreaks. Supervision and education of food service workers and consistent adherence by foodservice workers to good hygienic practices are critical and perhaps neglected elements in the control and prevention of food borne disease. The responsibility of all persons involved in food preparation particularly food service managers; needs to be emphasized (Penman et al., 1996; American Food Safety Institute, 1999).

Training food service workers in food safety allows favorable interaction between regulatory agencies and food establishments. However, it is unlikely to result in "desirable behavior change" unless sanitation in the establishments is firmly enforced. Training programs by themselves tend to effect workers' behavior for only a short period of time (perhaps long enough to pass a certification test or pass inspection) after which the workers will fall back into their old habits (Metts & Rodman, 1993a).

IX. Inspections

From the regulatory standpoint, most states traditionally have relied on health department inspections to evaluate the food handling and adequacy of food safety training in food service establishments (Almanza & Nesmith, 2004). It is thought that food employees may receive food safety training during inspections or as a result of said inspections. Also, periodically health departments will hold training programs. However, most of the training food employees receive is through the establishment they work for (Almanza & Nesmith, 2004).

Cook and Casey (1979) found that the inspection scores for food establishments having received foodservice management sanitation training versus those that were not receiving training did not vary significantly. They used a systematic approach to evaluate the impact of certification by establishing experimental and control groups and comparing inspection scores prior to and after certification. Scores improved in both the control and the experimental groups, but the difference between these groups was not statistically significant.

Penniger and Rodman (1984) sent a questionnaire to 20 certifying agencies (nine voluntary and 11 mandatory), asking if foodservice health inspection scores improved as a result of certification. Sixty-five percent of the agencies noted an improvement, 5% noted no improvement and 30% had no response (Kneller & Bierma, 1990).

Wright and Feun (1986) developed a prospective study with a control group and an experimental group who evaluated certification based upon a pre-inspection and three post-inspections. The first two post-inspections were conducted shortly after certification

and the third six months later. All three indicated no significant difference between control and experimental groups in pre- and post-inspection scores.

Kneller & Bierma (1990) found that certification improved the sanitation level of foodservice facilities in McLean County. It appears that information was, in fact, taken from the classroom and implemented in the day-to-day operation of a food service facility. Improvement occurred for as long as 18 months after a certified individual entered the facility and did not decrease dramatically, on average, until three years after certification, further decreasing the likelihood that it could have been caused by a historical event. No continued improvement after 18 months may imply a need for additional training, or for periodic recertification.

It was observed that food manager certification caused statistically significant improvements in total inspection scores. Certification has also reduced the number of violations of critical, procedural or procedural/structural nature (Kneller & Bierma, 1990; American Food Safety Institute, 1999).

A study conducted by Palmer et al. (1975) evaluated the changes in behavior and sanitation conditions that resulted due to training. In general, the sanitation scores following training improved by 50 to 60% compared to the pre-training scores.

X. Minnesota State-Mandated Food Manager Certification Requirements

Food manager certification was made mandatory by the Minnesota Department of Health as of July 1, 2000. The Minnesota Department of Health requires all foodservice operations to have a certified food manager on staff at all times. Training courses are

offered through educational institutions, independent consultants and some local public health agencies.

An applicant for certification as a food manager must complete a training course that addresses safe food preparation and handling, sanitation, and the prevention of food-borne illness. The course must cover improper holding temperatures, inadequate cooking, contaminated equipment, food from unsafe source, and poor personal hygiene. After taking a training course, the food manager must take a state-recognized exam. The exam must have been taken within the last three years before applying for a Food Manager Certificate.

A Minnesota Food Manager Certificate has to be renewed every three years. Renewal training requires that the Certified Food Manager attend one or more training courses providing a total of 4 hours. Each course must have covered at least one of these subjects: food sanitation and safety, or emerging trends in food preparation and handling, or the prevention of food-borne illness.

XI. Mandatory versus Voluntary Certification

A study conducted by Cotterchio et al., 1998, reported the effectiveness of the food manager training and certification program in increasing compliance with restaurant sanitary codes. Based on their findings, the restaurants for which managers were mandate to attend a training and certification program demonstrated a significant improvement in inspection scores compared to voluntary group.

Penniger and Rodman (1984) found that the majority of mandatory certification programs estimated that their training program is effectively certifying most managers in

their area. The mean certified was 83.6%, with the range between 65 to 99 percent. In the voluntary agencies, the averages range between 2% to 30% with one exception at 100%. The mean certified was 28.66%. The high range percentage of mandatory agencies seemed to support the premise that mandatory programs are more successful in certifying that voluntary programs.

Also, when conducting a study such as this it is desirable to include the results of a control group. However, in states such as Minnesota, where training/certification is mandatory, such a group (consisting of an establishment whose workers have not received certification or training) is impossible to find. If such a group was available then the inspection scores of the experimental group (the group receiving the training) could be compared to the sanitation scores of the control group (the group not receiving the training) before and after the training occurs. Then pre- and post-inspection score differences observed in the experimental group could be compared to the respective inspection scores observed in the control group (Metts and Rodman, 1993b).

XII. Future of the Foodservice Industry

The Foodservice Industry has always been a vital growing and dynamic industry in our modern society. Fast food chains have multiplied since World War II. The growth of foodservice businesses has been phenomenal. It ranks fourth in sales behind grocery stores, the auto industry, and general merchandise stores. It is first in the United States in number of business units and in employment: it hires almost eight million people. In such an expanding industry, a total of 250,000 employees are added yearly to meet their needs

and at least 10 percent or 25,000 must fill management positions (Davis, 1977; Penninger & Rodman, 1984).

Based on the Restaurant Industry Forecast, in 2006 restaurants in the United States will have sales of approximately $511 billion; 925,000 locations will serve more than 70 billion meal and snack occasions; have 12.5 million employees (the industry is the largest employer except for government); more than seven out of 10 eating-and-drinking places will be single-unit independent operations; eating-and-drinking places will be mostly small businesses, with seven out of 10 having fewer than 20 employees.

The typical employee in a foodservice occupation is as found in NRA (National Restaurant Association), 2006 is 55% female; 54% under the age of 30; 67% single; working part-time and averaging 25 hours per week; and 78% living in a household with two or more wage earners.

The number of foodservice managers is projected to increase 12% from 2006 to 2016 and eating-and-drinking places employ more minority managers than any other industry. Three out of five first-line supervisors of food preparation and service workers in 2003 were women, 16 percent were of Hispanic origin, and 14 percent were African-American (NRA, 2006). More than one-quarter (26 percent) of foodservice managers in 2003 were foreign-born (NRA, 2006).

Therefore, there is a definite need to have trained food managers and food employees working in the foodservice and retail industry. The training needs to be effective and continual.

This study conducted a self-reported knowledge gained after ServSafe™ training to measure the effectiveness of the training with respect to age, gender, location and

home. It also, compared the in-class training to on-line training with respect to gender and location.

Methods and Materials

1. Data collection

1.1: ServSafe™

The participants were full and part time employees of food service establishments in different cities in the State of Minnesota. The study focused on two types of data. Our sampling method was a pre/post cluster sampling in a sense that all subjects in all the participating cities were being measured in two ways. First, through their participation in ServSafe™ training and their final assessment. Next, via self-evaluation done both at the baseline as well as post-training. This part of the study was conducted among 707 food handlers who participated in the training followed by an examination from 19 different locations (cities) in Minnesota in 2010 and 2011. Participants had a choice to either complete the training in the classroom by an instructor-led course or by on –line course. However, all participants had to complete the examination in the classroom. Among 707 participants, 564 completed their training in-class and 143 who took it on-line.

1.2 Self-Reported Evaluations

This part of the study was conducted among 551 (378 women and 173 men) participants of whom, 530 completed the self-evaluation questionnaire before and after the examination in 14 different cities in Minnesota in 2010 and 2011 (Table 1). However, the two parts of the study were independent of each other meaning, there was no connection between the first and second part of the study.

Table 1. Number of Participants for In-Class and On-Line Training in Different Cities

City	In-Class	Female	Male	On-Line	Female	Male
St.Cloud	90	63	27	19	14	5
St.Paul	54	36	18	44	23	21
Marshall	62	40	22	21	17	4
Mankato	48	29	19	11	6	5
Moorhead	39	22	17	8	5	3
Bemidji	77	49	28	NA	NA	NA
Cloquet	32	26	6	5	5	0
Rochester	40	21	19	8	5	3
Montevideo	27	17	10	1	1	0
Farmington	11	9	2	NA	NA	NA
Worthington	29	20	9	1	0	1
Grand Rapids	19	10	9	NA	NA	NA
Little Falls	9	8	1	NA	NA	NA
Alexandria	7	4	3	NA	NA	NA
Thief River Falls	20	14	6	NA	NA	NA
Andover	NA	NA	NA	3	2	1
Brainerd	NA	NA	NA	6	4	2
Grand Marais	NA	NA	NA	3	1	2
Roseau	NA	NA	NA	13	11	2
Total	**564**	**368**	**196**	**143**	**94**	**49**

NA: Not Applicable (no participants in those townships)

Table 2: Number of participants for pre and post self-evaluations in different locations where they took the training.

City	# of Participants
Alexandria	20
Bemidji	61
Cloquet	25
Farmington	10
Grand Rapids	19
Little Falls	46
Moorhead	45
Montevideo	26
Mankato	64
Marshall	54
Rochester	34
St. Cloud	46
St.Paul	50
Thief River Falls	30
Total	**530**

2. Measures

2.1: *ServSafe ™ Examination*

The ServSafe™ Food Protection Manager Certification is accredited by the American National Standards Institute (ANSI)-Conference for Food Protection (CFP). The program blends the lates*t* FDA Food Code, food safety research and years of food sanitation training experience. Managers learn to implement essential food safety practices and create a culture of food safety. All content and materials are based on actual job tasks identified by foodservice industry experts.

The ServSafe™ development requires three steps. First step is to develop a Job task analysis, which outlines the essential knowledge skills, and abilities required for an entry-level food handlers to perform their job safely. Then, items are written, reviewed, and pilot tested. In the final step, the passing score is determined in a standard setting. There are 80 exam questions each worth 1 point in 10 content areas or domains; D1 through D10 with a passing score of 75%. (Table 3).

Table 3. Number of questions by Content Area on the ServSafe™ Examination

Domain/ Content	Points
D1: Foods	**36**
Ensure Food Protection	10
Purchase and Receive Food Safely	4
Store Food and Supplies Safely	8
Process, Prepare, Serve, and Display Food Safely	6
Prepare, Serve, Display, and Transport Food Safely Off-Site	8
D2: Clean and Sanitize Equipment and Utensils	**9**
D3: Facilities	**6**
D4: Monitoring Food Personnel	**12**
D5: Temperature Measuring Devices	**2**
D6: Allergens	**3**
D7: High- Risk Populations	**2**
D8: Legal and Regulatory Issues	**4**
D9: Facility Layout and Design	**1**
D10: Training Employees	**5**
Total	**80**

For the scope of this study, we only considered domains D1, D2, D3, D4, D5, and D10.

In this section of the study, our interest was to examine following hypothesis:

1. If there is a difference between In-Class and On-Line training with respect to average total scores and average domain scores
2. If average total score of participants is different among different locations (cities) where they took the exam
3. If the average domain score of participants is different among different locations (cities) where they took the exam
4. If average total score of participants is different among females and males (in general) where they took the exam.
5. If average total score of participants is different among females and males considering each city by itself where they took the exam.
6. If average domain score of participants is different for In-Class and On-Line training among females and males

2.2: *Pre/Post Self-Evaluation*

The self-evaluation questionnaire was designed by the University of Minnesota Extension Food Safety Team to test participants' abilities and skills in different areas of food safety before and after ServSafe™ training course. The questionnaire (Fig. 1) was divided into two parts: background information or sociodemographic characteristics and 7 "life skills" questions. The background information included participants' age, gender, hometown, ethnicity, type of establishment they worked in, and their zip code. For the scope of this study, the only background information considered were: participants' age,

gender, hometown, and the city where they took the training. Majority of participants took the training and examination close to where they lived in. The "Life Skills" questions (Table 4) were developed based on Life Skills Evaluation System from Washington State University Cooperative Extension program and focused on ability to solve food safety issues, communications, knowledge of current food safety regulations, and trying new techniques. The response for these questions was: none, slight, moderate, and great.

Table 4: Life Skills questions about food safety knowledge

#	**Life Skills Questions**
1	My ability to solve problems about food safety issues by looking at possible options.
2	My determination to keep accurate and useful records.
3	My ability to make safe food decisions.
4	My ability to communicate clearly about food safety to employees/others.
5	My knowledge level on the topic of food safety.
6	My understanding of current regulations regarding food safety.
7	My determination to try new techniques in food safety.

Fig. 1: Example of Self-Reported questioner

Food Manager Certification Course Evaluation

We want to know how well the Food Manager Certification Course works. You do not have to fill out this survey. If you decide not to fill out the survey, it will not affect your participation in future University of Minnesota Extension programs. Your answe will be anonymous and will not be identified in any way. Answering the questions means you have agreed to participate in this evaluation.

Tell us about yourself. (Check one response to each question.)

My age falls in the following group:	**I am:**	**My current home is located on(in) a:**	**I work in the following type of establishments:**	**Location where I attended:**
__ 0 – 17 __ 18 – 25 __ 26 – 35 __ 36 – 45 X 46 – 55 __ 56 – 65 __ 66+	___ female X male	___ farm ___ rural non-farm X town under 50,000 ___ city over 50,000 **I would describe myself as:** ___ African American ___ American Indian ___ Asian/Pacific Islander ___ Hispanic X White/Caucasian ___ Racially mixed	___ Fast Food ___ Fine Dining ___ On-Site (school, daycare, assisted living, care facility, etc.) ___ Retail X Casual Dining (café, restaurant, bar, etc.) ___ Other – Please list:	Alexandria **My zip code:** 56308 **I live in:** Douglas County

Life Skills	**Before I participated in Food Manager Certification Course**				**After I participated in Food Manager Certification Course**			
	Circle one number for each statement				Circle one number for each statement			
	None	Slight	Moderate	Great	None	Slight	Moderate	Great
1. My ability to solve problems about food safety issues by looking at possible options.	1	2	(3)	4	1	2	(3)	4
2. My determination to keep accurate and useful records.	1	2	(3)	4	1	2	3	(4)
3. My ability to make safe food decisions.	1	2	3	(4)	1	2	3	(4)
4. My ability to communicate clearly about food safety to employees/others.	1	2	(3)	4	1	2	3	(4)
5. My knowledge level on the topic of food safety.	1	2	(3)	4	1	2	3	(4)
6. My understanding of current regulations regarding food safety.	1	2	(3)	4	1	2	3	(4)
7. My determination to try new techniques in food safety.	1	2	(3)	4	1	2	3	(4)

Our hypotheses are as follows:

1. If training has no effect on post-training life skills (if training had any effect, this hypothesis will be rejected).
2. If age has any effect on post-training life skills measure.
3. If gender has any effect on post-training life skills.
4. If city varying where participants took the exam has any effect on post-training life skills
5. If residential complexity (farm. Rural, city less than 50K and cities bigger than 50K) of participants has any effect on the post training life skills mastery.

3. Statistical analysis

Paired t-test and Multivariate analysis of covariance (MANCOVA) were used. The data collected were percent score achieved by students, obviously, such scores did not have a normal distribution due to their limited range. So we applied a logarithm transform on each of the score after adding a 0.5 to adjust for possibility of zero value that did not confirm to such transformations. The transformed scores were then calculated as:

Logarithm D=log ((D+0.5)/(100-D-0.5)). The transformed values were then compared using two-way ANOVA tables as follows. The Analysis was performed using R 15.1 package. SAS software was also used to check the distributional assumptions.

Results and Discussion

1. ServSafe™ Training and Examination

Table 5 shows the percent total mean score and percent mean domain scores of participants who took the In-Class training. Rochester with 90.79% and Farmington with 75.73% had the highest and lowest mean total exam score respectively. In "Foods" content area (D1), Participants in Moorhead had the highest mean score with 89.05% whereas participants in Rochester got the lowest mean score with 70.40%. In "Cleaning and Sanitizing Equipment and Utensils" (D2), participants in Rochester with 87.90% and participants in Alexandria with 63.57% had the highest and lowest mean score respectively. In "Facilities" content area (D3), Moorhead with 95.23% had the highest mean score and Alexandria had the lowest mean score with 73.71%. In the "Monitoring Food Personnel/Personnel Hygiene" (D4), Participants in Little Falls got the highest mean score of 96.44% compared to participants in Thief River Falls who got the lowest mean score of 80.0%. In "Temperature Measuring Devices" category (D5), Alexandria had the highest mean score of 92.86% and Thief River Falls got the lowest mean score of 75%. In "Training Employees", participants in Rochester had the highest mean score compared to Thief River Falls' participants who got the lowest mean score of 98.50% and 80% respectively.

Table 5: In-Class Mean Total Score and Mean Domain Scores of Exam taken in different Cities

Mean Score %							
City	**Total Score**	**D1**	**D2**	**D3**	**D4**	**D5**	**D10**
St.Cloud	86.00	84.78	80.67	86.06	91.17	90.00	91.56
St.Paul	85.72	83.54	82.44	89.17	92.91	75.93	93.70
Marshall	84.47	79.29	82.06	89.42	91.29	83.06	93.23
Mankato	86.75	83.58	80.46	93.69	94.52	86.46	95.00
Moorhead	90.05	89.05	84.46	95.23	92.42	80.77	95.90
Bemidji	85.87	82.95	83.56	87.58	90.74	79.22	91.69
Cloquet	81.47	81.97	71.00	83.22	84.91	85.94	92.50
Rochester	90.79	70.40	87.90	91.90	94.60	91.25	98.50
Montevideo	85.44	83.89	76.33	87.56	89.93	87.04	90.37
Farmington	75.73	74.36	64.82	83.27	80.45	77.27	81.82
Worthington	84.62	83.24	81.76	87.24	88.55	82.76	83.45
Grand Rapids	84.58	79.95	77.42	78.00	89.89	78.95	86.32
Little Falls	88.44	85.78	84.11	94.44	96.44	77.78	97.78
Alexandria	83.57	84.14	63.57	73.71	88.14	92.86	94.29
Thief River Falls	75.90	74.05	69.00	80.85	80.00	75.00	80.00

D1: Foods; D2: Clean and sanitize equipment and utensils; D3: Facilities; D4: Personnel hygiene; D5: Temperature measuring devices, D10: Training employees

Table 6 shows the percent mean total score and percent mean domain scores of participants who took the training on-line. The results obtained are as follows: in total mean score participants in Grand Marais got the highest score (90%) and participants in St.Paul had the lowest mean score (83.20%). In Foods content area (D1), Grand Marais got the highest mean score (9.33%) and St.Cloud had the lowest mean score (81%). In cleaning and sanitizing equipment (D2), Cloquet with 86.80% and Andover with 74.33% had the highest and lowest mean scores respectively. In facilities content area (D3), both Andover and Grand Marais had the highest mean score with 94.30% and Mankato had the lowest mean score with 80.30%. In Monitoring food personnel/personnel hygiene content area (D4), Cloquet had the highest mean score (95.20%) and St.Paul got the lowest score (88.10%). In temperature measuring devices (D5), Andover, Cloquet, Mankato, and Roseau had the highest mean score of 100% and Brainerd and Grand Marais had the lowest mean score with 83.33%. In Training employees (D10), Andover with 100% mean score had the highest and Brainerd with 86.70% had the lowest mean score.

Table 6: On-Line Percent Mean Total Score and Mean Domain Scores in Different Cities

Mean Score %							
City	**Total Score**	**D1**	**D2**	**D3**	**D4**	**D5**	**D10**
Andover	85.70	85.00	74.33	94.30	92.00	100	100
Brainerd	84.00	83.33	78.00	91.70	90.30	83.33	86.70
Cloquet	89.00	87.80	86.80	86.60	95.2	100	96.00
Grand Marais	90.00	92.33	78.00	94.30	91.70	83.33	93.30
Mankato	84.60	83.18	83.00	80.30	90.90	100	90.90
Marshall	84.10	81.90	78.48	88.90	91.00	88.10	89.50
Moorhead	87.00	87.13	84.88	89.50	91.80	93.75	92.50
Rochester	89.00	87.88	84.88	87.50	93.80	93.75	92.50
Roseau	84.20	83.77	78.00	80.70	91.80	100	89.20
St.Cloud	83.50	81.00	79.05	91.20	89.10	86.84	91.60
St. Paul	83.20	82.75	80.18	86.70	88.10	90.91	92.30

D1: Foods; D2: Clean and sanitize equipment and utensils; D3: Facilities; D4: Personnel hygiene; D5: Temperature measuring devices, D10: Training employees

Table 7 is the summary of participants who received a passing score of 75% or more in In-Class training. Moorhead, Rochester, and Little Falls were the only cities with 100% pass.

Table 7: In-Class percent number of participants who passed the exam with at least minimum 75%

City	Total Pass %
St.Cloud	91
St.Paul	81
Marshall	84
Mankato	94
Moorhead	100
Bemidji	94
Cloquet	88
Rochester	100
Montevideo	96
Farmington	73
Worthington	86
Grand Rapids	95
Little Falls	100
Alexandria	86
Thief River Falls	65

Participants who took the training on-line in all participating cities had 100% pass except St. Cloud and St. Paul with of 89% and 84% pass respectively (Table 8). These results might be to due to higher number of participants in St.Paul and St.Cloud compared to other participating cities.

Based on percent pass/fail results, it seems that participants performed much better in on-line training compared with in-class training.

Table 8: On-line percent number of participants who passed the exam with a minimum 75%

City	Total Pass%
Andover	100
Brainerd	100
Cloquet	100
Grand Maria	100
Mankato	100
Marshall	100
Moorhead	100
Rochester	100
Roseau	100
St.Cloud	89
St. Paul	84

1. ***Is there a differential effect due to in–class and on-line instruction with respect to exam score and different domains?***

Based on p values at 0.05%, total exam score and domains except " temperature measuring devices" (D5) have no differential affect due to instruction mode (Table 9). Looking at the mean score of "temperature measuring devices" domain showed that participants in on-Line training scored higher (90%) than participants in in-class training (83%).

Table 9: F value and p-value of on-line and in-class training with respect to total exam and domains

Domains	**F value**	**P- value**
Exam Score	0.58	0.45
D1: Foods	0.85	0.35
D2: Clean and sanitize equipment and utensils	1.53	0.22
D3: Facilities (cross contaminations)	0.06	0.80
D4: Personnel Hygiene	0.33	0.56
D5: Temperature measuring devices	3.73	0.05
D10: Training employees	0.28	0.59

2. ***Is there a differential effect among cities with respect to the exam score and domains? In other words, if participants in different cities performed differently with respect to exam and domain scores?***

As it can be seen from Table 10, total exam scores and domains except "temperature measuring devices" (D5), are not affected by cities.

Table 10: F-value and p-value of different cities with respect to total exam score and domains

Domain	**F- value**	**p- value**
Total Exam Score	5.60	0.93
D1: Foods	5.01	0.47
D2: Clean and sanitize equipment and utensils	6.83	0.33
D3: Facilities (cross contaminations)	7.68	0.63
D4: Personnel Hygiene	10.79	0.75
D5: Temperature measuring devices	0.009	0.09
D10: Training employees	7.55	0.93

3. ***Is there any interaction between instruction mode and cities? In other words, does instruction mode effect varies by cities?***

Table 11 shows that, instruction mode (In-Class and On-Line training) doesn't have significant (at 5% level) varying effect when considering all cities together. However, looking at the p-values, there is a trend in "Exam" score, "Foods" (D1), and "Personnel Hygiene" (D4) content areas, suggesting that there might be some differences in those areas.

Table 11: F -values and p-values of In-Class and On-Line training with respect to total exam score and different domains considering all cities together

Domains	**F -value**	**P-value**
Exam Score	3.50	0.06
D1: Foods	3.23	0.07
D2: Clean and sanitize equipment and utensils	1.13	0.28
D3: Facilities (cross contaminations)	2.07	0.15
D4: Personnel Hygiene	3.16	0.07
D5: Temperature measuring devices	0.84	0.36
D10: Training employees	2.69	0.10

We examined each city to identify the ones that showed a significant difference between In-Class and On-Line instruction. Table 12, lists the P-values for such a comparison with respect to different domains. Based on our results, “Cleaning and Sanitizing Equipments” (D2) in Grand Marais; “Facilities” (D3) in Grand Rapids and Andover; “Monitoring Food Personnel/Personnel hygiene” (D4) in St. Paul and Grand Marais; and “Training Employees” (D10) in Rochester showed a significant difference for In-class and on-line classes (Table 12).

Table 12: p-values (at 5%) of participants in different cities for On-Line and In-Class mode of instruction with respect to different domains

City	D1	D2	D3	D4	D5	D10
St.Cloud	0.42	0.87	0.30	0.25	0.56	0.98
St. Paul	0.36	0.50	0.12	0.01	0.06	0.93
Marshall	0.31	0.31	0.87	0.27	0.40	0.60
Mankato	0.30	0.19	0.09	0.91	0.89	0.37
Moorhead	0.66	0.54	0.15	0.70	0.20	0.31
Bemidji	0.78	0.55	0.30	0.64	0.45	0.52
Cloquet	0.07	0.83	0.09	0.83	0.84	0.80
Rochester	0.50	0.44	0.94	0.85	0.74	0.02
Montevideo	0.70	0.22	0.16	0.47	0.61	0.06
Farmington	0.74	0.64	0.40	0.89	0.59	0.41
Worthington	0.11	0.08	0.48	0.21	0.16	0.17
Grand Rapids	0.51	0.39	0.02	0.81	0.00	0.47
Little Falls	0.94	0.58	0.63	0.29	0.29	0.75
Alexandria	0.59	0.98	0.99	0.29	0.72	0.72
Thief River Falls	0.39	0.49	0.29	0.52	0.47	0.19
Andover	0.57	0.93	0.00	0.67	NaN	NaN
Brainerd	0.24	0.70	0.37	0.20	0.70	0.18
Grand Marais	0.67	0.00	0.67	0.00	0.67	NaN
Roseau	0.26	0.82	0.46	0.63	NaN	0.38

NaN: Not applicable numbers (no participants in those cities)
D1: Foods; D2: Clean and sanitize equipment and utensils; D3: Facilities; D4: Personnel hygiene; D5: Temperature measuring devices, D10: Training employees

The mean scores of the content areas in which the participants depending on the location, where they had the training showed a significant difference between in-class and on-Line trainings (Tables 13 and 14). Andover and Grand Maria had only on-line participants (p-value of 0.00). Thus, there were no scores from in-class participants to compare the two. In Grand Rapids, all participants took the training in class and again there was no on-line training data to compare them. St.Paul and Rochester were the only two cities with both types of trainings. Tables 13 and 14 show that in both St.Paul and Rochester, participants who took the training in-class scored significantly higher than those who took it on-line.

Table 13: Total Mean percent score for on-line and in-class trainings in St.Paul

Total Mean Percent Score		
St.Paul	In-Class	On-Line
Monitoring Food Personnel (D4)	93	88

Table 14: Total Mean percent score for on-line and in-class trainings in Rochester

Mean Percent Score		
Rochester	In-Class	On-Line
Training Employees (D10)	98	93

4. Is there any interaction between mode of training and gender?

Results from Table 15 based on p-values (at 0.05%) for mode of training and gender, suggests that effect of mode of training (In-class vs. On-line) does not vary by gender.

Table 15: P-values for mode of training and gender with respect to total and domain scores

Total Score	Foods (D1)	Clean/ Sanitize (D2)	Facilities (D3)	Personnel Hygiene (D4)	Temperature Measuring (D5)	Training Employees (D10)
0.21	0.13	0.57	0.77	0.08	0.46	0.68

5. Is there any interaction between city and gender?

Based on p-values at 5% level, males and females performed significantly different in different cities (Table 16). Participants in St. Cloud, Marshall, Little Falls, and Bemidji performed significantly different in 4 content areas as follow:

St.Cloud in "Training Employees" (D10); Marshall in "Cleaning and Sanitizing Equipments" (D2) and in "Training Employees) (D10); Little Falls in "Training Employees" (D10), and Bemidji in "Foods" (D1) and also in "Monitoring Food Personnel" (D4).

Table 16: p-values of gender effect in different cities with respect to domains

City	**Foods (D1)**	**Cleaning/ Sanitizing Equipments (D2)**	**Monitoring food personnel (D4)**	**Training Employees (D10)**
Bemidji	0.05		0.01	
Marshall		0.05		0.01
St. Cloud				0.04
Little Falls				0.05

Average scores of content areas in which participants in Bemidji, Marshall, St.Cloud, and Little Falls had a significant difference, showed that males and females scored different in different content areas.

In Bemidji, Females scored higher than males in "Foods" (D1) content area but, in "Monitoring Food Personnel" (D4), females did better than males (Table 17).

Table 17: Mean percent score of Males and Females in Bemidji in D1 and D4 content areas

Bemidji	Foods (D1)	Monitoring food personnel (D4)
Female	81.8	93.1
Male	85.0	86.7

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In Marshall, in content area "Cleaning and Sanitizing Equipments" (D2), male scored higher than females. However, females scored higher in "Training Employees" (D10) content area.

Table 18: Mean percent score of Males and Females in Marshall in D2 and D10 content areas

Marshall	Cleaning/ Sanitizing Equipments (D2)	Training Employees (D10)
Female	80.0	96.5
Male	84.0	87.7

In St.Cloud, males scored higher than females in “Training Employees” (D10) content area (Table 19).

Table 19: Mean percent score of Males and Females in St.Cloud in D10 content area

St. Cloud	Training Employees (D10)
Female	86.9
Male	94.0

In Little Falls, females scored higher than males in ”Training Employees” (D10) content area (Table 20).

Table 20: Mean percent score of Males and Females in Little Falls in D10 content area

Little Falls	Training Employees (D10)
Female	100.0
Male	90.0

2. Pre-Post Self-Evaluation of Seven Life Skills

In order to evaluate the knowledge gained after the ServSafe™ training based on self-reported evaluations, p- values were accessed to test our hypothesis: ***Mean Pre and post self-reported evaluations are equal***.

Table 21 shows that, the hypothesis of equality of mean of pre and post life skills is rejected since all the p -values are very small (less than 0.05%), meaning that there was a difference before and after training based on self-reported knowledge gained.

Table 21: p-values for hypothesis 1: *Mean pre and post self-reported evaluations are equal*

Life Skills	t -value	p-value
1	34.56	0.000
2	30.47	0.000
3	30.42	0.000
4	33.22	0.000
5	37.46	0.000
6	38.89	0.000
7	32.39	0.000

The effect of gender, age, city, and residential complexity on post training life skills was analyzed after adjusting for their initial scores. Since all 7 life- skills are intercorrelated, we used MANCOVA to study these effects. However, in our model, we adjusted for their pre-training life skill scores. Table 22, summarizes the adjusted approximate F values and their corresponding p-values.

All the approximate F values are obtained after adjusting for before training life skills. It is obvious that none of them have any significant value, implying that differential effect of training is not affected by gender, age, city, and the residential complexity of the participants.

The implication of above results shows that our training methods were sufficient for all age groups regardless of their gender, city where they took the exam, and residential complexity where they lived in (farm, rural, city bigger or smaller than 50K). Thus, none of the other hypothesis is rejected; meaning that gender, age, city, and residential complexity had no effect on post-training life skills after controlling for their pre-training values.

Table 22: Approximate F values and p-values for post-training

Factor	Approximate F Value	p-Value
Gender	1.00	0.42
Age	0.58	0.76
City	1.28	0.25
Residential complex	0.88	0.52

However, above analysis provides a general 7 dimensional affect analysis. Table 23 shows the p-values corresponding to adjusted effects of these factors on each single life skill factor. Results show that, gender has an effect on post training life skill 3. City has an effect on life skill 7. Residential complexity has differential effect on life skill 1. However, age has no effect on any of post training life skills. All these p-values are obtained from ANCOVA for the 7 post training skills, all being adjusted for all 7 pre-training life skills.

Table 23: p- values for post training effect on Age, Gender, City, and residential hometown

Factor	**Post Life skill 1**	**Post Life skill 2**	**Post Life skill 3**	**Post Life skill 4**	**Post Life skill 5**	**Post Life skill 6**	**Post Life skill 7**
Gender	0.25	0.52	0.04	0.67	0.22	0.97	0.85
Age	0.95	0.79	0.58	0.16	0.72	0.75	0.63
City	0.94	0.87	0.83	0.94	0.96	0.93	0.02
Residential Home	0.02	0.37	0.26	0.41	0.37	0.35	0.14

To further understand significant p-values summarized in Table 23 in each category (gender in life skill 3, city in life skill 7, and residential home in life skill 1, we analyzed the data in two ways:

A. First, through participants' answer choices after the training in each category. Table 24 shows the number of males and females and their corresponding answer choices after the training. Of total or 530 participants, 1 chose answer choice 2 (slight) who was a female; 95 chose answer choice 3 (moderate) of which 74 (77.9%) were females and 21 (22.1%) were males; and 434 chose answer choice 4 (great) of which 289 (66.6%) were females and 145 (33.4%) were males. As it can be seen, in all answer choice post training, number of female participants exceeded the male participants.

Table 24: Gender and life skill 3, post training

	Answer Choice		
Gender	Slight (2)	Moderate (3)	Great (4)
Male	0	21	145
Female	1	74	289
Total	1	95	434

In life skill 7, post training, Bemidji had the highest number of participants who chose "Slight" (answer choice 2) after their training. Marshall, St.Cloud, and Mankato are the top 3 cities in which participants chose " Moderate" for their answer after the training. Bemidji, Mankato, and Moorhead are the top locations in which participants chose "Great" as their answer post training (Table 25).

Table 25: City and life skill 7, post training

	Answer Choice				
City	None (1)	Slight (2)	Moderate (3)	Great (4)	Total
Alexandria	0	0	1	19	20
Bemidji	0	2	14	46	62
Cloquet	0	0	9	16	25
Farmington	0	0	4	6	10
Grand Rapids	0	0	3	16	19
Little Falls	0	0	16	30	46
Moorhead	0	0	8	37	45
Montevideo	0	0	5	21	28
Mankato	0	1	20	42	63
Marshall	0	1	22	31	54
Rochester	0	0	8	26	34
St. Cloud	0	0	21	25	46
St. Paul	0	1	14	35	50
Thief River Falls	1	0	11	18	30

Table 26, shows the participants answer choices in different residential townships in life skill 1. Answer choice "Great" (4), was highest among participants in cities with less than 50,000 populations followed by rural, cities bigger than 50K, and farm.

Table 26: Residential townships and life skill 1

	Answer Choice			
Home	Slight (2)	Moderate (3)	Great (4)	Total
Farm	1	29	46	76
Rural	0	39	89	128
City<50K	2	75	166	243
City>50K	0	15	67	82

B. Then, based on number of participants who reported one degree or higher knowledge gained after the training compared to pre training. For example, participant who answered "none" to life skill 1 before the training but chose answer "slight" or "moderate" after training, had 1 and 2 degree of reported knowledge gained, respectively.

Gender and Life skill 3: My ability to make safe food decisions

In life skill 3, more females reported at least 1 degree of knowledge gained than males (Table 27).

Table 27: Participants with reported 1 or better degree of improvement post training with respect to gender

Total Participants	Participants with at least 1 degree improvement	Male	Female
530	386	111	275

Residential Home and Life skill 1: My ability to solve problems about food safety issues by looking at possible options

Based on the results from Table 28, participants coming from cities smaller than 50,000 populations reported the highest number of knowledge gained of at least 1 degree followed by rural, cities with more than 50K, and farm.

Table 28: Participants with reported 1 or better degree of improvement post training with respect to residential home

Total Participants	Participants with at least 1 degree improvement	Farm	Rural	City<50K	City>50K
530	415	53	103	193	65

City (Training location) and Life skill 7: My determination to try new techniques in food safety

According to the number of participants in each training location (cities) who reported at least 1 degree of knowledge gained after the training, Alexandria and Bemidji had the highest (19/20) and lowest (43/62) number of participants respectively (Tables 29 and 30).

Table 29: Participants who reported 1 degree or better knowledge gained post training with respect to city where they took the exam

City	**Total # of Participants**	**# of Participants with at least 1 degree improvement**
Alexandria	20	19
Bemidji	62	43
Cloquet	25	20
Farmington	10	8
Grand Rapids	19	15
Little Falls	46	37
Moorhead	45	39
Montevideo	26	21
Mankato	63	46
Marshall	54	42
Rochester	34	31
St. Cloud	46	33
St. Paul	50	37
Thief River Falls	30	23
Total	**530**	**414**

Based on the results obtained from Table 29, we categorized cities from highest percent self-reported knowledge gained of at least one degree after the training to lowest percent self-reported knowledge gained (Table 30).

Table 30: Self-Reported knowledge gained of at 1 degree from highest to lowest in which participants took the training

1.	Alexandria
2.	Rochester
3.	Moorhead
4.	Little Falls
5.	Montevideo
6.	Cloquet and Farmington
7.	Grand Rapids
8.	Marshall
9.	Their River Falls
10.	St. Paul
11.	Mankato
12.	St. Cloud
13.	Bemidji

We also looked at the difference between pre and post self-reported knowledge gained in each life skill with respect to age, gender, city where they took the exam, and their hometown.

To obtain the p-value, Pearson Chi-Square was used for home, gender, and city. But for Age, we used Linear-by-Linear Association because age was recorded as an ordinal variable as others were categorical. Based on results from Table 31, Home (where participants lived) and City (where participants took the exam) have no effect on the 7 life skills. However, in life skill 3, male and female performed significantly different. Age affected the life skill 1, 4, 5, and 6.

Table 31: p-values for differences of pre and post self-reported knowledge gained in 7 life skills

Factor	LS1	LS2	Ls3	LS4	LS5	LS6	LS7
Home	0.56	0.78	0.97	0.99	0.90	0.34	0.98
Gender	0.50	0.46	0.004	0.48	0.65	0.46	0.41
Age	0.04	0.99	0.07	0.02	0.04	0.03	0.40
City	0.13	0.79	0.41	0.37	0.87	0.38	0.73

To further analyze the significant of Gender in Life skill 3; and Age in life skills 1, 4, 5, and 6, we looked at the degree of reported knowledge gained by participants after the training compared to pre-training. For example, if a participant reported "slight" before training but "Great" after training, has gained 2 degree of knowledge. Table 32 shows the degree of knowledge gained by participants in life skill 3 with respect to gender.

Based on results from Table 32, more females reported degree of 0.0 to 2.0 knowledge gained after training compared to males. There were equal number of males and female with 3.0 degree knowledge gained post-training.

Table 32: Degree of Self-Reported Knowledge gained in Life Skill 3 with respect to Gender

Degree of knowledge gained post- training	**Male**	**Female**	**Total**
-1.0	1	1	2
0.0	54	88	142
1.0	80	238	138
2.0	28	34	62
3.0	3	3	6
Total	**166**	**364**	**530**

In Life skill 1 with respect to age, majority of participants who reported one degree knowledge gained were between 46-55 years old. 36 out of 115 participants who reported no knowledge gained, were mainly 46-55 years old. Participants with two degree reported knowledge gained were 36-45 years old. Total of five participants reported knowledge gained of three degree of which four were 26-35 and 36-45 years old and one was 18-25 years old (Table 33).

Table 33: Degree of reported knowledge gained by participants in Life skill 1 with respect to different age groups

Degree of knowledge gained post- training	**0-17**	**18-25**	**26-35**	**36-45**	**46-55**	**56-65**	**65+**	**Total**
0.0	0	8	33	22	36	14	2	115
1.0	1	44	70	76	96	40	6	333
2.0	0	8	22	27	13	6	1	77
3.0	0	1	2	2	0	0	0	5
Total	**1**	**61**	**127**	**127**	**145**	**60**	**9**	**530**

Table 34 shows the number of participants who reported different degree of knowledge gained in life skill 4 with respect to different age groups. Majority of participants reported 1 degree of knowledge gained in which mostly were 46-55 years old. The least reported knowledge gained is 3 degree in age groups of 36-45 and 56-65 years old.

Table 34: Degree of reported knowledge gained by participants in Life skill 4 with respect to different age groups.

Degree of knowledge gained post- training	**0-17**	**18-25**	**26-35**	**36-45**	**46-55**	**56-65**	**65+**	**Total**
0.0	0	12	32	18	35	15	3	115
1.0	1	32	64	76	83	40	3	299
2.0	0	14	26	32	25	4	3	104
3.0	0	3	5	1	2	1	0	12
Total	**1**	**61**	**127**	**127**	**145**	**60**	**9**	**530**

In life skill 5 with respect to age, majority of participants reported one degree of knowledge gained among age group 46-55 followed by 36-45, 26-35, 56-65, 18-25, and 65+ years old (Table 35).

Table 35: Degree of reported knowledge gained by participants in Life skill 5 with respect to different age groups

Degree of knowledge gained post- training	**0-17**	**18-25**	**26-35**	**36-45**	**46-55**	**56-65**	**65+**	**Total**
0.0	1	4	28	16	27	10	1	87
1.0	0	38	66	83	89	42	5	323
2.0	0	18	26	27	29	7	3	110
3.0	0	1	7	1	0	1	0	10
Total	1	61	127	127	145	60	9	530

Table 36 shows the number of participants who reported different degree of knowledge gained in life skill 6 with respect to different age groups. Most of participants reported one degree of knowledge gained in which majority were 46-55 years old. Participants with reported two degrees of knowledge gained were
36-45. Majority who reported three degrees knowledge gained were 26-35 and those with no knowledge gained were mainly 46-55 years of age.

Table 36: Degree of reported knowledge gained by participants in Life skill 6 with respect to different age groups

Degree of knowledge gained post- training	**0-17**	**18-25**	**26-35**	**36-45**	**46-55**	**56-65**	**65+**	**Total**
0.0	0	7	22	14	23	5	2	73
1.0	1	25	66	63	83	41	5	284
2.0	0	27	31	43	37	13	2	153
3.0	0	2	8	7	2	1	0	20
Total	1	61	127	127	145	60	9	530

Summary and Conclusions

This study contained two independent parts. The purpose of the first part, was to assess if there was a difference between on-line and in-class ServSafe™Training and to examine the effect of gender and location where participants took their training on food safety knowledge. Next, to assess the effectiveness of ServSafe™Training using the pre and post Self-Reported Evaluations and to examine the effect of demographics on reported knowledge gained.

In the first part of the study, there was no significant difference between modes of instruction. Average overall score of in-class and on-line training were 85.5% and 85.0% respectively. However, there was a significant difference in domain 5, "Temperature Measuring Devices". On-line participants scored higher with average score of 90% compared to in-class participants with average score of 83%. Participants who took the training on-line had 100 percent pass score (at 75% level) in all cities (total of 11) except in two cities (St.Paul and St.Cloud). This significant difference may be due to higher number of participants in St.Paul and St.Cloud compared to other cities. Participants who had their training in- class, had 100% pass in three cities in total of fifteen cities. This difference could be due to overall higher number of participants in all the cities where they took their training in class.

Our data suggests that on-line training is not only an effective training tool but also more effective than in class training in some areas. This is in accordance with Gallagher et al. (2005) findings. They examined the effectiveness of alternative methods of course delivery by comparing student profiles and instructional outcomes from a dental hygiene gerontology course offered both on line and in a traditional classroom

setting. Their results showed that students who took web-based course format demonstrated greater motivation and learning success based on final course grades, completion of assignments, and knowledge retention over time.

Raupach et al. (2010), examined whether participation in an online module on the differential diagnosis of dyspnoea impacts on student performance in a multiple choice examination of factual knowledge in cardiology and pneumology. They concluded that Students assigned to using the problem-based online module on the differential diagnosis of chronic shortness of breath scored higher in a test of factual knowledge than students not included in the study despite comparable achievement levels before entering the study.

A recent meta-analysis reviewed a total of 2011 published articles on the effectiveness of internet-based learning for students, postgraduate trainees and practitioners in a profession directly related to human or animal health. According to their results, interventions, internet-based have large and significant effects on the acquisition of knowledge, skills and behaviors compared to no intervention. (Cook et al. 2008).

Aggarwal et.al., (2011), compared the impact and acceptability of teaching Biostatistics and Research Ethics through on-line distance learning format or traditional on-site training, in a randomized study in India. They concluded that on-line and on-site training formats led to marked and similar improvements of knowledge in both areas of study.

A study by Feinstein, Dalbor, and McManus (2007), looked at the efficacy of ServSafe™online. They concluded that, percent of participants who passed the exam online was higher (81%) than those who took traditional (in class) exam during 2005

(79%). Although, our results didn't suggest such a difference, but conclude that on-Line training could be as effective as in-class training. One of our biggest obstacles was the unequal number of participants in both types of classes (on-line versus in-class) and considerably low number of participants in some cities, especially for on-line, (sometimes with no participants). Therefore, it is hard to conclude exclusively that online training is more effective than in-class training.

There was no interaction among cities where participants took their training with respect to average total exam scores and average domain scores when we considered all cities. However, when considered every single city, a significant difference was observed among them. Based on our results, "Cleaning and Sanitizing Equipments" (D2) in Grand Marais, "Facilities" (D3) in Grand Rapids and Andover; "Monitoring Food Personnel/Personnel hygiene" (D4) in St. Paul and Grand Marais; and "Training Employees" (D10) in Rochester showed a significant difference for In-class and on-line classes.

Our results showed no interactions between mode of training and cities where participants took their training, meaning that in-class and on-line instruction effect does not vary by cities where participants took their training. In addition, we didn't find any interaction between mode of training and gender, meaning that effect of mode of training (in-class vs. on-line) does not vary by gender. But, we found that there is a significant difference between gender and location. In Bemidji, Females scored higher than males in "Foods" (D1) content area but, in "Monitoring Food Personnel" (D4), females did better than males. In Marshall, in content area "Cleaning and Sanitizing Equipments" (D2), male scored higher than females. However, females scored higher in "Training

Employees" (D10) content area. In St.Cloud, males scored higher than females in "Training Employees" (D10) content area. In Little Falls, females scored higher than males in "Training Employees" (D10) content area.

We could not find any study in the literature that looked at the same factors as our study.

In the second part of the study we looked at the effect of ServSafe™Manager Training based on Self -Reported evaluations containing 7 life-skill questions. Additionally, we studied the effect of demographics (gender, age, location, and home) on self-reported knowledge gained post training by comparing it to pre training. Pre and post evaluations were done only for In-Class training.

Results show that, when considering all 7 life- skill questions, there was no differential effect with respect to gender, age, location (city where participants took their training), and residential townships (home; where participants lived) post training (at 0.05% p-value). However, when looked at each life skill individually, there was a significant difference in Life skill 3 with respect to gender (more females reported at least 1 degree of knowledge gained than males), life skill 7 with respect to city (Alexandria, Rochester, and Moorhead are the first 3 cities with highest number of participants who reported at least one degree of knowledge gained), and life skill 1 with respect to home (cities smaller than 50,000 populations reported the highest number of knowledge gained of at least 1 degree followed by rural, cities with more than 50K, and farm). There was no significant difference in any life skills with respect to age. Participants reported at least one degree of knowledge gained after training.

Feinstein, Dalbor, and McManus (2007), looked at the post training reported knowledge gained for online training. Their results show that training increased

participants' knowledge by 22 points. They also, looked at the knowledge gained in different ethnic groups. Their results show that it cannot be concluded that some ethnic groups learned significantly more or less than others. In our study, we could not study effect of ethnicity on food safety knowledge due to prevalence of one ethnic group (White).

We found no significant difference in knowledge gained with respect to age. A study by Abdul-Mutalib et al (2012) is in accordance with this. They showed that there was no significant relationship between food handler's practices with gender.

Our study shows that training is effective based on participants' reported knowledge gained. Many studies have showed the similar results. Kassa, Silverman, and Baroudi (2010), showed that restaurants with trained and certified food managers had significantly fewer critical food safety violations than restaurants without them. Another study conducted in British Columbia, Canada (Mclntyre et al., 2012), showed that knowledge scores were significantly higher in trained food handlers compared with untrained ones. According to a study by Martin et al. (1999), two months after a training program, participants were surveyed regarding changes in safe handling practices that could be attributed to their participation in the training program. A total of 77 of 187 participants returned the survey for a response rate of 41%. Six safe food-handling activities were positively impacted as a result of participation in the training program.

Limitations and Future Study

One of the biggest limitations we had was the small sample size especially in some locations. Some locations (cities) had a large number of participants who took in-class training with no on-line participants and vise versa. In order to use all the data from each city when there was no participant, we randomly assigned one subject for one group.

Another limitation was that we could not link two parts of the study. There was no data to link the pre/post self-reported evaluation to the ServSafe™ Training Examination. We suggest creating such a link for future studies to have an extra measuring tool to evaluate the effectiveness of training. We also like to see both on-line and in-class training offered in locations where are considered for study. This would give us more accurate data when comparing two types of training. We did not consider the effect of teachers who taught the in-class training. For future studies, we suggest to study their effect as well.

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