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ASSESSMENT OF FOOD SAFETY HANDLING PRACTICES AT FARMERS' MARKETS IN RHODE ISLAND

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ASSESSMENT OF FOOD SAFETY HANDLING

PRACTICES AT FARMERS' MARKETS

IN RHODE ISLAND

BY

ELIZABETH GRAN VANDEPUTTE

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE

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2014

MASTER OF SCIENCE THESIS
OF
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2014

ABSTRACT

From 2001 to 2010, foodborne illness outbreaks increased in the US and 17% of the outbreaks were from produce. High-risk, whole produce at farmers' markets present unique challenges to food safety practices in regards to temperature controls, potable water, and exposure to contaminants. Use of a Smartphone application decreases behavior change in those being observed as they are unaware of the observation taking place. The purpose of this descriptive study was to use direct observations to identify unsafe food handling practices among high-risk produce vendors at Rhode Island farmers' markets. This study used a Smartphone application as a tool for data acquisition, developed to perform direct observations of actual vendors' practices at farmers' markets. Observations were made at fourteen (7 state and 7 private) farmers' markets to collect food handling practices of 26 vendors selling high-risk produce. The mean observation time was 18.3 ± 5.8 minutes. Vendors had unsafe food handling practices that include eating, talking on the phone and touching money and then touching produce. The results of this study will be used as guidance for education programs targeting farmers' market managers and vendors that promote best practices in regards to high-risk, whole produce.

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PREFACE

This thesis was written to comply with the University of Rhode Island graduate school Manuscript Thesis format. This thesis contains one manuscript, *Assessment of Food Safety Handling Practices at Farmers' Markets in Rhode Island*, and has been written in the format for publication in the Food Protection Trends.

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CHAPTER 1

Assessment of Food Safety Handling Practices at Farmers' Markets in Rhode Island

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ABSTRACT

From 2001 to 2010, foodborne illness outbreaks increased in the US and 17% of the outbreaks were from produce. High-risk, whole produce at farmers' markets present unique challenges to food safety practices in regards to temperature controls, potable water, and exposure to contaminants. Use of a Smartphone application decreases behavior change in those being observed as they are unaware of the observation taking place. The purpose of this descriptive study was to use direct observations to identify unsafe food handling practices among high-risk produce vendors at Rhode Island farmers' markets. This study used a Smartphone application as a tool for data acquisition, developed to perform direct observations of actual vendors' practices at farmers' markets. Observations were made at fourteen (7 state and 7 private) farmers' markets to collect food handling practices of 26 vendors selling high-risk produce. The mean observation time was 18.3 ± 5.8 minutes. Vendors had unsafe food handling practices that include eating, talking on the phone and touching money and then touching produce. The results of this study will be used as guidance for education programs targeting farmers' market managers and vendors that promote best practices in regards to high-risk, whole produce.

INTRODUCTION

In 2011, 48 million Americans contracted a foodborne illness, equivalent to one in every six Americans (4, 5). A foodborne illness is defined as a preventable public health problem that happens from consuming foods or beverages contaminated by a disease-causing microorganism or pathogen, or from poisonous toxins or chemicals (1). In 2011, there were 31 known foodborne pathogens that caused 44% of identified foodborne illness cases that lead to hospitalizations and 44% that lead to death (4).

From 2001 to 2010, the recorded number of outbreaks due to produce increased to 17% of all foodborne illnesses (22). From 1996 to 2010, 131 produce-related reported outbreaks occurred, which resulted in 14,132 illnesses, 1,360 hospitalizations and 27 deaths (25). The Food and Drug Administration (FDA) defines high-risk produce as produce that presents a risk of serious adverse health consequences or death (25). The high-risk produce mentioned above consisted of berries, leafy green vegetables, tomatoes, cucumbers, melons, and fresh herbs (25).

Foodborne illness outbreaks from produce are increasing and since farmers' markets are becoming more popular for purchasing fruits and vegetables, high-risk produce safety practices of farmers' market vendors need to be addressed (12, 25). Produce consumption is expected to increase as the population rises to approximately 331 million in 2020 (3, 16). America's consumption of produce has increased close to 20% per capita per year from 1970 to 2004 (39). This 20% increase in produce could be in part due to health-related recommendations from the 2010 Dietary Guidelines for Americans as well as from MyPlate; both recommend consuming 9 servings of fruits and vegetables a day in order to increase one's intake of vitamins and minerals and to

decrease the risk for certain diseases (2, 11). Eating more fruits and vegetables as part of a balanced diet is also known to help achieve and maintain a healthy weight (11). Better food safety practices from farm to table for produce are also encouraged in an effort to contribute to a healthy diet (39).

With increased consumption of produce in the United States (US) and the concomitant increase in foodborne illnesses (3), there needs to be best practices for farmers, vendors, and consumers on how to reduce pathogen content and growth in order to help prevent future foodborne illnesses. Since produce can become contaminated at any point from the farm to the table—from growing, harvesting, packaging, transportation, distribution (22, 25), and home processing (18, 30)—it is important to prevent the microbial contamination of produce at all steps.

In order to reduce the microbial contamination of fresh and minimally processed fruits and vegetables, the FDA and US Department of Agriculture (USDA) developed Good Agricultural Practices (GAP). Good Agricultural Practices are a set of voluntary guidelines for commercial produce farmers that address factors that can be associated with the production of produce such as field/worker hygiene/sanitation as well as transportation from the farm to the table (35). Another effort to reduce microbial contamination and decrease the number of outbreaks is the FDA's Produce Safety Rule, "Standards for the Growing, Harvesting, Packing and Holding of Produce for Human Consumption" as promulgated by mandate by the Food Safety Modernization Act (25). These are proposed standards that are evidence-based and identify specific high-risk produce that are commonly contaminated by pathogens and lead to

foodborne illness outbreaks (25). Since foodborne illness outbreaks are increasing, it is important to look at the source and the location of the outbreak.

From 1994 to 2013, farmers' markets have increased over 450% from 1,755 to 8,144 markets in the US (12, 36). Farmers' markets have unique food safety issues because they are held primarily outside, where food products are exposed to environmental contaminants; where there is a lack of infrastructure such as electricity, running water, and soap; and the increased amount of produce sold increases the probability of foodborne illness outbreaks occurring (14, 17, 24). Farmers' markets vendor food safety practices have become increasingly important; however, there is limited research that describes vendor food handling practices at farmers' markets for high-risk, whole produce.

Food safety handling practices at farmers' markets are important to observe due to the increased amount of produce being sold and the increased amount of outbreaks from high-risk produce (22, 23). Mystery shopping or concealed direct observations are a way for an observer to reduce the bias found with traditional interviewing, survey research and self-report (19, 20, 43). Direct observations are an especially accurate way to assess food handler's food safety practices because they imitate a real customer and directly observe people performing their everyday job or task (37, 42, 43). However, the Hawthorne Effect—bias and artificial behavior change due to being observed—can greatly impact the results, making direct observations less valid (14, 20, 29, 32). Direct observations have mostly been used to assess and evaluate the performance of businesses and customer service, and there is limited

research on using direct observations to assess food safety handling practices of farmers' market vendors (14, 27, 41).

The purpose of this study focused on the assessment of vendor food handling practices of high-risk produce sold at farmers' markets in Rhode Island (RI). The primary aim of the study was to record through direct observation using a phone application (PA) the prevalence of safe and unsafe food handling practices of high-risk produce sold at farmers' markets in RI. It was hypothesized that vendors at farmers' markets have unsafe food handling practices that could impact the safety of their high-risk produce sold.

MATERIALS AND METHODS

Study Design

This was a descriptive study that involved primary data collection with the use of an Android mobile PA to directly observe high-risk produce vendors at farmers' markets in RI (14, 20, 32, 37, 43). The PA was used as a technological data collection instrument instead of using current mystery shopping protocol requiring memory and manual record keeping. This protocol would due to "real time" data recording better evaluate food safety handling practices of high-risk produce vendors at farmers' markets. This study was approved by the University of Rhode Island Institutional Review Board (IRB) # HU1213-146 and was exempt because of the public nature of the venue. In addition, there was no identifying information collected, and there was never a link between the vendor and the data. The goal of this study was to collect food handling practices via direct observation via a PA, with minimal to no detection by the subjects.

Selection of Farmers' Markets and Vendors

The sample population consisted of RI farmers' market vendors who appeared to be over the age of eighteen who were selling high-risk produce such as berries, leafy green vegetables, tomatoes, cucumbers, melons and fresh herbs (25, 26).

In the summer of 2013, there were 54 RI farmers' markets: 9 were state-run (located at state landmarks or parks), and the rest were privately run. Farmers' markets were selected for observation based on several demographic variables. First, 14 farmers' markets were chosen (7 state and 7 private). A total of 28 vendors were to be observed, the sample size was chosen based on a previous study that observed 18

farmers' market employees and was deemed an acceptable sample size (14). The farmers' markets were then broken down into whether they were high or low socioeconomic economic status (SES) farmers' markets. For the purposes of this study, SES was determined by acceptance of Electronic Benefit Transfer (EBT) cards (40). The EBT card allows for Supplemental Nutrition Assistance Program (SNAP) benefits which are funded by the USDA's Food and Nutrition Service (40). The farmers' markets were also identified as rural versus urban sites using the RI rural and urban Census Places definitions (9). These definitions delineate several levels of rural and urban populations. A farmers' market was considered rural if the location consisted of a population $\leq 50,000$ people and the farmers' market was considered urban if the population was $> 50,000$ people (2). Within rural there were other size differentiations consisting of $\geq 2,500$ people, $\geq 10,000$ people and $\leq 50,000$ people (9).

Development of Application as Observational Tool for Mystery Shopping

A mobile PA was developed as a data collection tool. The protocol for mystery shopping and direct observations normally consists of checklists, inspection forms, or memorizing the food handler's behaviors. Normally, the behaviors are written down on paper and pencil after the observation (19, 20, 41, 42). This can result in the loss of data, due to forgetting what was observed (19, 20, 41, 42). This study was modified from a previous study by Behnke et al. (14), using a similar aspect of a Smartphone and PA to capture direct observations, however, this current study focused on direct observations of high-risk produce vendor handling practices. Direct observations allow for the observer to capture behavior directly rather than relying on self-reporting

in which food handlers can overestimate the frequency in which food safety practices are carried out (14, 19-20, 32).

The mobile PA, “Food Safe Surveys” was developed at AHG, Inc (300 D. Pugh. St., State College, PA) through collaboration with the Research Nutrition and Food Sciences Department, URI, the Department of Food Science, The Pennsylvania State University. The mobile PA was designed for use on an Android platform (21). Specifically this PA, a two component system consisted of a mobile device application that is networked to a web-based interface. This system allows users to design custom questionnaires, surveys, or checklists via a web based system. The surveys are downloaded to the Food Safe Surveys program on a Smartphone or other mobile device to be used in applications for an easy-to-use interface. The custom made surveys and the data collected are kept secure and password-protected, both on the web and the mobile device interfaces (21).

The PA was used to aid the observer to record actual behavior or handling practices more efficiently without having to try and remember per mystery shopping protocol. The PA was originally developed to allow data entry in the field on a Smartphone and then once all the data was collected it was to be downloaded onto a computer or SD card and data would be imported into Excel. Excel data would be imported to Statistical Package for Social Sciences (SPSS) for analysis. However, initial problems required that the data manually be entered into Excel and then imported into SPSS. Answers to all questions were made private so access was limited to only password enabled researchers.

Smartphone Application Questions

An expert advisory committee was solicited from the RI Department of Health (RIDOH) and RI Department of Environmental Management (RIDEM) in an effort to answer a list of questions pertaining to licensure and costs for farmers' markets, the number of farmers' market certifications, products that can be sold at farmers' markets, and the degree of regulatory oversight and food handling practices and behaviors. The expert advisory group questions were also created to obtain a better understanding of the food safety recommendations within the RIDOH 2007 Food Code and how to apply the recommendations to RI farmers' market high-risk produce vendors (10). The questions used in this study were adapted from questions, previously developed and reviewed for application regarding critical and emerging food safety issues pertaining to state regulators' oversight of farmers' markets (21, 34).

Four separate meetings with the expert advisory group members were conducted: 1) Compliance Evaluation/Standardization Officer and 2) Chief of the Office of Food Protection at the RIDOH and 3) Deputy Chief and 4) Chief of RIDEM. Using the answers from the completed expert interviews, areas of shared interest and concern in relation to food safety practices of high-risk produce vendors at farmers' markets were identified. Questions for the mobile PA reflected both results of the advisory group interviews and general accepted food safety handling practices.

Application Questions

The 54 survey questions were uploaded to the website Food Safe Surveys (<http://www.ahg.com:8180/PSUFoodSci/html/>). The 54 items were entered in the

order they would be answered during a direct observation session and consisted of yes/no, multiple choice, 2-point scales, and free form text entry questions. The two-point scale consisted of 1 = unclean, 2 = clean.

The two-point scale for unclean and clean was used to define the overall cleanliness of the farmers' market, the vendor stand and the individual vendor. The criteria for overall cleanliness of the farmers' market consisted of unclean was categorized as having environmental contaminants visible such as animal droppings as well as animals walking around and clean was classified as cut grass or parking lot with no animal droppings and no dirty tents or tables. The criteria for the vendor stand consisted of unclean if dirty tables, containers, or visible brown spots on tablecloths or tents and was classified as clean if the table was clear of dirt and the high-risk produce was presented nicely in containers with no dirty water. Lastly, the criteria for the overall cleanliness of the farmers' market vendor was classified as unclean if the vendor had dirty nails, hair, or clothing contained holes or were dirty and was clean if the clothes were presentable with no dirt or holes visible.

Fifty-four questions were organized into three categories. The first category of seven questions was farmers' market demographics and could be answered prior to arriving to the farmers' market based on data found from the RIDEM (<http://www.dem.ri.gov/programs/bnatres/agricult/pdf/rimarkets.pdf>). Information included farmers' market name and three-digit code for a market vendor. Once at the farmers' market, the next category of ten questions was answered pertaining to the overall farmers' market environment. The final category of 37 questions on vendor handling practices and high-risk produce was answered after choosing high-risk

produce vendor(s) to observe. Complete observational assessments were made for one-two vendors per market depending on 1) size of market, and 2) produce sold-high risk only. Recorded observations were edited if necessary to make corrections and/or expand on assessments. One or two vendors at each farmers' market were chosen in order to make sure no one was identified. At two farmers' markets, only one vendor could be observed due to the fact that there was only one high-risk produce vendor present.

Example of actual questions:

Category One: Farmers' Market Demographics

- Is the farmers' market state run or privately run?
- Are EBT machines available at the market?

Category Two: Overall Farmers' Market Environment

- What is the overall cleanliness of the farmers' market?
- Is there evidence of hand washing facilities for vendors and customers?

Category Three: Vendor Handling Practices and High-Risk Produce

- Is there evidence that the food stand/vendor has GAP certification?
- Is any high-risk produce/other produce being sold precut?, If yes: How is it being stored?

Data Collection

Data was collected between July and August 2013 at 14 RI (7 state and 7 private farmers' markets). One to two vendors were observed at each farmers' market for a total of 26 vendors. Each vendor was observed one time for 10-30 minutes depending on the size of the market in an effort to not be recognized. Observations

were conducted during busy times at the farmers' markets because handling of produce was highest at this time and allowed the observer to be less conspicuous while conducting assessments. Randomly generated code numbers were used for identification for data entry to ensure no connection between vendor and number. Vendor anonymity was maintained throughout the observational study because, as stated, the goal of mystery shopping is the fact that vendors are unaware of observations. Observations were used to evaluate the vendors' food safety practices in relation to high-risk whole fresh produce (such as berries, leafy green vegetables, tomatoes, cucumbers, melons and fresh herbs) (25). Figure 1 shows screenshots of some of the questions in the PA.

Data Analysis

Data analysis was performed using SPSS version 22.0 for Windows. Descriptive statistics were assessed. Categorical variables were presented by numbers and percentages and continuous variables were presented as means \pm standard deviations. Chi-square tests or Fisher's Exact test (when the cells have an expected count less than 5) were run to compare 1) type of farmers' market (private and state), 2) SES (low and high), and 3) area (rural and urban) by hand washing facilities available and bathrooms available, and overall cleanliness of the market. The p-value for all statistical tests was set at $p < 0.05$.

RESULTS

Demographics

In total, 26 high-risk produce vendors at 14 farmers' markets in RI were directly observed using the PA during July through August 2013. One to two vendors were observed at each farmers' market. One vendor was observed at two out of the 14 farmers' markets due it being the only high-risk produce vendor at the market; two high-risk produce vendors were observed at the other 12 farmers' markets.

Demographic characteristics of the farmers' markets observed in RI include 7 (50%) state and 7 (50%) private farmers' markets predominately located in a rural area 10 (71.4%) with an average observation time of 18.3 ± 5.8 minutes per vendor (Table 1). Out of 14 observed farmers' markets, 6 (42.9%) accepted EBT cards and were considered low SES and 8 (57.1%) did not accept EBT cards as payment were considered high SES. Six farmers' markets had <4 total high-risk produce vendors present and 8 farmers' markets had ≥ 4 total high-risk produce vendors present.

There were 10 (71.4%) farmers' markets that were categorized as unclean, supported by the criteria consisting of environmental contaminants at the farmers' market such as geese droppings and animals being allowed to walk around. There were only 4 (28.6%) farmers' markets that were considered clean (the area had cut grass and the parking lot was clean with no animal droppings or animals walking around). Out of the 14 farmers' markets observed only 1 (7.1%) market had a hand washing facility available for customers and had both water and soap available for the customers to wash their hands. Three (21.4%) of the famers' markets had bathrooms

available for customers. Two (14.3%) bathrooms had both water and soap and 1 (7.1%) bathroom had hand sanitizer.

Chi-square tests for independence were performed on farmers' market demographic variables: type of farmers' market (private or state), SES (low or high), and area of farmers' markets (rural or urban) comparing overall cleanliness of market, hand washing facilities available and bathrooms available. Almost all comparisons were found to have no-significant associations, except for SES by overall cleanliness of the farmers' market had a significantly large effect size ($\phi = .548$, $p < .05$). This means that there was a strong association between the SES of the farmers' market and whether it was considered clean or unclean.

High-Risk Produce

Observations were made for when the high-risk produce was protected or not and how it was protected. Twenty-four (92.3%) of the 26 vendors were considered to have produce protected, which shows the frequency of high-risk produce protected as mandated by RIDEM and RIDOH (Table 2) (6, 8, 10). Vendors were classified as protects high-risk produce if the vendor stand had a tent to cover the produce, if the produce was on top of a table in plastic or wooden containers, and if it was in coolers (to keep certain produce at the appropriate temperatures and from wilting in the sunlight). Of the 24 vendors that protected their high-risk produce, all 24 (100%) had a tent and their produce on a table and in plastic or wooden containers. None of the vendors were selling their high-risk produce precut and were not processing.

Most high-risk produce was stored off the ground at the farmers' markets, but 9 vendors (34.6%) stored the high-risk produce directly on the ground. The top three

observed kinds of high-risk produce stored on the ground were cucumbers, onions, and tomatoes. Fifteen vendors (57.7%) had high-risk produce that had slight discoloration, brown marks or indents in the produce that were all classified as lightly bruised. The top five most observed kinds of bruised high-risk produce were tomatoes, radishes, peaches, blueberries, and onions.

Vendor Handling Practices

Out of the 26 vendors that were observed, 21 (80.8%) were categorized as unclean and 7 (19.2%) were clean (Table 2). Vendors were classified as unclean if the vendor had dirty nails and hair, or had holes and dirt on their clothes. Vendors were classified as clean if the vendors had clean clothes with no holes or dirt on them. Nineteen (73.1%) of the food stands were considered unclean because the tables on which produce rested were dirty, water in some of the containers was dirty, or the tent had brown spots on it. During each observation of the vendors, 1-15 money transactions took place. None of the vendors wore gloves to handle the high-risk produce during the observation, and none of the vendors had hand washing facilities at their stand, and they did not wash their hands during the time when the observations took place. During these observations, the vendors did not wear gloves. They would touch money and then the produce, which is an unsafe practice, due to the transfer of contaminants that could occur.

Vendor observations were made regarding whether the vendor engaged in any other behaviors that could compromise food safety and after all observations were complete the behaviors were divided into the following categories: walking away from the vendor stand, touching the body, touching money, eating and/or drinking, and

talking on the phone (Table 3). The highest frequency of an unsafe handling practice observed that the vendors partook in was touching money and then the produce 21 (80.8%). Eight (30.8%) out of 26 vendors also ate or drank and then touched produce as well. These practices are considered unsafe due to the fact that money is constantly in motion and can contain pathogens that can be transferred to high-risk produce. Only one vendor provided food safety information regarding how the vendor sterilized new jars for dried oregano storage.

The top three most common observed high-risk fruits were blueberries (8 vendors, 30.8%), peaches (7 vendors, 26.9%), and red raspberries (5 vendors, 19.2%) (Table 4). The top three most observed high-risk vegetables were tomatoes (17, 65.4%), zucchini (16, 61.5%), and peppers (15, 57.7%). Other kinds of produce that were most observed at the vendor stands were eggplant (14 vendors, 53.8%), corn (13 vendors, 50.0%), and beets (7 vendors, 26.9%).

DISCUSSION

This study found that vendors have behaviors and handling practices of high-risk produce that could increase the risk of foodborne illnesses. The PA was deemed an effective tool in assisting the observer in recording these unsafe practices with what appeared to be no detection from the vendors. This study also showed that vendors rarely distributed food safety information pertaining to the high-risk produce to their customers.

Vendors are usually engaging in multiple roles which can increase the risk of contamination of produce (14). A high percentage of vendors engaged in unsafe personal practices such as touching money (80.8%) and eating and/or drinking (30.8%) before touching produce, which increases risk of pathogens being transferred to produce. Money can harbor multiple contaminants such as coliforms and *Staphylococcus aureus* (13). To a lesser degree, another unsafe vendor practice observed was vendors touching their bodies (7.7%) immediately before touching produce. Personal and hand hygiene are very important for farmers and vendors—especially washing up after working in the fields with manure (31). Farmers and vendors need to make sure that they are practicing safe hygienic practices before going to a farmers' market in order to prevent pathogens such as *E. coli* O157:H7 and *Salmonella* (from the manure that can be on vendor hands or clothes) from contaminating the produce (31, 33).

Only three farmers' markets had a bathroom available for vendors and customers and only 2 had water and soap available. One bathroom contained hand sanitizer, which is not recommended to wash hands with, because it can introduce new

chemical contaminants onto produce (39). With these unsafe practices and the lack of infrastructure at farmers' markets such as hand washing sinks and bathrooms with soap and water, there could be increased risk. This highlights the importance of vendors and market managers working together to get infrastructure in place at farmers' markets to help decrease the risk of foodborne illnesses (17).

A safe practice seen was that most (92.3%) of the high-risk produce was protected under tents, on a table in plastic or wooden containers or in coolers. Tents help keep produce out of the sun (and hot conditions) for long periods of time, lowering the risk of pathogen presence at higher temperatures, and therefore decreasing one's risk for foodborne illnesses (31). Another safe practice observed was no vendors were seen processing the high-risk produce at their stand as well as no vendors were seen selling high-risk produce cut up. However, some handling practices were observed that increased risk of pathogen contamination on high-risk produce. Some high-risk produce (34.6%), such as cucumbers, onions, and tomatoes, were directly on the ground or in boxes that were directly on the ground. Exposure to the ground in this way greatly increases the risk of exposure to *E. coli* from animal and bug feces (38). A majority of produce (57.7%) was lightly bruised, which increases the risk that pathogens like *Salmonella*, *E. coli*, *Campylobacter species.*, and *Listeria monocytogenes* could contaminate the produce through bruised area (15).

The PA was successful in recording the direct observations of vendors and behaviors and high-risk produce handling practices. When employees know that they are being observed, they tend to change their behaviors to match what the observer would deem appropriate or to please the observer (14, 19, 20). The Hawthorne Effect

was decreased, due to the use of the PA and the fact that the vendors did not know that they were being observed, and the fact that the observer was not asked what they were doing at the farmers' market. The results from the PA showed that vendors need more food safety knowledge on correct handling practices of high-risk produce.

Additional findings were that only one vendor was observed providing food safety information to their customers. Specifically, this vendor explained how new jars are sterilized for dried oregano storage in order to prevent any contamination from occurring. This result suggests that there is a lack of food safety information given on how to wash produce correctly before consuming. Vendors should be telling consumers to wash the fresh produce before eating, especially with high-risk produce, because the skin on produce can contain multiple contaminants that can lead to foodborne illnesses (7, 11, 28, 39).

A strength of this study was the use of a PA to record direct observations on vendor handling practices. This specific PA was more successful in the field due to the fact that in this study there were no problems with internet accessibility or uploading the data into the phone, whereas compared to a previous study the PA had problems with a delay in the uploading of data, due to slow internet accessibility (14). Additionally, it is assumed that the PA greatly decreased the Hawthorne Effect, due to the fact that the observer looked as though they were texting on a Smartphone, a very common occurrence (14). Another strength was the sample size of 26 vendors observed, which is more than the followed protocol of 18 vendors from a previous study (14).

There were a couple of limitations that need to be mentioned, such as the farmers' markets and vendors were observed by only one person. One person observing the vendors with the use of a PA means that data could have been possibly missed. This could be due to the fact that the observer has to look down at the phone for 5-10 seconds to enter in data and could have missed the vendor performing a food handling practice. Lastly, another limitation occurred after data collection was complete. A problem with the initial Smartphone application meant that data had to manually be entered into Excel. However, the PA was modified and reinstalled, data was reentered, and researchers verified that it now works correctly and exports and downloads onto the computer into Excel.

CONCLUSION

Results of this study revealed that vendors at RI farmers' markets don't always use best practices for handling high-risk produce and could be lacking in food safety education. Future applications could allow for more direct observations to be taken at farmers' markets and on more vendors throughout a bigger geographical region to understand handling practices more wide scale. As well as have two observers observe the farmers' markets and vendors. Also information on best practices needs to be shared with vendors and farmers' market managers. Focus groups could be conducted with farmers' market managers and vendors to discuss infrastructure and ways to incorporate more hand washing facilities and bathrooms, as well as best practices in order to have a better chance that the vendors will follow them. More communication and the development of educational materials and workshops to better inform farmers' market managers and vendors on safe high-risk produce handling practices and behaviors is needed. Educational outreach workshops are needed to facilitate the best handling practice guidelines for foods at farmers' markets in order to make better hand washing more practicable.

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TABLES

Table 1. Demographic characteristics of farmers' markets observed in Rhode Island (N=14)

	Frequency	Percent
Type of Farmers' Market		
State	7	50.0
Private	7	50.0
Location of Farmers' Market		
Rural	10	71.4
Urban	4	28.6
Electronic Benefit Transfer Card		
No	8	57.1
Yes	6	42.9
Overall Cleanliness of Farmers' Market		
Unclean	10	71.4
Clean	4	28.6
Hand Washing Facilities		
No	13	92.9
Yes	1	7.1
If Yes to Previous Question, (N=1)		
Was Water Available		
No	0	0
Yes	1	100.0
Was Soap Available		
No	0	0
Yes	1	100.0
Was Hand Sanitizer Available		
No	1	100.0
Yes	0	0
Bathrooms Available		
No	11	78.6
Yes	3	21.4
If Yes to Previous Question, (N=3)		
Was Water Available		
No	1	33.3
Yes	2	66.7
Was Soap Available		
No	1	33.3
Yes	2	66.7
Was Hand Sanitizer Available		
No	2	66.7
Yes	1	33.3

Table 2. Handling Characteristics of Vendors Observed in Rhode Island (N=26)

	Frequency	Percent
Evidence of GAP Certification		
No	26	100.0
Yes	0	0
Language other than English Spoken		
No	24	92.3
Yes	2	7.7
Vendor Provided Food Safety Information		
No	25	96.2
Yes	1	3.8
Overall Cleanliness of Food Stand		
Unclean	19	73.1
Clean	7	26.9
Overall Cleanliness of Vendor		
Unclean	21	80.8
Clean	5	19.2
Gloves Worn to Handle High-Risk Produce		
No	26	100.0
Yes	0	0
Hand Washing Facilities at Vendor Stand		
No	26	100.0
Yes	0	0
Vendors Wash Their Hands		
No	26	100.0
Yes	0	0
High-Risk Produce Protected		
No	2	7.7
Yes	24	92.3
If Yes to Previous Question, How is it Protected (N=24)		
Tent		
No	0	0
Yes	24	100.0
On a Table		
No	0	0
Yes	24	100.0
Plastic or Wooden Containers		
No	0	0
Yes	24	100.0
Coolers		
No	20	76.9
Yes	4	15.4

Table 2. Handling Characteristics of Vendors Observed in Rhode Island (N=26)
continued

	Frequency	Percent
High-Risk Produce Sold Precut		
No	26	100.0
Yes	0	0
High-Risk Produce Being Cut Onsite		
No	26	100.0
Yes	0	0
Other Produce Being Sold Precut		
No	26	100.0
Yes	0	0
Other Produce Being Cut Onsite		
No	26	100.0
Yes	0	0
High-Risk Produce Being Stored on the Ground		
No	17	65.4
Yes	9	34.6
Bruises Visible on High-Risk Produce		
No	11	42.3
Yes	15	57.7
If Yes to Previous Question, Is it: (N=15)		
Lightly Bruised	15	100.0
Heavily Bruised	0	0

Table 3: Unsafe High-Risk Produce Handling Practices by Vendors (N=26)

	Frequency	Percent
Walking away from the vendor stand		
No	22	84.6
Yes	4	15.4
Touching body		
No	24	92.3
Yes	2	7.7
Touching money		
No	5	19.2
Yes	21	80.8
Eating and/or Drinking		
No	18	69.2
Yes	8	30.8
Talking on the Phone		
No	21	80.8
Yes	5	19.2

Table 4. High-Risk Produce Observed at Vendor Stands (N=26)

	Frequency	Percent
High-Risk Fruits		
Apples		
No	22	84.6
Yes	4	15.4
Blackberries		
No	24	92.3
Yes	2	7.7
Blueberries		
No	18	69.2
Yes	8	30.8
Cantaloupes		
No	24	92.3
Yes	2	7.7
Peaches		
No	19	73.1
Yes	7	26.9
Golden Raspberries		
No	25	96.2
Yes	1	3.8
Red Raspberries		
No	21	80.8
Yes	5	19.2
Strawberries		
No	25	96.2
Yes	1	3.8

Table 4. High-Risk Produce Observed at Vendor Stands (N=26) *continued*

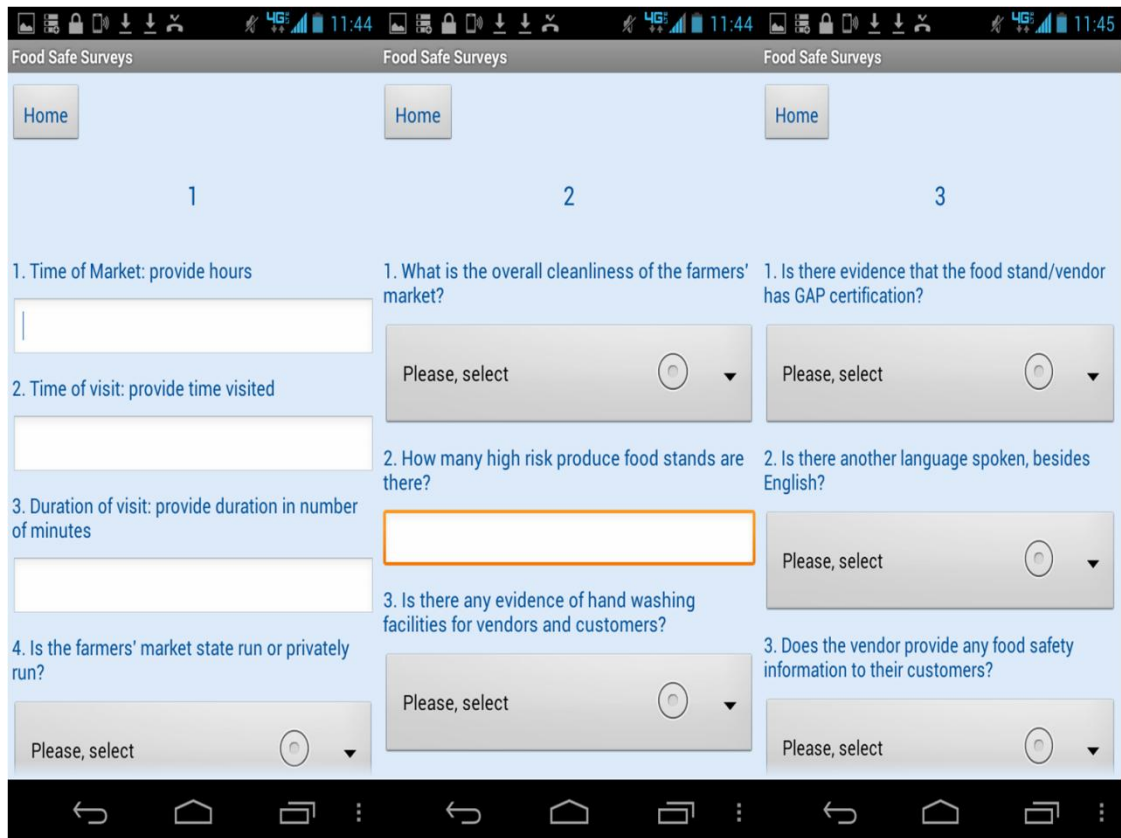
	Frequency	Percent
High-Risk Vegetables		
Basil		
No	18	69.2
Yes	8	30.8
Broccoli		
No	22	84.6
Yes	4	15.4
Cabbage		
No	23	88.5
Yes	3	11.5
Carrots		
No	21	80.8
Yes	5	19.2
Cauliflower		
No	25	96.2
Yes	1	3.8
Cucumbers		
No	12	46.2
Yes	14	53.8
Garlic		
No	21	80.8
Yes	5	19.2
Green beans		
No	20	76.9
Yes	6	23.1
Herbs		
No	23	88.5
Yes	3	11.5
Kale		
No	22	84.6
Yes	4	15.4
Lettuce		
No	13	50.0
Yes	13	50.0
Onions		
No	14	53.8
Yes	12	46.2
Oregano		
No	25	96.2
Yes	1	3.8
Parsley		
No	19	73.1
Yes	7	26.9

Table 4. High-Risk Produce Observed at Vendor Stands (N=26) *continued*

	Frequency	Percent
Peas		
No	25	96.2
Yes	1	3.8
Peppers		
No	11	42.3
Yes	15	57.7
Radishes		
No	19	73.1
Yes	7	26.9
Scallions		
No	22	84.6
Yes	4	15.4
Spinach		
No	24	92.3
Yes	2	7.7
Tomatoes		
No	9	34.6
Yes	17	65.4
Yellow squash		
No	15	57.7
Yes	11	42.3
Zucchini		
No	10	38.5
Yes	16	61.5

FIGURE

Figure 1. Observational instrument screenshot



APPENDIX A:
REVIEW OF LITERATURE

INTRODUCTION

Approximately 48 million Americans contract foodborne illnesses each year, equivalent to one in every six Americans (5, 7). The impact of foodborne illnesses on individuals and public health costs keeps increasing (5, 7). Foodborne illnesses lead to 128,000 hospitalizations and 3,000 deaths each year (7). An annual 10% decrease in foodborne illnesses would result in five million fewer Americans getting sick (5) with a savings of \$5.1-7.8 billion dollars (63). The recorded number of outbreaks due to produce increased to 17% of all foodborne illnesses from 2001 to 2010 (30).

Produce that typically causes foodborne illnesses includes many fruits, vegetables, and herbs classified as high-risk by the Food and Drug Administration (FDA) such as berries, leafy green vegetables, tomatoes, cucumbers, melons, and fresh herbs (34, 40). These high-risk produce items are some of the more popular choices by Americans (13). Additionally, they are strongly recommended in the United States Department of Agriculture's (USDA) Dietary Guidelines for Americans (DGA) because many Americans are not meeting the recommended intake for fruits and vegetables and these high-risk produce are better choices because of their high nutrient density (13). As well as more consumers are buying fruits and vegetables at farmers' markets to support their local farmer (53, 68).

Farmers' markets have become a popular source for fresh produce as the number of markets has increased over 150% in just the last five years (17). It is these high-risk produce that are some of the more sought after items at markets (34). As the

number of farmers' markets and the amount of food purchased there increases, these sites become larger parts of the production chain (13, 30, 31). The rapid growth in farmers' markets has created challenges in developing and disseminating best practices and guidelines for food safety issues at these markets. Proper handling techniques by farmers' market vendors need to be in place in order to help decrease the risk of contracting a foodborne illness. Hence, farmers' market vendor's handling practices need to be assessed in order to make educational materials, to teach vendors how to institute best practices at farmers' markets when selling high-risk produce.

OVERALL FOODBORNE ILLNESS ISSUES

As defined by the Centers for Disease Control and Prevention (CDC), a foodborne illness is a preventable public health problem that happens when people become sick by consuming foods or beverages contaminated by a disease-causing microorganism, pathogen, or from poisonous toxins or chemicals (8). In order to prevent foodborne illnesses, safe food handling practices need to be maintained from the field to the table (16). There are over 250 different foodborne diseases that are caused by bacteria, viruses, or parasites (8). Bacteria can live outside the human body, can grow on or in food and cause illness by infection or intoxication, whereas parasites and viruses need a living host (such as the human body) to multiply and grow (66). As of 2011, 31 known foodborne pathogens have caused approximately 44% (55,961) of the identified foodborne illness cases that lead to hospitalizations and 44% (1,351) that lead to death (5).

Both known and unidentified pathogens are responsible for foodborne illnesses that can lead to a multitude of symptoms such as gastrointestinal issues e.g.

nausea, diarrhea, vomiting, and abdominal cramps, and can lead to hospitalizations and death if not treated appropriately (5, 66). The most common pathogens are Norovirus, *Salmonella* (nontyphoidal), *Campylobacter species*, *Staphylococcus aureus*, *Escherichia coli* (STEC) O157 (*E. coli*), and *Listeria monocytogenes* (5, 22). The most common pathogens are also associated with increased risk of foodborne illnesses in certain high-risk populations (5, 7).

Though approximately 48 million Americans contract a foodborne illness each year, some populations are more vulnerable to getting these diseases (5). Populations classified as high-risk for contracting foodborne illnesses are pregnant women, children or bottle-fed infants, the elderly, and people with weakened immune systems (68). In 2012, children less than five years of age had the most foodborne illnesses and people greater than 65 years of age had the highest hospitalization rates and death due to foodborne illnesses (7). Issues with foodborne illness persist, however some pathogens that cause foodborne illnesses have had little or no changes in 2012 compared with 2006-2008 as shown in Figure 1 (5). With some pathogens contributing to increased foodborne illnesses, it is important to understand the etiology, causes, and sources of foodborne illness outbreaks (7, 63).

Figure 1. Food Safety Progress Report for 2012, Adapted from, CDC Estimates of Foodborne Illness in the United States: CDC 2011 Estimates (5).



Foodborne Illness Surveillance

In order to understand the etiology, causes, and sources of foodborne illness outbreaks different surveillance systems are used by the CDC. The CDC mostly relies on information sent in from state and local health departments, as well as collaborating with the USDA Food Safety and Inspection Service (FSIS), and the FDA (11). One of the CDC’s surveillance systems consists of Foodborne Disease Active Surveillance Network or FoodNet which reports trends in foodborne infection and is also able to track how food safety policies impact the nation (11). Other surveillance systems are National Antimicrobial Resistance Monitoring System-enteric bacteria, National Molecular Subtyping Network for Foodborne Disease Surveillance (PulseNet),

National Surveillance for Enteric Disease, Foodborne Disease Outbreak Surveillance System, Environmental Health Specialists Network, DPDx: Laboratory Identification of Parasites of Public Health Concern, and National Notifiable Diseases Surveillance System (11). With these surveillance systems, it allows the US to provide more information on the occurrence of foodborne illness outbreaks and each system may focus on specific pathogens that are most likely to be transmitted through food (11). Surveillance is imperative in order to help detect and prevent foodborne diseases and outbreaks from occurring as well as monitoring and tracking foodborne illness outbreaks. This is important to identify where and how the outbreak occurred and how many people it affected (11).

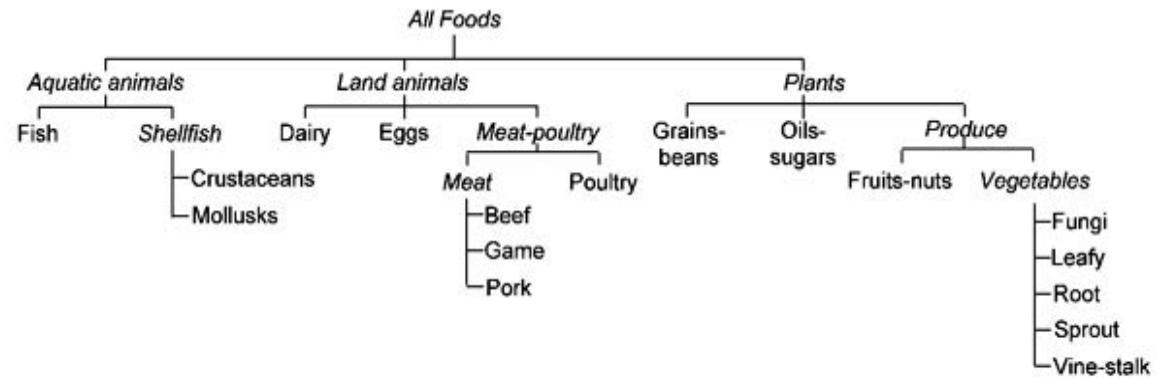
Foodborne Illness Outbreak by Commodities

The FDA defines a raw agricultural commodity as any food that is in its raw or natural state, which can consist of fresh produce (10). The FDA and CDC organize foods into different commodities in order to help better direct food safety efforts based on foodborne illness outbreak data (58). The FDA also created a list of 28 commodity categories to be used to show the trends in reportable food data such as seafood, produce, dairy, etc (12).

Painter et al (57). composed a system using CDC data for grouping foods into 17 mutually exclusive single food commodities in order to develop a way to categorize foods. This model was developed in order to better designate which foods contributed specifically to the human illnesses based on which commodities from which they originated (57). Painter chose the commodities based on them being identifiable to consumers and combined foods having similar production techniques and regulatory

issues (57). In addition, these commodities are found in grocery stores and are familiar to industry and public health agencies (57). Three commodity groups were created reflecting the derivation of nearly all food: aquatic animals, land animals, and plants (57, 58). From these three groups, a total of 17 food commodities were identified to narrow down possible foodborne outbreaks as shown in Figure 2 (57, 58).

Figure 2. Seventeen Food Commodities, Adapted from: Recipes for foodborne outbreaks: a scheme for categorizing and grouping implicated foods (57).



Hierarchy of food commodities. *Italics* indicate commodity groups.

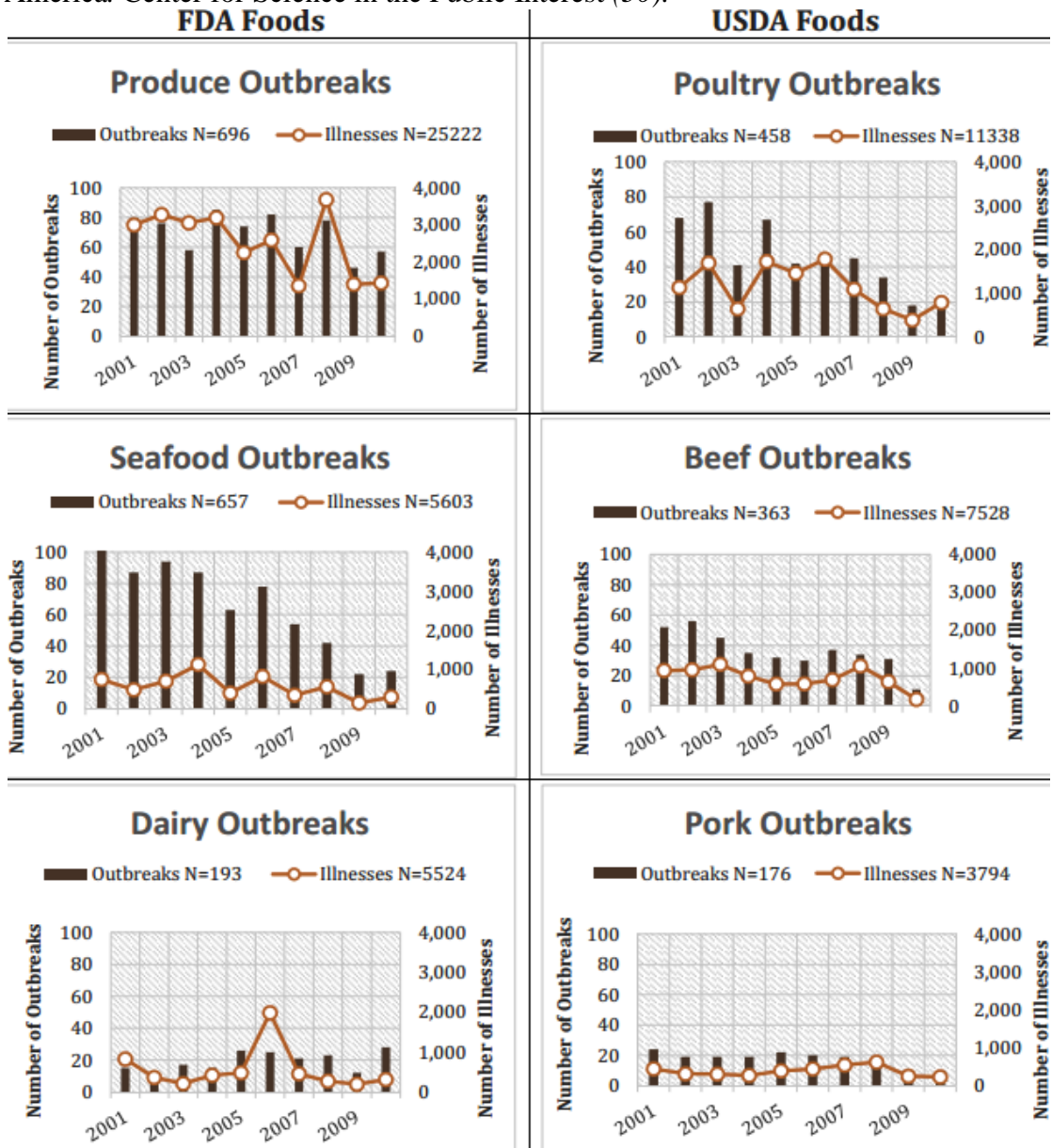
Painter et al (58) conducted another study to further assess the impact of 17 food commodities from 1998 through 2008, when there were 13,352 identified foodborne illness outbreaks in the US, causing 271,974 illnesses. From those 13,352 outbreaks, a total of 4,589 outbreaks were identified to have come from a specific food and a single etiologic event (58). At times it can be difficult to link an illness to the specific food; this is because most pathogens are transmitted through a variety of foods (58).

The Center for Science in the Public Interest (CSPI) analyzed 4,229 US foodborne illness outbreaks from 2001 through 2010 that had been identified by the CDC, USDA and FDA and published a report to improve the public's health officials'

and policy makers' understanding of foodborne illness (30). The CSPI used a different classification system than mentioned previously. The CSPI researches grouped foods in 13 consumer-focused categories and 37 sub-categories; and were designed to be more recognizable by consumers (30). Outbreaks were utilized for this analysis if the data included the pathogen and the contaminated food responsible for the outbreak (30). For the specific groups, luncheon meats caused the least amount of outbreaks with 134 and 4,151 illnesses, then pork with 176 outbreaks and 3,794 illnesses, beef with 363 outbreaks and 7,528 illnesses, poultry with 458 outbreaks and 11,338 illnesses, and seafood with 657 outbreaks and 5,603 illnesses (30). From 2001 to 2010, produce was the most common cause of outbreaks: 696 outbreaks (17%) and 25,222 illnesses (24%) as shown in Figure 3 (30). Within the produce category, fruits were the cause of 100 outbreaks and 3,629 illnesses, vegetables caused 235 outbreaks and 11,839 illnesses and produce dishes with multiple ingredients caused 361 outbreaks and 9,754 illnesses (30).

The foodborne illness outbreaks have increased from 1996 to 2010 and accounted for approximately 131 produce-related reported outbreaks that resulted in 14,132 outbreak-related illnesses, 1,360 hospitalizations, and 27 deaths (34). During this time period, there were approximately 20 different fresh produce commodities including many of the high-risk produce, consisting of leafy greens (lettuce and spinach), tomatoes, melons, berries, fresh herbs, and green onions; as well as fresh-cut fruits and vegetables (34).

Figure 3. Foodborne Illness Outbreaks in Different Commodities, 2001-2010, Adapted from: *Outbreak Alert! 2001-2010. A Review of Foodborne Illness in America.* Center for Science in the Public Interest (30).



PRODUCE

Produce can be contaminated at any point from farm to table growing, harvesting, packaging, transportation, distribution (30, 34), and home processing (26, 47). It is important to prevent the microbial contamination of fruits and vegetables at all steps from the farm to the table in order to help reduce foodborne illnesses that are

associated with fresh produce contamination. There are three types of food safety hazard contaminations: biological, chemical and physical. Biological food safety hazards occur from parasites, viruses, and bacteria that contaminate produce. Frequent biological food safety hazards of foods are *Salmonella* contaminated cantaloupes, tomatoes, and sprouts, pathogenic *E. coli* contaminated leafy greens, *Cycolspora* (a parasite) contaminated raspberries, and Hepatitis A contaminated green onions (33, 35, 36). Chemical contaminants consist of pesticides, heavy metals, organic sanitizers, etc (33). Physical injuries contribute to contamination because of produce's high moisture content and soft texture resulting in bruises and microbial growth on the damaged part (32). A decrease in quality of the produce could lead to a safety problem (32).

Before harvesting, produce can become contaminated from a multitude of sources such as the soil/fertilizer, irrigation water, air, animal manure, and animal carcasses (40, 52). Post-harvested fruits and vegetables are still susceptible to contaminates from poor hygiene practices of workers and farmers in the field and on unclean, un-sanitized (when appropriate) equipment used to harvest, process, and transport the produce (40, 52). Food handlers, pickers, packers, and consumers are sources of pathogens as well and contribute to produce becoming contaminated and leading to foodborne illness outbreaks (35, 36, 40).

The FDA and USDA developed Good Agricultural Practices (GAP), a set of guidelines for farmers that grow produce. It addresses good agricultural and handling practices that are recommended to minimize microbial contamination of fresh and minimally processed fruits and vegetables (60). Good Agricultural Practices are

important for not only commercial farms, but also home gardeners handling fruits and vegetables. Currently, conducting GAP on farms is considered voluntary and not mandatory (60).

Foodborne Illness Outbreaks Related to Produce

Even with voluntary GAP in place, foodborne illness outbreaks are still occurring. Produce consumption has been the source of numerous foodborne illness outbreaks and food recalls (69). Approximately 15% of outbreaks (n=684) and 23% of illnesses (n=26,735) were due to produce from 1998 through 2007 (55). From 1998 to 2006, approximately 76% of produce related outbreaks occurred from five commodity groups consisting of 1) lettuce/leafy greens (30%), 2) tomatoes (17%), 3) cantaloupes (13%), 4) herbs (basil, parsley) (11%), and 5) green onions (5%) (51).

Recent foodborne illness outbreaks due to high-risk produce have received a lot of media attention (67). Though these outbreaks happened over the course of seven years, and in different geographical locations, there were many outbreaks from similar pathogens and a lot of the vehicles were high-risk produce (67). In 2008, there was a *Salmonella* outbreak from contaminated jalapeno and serrano peppers that led to 1,442 illnesses, 286 hospitalizations, and two deaths in 43 states in the US, the District of Columbia and Canada (54, 55). The outbreak originated in Mexico and it is still not known where in the production chain the contamination was introduced, though it is speculated that contamination might have occurred on the farm or possibly during the processing or distribution (54, 55). Another Salmonellosis outbreak in Idaho in 2011 was from Evergreen Fresh alfalfa sprouts that lead to 21 illnesses, and three hospitalizations in five US states (55).

In September 2006, there was a recall on fresh, raw spinach because of *E.coli* 0157:H7 contamination that resulted in 205 illnesses, 104 hospitalizations, and three deaths in 26 states (36, 38). The spinach originated from Salinas Valley, California, but how the spinach became contaminated has not been completely ascertained. The final speculation was that the spinach may have been contaminated from the cattle manure that was produced on the same farm as the spinach (21). There are manure guidelines to minimize microbial risks that could contribute to foodborne illnesses (15). Animal manure may have many nutrients, but can also contain *Listeria*, *Salmonella*, and *E.coli* 0157:H7 that can cause foodborne illnesses (15).

In order to help prevent this contamination, using aged or composted manure have lower risk for contributing to foodborne illnesses (15). Use of raw manure by farmers is widespread. In a survey, conducted on small to medium-sized farms, approximately 56% of 128 farmers stated they used manures and of those farmers using manure approximately 45.3% used poultry litter or 35.9% used poultry manure (48). From the 56% of farmers' that used manure 18%, used a mixture of the raw and composted manure and 15.6% of farmers did not compost at all (48). Aged manure is manure that has aged for at least six months prior to applying it to farms, by being exposed to air and the outside elements in order to help decrease foodborne pathogens (15). Composted manure has been properly composted and maintained at least 131°F for 3-15 days, depending on the compost process used (15). The high temperature helps kill foodborne pathogens. If using manure than one needs to wait 120 days after manure application to harvest produce (15). Manure should be stored as far away from where a farmer grows and handles the fresh produce in order to mitigate pathogens

from manure contaminating produce (15). If the manure is stored too close it can contaminate the produce. For example, if it rains and the farm is down a hill, the runoff of water could contaminate the soil with *E. coli* O157 H7.

In another outbreak, *E. coli* O145 contaminated shredded romaine lettuce, resulted in 26 confirmed and seven possible cases, with 13 hospitalized and no deaths and contamination from the soil was the most likely source (55). An *E. coli* O104 H4 outbreak in northern Germany in May 2011, led to 3,911 cases, 47 deaths and 777 patients that developed hemolytic uremic syndrome due to contaminated fenugreek seed sprouts (55). In 2011 an outbreak, linked to cantaloupe caused 145 illnesses, in which 143 were hospitalized and 33 deaths in 28 states in the US. The cantaloupe was contaminated with *Listeria monocytogenes* (55). The cantaloupes came from Granada, Colorado from Jensen Farms and that the *Listeria monocytogenes* came from the equipment used in the packing facility on the farm. With the constant, foodborne illness outbreaks and an effort to keep produce safe, the FDA and USDA came up with a new way to help reduce outbreaks from occurring.

Reducing Issues

In response to current, produce safety concerns, the FDA has drafted produce standards rule, as mandated by the congressional Food Safety Modernization Act (FSMA) (34). The rule identifies examples of the high-risk produce including leafy green vegetables (such as lettuce and spinach), seed sprouts, carrots, cabbage, garlic, mushrooms, nectarines, pears, summer squash, berries (strawberries, blueberries, raspberries, and blackberries), melons (cantaloupes, watermelons, and honey dew), tomatoes, apples, broccoli or cauliflower, cucumbers, green beans, onions, herbs,

peaches, peas, peppers, radishes, and scallions (34, 40). The rule also states produce that receives a kill-step or is not normally consumed raw is not included in the rule for high-risk produce such as; potatoes (34, 40).

The FSMA was signed into law in January 2011 by Congress and helps the FDA to better protect the public health by strengthening the food safety system (34). The FDA can also focus more on preventing food safety problems then reacting to problems after they occur (34). As part of the FDA's Produce Safety Rule in the FSMA, there are the proposed "Standards for the Growing, Harvesting, Packing, and Holding of Produce for Human Consumption (34)," that identify specific high-risk produce that are commonly contaminated by pathogens and lead to foodborne illness outbreaks (34). The proposed standards are evidence-based and currently in comment period (34). They consist of best practices for dealing with high-risk produce to minimize health risks, with an increased concentration on preventing food safety issues (34). Additionally, the proposed standards provide enhanced infrastructure for tracking and monitoring food safety practices of high-risk produce growers (34). By improving the food safety related to high-risk produce, this will eventually help minimize contamination that could cause serious adverse health consequences and deaths (34).

Increased Produce Consumption due to Health Messages

From 1970 to 2004, Americans increased produce consumption by 19.9% to 694.3 pounds per capita per year (2). America's consumption of produce will continue to increase, due, in part, to the rise in population from 281.4 million in 2000 to approximately 331 million in 2020 (23, 69). Income and demographic shifts by 2020

could result in an 8.1% and 7.2% increase in fruits and vegetables, respectively, per capita (23). Additionally, the increase in produce consumption could be traced to health-related recommendations. The 2010 DGA recommend two cups of fruits and two and a half cups of vegetables per day because research showed consuming nutrient-dense foods and beverages can decrease risk for certain diseases (13). The health promoting nutrients in fruits and vegetables include dietary fiber, folate, magnesium, potassium, and vitamins A, C, and K (13). Due to the many produce related health benefits, MyPlate, the newest government Nutrition tool, recommends half of one's diet be made up of fruits and vegetables.

MyPlate replaced the MyPyramid in June 2011 and is a visual picture of a plate separated into the different food groups in order to help consumers learn to adopt healthier eating habits that follow the DGA through practical information (1, 13). Myplate recommends that fruits and vegetables make up half a person's plate in order in an effort to increase consumption of multiple nutrients and a variety of and vegetables including beans and peas, starchy, dark green, red and orange and other vegetables (1). MyPlate also shows the commonly eaten fruits and vegetables in each category which is consistent with the high-risk produce associated with many foodborne outbreaks (1). Some of the commonly eaten fruits are apples and peaches, and commonly eaten vegetables are broccoli, lettuce, spinach, kale, cauliflower, peas, carrots, squash, onions, green beans, peppers, zucchini and tomatoes (1). Consuming at least two and a half cups of fruits and vegetables each day is associated with a reduced risk of cardiovascular disease and may be protective against certain types of cancer (13). Eating more fruits and vegetables as part of a balanced diet is also known

to help achieve and maintain a healthy weight (13). Better food safety practices from farm to table for produce are also encouraged in an effort to contribute to a healthy diet (69). Food safety practices were first added to the DGA in 2000 and consisted of a section on how to keep food safe and help decrease one's risk for foodborne illnesses (18). With increased consumption of produce in the US and the concomitant increase in foodborne illnesses (2), there needs to be best practices for farmers, vendors, and consumers on how to reduce pathogen content and growth in order to help prevent future foodborne illnesses.

The FDA and USDA DGA recommend all produce be thoroughly washed under running water and dried by the consumer before eating to remove soil debris and other contaminants, prolong shelf life, and decrease the occurrence of foodborne illnesses (9, 13, 69). Certain produce such as melons and cucumbers should be firmly scrubbed with a produce brush to remove pathogens from rind to prevent microbes from transferring from the outside to the inside of the produce (9, 13, 69). However, produce such as ready-to-eat (RTE) prewashed lettuce or precut carrots do not need to be washed and rinsed by consumers, because new chemical contaminants could be introduced via soap or detergents (69). Produce should be dried immediately with a cloth towel or paper towel to reduce mold growth, which will happen if the produce remains wet for too long (13). In order to make sure that produce is as safe as possible to consume by consumers prevention plans need to be in place from the farm to the table. Consumers have incomplete practices due to lack of education on safe food handling practices (52, 64). Not only do consumers have a lack of education on food safe handling practices, but farmers' market vendors do as well. With the number of

foodborne illnesses increasing for high-risk produce, more research needs to be performed on where these outbreaks are occurring the most, in order to create educational materials on food safety practices for vendors.

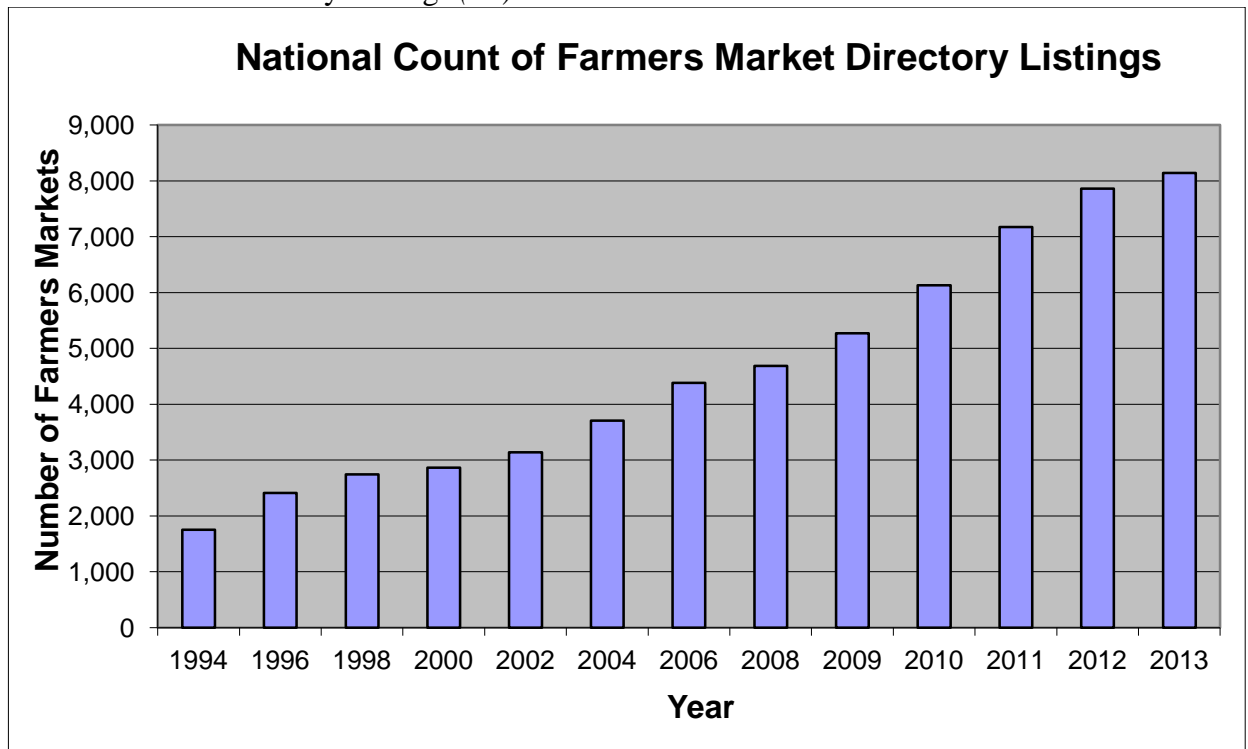
Not only are the number of foodborne illnesses for high-risk produce increasing, but where the outbreaks are occurring in specific locations are increasing as well. The five most common locations for the source of an outbreak are 1) restaurants (1,786 outbreaks and 32,919 illnesses), 2) private homes (922 outbreaks and 12,666 illnesses), 3) workplace (328 outbreaks and 7,823 illnesses), 4) multiple locations/unknown (247 outbreaks and 8,518 illnesses) and 5) schools (157 outbreaks and 6,943 illnesses) (30). Farmers' markets were not specifically stated, in this list, but farms were number eight in the table along with camping/picnic contributing to (128 outbreaks and 4,348 illnesses) (30). When looking at certain aspects of how farmers' markets may contribute to foodborne illnesses, it is unknown what outbreaks and illnesses can be traced back to farmers' markets in the US. Since farmers' markets are becoming a more popular source of high-risk produce for the American public, it is imperative that more research be conducted to ensure the best food safety practices are in place to minimize risk of foodborne illness at farmers' markets.

FARMERS' MARKETS

Farmers' markets have increased over 450% since 1994, from 1,755 to 8,144 in 2013, as shown in Figure 4 (17, 61). Within the past five years, farmers' markets have increased over 150% and have become a popular source for fresh produce, specifically high-risk produce which are some of the more sought after items at markets (17, 34). Farmers' markets averaged \$242,581 in sales with 959 customers

each week in 2005 (61). As the number of farmers' markets and the amount of produce purchased there increases; these sites are important to regulate to prevent and reduce the risk of foodborne illnesses (13, 30, 31).

Figure 4: National Count of Farmers Market Directory Listings, Adapted from United States Department of Agriculture Agricultural Marketing Service. National Count of Farmers Market Directory Listings (17).



Foodborne Illnesses and Farmers' Markets

Farmers' markets present unique challenges to implement regulatory standards, since their locations lack infrastructure such as electricity, running water, and soap (25). In addition to these unique challenges, there are the typical challenges such as proper temperatures, prepackaging, personal hygiene, and exposure to foodborne pathogens (20, 34, 38). Foodborne pathogens that have tested positive on high-risk produce purchased at farmer's markets include *Campylobacter*, *E. coli* 0157:H7, and *Salmonella* (19, 24, 59).

Campylobacter was found in high-risk produce tested from farmers' markets, including vegetables purchased at northeast outdoor farmers' markets (59).

Campylobacter can contaminate produce through untreated water applied to the vegetables, soil contaminated with raw sewage sludge, fecal matter from the animals or from farmers that were infected or ill and contaminated produce at harvest (59). Out of 533 summer samples of ten different vegetables at the outdoor farmers' markets, *Campylobacter* was isolated in 1.6-3.3% of six vegetables; spinach, lettuce, radishes, green onions, parsley, and potatoes (59). There were also 511 summer samples and 520 winter samples that were taken from supermarkets, but all tested negative for *Campylobacter* (59). The authors speculated that the farmers' markets' vegetables were contaminated due to unsanitary production, storing conditions and farmers with unsanitary personal hygiene practices (59). As a result it is imperative to assess food safety practices at farmers' markets. *E. coli* 0157 H7 has also been found in produce at farmers' markets.

E. coli 0157 H7 is the worst type of *E. coli*, because it can cause bloody diarrhea as well as can result in kidney failure (65). *E. coli* usually contaminates water, raw vegetables or undercooked ground beef (65). A study conducted at retail distribution centers and farmers' markets found that *E. coli* 0157 H7 was highest in high-risk produce such as parsley (13.4%), organic leaf lettuce (11.6%), head lettuce (6.5%), scallions (6.4%), cilantro (4.9%) and muskmelon (1.3%) (19). *E. coli* 0157 H7 was found more frequently in the herbs and leafy greens, because these have greater surface area and are handled more often by the food employees (19). The pathogens

survive longer because there is less environmental stress on the produce and this can cause increased foodborne illness outbreaks (19).

A study looked at multiple foodborne contaminants from 36 farmers' markets in the summer of 2007 in Alberta, Canada (24). Samples obtained consisted of produce classified as high-risk for foodborne contaminants and included lettuce, spinach, tomatoes, carrots, green onions, and strawberries (24). The study found a total of fifty-five (8.2%) *E. coli* O157 H7 isolated from 673 obtained samples of *E. coli* O157 H7 and *Campylobacter* (24). For the 672 samples for *Salmonella* and 644 samples for *E. coli* O157:H7, there was no isolation of the pathogens from any of the samples (24). These foodborne pathogens cause many foodborne illness outbreaks and many of these outbreaks were due to improper hand hygiene at the farmers' markets when handling produce.

Farmers' Markets Environment and Guidelines

Environments at farmers' markets vary depending on items sold. Farmers' markets and produce stands are defined differently in the US depending on products sold and how often the market is open. Rhode Island's Department of Health (RIDOH) defines a farmers' market as a market that contains two or more farmers that sell produce grown exclusively on their farms (4). The RIDOH also classifies a farmers' market as a temporary event because vendors are only selling whole, uncut produce in which does not require a Food Business License and the vendors meet the requirements for a temporary event (4). The farmers' markets are held outside weekly from early spring to late fall and inside during the winter months (20). As a result of

the variable locations of farmers' markets depending on seasons, food safety and regulations can vary.

Farmers' markets can create food safety issues due to the seasonality and physical setting of the markets (20). Since a majority of farmers' markets are held from mid-spring through late fall, they are often held outdoors in fields and parks, where food products could be exposed to many pathogens, increasing the possibility of foodborne illness (33). Food safety issues at farmers' markets include produce resting on the ground in the grass/dirt, bugs crawling over the produce and visible bruises and holes on the produce (73). When these issues are not dealt with properly, the high-risk produce is more susceptible to contamination, microorganism growth and eventually can result in foodborne illness (73). Food safety practices at farmers' markets must be implemented; however, there is limited research assessing food handling practices at farmers' markets for high-risk, whole produce.

Due to the increase in popularity of farmers' markets across the US, more states' divisions of agriculture and health departments are developing food safety training programs for farmers' market managers and vendors (3, 6). Multiple states have developed training programs on food safety recommendations for farmers and food vendors to implement and provide guidance, to help reduce the contamination of produce as well as protect the farmers' market and the farm from loss and liability that can be associated with foodborne illnesses (3, 14). Training programs may contain food specific information about the foods that can be sold and the precautionary measures that need to be taken with them to prevent foodborne illnesses (3). Precautionary measures include defined temperatures and storage regulations to ensure

fresh, safe, and quality food for consumers (3). However, each state's farmers' markets follow different food safety recommendations based on the state, county or town regulations. The market manager in charge of the market may also develop their own farmers' market rules/regulations (14). Even with rules/regulations, farmers' markets have an impact on whether or not the rules can be followed, such as if there is no hand washing facilities for vendors to wash their hands.

Foodborne Illnesses and Hand Hygiene

Foodborne related risks at farmers' markets could be related to hand hygiene issues. For example cross-contamination can occur when food employees do not wear gloves when handling raw animal products or hands are not properly washed before handling produce (46). A direct observational study conducted in 18 Indiana farmers' markets concluded that when employees are engaged in multiple roles such as server or cook, server and cashier, or cook and cashier, then the employee is significantly more likely to touch money or personal belongings/clothing without the appropriate hand washing to follow these activities (20). Also when there were more employees working at the same time, it was found to significantly lead to a higher likelihood of increased frequency of violations related to the touching of RTE foods (20). The study concluded that when farmers' markets lack accessible hand washing facilities, employees with multiple roles have limited options to wash their hands (20).

Farmers' Market and Consumer Motivations

A survey about consumers' motivations to attend farmers' markets was conducted in the Niagara Region of Canada (41). Participants stated that they shop at farmers' markets because they believe the produce is fresher, cheaper and could be

healthier than produce found at a grocery store, because the produce is usually local at a farmers' market, whereas at a grocery store it might be from another country (41). These reasons could be key factors in increasing more local produce production and consumption and contribute to more marketing operations for advertising to consumers to come to farmers' markets (41, 68). Farmers' markets provide a direct connection for consumers to fresh fruits and vegetables and play a critical role in increasing produce consumption in many communities because they promote direct farmer to consumer relationships (68). To continue to promote this farmer to consumer relationship, food safety practices must be implemented to ensure the safety of the consumer. It is important to figure out the best technique such as direct observations in order to figure out what safe and unsafe food handling behaviors are being conducted at farmers' markets.

DIRECT OBSERVATIONS

Questionnaire studies have been conducted in order to examine knowledge, attitudes, and self-reported practices of food handlers (27, 28, 45, 50). Direct observation of food handlers is a more accurate way to assess the compliance of food handlers and food safety practices in foodservice establishments, and studies have shown lower compliance with food safety recommendations when relying on self-reports (27, 28, 44, 45, 50). The use of direct observation through checklists, inspection forms, paper and pencil, and notational analysis (recording frequency of observed events in an ordered sequence) are all useful, but there are limitations, because people tend to answer with what they think the observer deems appropriate and tend to change their behavior in order to please the observer (27, 28, 44, 45, 50).

Previous research states that food handlers tend to overestimate the frequency with which they carry out food safety practices either from being optimistic or social desirability (27, 28, 44, 45, 50). Furthermore, mystery shopping through the use of direct observations is a way for the observer to observe a food handler without the food handler knowing they are being watched.

Direct Observation-Food Safety Practices

Direct observations consist of capturing actual behavior in the specific context of a situation (44). Direct observations of food safety practices in foodservice establishments allow for better understanding of food safety practices of the foodservice employees (44, 49, 50). An example of an observational study protocol is notational analysis which consists of a tool (paper and pencil, video, or phone, etc.) that is able to record the occurrence of observed events in an ordered succession (49, 50). The data collected from observational studies can result in calculated compliance with food safety regulations and best practices (28).

In an observational study, the FDA found that 64% out of compliance for improper cleaning and sanitizing of food-contact surfaces before use in full service restaurants (39). It has been shown that 82% of foodborne outbreaks are due to food workers, in which the foodborne pathogen had been transmitted from their hands due to the lack of washing and wearing gloves (37).

An observational study was conducted by Green and colleagues (45) on food worker hand washing practices in restaurants in six states. There were 321 restaurants observed, that consisted of 196 independently owned and the other 121 were considered chains or franchises collected data by surveying the kitchen and the

physical environment of the restaurant and then 55-60 minutes the workers were observed preparing food (45). The exclusion criteria were that the restaurants were not institutions consisting of supermarkets, temporary food stands, caterers, or mobile food carts (45). The main work activity observed was hand washing behaviors in which out of 2,195 work activities there were 532 (24%) that resulted in gloves were supposed to be taken off before the washing of hands and were not and 192 (36%) wore their gloves while washing their hands (45). Only 32% of hand washing was conducted appropriately with the Food Code Guidelines indicating that food workers may not know when to wash their hands or that they chose not to wash their hands (45). The result of this study was that hand washing practices of food workers needed to be improved (45).

A study was conducted in Maryland and Virginia in May and November 2009 in deli departments at six chain and three independent retail establishments (50). The study concluded using notational analysis that in independently owned deli stores food service employees only washed their hands as specified in the 2005 FDA Food Code three (14%) out of 22 times before putting on new gloves (50). Those employees in chain retail deli stores washed their hands 56 (48%) out of 116 times (50). For the total number of food employees washing their hands was 73 (17%) out of 439 recommended times at chain stores and for independent stores food employees washed their hands 5 (2%) out of 273 recommended times (50). A reason for the low compliance with the 2005 FDA Food Code, was from the numerous times the food service employees had contact with potentially contaminated equipment and utensils while wearing gloves, then touching RTE foods (50).

Some of these studies looking at hand washing and glove use may even have higher compliance than normal, because the food service employees' knew they were being observed and the Hawthorne Effect may have occurred. Most food safety compliance research is done when the subjects know they are being observed which could result in a change of behavior (20, 43, 50).

Hawthorne Effect

The biggest limitation using traditional, observational studies is the Hawthorne Effect (20, 43, 50). The Hawthorne Effect hypothesizes that when people know they are being observed they tend to change their behaviors; therefore observed and recorded results could be influenced and would not collect what normally happens during the observed task (28, 45). The term was derived from the experiment performed in 1924 at the Massachusetts Institute of Technology in Hawthorne, Massachusetts in which a series of three tests were conducted in order to see if there was a relationship between the illumination and production in factory situations (29). During each test, the workers increased their production; no matter if the lights were brighter or dimmer. When incentives were introduced the workers also improved their performance (29). A conclusion that arose from this was when workers were aware of being a subject in a study; a change in their mental attitude was created by the simulated environment of the study and lead to uncertain results (29). Therefore, this study led to a definition of the Hawthorne Effect (29).

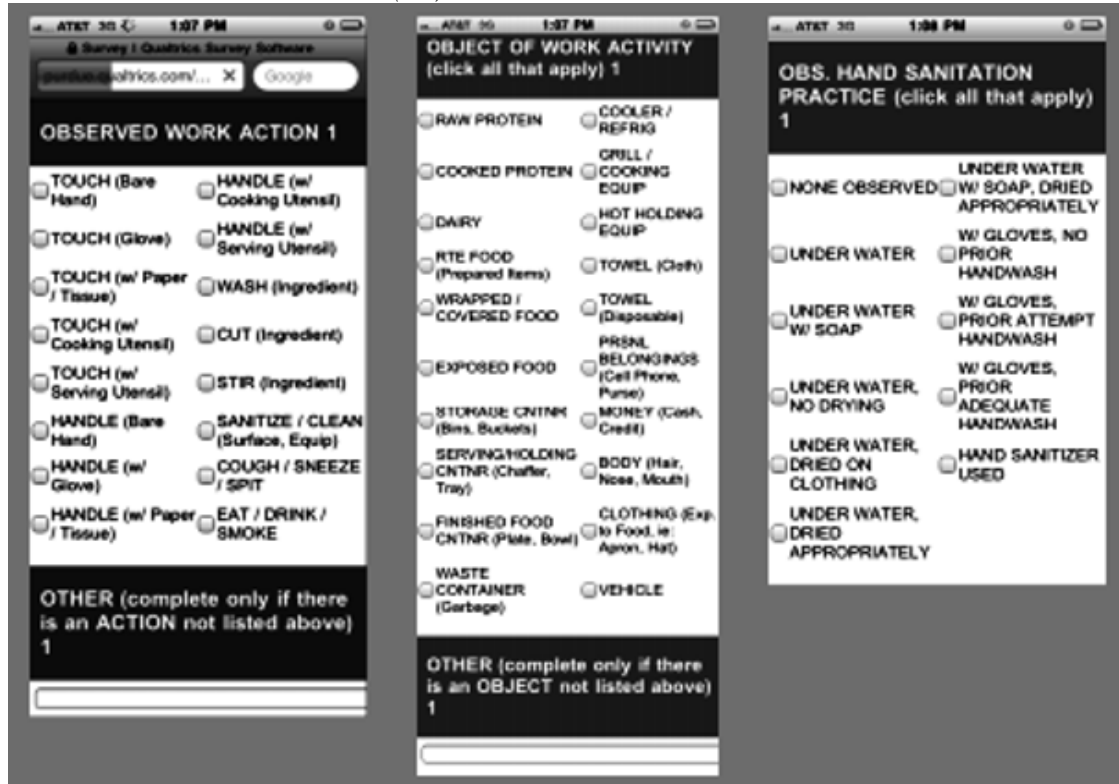
A study conducted in South Wales on 115 food handlers in 29 catering businesses were observed on three separate occasions (28). The food handlers were observed conducting food preparation and hygiene actions in the workplace and

results showed that there is a need to improve the standards to reduce cross contamination (28). One of the limitations of this study among others is the Hawthorne Effect because the participants knew they were being observed, so this could have affected the behavior of the food handlers and could have affected the validity of the study results (28). In order to help minimize the Hawthorne Effect, in this study the researchers discarded the first 30 minutes of observations/notations to allow the participants to accustom themselves to being observed and the researchers wore similar clothing to better blend in with the business surroundings (28). Additionally, the researchers conducted the observations at the busiest times, so as to obtain the most accurate results (28).

In another study performed at farmers' market the Hawthorne Effect was shown to be minimized when the use of a Smartphone application (PA) was used to observe food employees' food safety practices (20). Observations are recorded on the PA like a person texting on their phone which is an everyday normal activity; instead of using paper and pencil, which can be more obvious that the food employees' are being observed. The PA allows food safety behavior data to be collected without intrusion, which decreases the Hawthorne Effect (20). The food vendors were able to be observed discretely because of the PA (20). An example of what the PA questions looked like is shown in Figure 5 (20). This study did however, experience problems with the Smartphone due to limited internet accessibility at the farmers' market, which caused a delay in the uploading of data and could have caused a gap in observations (20). Research on the use of a Smartphone or Android phone to collect observations of food safety practices in order to decrease the Hawthorne Effect, however is limited. To

date, there is no research on the use of a PA to observe high-risk produce food safety practices of farmers' market food vendors.

Figure 5. Observational Instrument Screenshot, Adapted from *Assessing Food Safety Practices in Farmers' Markets (20)*.



Mystery Shopping

Mystery shopping protocols use direct observations that reduce bias found with traditional interviewing and survey research (72). Mystery shopping measures the process of an observation and not just the outcomes; it is able to show all the different parts and what happens in between an observation from beginning to end without being noticed (72). Direct observation is a way for the observer to take part in real everyday life situations and observe people performing their job or task and it emphasizes the delivery and quality of a service, instead of a survey that gathers opinions (62, 71, 72). This type of observation can be taught to make the mystery

shoppers more methodical observers and be more aware to the multiple pieces of the service experience, so that the normal customers do not notice the researchers (56). Covert direct observations of food handling practices can cause a change in behavior therefore; mystery shopping can provide information on typical practices without changing behaviors by observation.

A study that used concealed direct observations or mystery shopping to observe Spanish-speaking employees at *carnicerias* in Pennsylvania had researchers observe food handlers, but concealed themselves as everyday food shoppers, so that hopefully no changes of normal behavior occurred (62). The two researchers observed ten random *carnicerias* and filled out evaluation sheets together directly after observing the *carnicerias*, in order to understand where the gap in knowledge for the employees was pertaining to food safety (62). Afterwards, multiple objectives and training lessons were developed to teach the employees about food safety in order to decrease the risk of foodborne illnesses from occurring in the workplace (62). Mystery shopping has mostly been used to assess and evaluate the performance of businesses and customer service, and there is limited research on using mystery shopping/direct observations to assess food safety handling practices, especially at farmers' markets (42, 70).

CONCLUSION

As of 2011, foodborne illnesses were estimated to effect one in every six (48 million) Americans each year (5, 7). The CDC collects data on foodborne bacteria, viruses, and microbes/pathogens in order to figure out what causes foodborne illnesses in the US (5, 7). There are 31 pathogens that are known to cause foodborne illnesses

and lead to 128,000 people being hospitalized and 3,000 deaths each year (5, 7). Due to the increases in foodborne illnesses there are increased health care costs as well (63). Foodborne illnesses due to produce, have been increasing as shown from the 17% of foodborne illness outbreaks from produce from 2001 to 2010 (30). Produce consisting of fruits and vegetables are imperative in the daily diet as recommended by the USDA DGA due to the nutritional content and health benefits provided (13). Additionally high-risk produce are seen as better choices and more consumers are starting to buy these fruits and vegetables at farmers' markets (53).

The National Count of Farmers Market Directory Listings shows that farmers' markets have increased from 1,755 farmers' markets in 1994 to 8,144 in 2013 (17, 61). Farmers' markets are a large and popular source where consumers buy their fresh produce, specifically high-risk produce such as leafy green vegetables, tomatoes, apples, berries, and cucumbers (34). Additionally, due to the growth of farmers' markets across the US there are increased challenges in developing best practices and guidelines for food safety issues at farmers' markets.

Farmers' markets are unique in terms of location, infrastructure, and the regulatory challenges these factors present. There is very little data on what food safety practices are being followed and whether there are common high-risk food safety behaviors across vendors that may be putting human health and wellness at risk. Therefore, which food safety practices farmers' market vendors comply and don't comply with need to be assessed. Once handling practices are determined, education materials in the form of outreach workshops, web videos, and written materials can be

disseminated to communicate a menu of best practices that can be instituted at these unique settings that sell high-risk produce.

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APPENDIX B:
EXTENDED METHODOLOGY

Research Design

This was a descriptive study that collected data via direct observations (4, 6, 11, 13, 17) at Rhode Island (RI) farmers' markets during July and August 2013. A mobile Smartphone Application (PA) was used to collect the data by directly observing high-risk produce vendors. The PA was used as a technological data collection instrument instead of using current mystery shopping protocol requiring memory and manual record keeping. This protocol would due to "real time" data recording, better evaluate food safety handling practices of high-risk produce vendors at farmers' markets.

Selection of Farmers' Markets and Vendors

The sample population consisted of RI farmers' market vendors who appeared to be over the age of 18 selling high-risk produce. High-risk produce, as defined by the FDA, are those produce that present a risk of serious adverse health consequences or death that may occur (8). Examples of high-risk produce are berries, leafy green vegetables, tomatoes, cucumbers, melons and fresh herbs (8, 9).

In the summer of 2013, there were 54 RI farmers' markets, 9 were state-run (located at state landmarks or parks), and the rest were privately run. Farmers' markets were selected for observation based on several demographic variables. First, 14 farmers' markets were chosen (7 state and 7 private farmers' markets). A total of 28 vendors were to be observed, the sample size was chosen based on a previous study that observed 18 farmers' market employees and was deemed an acceptable sample

size (4). The farmers' markets were then broken down into whether they were high or low Socioeconomic Economic Status (SES) farmers' markets. For the purposes of this study, SES was determined by acceptance of Electronic Benefit Transfer (EBT) cards (14). The EBT card allows for Supplemental Nutrition Assistance Program (SNAP) benefits which are funded by the United States Department of Agriculture's Food and Nutrition Service (14). There were 22 total farmers' markets that accepted EBT cards (low SES), and 32 that did not (high SES) (1). The farmers' markets were also identified as rural versus urban sites using the RI rural and urban Census Places definitions (2). These definitions delineate several levels of rural and urban populations. A farmers' market was considered rural if the location consisted of a population $\leq 50,000$ people and the farmers' market was considered urban if the population was $> 50,000$ people (2). Within rural there were other size differentiations consisting of $\geq 2,500$ people, $\geq 10,000$ people and $\leq 50,000$ people (2).

Development of Application as Observational Tool for Mystery Shopping

A mobile PA was developed as a data collection tool for the observational study. The protocol for mystery shopping or direct observations normally consists of checklists, inspection forms, or memorizing the food handler's behaviors. Normally, the behaviors are written down on paper and pencil after the observation (5, 6, 15, 16). This can result in the loss of data, due to forgetting what was observed (5, 6, 15, 16). This study was modified from a previous study by Behnke et al (4), using a similar tool of a Smartphone and PA to capture direct observations, however, this current study focused on direct observations of high-risk produce vendor handling practices (4-6, 10, 11). Direct observations allow for the observer to capture behavior directly

rather than relying on self-reporting in which food handlers can overestimate the frequency in which food safety practices are carried out (4-6, 11).

The mobile PA, “Food Safe Surveys” was developed at AHG, Inc (300 D. Pugh. St., State College, PA) through collaboration with the Research Nutrition and Food Sciences Department, URI, the Department of Food Science, The Pennsylvania State University (7). The mobile PA was designed for use on an Android platform (7). Specifically this PA, a two component system consisted of a mobile device application that is networked to a web-based interface. This system allows users to design custom questionnaires, surveys, or checklists via a web based system. The surveys are downloaded to the Food Safe Surveys program on a Smartphone or other mobile device to be used in applications for an easy-to-use interface. The custom made surveys and the data collected are kept secure and password-protected, both on the web and the mobile device interfaces (7).

The PA was used to aid the observer to record actual behavior or handling practices more efficiently without having to try and remember per mystery shopping protocol. The PA was originally developed to allow data entry in the field on a Smartphone and then once all the data was collected it was to be downloaded onto a computer or SD card and data would be imported into Excel. Excel data would be imported to Statistical Package for Social Sciences (SPSS) for analysis. However, initial problems required that the data manually be entered into Excel and then imported into SPSS. This has been fixed and there can be direct download of data from the phone to Excel; see Appendix E for full directions on downloading the PA.

Answers to all questions were made private so access was limited to only password enabled researchers.

Development of Questions into Application

Advisory Committee

An expert advisory committee was solicited from RI Department of Health (RIDOH) and RI Department of Environmental Management (RIDEM) in an effort to answer questions pertaining to licensure and costs for farmers' markets, number of farmers' market certifications, products that can be sold, degree of regulatory oversight and food handling practices and behaviors. The expert advisory group questions were also created to obtain a better understanding of the food safety recommendations within the RI DOH 2007 Food Code and how to apply the recommendations to RI farmers' markets, individual vendors and more specifically, high-risk produce vendors (3). The questions for this interview were adapted from questions, previously developed and reviewed for application regarding critical and emerging food safety issues pertaining to state regulators' oversight of farmers' markets (7, 12). The full list of questions for the expert advisory group is in Appendix C.

Four separate meetings with the expert advisory group members were conducted: 1) Compliance Evaluation/Standardization Officer at RI DOH; 2) Chief of the Office of Food Protection at RI DOH; 3) Deputy Chief of RI DEM; and 4) Chief of RI DEM. Using the answers from the completed expert interviews, areas of shared interest and concern in relation to food safety practices of high-risk produce vendors at state farmers' markets were identified. Questions for the mobile PA reflected both

results of the advisory group interviews and general accepted food safety handling practices.

Application Questions

The 54 survey questions were uploaded to the website Food Safe Surveys (<http://www.ahg.com:8180/PSUFoodSci/html/>). The 54 items were entered in the order they would be answered during a direct observation session and consisted of yes/no, multiple choice, 2-point scales, and free form text entry questions. The two-point scale consisted of 1 = unclean, 2 = clean.

The two-point scale for unclean and clean was used to define the overall cleanliness of the farmers' market, the vendor stand and the individual vendor. The criteria for overall cleanliness of the farmers' market consisted of unclean equals environmental contaminants visible such as animal droppings as well as animals walking around and clean were classified as cut grass or parking lot with no animal droppings and no dirty tents or tables. The criteria for the vendor stand consisted of unclean if dirty tables, containers, or visible brown spots on tablecloths or tents and was classified as clean if the table was clear of dirt and the high-risk produce was presented nicely in containers with no dirty water. Lastly, the criteria for the overall cleanliness of the farmers' market vendor was classified as unclean if the vendor had dirty nails, hair, or clothing contained holes or were dirty and was clean if the clothes were presentable with no dirt or holes visible.

Fifty-four questions were organized into three categories; (see Table 1 below for a sample of questions, see Appendix D for all the questions). The first category of seven questions was farmers' market demographics and could be answered prior to

arriving to the farmers' market based on data found from the RI DEM (<http://www.dem.ri.gov/programs/bnatres/agricult/pdf/rimarkets.pdf>). Information included farmers' market name and three-digit code for a market vendor. Once at the farmers' market, the next category of ten questions was answered pertaining to the overall farmers' market environment. The final category of 37 questions on vendor handling practices and high-risk produce was answered after choosing high-risk produce vendor(s) to observe. Complete observational assessments were made for one-two vendors per market depending on 1) size of market, and 2) produce sold-high risk only. Recorded observations were edited if necessary to make corrections and/or expand on assessments. One or two vendors at each farmers' market were chosen in order to make sure no one was identified. At two farmers' markets, only one vendor could be observed due to the fact that there was only one high-risk produce vendor present.

Table 1: Example of actual questions:

Category One: Farmers' Market Demographics

- Is the farmers' market state run or privately run?
- Are EBT machines available at the market?

Category Two: Overall Farmers' Market Environment

- What is the overall cleanliness of the farmers' market?
- Is there evidence of hand washing facilities for vendors and customers?

Category Three: Vendor Handling Practices and High-Risk Produce

- Is there evidence that the food stand/vendor has GAP certification?
- Is any high-risk produce/other produce being sold precut?, If yes: How is it being stored?

Institutional Review Board Approval

This study utilized direct observation of public behavior. No identifying information about observed individuals or actual vendors' stands was collected. As defined by the Institutional Review Board, this study was minimal risk because the probability of being harmed or having discomfort in the research is not greater than those encountered in normal everyday life or during routine physical or psychological exams or tests. This particular study was minimal risk and classified as exempt because there was no connection between the data collected and any persons or businesses were recorded. The mobile PA was only used for data entry; no video, pictures, or audio were collected using the mobile PA.

Observations of the farmers' market vendors were taken at a distance away from the vendor and there was no intentional direct contact with the subjects being observed. The farmers' market vendor stands had no identifying information used to provide an identification number and no names of farms or vendors were used so there is no link between data and vendors. The goal was to identify overall trends in high-risk produce food safety handling practices and not with particular vendors or employees. The aim of the study was to use the results as guidance for educational programs that target farmers' market managers and vendors to promote best practices

to benefit public health. This study was approved and classified as exempt by the University of Rhode Island’s (URI) Institutional Review Board (IRB) # HU1213-146.

Observation of Vendors

Data was collected between July and August 2013 at 14 RI (7 state and 7 private farmers’ markets). One to two vendors were observed at each farmers’ market for a total of 26 vendors. Each vendor was observed one time for 10-30 minutes, depending on the size of the market in an effort to not be recognized. Observations were conducted during busy times at the farmers’ markets because handling of produce was highest at this time and allowed the observer to be less conspicuous while conducting assessments. Randomly generated code numbers were used for identification for data entry to ensure no connection between vendor and number. Vendor anonymity was maintained throughout the observational study because as stated before the goal of mystery shopping is the fact that vendors are unaware of observations. Observations evaluated the vendors’ food safety practices in relation to high-risk whole fresh produce. An example of a visit to a farmers’ market is shown in Table 2.

Table 2: Example of a Visit to a Farmers’ Market

Example of a Visit to a Farmers’ Market	
Actions	Minutes
Arrival at farmers’ market	0
Observe/Record overall farmers’ market cleanliness into the phone app	5
Find a spot to sit and observe	
Observe 1-2 high-risk produce vendors	10-30 per observation
Answer questions on the phone app pertaining to the observations at each of the 1-2 high-risk produce vendors	
Once all the questions on the phone app for the 1-2 produce vendors are answered then the observation is complete	

Smartphone Application Data Input

Manual import was required due to initial problem with the PA. The intent was that all data could be exported directly onto the computer on a micro SD card or through a USB cable. An updated PA was reinstalled, data was reentered and exported and downloaded onto the computer into Excel.

Data Analysis

Once the observations at the farmers' markets were completed then the question data was manually entered into Excel from the mobile Smartphone. The data collected from the farmers' markets was analyzed with the Statistical Package for the Social Sciences (SPSS) version 22.0 for Windows. Descriptive statistics were assessed. Categorical variables were presented by numbers and percentages and continuous variables were presented as means \pm standard deviations. Chi-square tests or Fisher's Exact test (when the cells have an expected count less than 5) were run to compare 1) type of farmers' market (private and state), 2) SES (low and high), and 3) area (rural and urban) by hand washing facilities and bathrooms available, and overall cleanliness of the market. The p-value for all statistical tests was set at $p < 0.05$.

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APPENDIX C:

EXPERT INTERVIEW QUESTIONS

1. Licensing requirements-defining farmers' markets in Rhode Island

- a. Do farmers' markets have to have a license to operate? Yes____No____
 - i. If no, skip to question 1.b.
 - ii. If yes, as I understand Rhode Island does not have local oversight only state oversight, is this correct? Yes____No____

- b. Are there any costs that farmers' markets need to pay? Yes____No____
 - i. If no skip to question 1.c.
 - ii. If yes, what are the specific costs and to who are they paid?

- c. Are there any costs that individual vendors need to pay to be in a farmers' market? Yes____No____
 - i. If no, skip to question 1.d.
 - ii. If yes, what are the specific costs and to who are they paid?

- d. From the RI DEM website, I calculated a total of 54 farmers' markets in Rhode Island, can you tell me if this is correct or not? Yes____No____
 - i. If no, then how many?
 - ii. If yes, how many are state run and/or privately run in Rhode Island?

- e. In Rhode Island, are there differences between state and privately run market oversight? Yes____No____
 - i. If no, skip to question 1.e.
 - ii. If yes, what does that entail?

- f. In Rhode Island, are there differences between state and private market requirements for entrance for vendors into the market?

g. Do we have a farmers' market certification (or similar) program in Rhode Island? Yes____No____

- i. If no, then skip to question 1.h.
- ii. If yes, then what kind of certification is it?

h. How does a farmer get space allocation to sell food at a farmers' market?

i. Do all farmers' markets operate the same in letting farmers' and/or vendors into the market place? Yes____No____

i. If no, what are some examples of how farmers' sign up for a farmers' market?

ii. If yes, what is an example of how farmers' sign up for a farmers' market?

j. Does Rhode Island allow food vendors, other than produce, at the markets? Yes____No____

- i. If no, then skip to question 2.
- ii. If yes, what are the licensing requirements for food vendors at the markets?

2. Regulatory authority

a. Are farmers' markets regulated in Rhode Island regarding food safety issues? Yes____No____

- i. If no, then skip to question 3.
- ii. If yes, go to question 2.b.

b. Which state agency/agencies are responsible for primary regulation of state farmers' markets? Please specify

c. If regulated, are there regular food safety inspections of the farmers' markets in Rhode Island?

Yes ___ No ___

i. If no, farmers' markets are not regulated; does anybody every go check a farmers' market or what kinds of reasons do you need in order to go check a farmers' market? Then answer question 2. c.b.

ii. If yes, answer question 2.c.a.

a) At what frequency? Is there a pre-determined schedule or is it based on complaints or problems?

b) What do inspectors normally look for when they inspect? Is there a code/regulation/protocol that is followed?

3. Specific requirements/regulations concerning fresh (unprocessed) produce

a. Do farmers in Rhode Island participate in GAP (Good Agricultural Practices Program) and have food safety plans and/or audit?

Yes ___ No ___

i. If no, then go to question 3.c.

ii. If yes, then answer question 3.b.

b. Does Rhode Island require farmers to have GAP programs to participate as vendors at farmers' markets?

Yes ___ No ___

i. If not a state/local requirement, do you know if individual markets have their own requirements related to GAP?

Yes ___ No ___

a) If no, then go to question 3.c.

b) If yes, then answer question 3.b. ii.

ii. If so, do you find these more at state or privately run markets?

c. Do you know if any farmers' markets provide a checklist or guidance to participating farmers or food vendors prior to set-up regarding expected food handling and sanitation/hygiene?

Yes ___ No ___

i. If no, go to question 4.

ii. If yes, do you know if I can access the checklist myself?

Yes ___ No ___

4. Specific requirements/regulations concerning on-site processing and food sampling

a. What, if any, regulations are in place in Rhode Island governing farmers' markets concerning on-site processing?

i. Can vendors cut to order or does everything have to be pre-cut or processed at an approved facility, prepackaged and then brought to the market?

Yes ___ No ___

ii. Other than whole, unprocessed produce, can vendors engage in on-site, minimal processing of foods?

Yes ___ No ___

Yes or no then explanation:

b. What food products and forms are allowed to be sold at farmers' markets that are processed elsewhere and brought to markets by vendors?

i. Minimally processed (cut) produce Yes ___ No ___

ii. Dairy products Yes ___ No ___

1) Cheese Yes ___ No ___

2) Raw milk Yes ___ No ___

iii. Seafood Yes ___ No ___

1) Mollusks – oysters, clams, mussels- shellstock only, shucked, farmed, wild harvest Yes ___ No ___

2) Finfish- whole, headed/gutted, steaks, fillets Yes ___ No ___

iv. Meat/Poultry- whole, pre-cut, refrigerated/frozen Yes ___ No ___

v. Any other foods not stated, if so what are they?

c. What, if any, regulations are in place for on-site food sampling and/or general food serving?

d. Are farmers' market vendors required to wear gloves at all? Yes ___ No ___
i. If yes, in what circumstances?

e. Are there any hand washing stations required at farmers' markets?
Yes ___ No ___

f. Does Rhode Island require temperature control for food that is processed/cut
and considered potentially hazardous?
Yes ___ No ___

- i. If no, skip to question 5.
- ii. If yes, what guidance/regulations do farmers/vendors need to follow?

iii. Can farmers easily find these regulations they need to follow and where
are they located?

5. Have there been complaints, illnesses or other problems related to food safety issues
at farmers' markets in Rhode Island? Yes ___ No ___

- i. If no, skip to question 6.
- ii. If yes, what were some of the complaints or is there a website that
explains this?

6. If you were going to a farmers' market to buy produce, what would you want to
know about the farmers' market/vendor to make sure you are buying food that is safe?

7. Would you personally like to see any changes in the way farmers' markets are
regulated in Rhode Island? Yes ___ No ___

- i. If no, skip to question 8.
- ii. If yes, what would you like to see changed? Why?

8. Would you personally look for any food safety issues at farmers' markets?

Yes____No____

i. If no, then conclude the interview

ii. If yes, then answer question 8.a.

a. What kinds of issues would you look for at farmers' markets, anything specific? (Can help with a lead in question such as: Are there any handwashing issues at farmers' markets? What about glove usage?)

b. Is there an inspection template perhaps for retail that I might be able to use that could be modified to be more appropriate for farmers' market?

Yes____No____

APPENDIX D:

QUESTIONS FOR PHONE APPLICATION

Key: Bolded terms in parenthesis on the left of the question represent in the variable view the id name in SPSS. Questions to the right of the bolded terms in parenthesis represent what is being answered in SPSS. The bolded numbers to the right of the questions represent how the question is being coded in SPSS.

Category One: Farmers' Market Demographics:

Time of market – provide hours

Time of visit – provide time you visited

(Duration): Duration of visit – provide duration in number of minutes

(Type): Is the farmers' market state run or privately run? State (1) Private (2)

(SES): Is the farmers' market in a high SES or low SES? Low SES (1) High SES (2)

(EBT): Are EBT machines available at the market? No (1) Yes (2)

(Area): Is the farmers' market in a rural or urban area? Rural (1) Urban (2)

Category Two: Overall Farmers' Market Environment:

(OverallcleanlinessFM) What is the overall cleanliness of the farmers' market?

1-3 pt Likert Scale: very unclean (1)

neutral (2)

very clean (3)

Recoded this question to just unclean (1) and clean (2), because there was nothing to base neutral off of for the cleanliness of the farmers' market.

(Totalhighriskproducefoodstands) How many high risk produce food stands are there? Enter in number

(HandwashingfacilitiesFM) Is there any evidence of hand washing facilities for vendors and customers? No (1) Yes (2)

If yes, was water available? No (1) Yes (2)

If yes, was soap available? No (1) Yes (2)

If yes, was hand sanitizer available? No (1) Yes (2)

(Bathrooms) Are there any bathrooms available? No (1) Yes (2)

If yes: Is there any water in the bathrooms? No (1) Yes (2)

If yes: Is there any soap in the bathrooms? No (1) Yes (2)

If yes: Is there any hand sanitizer in the bathrooms? No (1) Yes (2)

Category Three: Vendor Handling Practices and High-Risk Produce:

(GAP) Is there evidence that the food stand/vendor has GAP certification?

No (1) Yes (2)

(Language) Is there another language spoken, besides English? No (1) Yes (2)

(Foodsafetyinfo) Does the vendor provide any food safety information to their customers? No (1) Yes (2)

If yes: What information does the vendor provide? COMMENT BOX

(Overallcleanlinessfoodstand) What is the overall cleanliness of the food stand?

1-3 pt Likert Scale: very unclean (1)

neutral (2)

very clean (3)

Recorded this question to just unclean (1) and clean (2), because there was nothing to base neutral off of for the cleanliness of the food stand.

(Overallcleanlinessvendor) What is the overall cleanliness of the vendor?

1 -3 pt Likert Scale: very unclean (1)

neutral (2)

very clean (3)

Recoded this question to just unclean (1) and clean (2), because there was nothing to base neutral off of for the cleanliness of the vendor.

(Highriskproduceprotected) Is the high-risk produce protected?

No (1)

Yes (2)

If yes: How is it protected

COMMENT BOX

If no:

COMMENT BOX

(Highrisksold) What high-risk produce is being sold?

Enter in what is being sold

(Otherproduce) What other produce is being sold at this food stand?

Enter in what is being sold

(Highriskproducesoldprecut) Is any high-risk produce being sold precut?

No (1)

Yes (2)

If yes: Which high-risk produce?

COMMENT BOX

How is it being stored?

COMMENT BOX

(Highriskproducecutonsite) Is any high-risk produce being cut onsite?

No (1)

Yes (2)

If yes: Which ones?

COMMENT BOX

(Otherproducesoldprecut) Is any other produce being sold precut?

No (1)

Yes (2)

If yes: How is it being stored?

COMMENT BOX

(Otherproducecutonsite) Is any other produce being cut onsite? No (1) Yes (2)

(Highriskproducestoredground) Is the high-risk produce stored on the ground?

No (1) Yes (2)

If no: Which high-risk produce is off the ground? COMMENT BOX

(Visiblebruiseshighriskproduce) Are there any visible bruises on the high-risk produce?

No (1) Yes (2)

(Bruised) If yes: Is it

Lightly bruised (1)

Heavily Bruised (2)

If yes: What high-risk produce is bruised?

COMMENT BOX

(Moneytransactions) How many transactions of handling money took place in one observation?

Enter in number

(Gloves) Did the farmers' market vendor wear gloves to handle high-risk produce?

No (1) Yes (2)

If yes: Did the vendor engage in behaviors that could compromise food safety?

No (1) Yes (2)

If yes: What behaviors did the vendor engage in that could compromise food safety?

COMMENT BOX

(Handwashingfacilitiesfoodstand) Is there any evidence of hand washing facilities for the vendor at their stand?

No (1) Yes (2)

If yes, was water available?

No (1) Yes (2)

If yes, was soap available?

No (1) Yes (2)

If yes, was hand sanitizer available?

No (1) Yes (2)

(Vendorwashhands) How many times did the vendor wash their hands?

(Water)With water ENTER #

(Waterandsoap)With water and soap ENTER #

(Handsanitizer)With hand sanitizer ENTER #

(Unsafebehaviors) Did the vendor engage in any other behaviors that could compromise food safety?

COMMENT BOX

Additional Comments:

COMMENT BOX

Criteria for unclean and clean:

- **For overall cleanliness of Farmers' Market:**
 - **unclean:** had environmental contaminants: geese droppings, animals allowed to walk around-dogs;
 - **Clean:** area had cut grass or parking lot was clean with no droppings or animals walking around; all stands in fm looked presentable, no dirty tents or tables.
- **For overall cleanliness of farmers' market vendor stand:**
 - **unclean:** table was dirty, water in some containers was dirty, tent had brown spots on it
 - **Clean:** table was clear and clean-no dirt. Produce presented nicely on table in containers
- **For overall cleanliness of farmers' market vendor:**
 - **unclean:** dirty nails, hair, clothing-had holes
 - **clean:** clean clothes-no dirt or holes, looked presentable

APPENDIX E:

PHONE APPLICATION DIRECTIONS

Inputting questions into Food Safe Surveys website:

- First go to the website: <http://www.ahg.com:8180/PSUFoodSci/html/>
- Put in the log in information: email and password
- Click on new survey
- Enter in the Survey Name and click the private option
- Click the Start Creating Survey button
- Select the Category: You can add your own category name or pick a category that is already available
- Type in the question
- Select the response type: options are: yes/no, multiple choice, scale, and free text
- Once finished creating the question, click the add question button
- Continue adding the categories and questions until complete: once all questions have been inputted, click the finish survey button
- Now the survey is complete and available to see through the phone application (next step is to install the phone application onto the phone)

Installing the phone application onto the phone:

- First step for downloading the phone application to the phone is to go to the Google store (could also be called Play Store) on the phone
- Click and make an account if you don't already have one

- Make a gmail account and password –follow the directions for making your account-security questions, etc
- Log into your gmail account to make sure that it created your email
- Once that works, you can now access the Google store
- Type into the search bar: apps
- Then once you are in the application part type in the search bar: Food Safe Surveys (AHG, Inc.)
- Click on the application and download/install it to the phone
- Once it is installed you can start using the application by clicking on the application's icon

Inputting answers into the phone application:

- Click on the food safe surveys application
- Put in your username and password
- Then click on the start new survey button
- Click the download from server button
- Then click the set of questions (your survey) that you want downloaded to the application and hit download selected
- After downloading from the survey click on the set of questions (your survey) you want to enter answers into
- Next, your survey name will be at the top and a series of blank spaces will be displayed for you to enter location, address, city, state, zip, and notes. Enter in the information that you need and click the next button

- The next screen will be vendor #1: enter in the vendor name and then tap on the first group of questions to start answering.
- Click on the first set of questions and enter in your answers. Press submit when completed.
- Continue to answer each set of questions until all questions are completed for that vendor.
- After collecting data/answering the questions, click the done/prepare for export button at the top of the screen: this will create two excel files (one with the vendor information and the other with the answers)
- Once you have done this you can now download your answers to the computer

Downloading the phone application answers to the computer:

- Look for an icon that says “Files” on your phone and click on it
- Then click on the device storage button
- Next scroll to find your DCIM folder and click on it
- You should see a folder that has all the food safe survey data you exported, click on that button
- Using the USB cable, plug your phone to the computer with the USB cable (this is the cable attached to your phone charger)
- Once the phone is recognized, you will be promoted to install the new hardware/software for the phone. The computer screen will prompt you with instructions.
- Once finished installing, go to the “My computer” on your desktop and open it and then you will see the icon for the phone, click on it open the files

- You should have the food safe survey- and there should be two documents: one will be the data in an excel file you can copy and save on the computer the other will be another excel file with other notes you may have added to each survey, you can copy and save that to the computer as well.
- Once you are finished, copying the folders from the phone to the computer you can disconnect the USB from the computer and phone.