ARTICLES

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Assessing Food Safety Practices in Farmers' Markets

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ABSTRACT

Temporary foodservice establishments such as farmers' markets are increasing in popularity. However, rules governing the vendors at establishments tend to be inconsistent compared with rules that apply to permanent establishments. For example, some vendors are exempt from formal health department supervision, while others may sell food prepared in uninspected home facilities. This preliminary study employed a novel technology-oriented approach to assess key farmers' market food safety practices, such as hand washing and glove usage. Employee behaviors were observed and coded in accordance with Indiana State Department of Health criteria.

Using Smartphone technology, direct observations on eighteen employees in Indiana farmers' markets were conducted, yielding 900 sequential food handling transactions. Results revealed that food safety behaviors were infrequently practiced, suggesting an increased risk of foodborne illnesses. MANOVA results showed that employees engaging in multiple simultaneous work roles demonstrated an increase in potential violations; however, simply increasing the number of employees working a booth does not ensure adequate work role segregation. The results signify the importance of having clearly divided employee work roles, a practice that contributes to better food safety behaviors at farmers' markets.

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INTRODUCTION

Temporary foodservice establishments (TFE) are defined as "retail food establishments that operate for a period of no more than fourteen consecutive days in conjunction with a single event or celebration with the approval of the organizers of the event or celebration" *(17)*. Under this definition, fairs, farmers' markets, and roadside food stands all qualify as temporary foodservice establishments. Farmers' markets have experienced massive expansion in terms of magnitude and sales revenue, growing from a reported 1,755 markets (1994) to 5,274 (2009), an average growth rate of 8.6 percent every year *(26)*. More recently, there were 81 farmers' markets located in Indiana *(26)*. According to the National Farmers' Market Manager Survey (2005), total revenues across the United States were estimated to exceed $1 billion, with markets averaging 959 customers per week and average annual sales of $242,581 *(26)*. Considering the increasing popularity and significant economic impact of farmers' markets, research focusing on farmers' markets is warranted.

Farmers' markets face issues similar to those inherent to other temporary foodservice establishments. They serve food to many people; however, regulations governing them are often vague and less stringent than those for permanent facilities. For example, retailers cat-

egorized as "Home-based Vendors" under Indiana Code are exempt from many food establishment regulations *(22)*. Additionally, Indiana Code 16-42-5-29 provides exemption from food establishment requirements for individual vendors at farmers' markets. The code does permit inspection by the state health department if products are misbranded or adulterated, or if a consumer complaint has been received *(17)*; however, because of the short-term operational nature of temporary foodservice operations, investigation of complaints may occur well after the conclusion of retail sales, making the investigation pointless.

Farmers' market vendors often sell their products outdoors, exposed to environmental contaminants such as dirt, insects, and pollution, and the markets are often located in sites that have little access to potable water for hand or product washing, or to electricity for refrigeration *(30)*. Additionally, most farmers' markets are seasonal, usually from spring through early fall, when their products are likely to be exposed to unsafe holding temperatures. Employees working under these circumstances contend with potential cross contamination from sources such as other food products; improperly cleaned storage, serving, or preparation equipment; and improperly used cleaning agents, sanitizers or other chemicals. Given these conditions, there exists significant potential for foodborne illness due to cross-contamination, improper food holding, or environmental exposure. These unique challenges associated with farmers' markets and similar temporary foodservice establishments potentially compromise public safety. It is in the public interest to examine these issues and offer guidance to the operators of these markets, emphasizing the importance of following appropriate food handling practices.

The increasing popularity of farmers' markets, coupled with inadequate oversight, can contribute to incidents of foodborne illnesses due to lack of training and hand washing compliance. The Centers for Disease Control and Prevention (CDC) identified 95 foodborne illness outbreaks potentially associated with fairs, festivals, and temporary mobile services from 1988 to 2007, which resulted in almost 4,000 illnesses with 144 hospitalizations *(5)*. The majority of these outbreaks were linked, either suspected or confirmed, to bacteria or viruses, such as Norovirus, *Salmonella*, and *Staphylococcus*, which are generally controllable with proper hand washing *(5)*. A recent study of 321 restaurants in the states of Colorado, Connecticut, Georgia, Minnesota, Oregon, and Tennessee found that workers used soap only 28% of the time during required hand washing activities and washed their hands appropriately after handling raw animal products only 23% of the time *(12)*. The authors concluded that workers either did not know when to wash their hands or occasionally chose not to wash their hands, both of which placed the dining public at risk.

More recently, a study examining the effect of formal training on influencing attitudes and behaviors of foodservice employees in permanent establishments found that having sinks available and located in convenient locations were the top two items that could facilitate hand washing, and that having managers monitor employees' behaviors would encourage proper food handling *(3)*. However, in the case of farmers' markets, although a hand washing station of sorts may be in place, it likely does not have hot water and is generally positioned secondary to operational needs within limited confines. Managerial monitoring implies trained and incentivized oversight, but, in the case of farmers' markets, the manager is often also the cashier, cook, and server – sometimes simultaneously – and, as already noted, may not possess formal food safety training, since it is not always a code requirement.

Research supports the contention that food safety knowledge is lacking in vendors. At a large regional festival in Indiana, average inspection scores ranged from 62% in 2006 to 73% in 2008, both of which fell below the 75% passing threshold for health inspections in Indiana. This study also found that 37% of vendors in 2006 and 52% of vendors in 2008 had no prior foodservice work experience, and that many of the employees were untrained volunteers assisting not-for-profit organizations *(21)*. Additionally, Worsfold et al. *(30)* found that almost 25% of surveyed farmers' market vendors in the U.K. were unable to correctly assess the risk associated with their wares and that 84% disagreed with the idea that their products could cause food poisoning. Lastly, Guzewich and Ross's *(14)* review of the literature on the topic of foodborne illnesses found that 82% (n = 66) of the reported outbreaks implicated food workers as the source of infection and that "the majority of the outbreaks associated with food workers involved transmission of the pathogen by the food worker's hands" *(14)*.

Over the decades, foodborne illness outbreaks have cost the U.S. society between $2.9 and $6.7 billion annually *(4)*. In 2007, the CDC reported that a total of 1,097 foodborne illness outbreaks occurred, resulting in 21,244 illnesses and 18 deaths *(2)*. Of these outbreaks, 297 involved diseases that are, for the most part, preventable with appropriate food handling behaviors, such as hand washing. Regarding food safety practices associated with food-away-from-home, Howes et al. *(16)* reported that improper food handling accounted for 97% of foodborne illness outbreaks in foodservice establishments. Collins *(7)* noted that 80% of foodborne illness outbreaks were associated with food away from home. More recently, 45% of outbreaks in the U.S. and 54% of outbreaks in the U.K. were associated with restaurants and hotels *(24)*.

Since half of every dollar spent on food consumption in the United States is spent on food consumed at restaurants *(1)*, the examination of food safety issues in foodservice establishments is justified. The FDA *(9)* recommends that foodservice employees should use barriers when working with ready-to-eat (RTE) foods. RTE food is defined as food that is safe to eat without further cooking; therefore, RTE foods that are prepared or produced on premise in temporary foodservice establishments for immediate sale and consumption should be handled with some form of barrier, such as gloves, paper, or utensils. Given the results of an observational study conducted by FDA *(9)* that 57% of restaurants failed to prevent bare-hand contact with RTE foods, it is appropriate to examine the food safety practices of vendors who produce RTE foods onsite in temporary foodservice establishment venues, such as farm-

TABLE 1. Rubric for assessing hand washing requirements in RTE food vendors from Indiana food code

Food-related Behaviors[a] That Require Hand Washing
Before/After touching or handling raw proteins with bare hands
After touching or handling raw proteins with bare hands
Before putting on gloves for food preparation
Unsanitary Object-related Behaviors That Require Hand Washing
Touch or handle personal belongings with bare or gloved[b] hands
Touch or handle clothing with bare or gloved hands (clothing not related to food preparation, i.e., aprons)
Touch or handle money with bare or gloved hands
Touch or handle street/ground with bare or gloved hands
Touch or handle animal with bare or gloved hands
Equipment-related Behaviors That Require Hand Washing
Touch or handle waste container/garbage with bare or gloved hands
Touch or handle vehicle with bare or gloved hands
Employee-related Behaviors That Require Hand Washing
Touch or handle body parts (other than clean hands and clean portions of exposed arms) with bare or gloved hands
Eating/Drinking/Smoking
Coughing/Sneezing/Spitting
After using the restroom

Note.

[a]There are other behaviors that require hand washing, such as touching/handling contaminated utensils; however, given the discrete nature of the observations and the distance at which the observations occurred, it was not possible to assess these behaviors with reliability.

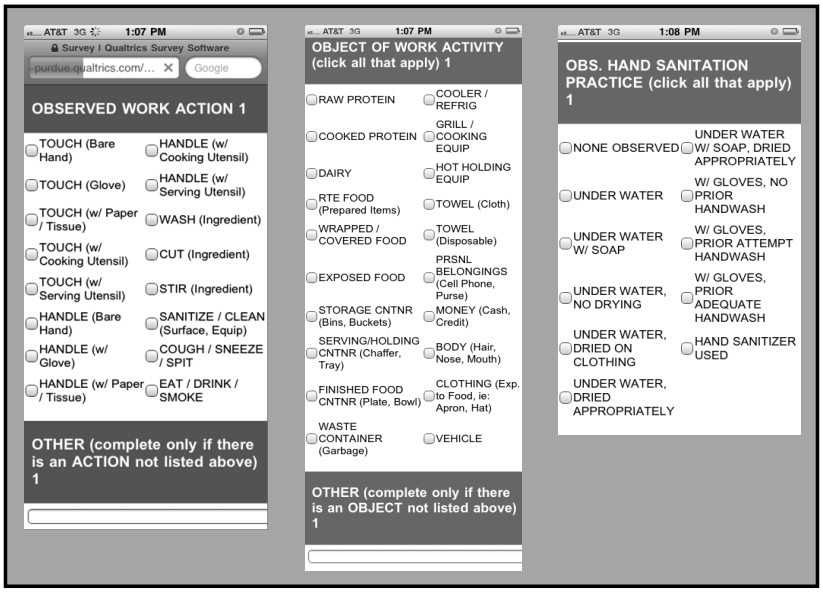
[b]Having gloved hands is not itself a requirement for hand washing; however, once the gloves have been contaminated, they should be discarded and replaced, with hands washed in between.

ers' markets. Therefore, given the unique circumstances associated with farmers' markets and the importance of proper hand washing, hand washing behavior was identified as a key food safety practice for this study.

Many studies and methods have been utilized to examine the question of food safety in permanent establishments. In particular, Clayton and Griffith *(6)* utilized a notational analysis approach to assess food safety practices. They found that notational analysis had several advantages over traditional checklists, for example, reduction of the amount of observer interpretation. Previously used methods such as self-reporting, risk assessment, traditional checklists, and inspections may have provided limited information in regard to operational food safety practice*s (11, 15, 20, 23, 25)*. The use of notational codes allowed a detailed recording of employees' behaviors and the specific sequence of actions, allowing researchers to identify those points in the food preparation process where hand washing activities should have occurred *(6)*.

Direct observation has proven effective in assessing hand washing behaviors. Although written for the healthcare field, the Consensus Measurement in Hand Hygiene (*8)* project identified the direct observation of hand washing behavior as the "gold standard" of measurement methods. The report noted that observation enables researchers to examine the type of hand hygiene products used, the thoroughness of cleaning, and the use of gloves. Even though the project aims to enhance the hand hygiene practices of healthcare workers, the methods used offer useful evidence on effective assessment of hand hygiene practices in general and provide clear guidelines that are transferable to the foodservice industry. Moreover, observational methods have been used in previous food safety studies as an effective tool that accurately captures food handling behaviors *(13, 18, 27)*. Redmond and Griffith *(28)* reviewed food safety studies using various research methods and noted that observational methods offer the most reliable data on

FIGURE 1. Observational instrument screenshot



food safety behaviors compared to other methods, such surveys, interviews, and focus groups.

The authors of the Consensus Measurement in Hand Hygiene concluded that the biggest limitation of direct observation is the "Hawthorne Effect" *(8)*: when people notice that they are being observed, they may change or modify their behaviors. Similarly, in Clayton and Griffith's study *(6)*, the "Hawthorne Effect" was identified as a limitation of the notational observation approach; even though the authors excluded actions recorded in the first thirty minutes of observation from the analysis, to allow the workers to become accustomed to the researcher's presence, the Hawthorne Effect was still considered a limitation. Another observational study on food workers' hand washing practices attempted to reduce the Hawthorne Effect by not revealing exactly which behaviors were being recorded and by discarding the first fifteen minutes of observations to allow workers to become acclimated to the presence of the researcher *(12)*; however, these efforts were not enough to eliminate the influence of the researcher's presence. Therefore, with observational studies, efforts to minimize the Hawthorne Effect must be considered.

The identification of problematic food handling behaviors can lead to the development of appropriate educational interventions. Concurrently, the application of direct observational techniques permits the study of these food handling behaviors, specifically, hand washing. Thus, this study focused on the assessment of key food safety practices, specifically, behaviors related to food handling, such as hand washing, in temporary foodservice establishments that produce food on-site for immediate consumption.

MATERIALS AND METHODS

This study used observational techniques in combination with a previously developed observational instrument *(29)* at farmers' markets. The following research questions guided this study:

(1) Does the frequency of employee hand washing behaviors at farmers' markets differ significantly ($P < 0.05$) from Indiana State Department of Health criteria?

(2) Is there a significant relationship ($P < 0.05$) between the frequency of hand washing compliance and employee gender?

(3) Is there a significant relationship ($P < 0.05$) between the frequency of hand washing compliance and employee characteristics?

Two studies were foundational for the development of the observational instrument applied in this study *(6, 12)*. Clayton and Griffith's *(6)* instrument used handwritten notational coding to track food safety actions in restaurants and catering operations and was the basis for the instrument later used in the Green et al. *(12)* study. Since both studies shared the limitation of the Hawthorne Effect, the goal of this study was to collect data via observation, with minimal detection by the subjects. The focus was safe food handling, specifically the hand washing behaviors of vendors at local farmers' markets in Indiana. The study was approved for Institutional Review Board research exemption because of the public nature of the venue and the fact that there would be no intentional direct contact with the subjects. Vendors who sold ready-to-eat hot or on-site prepared foods appeared to represent the greatest potential for food safety violations and therefore became the sample population.

The instrument used to record the observations, which was developed in accordance with the recommendations of the Consensus Measurement in Hand Hygiene *(8)* project was modified with permission, from the original instrument used by Clayton and Griffith *(6)* in order to account for the unique operational issues associated with temporary foodservice establishments. Additionally, this instrument used a technology-based approach in that it captures the observer's notations through the use of Qualtrics Survey Software hosted on an internet-accessible server and formatted for use with iPhones.

The instrument was designed to capture fifty separate observations and to allow for frequent data uploads throughout the process. Each observation consisted of a series of sequential actions that were considered a "transaction." For example, the first transaction was indicative of an action, such as "handle," "touch," or "eat/drink." Next, observers would identify the object of the prior action, such as "RTE Food," "Waste Container," or "Cooking Utensil," as well as specific qualifying details, such as "Wrapped" or "Exposed." Last, the instrument provided an opportunity to record specific hand sanitation practices, such as "Washing Hands Under Water With Soap," "With Gloves, Prior Attempted Hand Wash," or "No Hand Washing Behavior Observed." Eventually, a total of fifty

TABLE 2. MANOVA results of effect of position and number of employees on food safety behaviors requiring hand washing

Source	Dependent Variable	F	*P*-value
Position	Food-related behavior[a]	5.934	.041*
(Single/ Multiple)	Unsanitary object behavior	7.866	.023*
	Equipment-related behavior	.000	1.000
	Employee-related behavior	.848	.384
Number of Employees	Food-related behavior	6.784	.014*
(1, 2, 3, and 4 or more)	Unsanitary object behavior	1.351	.325
	Equipment-related behavior	.252	.858
	Employee-related behavior	2.231	.162
Position * Number	Food-related behavior	.001	.976
of Employees	Unsanitary object behavior	3.936	.083
	Equipment-related behavior	.623	.453
	Employee-related behavior	4.487	.067

Note. $R^2 = .880$ (Adjusted $R^2 = .744$)

[a]Behaviors require hand washing

[b]Total behaviors aggregates the four categories of food safety behaviors requiring hand washing

*$P < .05$, ** $P < .01$

actions, objects, and sanitation practices were listed on the instrument with text options available for items not provided (see Fig. 1). Demographic information was also collected.

To identify properly when hand washing should occur, researchers referenced the hand washing criteria provided by the Indiana State Department of Health and consulted with representatives of the local health department and food safety professionals to develop a rubric appropriate for use with temporary foodservice establishments and the subsequent analyses (see Table 1). Employees were observed in terms of the frequency and quality of handwashing behaviors. Attempted handwashing was identified if an employee approached a sink and turned on the water and then performed a minimum of hand rinsing. Adequate handwashing was identified when an employee rinsed with soap and water before drying with a disposable towel according to the guidelines of Clayton and Griffith *(6)*. A trained team of researchers with extensive experience from the piloting of the instrument were used as the observers, who recorded the employees' food safety actions.

RESULTS

In total, eighteen farmers' market employees were observed, yielding fourteen single-observer observations and eight parallel observations. Having two observers ensured the reliability of observation data, which was tested by inter-observer reliability in accordance with research procedures outlined by Gall, Gall, and Borg *(10)*. This yielded a total of eighteen discrete observations with fifty transactions each, for a grand total of 900 employee food handling "transactions." Demographic variables include 6 male (36%) and 12 female (64%) employees, 9 employees (50%) with single work roles (server, cook, cashier) and 9 employees (50%) with multiple work roles (server or cook, server and cashier, or cook and cashier).

To verify the reliability of data observed and rated by the two researchers, inter-rater and inter-observer reliability were tested by use of Cohen's Kappa. In this procedure, values in excess of .70 are considered adequate. For this study, results of both inter-rater and inter-observer reliabilities ranged from .80 to 1, indicating a high degree of agreement.

The first research question concerned the frequency of hand washing compliance compared with the Indiana State Department of Health criteria. Few hand washing activities were detected, demonstrating that this sample of farmers' market vendors did not follow Indiana State Department of Health guidelines. Across the observations and transactions, hand washing was required for 417 out of 900 (46.38%) transactions; however, with only two observed attempts at hand washing, compliance was practically non-existent. Part of the problem was that even though Health Department guidelines require temporary hand washing facilities for vendors who prepare and serve food on site, only nine out of the eighteen vendors actually had access to some sort of hand washing

TABLE 3. MANOVA results of effect of position and number of employees on food safety behaviors requiring hand washing

Source	Dependent Variable	F	*P*-value
Position	Touch RTE food	.576	.464
	Touch personal belongings/clothing	13.118	.004**
	Touch money	9.549	.010*
	Touch waste container/garbage	.084	.778
	Touch vehicle	.001	.972
	Touch body	2.225	.164
	Eat/ Drink/ Smoke	.088	.772
	Total behaviors	21.853	.001**
Number of employees	Touch RTE food	5.977	.011*
	Touch personal belongings/clothing	2.700	.097
	Touch money	.263	.851
	Touch waste container/garbage	.379	.770
	Touch vehicle	.171	.914
	Touch body	1.899	.188
	Eat/ Drink/Smoke	1.599	.246
	Total behaviors	6.057	.011*
Position * Number of employees	Touch RTE food	1.742	.220
	Touch personal belongings/clothing	1.504	.265
	Touch money	.245	.787
	Touch waste container/garbage	.429	.662
	Touch vehicle	.327	.728
	Touch body	.474	.635
	Eat/ Drink/Smoke	.137	.873
	Total behaviors	2.235	.153

*$P < .05$, ** $P < .01$

facility. The employees were not only out of compliance with guidelines, but unable to meet hand washing requirements because of the lack of hand washing facilities.

The second research question related to a possible relationship between frequency of hand washing compliance and employee gender. Results showed no significant difference between genders.

The third research question pertained to a potential relationship between frequency of hand washing required and certain employee characteristics: the position of employees, and the number of employees. MANOVA results revealed that the frequency of behaviors requiring hand washing varied depending on the employee's position and the number of employees present in the operation. Employees with clearly defined singular roles (server, cook, and cashier) needed to wash their hands less often when engaged in food-related behaviors (t = 5.934, $P < .05$) and unsanitary object-related behaviors (t = 7.866, $P < .05$) than employees with multiple work roles (server/cook, server/cashier, server/cook/cashier).

An effect of the number of employees was found when they were engaged in food-related behaviors (t = 6.784, $P < .05$) and total behaviors (t = 5.189, $P < .05$). When examined categorically, results indicated that when there were more than two employees, the frequency of required hand washing opportunities also increased (see Table 2).

To examine further the effect of position and number of employees on each food safety behavior requiring hand washing, seven discrete food safety behaviors from the established rubric (see Table 1) were used in MANOVA as dependent variables. Although the rubric identifies fourteen behaviors requiring hand washing, only the observed behaviors were included in the second

MANOVA analysis. When examined by each specific behavior, results indicated that most of the unsanitary object violations pertained to behaviors related to the inappropriate touching of personal belongings, clothing, and money, while the food-related behaviors were related to handling ready-to-eat food without subsequent hand washing (see Table 3). When an employee was engaged in multiple roles, the person was more likely to touch personal belongings/clothing ($F = 13.118$, $P < .01$) and touch money ($F = 9.549$, $P < .05$). Given that no hand washing was detected, indicating lack of compliance with Indiana State Department of Health guidelines, the possibility of increased frequency of violations was higher for employees with multiple roles than for employees with singular roles. The number of employees was found to lead to higher possibility of increased frequency of violations related to touching RTE food ($F = 5.977$, $P < .05$) and total behaviors ($F = 6.057$, $P < .05$). The result implies that simply having numerous employees in the operation does not ensure that they have clearly separated roles or that they engage in correct food safety behaviors.

DISCUSSION

Data analysis of the eighteen observations indicated that compliance with hand washing regulations was attempted on only two occasions out of 900 total transactions. The lack of compliance with hand washing regulations suggests that RTE food vendors in temporary foodservice establishments, such as farmers' markets, may pose a relatively high risk of foodborne illness to consumers. Results revealed the effect of employee position, indicating a higher possibility of violations for employees engaged in multiple simultaneous work roles than for those with singular work roles. It was also found that simply increasing the number of employees does not ensure separated work roles, signifying the importance of having clearly segregated work duties among employees at temporary foodservice establishments.

Smartphone technology proved to be an efficient and effective method of gathering data in this setting. The use of Smartphones in observational studies began with the Columbia University Mechanical Engineering Department in New York City *(19)*. In January 2010, researchers collected data by use of HTC G1 Smartphones running Google's Android operating system to survey 300 farmers in rural Mali. The authors asserted that this method had the advantages of allowing remote monitoring of data collection, facilitating the data collection procedure, and reducing survey times. For the purposes of this study, using Smartphones for data collection permitted researchers to observe vendors discretely, thus minimizing the Hawthorne Effect, with the expectation that the appearance of observers tapping on an iPhone would look like texting, which has become a commonplace activity.

On average, it took about 30.67 minutes to observe each sequence of fifty transactions, during which time the observers seemed to attract no undue attention from the employees. There seemed to be little to no evidence of the Hawthorne Effect when Smartphone technology was used to collect the observational data. The advantage of using Smartphones in the study was evident, since nobody noticed or inquired about the observers' activities.

A more traditional method, such as pencil and paper, would have made it obvious that employees were under observation, and thus could have caused them to display behaviors that did not reflect reality. In this study, the use of the Smartphone allowed researchers to capture authentic behaviors, thus minimizing any possible Hawthorne Effect. The common practice of farmers' market employees assuming multiple, simultaneous job roles may contribute to the deficit in safe food handling behaviors, as does the lack of hand washing facilities. Employees who perform multiple food preparation duties without accessible hand washing facilities have few options when it comes to hand hygiene. These issues pose an increased risk to public health and identify a need for increased training and oversight. A single foodborne illness outbreak, if connected to a temporary establishment, could have severe repercussions on the individual vendor as well as the event or locale where the establishment operates. The associated loss of revenue and reputation could be detrimental to the local farmers, small restaurants and businesses that depend on temporary events to generate incremental income.

This study represents a novel application of Smartphone technology for the discrete observation of food safety behaviors. Although only eighteen employees were observed, the results of the study contribute to findings of previous studies by establishing the applicability of Smartphones for use in future studies with larger samples. Moreover, eighteen observations yielded 900 transactions, which was sufficient for statistical analyses.

There were some limitations associated with this study. The first related to the use of the Smartphone for data collection. For the most part, this worked as anticipated; however, it was noted that the act of having to look up repeatedly at the observed employee and then back down at the iPhone for data entry led to small gaps in observations, during which time the employee could be moving on to other tasks. While these gaps were short, maybe only 5–10 seconds, they did exist. Internet accessibility was occasionally a problem. Sometimes in remote locations or large crowds, wireless accessibility was slow, causing a lag in uploading data. This lag, in turn, could lead to similar gaps in observations. The development of an application that stores the observations on the Smartphone for later upload would be beneficial.

Another limitation was found in the sample size. Although there were 900 observed transactions, they represented only eighteen observed employees. This is because the data were collected in the fall, and the season ended before more observations could be made. Beginning observations in the spring would offer the greatest opportunity for increasing sample size.

Results of this study indicate that safe food handling behaviors in temporary foodservice establishments, such as farmers' markets, are lacking. Providing guidance to operators in the fundamentals of foodservice sanitation, employee work roles and task segregation, as well as designing facilities efficiently so that hand washing can become a priority, is recommended.

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