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Identification of Risky Food Safety Practices at Southwest Virginia Farmers' Markets

ABSTRACT

The growing popularity of farmers' markets, coupled with an increased number of produce-related foodborne outbreaks, highlights the need to ensure proper food handler practices by small produce vendors at these markets to protect farmers, patrons and local economies. The absence of proper food safety practices may increase contamination or microbial growth opportunities in the farmers' market sector. The purpose of this study was to identify risky food safety practices by produce vendors at Southwest Virginia farmers' markets, using an observational data collection method. Five farmers' markets were observed for risky food handling practices via a secret shopper method. Vendors and market managers at three of the observed markets received food safety training delivered through cooperative extension. The vendors and market managers in the remaining two markets did not receive any training. Regardless of training, numerous risky food safety behaviors were observed, including temperature abuse, cross-contamination opportunities, and poor personal hygiene and sanitation. There were no differences in the prevalence of risky food safety practices between trained and non-trained vendors and market managers. The results of this study highlight the need for effective and relevant food safety training and/or interventions with small produce vendors, which can result in vendors using safe food handling practices.

INTRODUCTION

According to the United States Department of Agriculture Economic Research Service (USDA ERS), direct-to-consumer marketing of foods increased to $1.2 billion in sales in 2008, compared with $551 million in 1997 *(22)*. Farmers' markets are a growing sector among the direct-to-consumer outlets for foods. The number of farmers' markets in the U.S. has increased significantly over the past decade, from 3,706 in 2004 to 8,268 in 2014 *(40)*. The increased number of farmers' markets and popularity of buying local

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foods result from consumers' demand for the services and products that farmers' markets provide *(1)*.

Farmers' markets offer a unique opportunity for growers to sell agricultural products directly to the consumer, often with higher profit margins than possible otherwise *(13)*. However, these products are not without risk of being contaminated with foodborne pathogens. A foodborne illness outbreak could have substantial monetary implications that could quickly bankrupt a vendor. A review of 511 foodborne illness jury trials between 1979 and 2014 showed that plaintiffs won 34.8% of cases and received an average award of $276,148 *(20)*.

Of the commodities sold at the markets, fresh produce constitutes 82% of the total foods for sale *(1)*. Produce accounted for 46% of the 4,589 foodborne illness outbreaks linked to a specific commodity between 1998 and 2008 *(7, 26)*. More illnesses were attributed to leafy greens than to any other commodity, with more than two million illnesses between 1998 and 2008 *(26)*. The growing number of produce-related foodborne outbreaks, coupled with the growing number of farmers' markets selling fresh produce, highlights the need for a food safety focus within these markets to protect farmers, patrons and local economies *(25)*.

There is a perception within the local food movement that locally grown produce is safer and carries less risk than products grown elsewhere, since these products do not travel long distances or come from a large industrial-sized farm *(28, 33)*. However, regardless of scale, fresh produce hazards and risks are similar. Foodborne illness outbreaks have been linked to traditional local food systems, including roadside stands and farmers' markets *(8, 11, 16, 24)*.

Many risk factors may increase the likelihood of contamination at a farmers' market. Produce sold in outdoor markets can be handled and stored with little control over sanitation, worker hygiene and temperature control, compared to these factors in supermarkets *(33, 41)*. Additionally, many markets sell cut produce; cutting produce increases the risk of contamination by creating wounds that allow harmful bacteria to enter internal tissues and grow *(35)*. If these products are not held at refrigeration temperatures, pathogens can multiply rapidly. Some farmers' markets create their own market bylaws, which may or may not address food safety and which vary among markets. The lack of food safety rules and formal food safety training of farmers' market vendors and market managers warrants investigation to identify risky food safety behaviors practiced at farmers' markets *(31)*. The secret shopper protocol used in this study is a form of concealed direct observation, which can be used to observe vendors and market managers without their knowledge. Utilizing this method can help reduce bias and artificial behavior change that can be caused by awareness of being observed (the Hawthorne effect), allowing more accurate observational behavioral data to be gathered *(3, 9, 14, 17)*. Concealed direct observations provide an accurate account of food safety behaviors practiced in a given time period by allowing researchers to capture behaviors directly rather than relying on self-reporting, in which, food handlers often overestimate the frequency of proper food safety practices *(3, 9, 10, 17)*.

The purpose of this study was to identify risky food safety behaviors practiced at Southwest Virginia farmers' markets through the use of a secret shopper protocol and determine if there is a difference between those vendors and market managers who have previously received food safety training and those who have not.

MATERIALS AND METHODS

Farmers' market site and vendor selection

A total of five farmers' markets were observed in this study. A convenience sample was used to select the farmers' markets because of the proximity of the markets and budget restraints. A convenience sample is a non-probability sampling technique in which subjects are selected because of their convenient accessibility and location (Marshall, 1996). The USDA definition of a farmers' market was used to identify a farmers' market unit: a multi-stall market at which farmer-producers sell agricultural products directly to the general public at a central or fixed location *(39)*. Each vendor selling raw produce was observed.

Food safety training

Vendors and market managers from three of the five markets received food safety training; vendors and market managers from the remaining two markets did not. The training delivered was developed to specifically address the food safety education needs of small growers selling in farmers' markets. This two-hour food safety training, delivered through local cooperative extension agents, was adapted to the specific audience and included Good Agricultural Practices (GAPs) principles (water use, manure use, personal hygiene and sanitation, animal exclusion) for use on the farm as well as stressing the importance of food handler principles, including temperature control and sanitation during storage, transport and handling of food at the market. Key concepts such as temperature control of cut produce items, sanitation and proper food sampling were covered in the training. Although the food safety training curriculum addressed GAPs, adherence to those principles were not part of this study; rather, only food handler practices at the market level were observed.

Development of observational instrument

The observational instrument used to identify risky food safety behaviors was modified from Smathers and colleagues, who used the instrument for similar purposes in North Carolina *(32)*. An advisory committee with multiple food safety experts from Virginia Tech and North Carolina State University helped to define specific risky food safety behaviors targeted for observation. The instrument was designed to focus on behaviors and infrastructure

impacting three of the five U.S. Centers for Disease Control & Prevention (CDC)-identified common risk factors for foodborne illness: (1) temperature abuse, (2) lack of hygiene and sanitation by food handlers and (3) cross-contamination *(2)*. The observational instrument addressed sixteen risky food safety behaviors associated with food handling In addition to observation of food handling practices, markets were also observed for overall infrastructure that may contribute to risk, including the absence of a protective covering or tent, the presence of animals/pets, lack of access to electricity, lack of availability of trash receptacles, and the lack of availability of public handwashing stations with free-flowing water and soap *(Table 1)*.

Observational instrument

The observational criteria were designed so that observations of the pre-determined risk factors could be recorded via a smartphone. The use of a smartphone application allowed for concealed data collection and reduction of the Hawthorne effect *(3)*. The observational instrument was configured in the Qualtrics (Provo, UT; http://www.qualtrics.com/) smartphone application which was loaded onto an Android platform. The presence of each behavior or contributing infrastructure could be recorded using a multiple choice answer (yes, no, N/A) or an open-ended answer (text entry). Utilizing Qualtrics software permitted data collection with use of any smartphone.

TABLE 1. Observational instrument used to identify risky food safety behaviors practiced by markets and their produce vendors

Observational Criteria
Sale of Pre-cut Produce
Use of Temperature Control for Pre-cut Produce
Use of Thermometer to Measure Temperature of Pre-cut Produce
Temperature Recording of Pre-cut Produce
Temperature-sensitive Samples Offered
Use of Temperature Control for Temperature-sensitive Samples
Use of Thermometer to Measure Temperature of Temperature-sensitive Samples
Temperature Recording of Temperature-sensitive Samples
Access to Electricity*
Handling Money and Produce without Proper Handwashing
Glove Use
Proper Glove Use
Product Storage on Ground
Can the Table be Easily Cleaned
Can Produce Bins be Easily Cleaned
Use of a Protective Covering
Are Animals Allowed in the Market*
Are Trash Receptacles Available*
Presence of Hand Sanitizer
Availability of a Handwashing Station at Vendor Site
Proper Handwashing
Availability of Handwashing Station in Another Location at the Market*

*Indicates an observation of the entire market infrastructure, not specific vendor.

Data collection

Observations of farmers' markets were performed between May and October 2014. Of the three markets where vendors and market managers had received training, two were visited three times and one was visited four times. Of the two markets where vendors had received no food safety training, one market was visited four times and the other visited two times. Each produce vendor was observed for an average of 15 minutes per observation, with a range of one to six observations per vendor. Observations were recorded instantly with the smartphone app. Vendor and market anonymity was maintained via coding of data to prevent any connection of data to vendor or market. Observational data collection was approved by the Institutional Review Board of Virginia Tech (IRB 13-562).

Data analysis

Data analysis was performed using the JMP Pro version 10.0.2 for Windows (Cary, NC; http://www.jmp.com/en_us/software/jmp-pro.html). Statistical analysis and significance testing were assessed using chi-square tests or Fisher's Exact Test to compare risky food handling practices observed at farmers' markets where vendors had received food safety training with practices observed where there had been no such formal training. Fisher's Exact Test was utilized for sample sizes less than five, as the chi-square test is less reliable for sample sizes smaller than five. Fisher's Exact Test was utilized to compare statistics associated with offering samples. P value ≤ 0.05 was considered significant.

RESULTS

Farmers' market demographics

Forty-two produce vendors were observed across five Southwest Virginia farmers' markets. Vendors and market managers who had previously received food safety training delivered through Virginia Cooperative Extension (VCE; n = 32) were observed at three markets, and vendors and market managers who did not receive any training and have no current relationship with VCE (n = 10 vendors) were observed at two markets. All vendors observed sold one or more of the following produce commodities: berries (blackberries, blueberries, strawberries), cucumbers, herbs (basil, cilantro, parsley, sage, thyme), cut and whole leafy greens (cabbage, chard, kale, lettuce mixes), green onions, peppers (banana, green, jalapeño, serrano, yellow), tomatoes, yellow squash, and zucchini.

Observed foodborne illness risk factors associated with temperature abuse

The foodborne illness risk factors observed that were associated with food handling at the market are shown in *Tables 2 and 3*. Of the 32 trained and ten non-trained vendors, 17 (53.1%) and five (50%) sold pre-cut produce, respectively. Of those, five (29.4%) and two (40%) used some form of temperature control. Methods of temperature control included bags of ice placed at the bottom of produce containers and produce immersion in a pool of ice water to keep the pre-cut leafy greens at a low temperature. No vendors were observed using a thermometer to monitor and record temperatures. Vendors offering samples were also observed practicing risky food safety behaviors. Of the 32 total trained vendors, four (12.5%) offered samples. Three out of the four offered samples requiring temperature control for safety, including cut tomatoes and mushrooms, and two of the three vendors (66.7%) used bags of ice to lower the temperature of the environment surrounding the samples. However, there was no thermometer use to monitor the temperature of samples offered and no temperature recording. None of the non-trained vendors were observed offering any samples.

Observed foodborne illness risk factors associated with cross-contamination

Eight (25.0%) of the trained and one (10.0%) of the non-trained vendors had designated employees to handle monetary transactions and separate employees to handle food sales, to prevent cross-contamination.

Most vendors (71.9 and 90.0% trained and non-trained, respectively) kept produce stored on display tables at least three feet off the ground, and nine (28.1%) trained vendors and one (10.0%) non-trained vendor stored produce at ground level in open cardboard boxes. Twelve (37.5%) trained and four (40.0%) non-trained vendors were observed displaying food on a table that was made of porous material, such as wood, and could not be easily cleaned. Similarly, 15 (46.9%) trained and four (40.0%) non-trained vendors were observed using produce bins that could not be easily cleaned, such as wooden baskets and cardboard boxes.

Observed foodborne illness risk factors associated with poor personal hygiene

None of the vendors (n = 42) had a handwashing station at their site, were observed using gloves, or had hand sanitizer present at their stall.

Chi square and Fisher's Exact Tests revealed no significant differences in the number of food safety risky behaviors observed between market managers and vendors who had food safety training versus those who had not.

Food safety risk at the market level

The food safety risk factors observed at the market level is shown in *Table 3*. While all vendors had protective covering, two (66.7%) and one (50.0%) of trained and non-trained markets, respectively, provided permanent covering for vendors. Vendors who were not provided with permanent covering brought temporary covering of their own in the form of a portable tent. All three of the markets with training (100.0%) and one (50.0%) of the markets without

TABLE 2. Percentage of observed risky food safety behaviors associated with food handling from food safety trained and non-trained vendors

	Percentage of Non-trained Vendors n = 10	Percentage of Trained Vendors n = 10	Chi-square or Fisher's Exact Test Comparison[a]
Sale of Pre-cut Produce	53.1	50	0.8629
Use of Temperature Control for Pre-cut Produce[b]	29.4	40	0.6593
Use of Thermometer to Measure Temperature of Pre-cut Produce[b]	0	0	X
Temperature Recording of Pre-cut Produce[b]	0	0	X
Offering of Temperature-sensitive Samples	12.5	0	X
Use of Temperature Control for Temperature-sensitive Samples[c]	66.7	N/A	X
Use of Thermometer to Measure Temperature-sensitive Samples[c]	0	N/A	X
Temperature Recording of Temperature-sensitive Samples[c]	0	N/A	X
Handling Money and Produce without Proper Handwashing	75	90	0.2828
Proper Glove Use	0	0	X
Product Storage on Ground	28.1	10	0.2088
Table Can be Easily Cleaned	62.5	60	0.8872
Produce Bins Can be Easily Cleaned	53.1	60	0.7021
Use of a Protective Covering	100	100	X
Presence of Hand Sanitizer	0	0	X
Availability of a Handwashing Station[d]	0	0	X

[a]For all statistical comparisons, a = 0.05. A chi-square test was used for all comparisons unless n < 5; then Fisher's Exact Test was used.
[b]Percentage calculated from market vendors that sold pre-cut produce.
[c]Percentage calculated from market vendors that sold temperature-sensitive samples.
[d]These results reflect the presence of a handwashing station at an individual vendor's site, not the market as a whole.

TABLE 3. Observed factors that contribute to overall farmers' market food safety risk in markets with trained vs. non-trained vendors and managers

Observational Criteria	Percentage of Markets with Trained Vendors[a]	Percentage of Markets with Non-trained Vendors[b]
Access to Electricity	33.3	0
Animals Allowed in the Market	100	50
Availability of Trash Receptacles	33.3	50
Availability of Proper Handwashing Stations	66.7[c]	50.0

[a]n = 3
[b]n = 2
[c]One of the markets had a handwashing station open to the public that was adjacent to the market, not within the market.

training allowed pets at the market, and both vendors and patrons were observed with pets. Only one (33.3%) of the markets with training had access to electricity, which allowed vendors to utilize a miniature refrigerator for storage of temperature-sensitive products such as milk. One (33.3%) of the markets with training and one (50.0%) without training had trash receptacles present for vendors and patrons to use for trash disposal, and this lack could potentially serve as a contamination source.

One (33.3%) market with (n = 3) and one (50.0%) without training provided a proper handwashing station that included running water, soap and paper towels. The handwashing station at the market with training was located in a bathroom facility on the outer perimeter of the markets. The handwashing station at the other market was a stand-alone station located outside a portable bathroom facility. Additionally, another market whose vendors had received training had a public handwashing facility (not associated with the market) across the street from the market.

DISCUSSION

Foodborne illness risk factors associated with temperature abuse

Temperature abuse can allow harmful bacteria to proliferate, contributing to foodborne illness *(4)*. In this study, temperature abuse was observed in the case of 68.2% of vendors whose cut produce was not kept in a temperature-controlled environment. The FDA food code identifies cut leafy greens, cut melons and cut tomatoes as needing temperature control, because these foods are capable of supporting the growth of various infectious microorganisms or toxins *(12)*. Previous studies have highlighted the effects of temperature abuse, reporting a 2.0 log CFU/g increase in *E. coli* O157:H7 populations on lettuce held at 12°C for 3 days *(18)*. It has also been proven that the growth of *E. coli* O157:H7 can outpace that of spoilage bacteria and the appearance of quality deterioration, resulting in unsafe product without visual signs of its being unsafe *(19)*.

Similarly, temperature abuse of cheese products has been reported at farmers' markets, where 47% of the observed vendors did not have adequate refrigeration, resulting in cheese storage at temperatures exceeding 41°F *(36)*. Temperature abuse has also been observed in farmers' markets in British Columbia when vendors of products including eggs, frozen fish and baked goods with whipped cream topping did not use adequate refrigeration *(23)*.

Foodborne illness risk factors associated with poor personal hygiene

Proper handwashing practices can reduce the risk of foodborne illness and other infections *(15)*. While two markets observed in this study provided a public handwashing facility with soap and running water within the market for vendors and patrons, none of the vendors were observed practicing proper handwashing during the observational period. Multiple studies have reported poor food handler hygiene practices associated with an overall lack of handwashing facilities at the markets *(3, 23)*. The results of these studies highlight the lack of infrastructure at farmers' markets, creating an environment with inadequate access to tools needed for practicing proper hygiene and sanitation.

Foodborne illness risk factors associated with cross-contamination

Paper money has the potential to be contaminated with bacteria. Heterotrophic aerobic bacteria (98.4%), coliforms (87.3%), and staphyloccoci (79.4%) have been isolated from paper and polymer currency *(29)*. McIntyre and colleagues reported that 90.9% of observed vendors handled money and food without practicing proper handwashing *(23)*. Another study observing 18 farmers' market vendors found that touching money and then food without proper hand-washing was the most common unsanitary practice *(3)*. While the improper use of gloves can be a source of contamination for food handlers, proper glove use can substantially reduce opportunities for food contamination *(38)*; it may reduce cross-contamination opportunities that come from handling money and food. None of the vendors in this study were observed using gloves properly, which may contribute to an increased risk of contamination.

Similarly, while proper handwashing with soap and running water is the most effective method of removing potentially harmful bacteria from hands, hand sanitizer solutions offer an alternative option when handwashing stations are not available, such as at a farmers' market *(37)*. Although both proper glove use and the use of hand sanitizer solutions can reduce bacterial populations when done properly, none of the vendors or market managers observed in this study used gloves or hand sanitizer.

Food safety training

Market managers and vendors in three of the five farmers' markets observed in this study had previously received food safety training. However, no significant differences were observed between practices of market managers and vendors who had training and practices of those who had not. These results illustrate that food safety education and training are not necessarily correlated with behavior change.

A study conducted by Park et al., *(27)* evaluated a food safety training method for food handlers in restaurant operations. In this study, employees were given a questionnaire covering food safety knowledge, and an on-site observational inspection was performed before and after the training. Food safety knowledge showed a significant improvement after the training; however, food safety practices and sanitation performance remained unchanged. Another kind of food

safety training utilizing both theoretical and practical (hands-on) approaches was evaluated on the basis of microbiological counts of food contact surfaces, food tools, food equipment surfaces and hands in canteens and cafes of a university campus. It was found that microbial counts were significantly decreased after training had been implemented. The researchers associated the success of the food safety training to the use of combined theoretical and practical (hands-on) training *(34)*. However it is important to note that this study was conducted in a setting more controlled than that of an outdoor market.

Furthermore, Chapman and colleagues *(6)* utilized food safety infosheets as a communication tool to influence proper food safety behaviors. It was found through video observation that food handlers in eight food service operations demonstrated a significant increase in mean handwashing attempts, and a significant reduction in indirect cross-contamination events. Previous research indicates that the most influential food safety training programs utilize theoretical, practical (hands-on), and infosheets as teaching tools to influence positive behavior change *(34)*. The finding of no significant differences in food safety behaviors observed in the present study between market managers and vendors who had food safety training and those who did not, highlights the need for development of training more specific for market vendors that utilizes a diverse range of training tools.

CONCLUSIONS/RECOMMENDATIONS

Regardless of training, numerous risky food safety behaviors were observed. Vendors were observed lacking temperature control of pre-cut produce, creating opportunities for cross-contamination, and demonstrating a lack of proper hygiene and sanitation practices. These findings are not uncommon in other observational studies of food safety practices at farmers' markets and other food service venues. The lack of facilities and infrastructure at farmers' markets, compared with retail grocery stores, creates opportunities for preventable hygiene and food contamination concerns *(3, 9, 15, 17, 23, 30, 36)*.

The results of this study highlight the need for effective food safety interventions at farmers' markets, farmers' market facility and infrastructure development to improve food safety behaviors, and food safety training that utilizes various training tools to positively influence food safety behavior. Farmers' markets may also benefit from creating a food safety plan for their market that addresses the risk factors observed in this study.

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