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A Comprehensive Needs Assessment of Food Safety Practices of Farmers' Market Vendors in Pennsylvania Using Direct Concealed Observations, Self-reported Surveys, and State Sanitarian Surveys

ABSTRACT

Having evolved since the colonial era, farmers' markets have replaced old-world style markets, with over 8,500 U.S. farmers' markets in operation today. As farmers' markets have increased in size, scope, and complexity, so have the potential food safety risks. Previous research has revealed that farmers' market vendors in the U.S. can lack important knowledge and experience in food safety practices. Numerous foodborne illness outbreaks and recalls associated with food products from farmers' markets also have been reported, further highlighting the need to improve food safety practices of farmers' market vendors. In response, some U.S. states have passed legislation or implemented policies specifically addressing food safety at farmers' markets. Research in these areas continues to be critical to ensure public safety and preserve the farmers' market movement. Using a 3-way approach, this study assessed food safety at Pennsylvania farmers' markets using direct concealed observations (DCOs), self-reported vendor surveys, and state sanitarian surveys. The results revealed key distinctions between

observed vendor food handling practices, by both researchers and state sanitarians, and vendor self-reported practices and assessed knowledge. The findings suggest that farmers' market vendors in PA would greatly benefit from a customized food safety training program to address the identified issues and regulatory requirements for selling safe foods in Pennsylvania.

INTRODUCTION

Having evolved since the colonial era, farmers' markets have replaced old-world style markets, with over 8,700 U.S. farmers' markets in operation today (24). As the number of farmers' markets have grown, so have the diversity and complexity of foods sold at farmers' markets (24). Currently, the USDA Agricultural Marketing Service (AMS) National Farmers' Market Directory lists over 30 categories of human and pet food products sold at U.S. farmers' markets (24). Although fresh produce remains the dominant product sold at farmers' markets, Time and Temperature Control for Safety (TCS) foods, such as meat, seafood, and Ready-to-Eat (RTE) prepared foods, are much more common at

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farmers' markets than they have been in the past (9, 24). According to the USDA-AMS directory of 2018, 40% (3,523) of farmers' markets are selling prepared foods, 66% (5,784) meat or poultry, and 16% (1,420) fish or seafood (24). These significant changes in the kinds of foods sold at farmers' markets present new food safety challenges and implications. As a result, several studies have revealed high-risk food safety factors unique to farmers' markets and farmers' market vendors.

A study in British Columbia surveyed 107 farmers' market vendors and revealed that 34% of farmers' market vendors were unable to identify TCS foods among a list of common foods, and 29% were unable to identify proper methods of reducing the temperature of TCS foods (16). In 2009, sampled produce (n = 600) from Canadian farmers' markets revealed that 18% of lettuce (n = 128), 27% of spinach (n = 59), and 5% of green onion (n = 129) samples were positive for *E. coli*, with an additional spinach sample positive for *Cryptosporidium* (8). Similarly, *E. coli* was detected in 40% (20/50) of beef, 18% (9/50) of pork, 28% (15/54) of kale, 29% (15/52) of lettuce, and 17% (8/46) of spinach samples obtained from Pennsylvania farmers' markets (20). *Listeria* spp. also was isolated from 8% (4/50) of beef, 2% (1/54) of kale, 4% (2/52) of lettuce, and 7% (3/46) of spinach samples in the same study (20). A comparative study on farmers' market- and supermarket-purchased raw, whole chicken showed that 28% and 90% of whole chicken purchased from farmers' markets (n = 100) in Pennsylvania were positive for *Salmonella* spp. and *Campylobacter* spp., respectively, compared to 8% and 52%, respectively of poultry purchased at supermarkets (n = 100) (19). Lastly, a survey performed in Pennsylvania among 21 farmers' market poultry vendors revealed that 43% did not use any sanitizers or antimicrobials during their poultry processing operations, only 24% used chemical sanitizers to clean their processing areas, and 33% indicated that they did their processing outside (21).

Unfortunately, the kinds of hazards identified in these studies also have caused several documented foodborne outbreaks. Since 2008, eight major foodborne outbreaks and two recalls have been attributed to foods sold at farmers' markets, causing 91 known reported illnesses, the kidney failure of a 4-year-old girl, and 1 death (1-3, 4, 6, 10, 11, 14, 22). The causative outbreak pathogen agents were *Campylobacter*, *E. coli* O157:H7, *Salmonella*, and *Listeria monocytogenes*. Food contaminated with these pathogens have included raw bagged peas, shelled peas, fresh strawberries, raw milk, various cheeses, RTE Mexican dishes, and unpasteurized apple cider (1-3, 4, 6, 10, 11, 14, 22).

Historically, vendors selling food products at farmers' markets in most U.S. states were exempt from food safety and sanitary regulations; however, many states have moved from relying on traditional cottage food laws to enacting modern food safety regulations addressing farmers' markets. To date, 26 states and the District of Columbia

have passed legislation addressing farmers' market food safety, food fraud, and licensing (5, 17). The reported outbreak incidents and food safety risks shown to occur at farmers markets threaten to jeopardize the farmers' market movement, toppling a billion dollar industry, endangering the livelihoods of hundreds of thousands of farmers in the U.S., and causing sickness and potential death of consumers. More robust and comprehensive studies are needed to evaluate the food safety implications of farmers' markets in the U.S. Therefore, the purpose of this study was to utilize a comprehensive approach to assess food safety at farmers' markets in Pennsylvania through the use of direct concealed observations, self-reported vendor surveys, and state sanitarian surveys.

MATERIALS AND METHODS

This project was approved by the Pennsylvania State University Institutional Review Board (IRB #44749). Pennsylvania Department of Agriculture (PDA) sanitarians were recruited for surveys via an email drafted by the authors and disseminated by the Director of the PDA Food Safety Bureau. Names and identities of all participants were kept confidential, and participant identities were not associated with any of the collected observations or survey responses. The validity of each survey tool was assessed through review by professors and food safety experts in the Department of Food Science at PSU. Reliability assessments of survey tools were assessed using Cronbach's alpha.

Direct concealed observations (DCOs) of farmers' market vendors in PA

A convenience sample of 42 farmers' market vendors from 8 farmers' markets across Pennsylvania were selected for the direct concealed observations (DCOs). Selected farmers' markets were located in the western, central, and eastern parts of Pennsylvania, in major city centers; however, the exact locations remained confidential. Vendors selected for the DCOs sold raw foods, ready-to-eat (RTE) foods, RTE prepared foods, and Time and Temperature Control for Safety (TCS) foods. At each farmer's market site, 5 to 6 farmers' market vendors were selected and observed. DCOs were performed using the smart-phone application "Food Safe Surveys," which was designed specifically for concealed observational research (15). Using the "Food Safe Surveys" web-based survey app, a customized questionnaire was developed, containing 20 farmers' market-specific questions and 26 vendor-specific questions. [Table 1](#) outlines only the observational questions used for the assessment. All needs assessment survey tools and results from this study can be accessed online (18). DCOs were performed on-site at each farmers' market from January to August 2015. Overall, 25 vendors were observed 3 times; 11 were observed 2 times, and 6 were observed 1 time, for a total of 22 separate farmers' market visits, with 102 observations performed.

Each vendor was observed for approximately 20–30 minutes by an observer standing or sitting out of the view of the targeted vendor. Repeat visits to farmers' markets were performed to identify whether observed vendor behaviors might be sporadic, repeated, or possibly performed because of conditions unique to the selected day of observation. A total of 102 individual DCOs of 42 vendors were performed, including 10 to 26 individual observations, resulting in a total of 1,020 to 2,652 total observations recorded.

Farmers' market self-reported vendor survey

Based on the results of the DCOs, a paper-based self-reported survey was developed for vendors to further explore key gaps identified by the initial vendor observations. The survey consisted of 38 questions in four sections, including self-reported market behaviors (14 questions), retail food safety knowledge (8 questions), retail food safety attitudes (8 questions), and training preferences and demographics (8 questions) (18). All questions were formatted as multiple choice, except the attitudinal questions, which were formatted using a five-point Likert scale. A convenience sample of two farmers' markets and one community-organized farmers' market vendor outreach program were targeted for conducting the needs assessment survey, based on established available contacts with farmers' market managers and community leaders. Vendors were approached at the farmers' market or event and asked to participate in the survey. Typically, vendors spent 15–30 minutes to complete each survey and were awarded \$10 cash for their participation. Of the approximately 70 farmers' markets available for participation in the survey, 55.7% (39/70) completed the survey in its entirety, which was considered suitable, based on the time constraints and funds available for incentives. Approximately 20 categories of food products were sold by these vendors, including RTE, TCS, and prepared foods.

Pennsylvania state sanitarian survey

The purpose of this survey was to collect information and observations made by PA state sanitarians during their inspections of farmers' markets and to determine the conditions that led to inspection outcomes. With the Pennsylvania Department of Agriculture (PDA) Food Establishment Inspection Report (18), paper-based and identical web-based surveys were developed, using RedCap (Research Electronic Data Capture) software (12). The survey consisted of 35 questions, with each question having two parts. Part I (scored on a Likert scale) asked state sanitarians to rank the frequency that an item had been observed to be "out of compliance" during vendor inspections, and Part II (multiple choice questions) asked state sanitarians to state "why the non-compliance occurred" (18). Paper-based surveys were administered at a collaborating training event in State College, PA. With

the web-based and paper-based in-person surveys, 52.2% (47/90) of the PA state sanitarians consented and completed the survey. Participants could choose to skip questions or parts of questions, which resulted in varied Part I and II response rates for different question. PA state sanitarians who participated in the survey reported that they had inspected farmers' market vendors in the past three years. Approximately one-half of the surveyed state sanitarians reported inspecting > 31 vendors, with 25% (11/44) having inspected more than 70 vendors in the same timeframe.

Statistical analysis

DCOs, self-reported vendor survey responses, and PA state sanitarians survey responses were compiled and analyzed by converting response rates to percentages. Comparison of measures of central tendency also were calculated for certain questions. Pearson's Chi-Square and Cramer's V tests ($\alpha = 0.05$) also were used to determine associations between certain observational results, and Cronbach's alpha tests were used to test for reliability. All statistical testing was carried out using SPSS; IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.

RESULTS

Results from the DCOs, self-reported vendor survey, and PDA state sanitarian surveys were organized by topic to triangulate data analysis and to detect similarities or differences among the assessments (Table 1). During DCOs, most vendors wore clean clothing (86.3%; 88/102) (Table 2); however, only 23.5% (23.5/102) used a hair covering when handling food (Table 2). Similarly, 60.4% (26/43) of PA state sanitarians reported that personal cleanliness was "almost never" or "rarely" a compliance issue during inspections (Table 2). Approximately one-half of the vendors used a wood vending surface, and 89.2% (91/102) of those were visually clean (Table 2). Likewise, 55.8% (24/43) of PA state sanitarians reported that use of food contact surfaces that were of cleanable material was "rarely" or "almost never" a compliance issue, but that non-compliance was commonly due to vending surfaces being made of non-cleanable materials, such as wood. In addition, 31.8% (14/44) of PA state sanitarians reported that food contact surfaces were not cleaned or sanitized often – "almost always," while 38.6% (17/44) reported the inspection item was "sometimes" out of compliance (Table 2). One common reason for the inspection deficiency was that vendors were unaware of the requirement for, or proper methods of, cleaning or sanitizing food contact surfaces (67.5%; 27/40) (Table 2). Interestingly, surveyed vendors self-reported that they do clean or sanitize their food stand or deli case with soap and water (25%; 9/36), chlorine/bleach (19.4%; 7/36), sanitizing wipes (27.8%; 10/36), or other cleaner (2.8%; 1/36), while a majority (63.8%; 23/36) report using a clean cloth or disposable surface covering (Table 2).

TABLE 1. Summary of needs assessment tools organized by common themes for triangulation analyses

Theme or Topic	Farmers' market vendor direct concealed observations (DCOs)	PA State Sanitarian surveys; Reported observations from state inspections*	Farmers' market vendor self-reported behaviors (SB) survey questions
Vendor hygiene and vending area conditions (ref. Table 2)	<ul style="list-style-type: none"> • (DCO) Condition and type of vending surface • (DCO) Condition of vendor clothing • (DCO) Presence of vendor hair coverings 	<ul style="list-style-type: none"> • Inspection item "Food contact surfaces cleaned and sanitized" • Inspection item "Discharge from eyes, nose, and mouth" • Inspection item "Personal cleanliness" • Inspection item "Food contact surfaces cleanable, properly designed, and used" 	<ul style="list-style-type: none"> • (SB) "Do you clean or sanitize your food stand and/or deli cases with any of the following before each market day?"
Disposable glove use (ref. Table 3)	<ul style="list-style-type: none"> • (DCO) Disposable glove use • (DCO) Behaviors performed without changing gloves among glove users 	<ul style="list-style-type: none"> • Inspection item "No bare hand contact with RTE foods or approved alternative method properly followed" • Inspection item "Gloves used properly" 	<ul style="list-style-type: none"> • (SB) "Do you use disposable gloves to handle foods you sell at farmers' markets?"
High risk food-handling habits and handwashing habits (ref. Table 4)	<ul style="list-style-type: none"> • (DCO) Behaviors performed when handwashing was required and not performed among non-glove users • (DCO) Presence of hand sanitizer in the vending area • (DCO) Vendor handwashing habits 	<ul style="list-style-type: none"> • Inspection item "Proper eating, tasting, drinking, or tobacco use" • Inspection item "Hands clean and properly washed" • Inspection item "No bare hand contact with RTE foods or approved alternative method properly followed" • Inspection item "Contamination prevented during food preparation, storage, and display" • Inspection item "in-use utensils; properly stored" 	<ul style="list-style-type: none"> • (SB) "If you do not use disposable gloves at farmers' markets, do you use another technique to avoid touching foods with your bare hands?" • (SB) "Please select the following responses that best describes your handwashing station" • (SB) "Please select the following responses that best describe your handwashing habits at the farmers' market" • (SB) "Please select the following responses that best describes when you might wash your hands or use hand sanitizer at the farmers' market"
Packaging, labeling, and food display (ref. Table 5)	<ul style="list-style-type: none"> • (DCO) Presence of unpackaged foods placed directly onto uncovered vending surfaces • (DCO) Packaging methods at the farmers' market 	<ul style="list-style-type: none"> • Inspection item "Food in good condition, safe, and unadulterated" • Inspection item "Food separated and protected" 	<ul style="list-style-type: none"> • (SB) "If you sell raw produce, meats, or other raw foods, which foods are pre-packaged before selling them at farmers' markets?"

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TABLE 1. Summary of needs assessment tools organized by common themes for triangulation analyses (cont.)

Theme or Topic	Farmers' market vendor direct concealed observations (DCOs)	PA State Sanitarian surveys; Reported observations from state inspections*	Farmers' market vendor self-reported behaviors (SB) survey questions
Cold storage and thermometer use (ref. Table 6)	<ul style="list-style-type: none"> • (DCO) Cold storage of foods which require cold storage • (DCO) Presence of thermometers in cold storage containers • (DCO) Types of cold storage used by vendors 	<ul style="list-style-type: none"> • Inspection item "Proper cooling methods used and adequate for temperature control" • Inspection item "Thermometer provided and accurate" 	<ul style="list-style-type: none"> • (SB) "If you sell food items that require cold storage, how do you store them at farmers' markets?" • (SB) "If you sell food items that require cold storage do you use a thermometer at farmers' markets to check the temperature of the foods?" • (SB) "If you use a thermometer at farmers' markets, how often do you calibrate it?"

*Inspection items refer to those items present on the Pennsylvania Department of Agriculture Food Establishment Inspection Report. Surveys of PA State Sanitarians listed exact inspection item statements and asked PA State Sanitarians to rank the frequency an inspection item had been observed to be "out of compliance" during inspections of farmers' market vendors in Part I (Likert scale), and Part II (multiple choice) was a follow-up question asking why the non-compliance generally occurred. Response rates varied between Parts I and II within each question because of incomplete responses or no responses for each question per participant.

Disposable glove use at the farmers' market among observed vendors was found to be uncommon. Only 23.5% (24/102) of the DCOs indicated that disposable gloves were present at the vending stand (Table 3). Likewise, only 34.2% (13/38) of surveyed vendors self-reported using disposable gloves at the farmers' market (Table 3). Among observations of vendors using disposable gloves, 43.5% (10/23) revealed improper glove use behaviors; the most common improper behavior observed was handling money with gloves, and then handling unpackaged foods without changing gloves. Similarly, 32.6% (14/43) of PA state sanitarians reported that non-compliance for the inspection item "glove used properly" occurred "often-almost always" and 39.5% (17/43) reported "sometimes." Furthermore, 73.8% (31/42) of PA state sanitarians found the handling of money to be the most common reason for the non-compliance. In addition, 32.6% (14/43) of the sanitarians reported that the inspection item, "no bare hand contact with RTE foods" was in non-compliance "often-almost always" and 48.8% (21/43) "sometimes" (Table 3). Over one-half of the sanitarians stated that this non-compliance issue was due to vendors having disposable gloves available but not using them (Table 3).

In Pennsylvania, farmers' market vendors are required to use a hand washing station if they are preparing food samples or selling RTE and certain unpackaged TCS foods. However, it is expected that the handling of any unpackaged food be performed in a sanitary manner. Since it was not always clear whether certain foods are considered RTE or TCS foods (i.e., washed produce), observations of a "lack of handwashing" or "improper food handling" reflected the handling of any unpackaged food product. Over the course of the DCOs, few instances of handwashing were observed, whether it was required or not (Table 4). Handwashing was considered a requirement during 57.8% (59/102) of the observations; however, only 8.5% (5/59) of those observations involved vendors performing proper handwashing when this was considered "required." Among instances where handwashing was considered required and not performed, 87% (47/54) were due to handling money with bare hands, and then handling unpackaged foods without washing their hands (Table 4). Other improper behaviors performed by the vendors included touching the body/face, eating, coughing or sneezing, and handling raw foods and then RTE foods without washing hands (Table 4). Inadequate or lack of

TABLE 2. Farmers' market vendor self-reported survey responses, direct concealed observations, and PA State Sanitarian reported observations related to vendor hygiene and vending area conditions

Needs Assessment Tool	Observation, Survey Question, or Inspection item		Observation or Survey Response ^{a,b}
Farmers' market vendor direct concealed observations (DCO)	(DCO) Condition of vending surface (n = 102)		<ol style="list-style-type: none"> 1. Appears clean (89.2%; n = 91/102) 2. Appears soiled or dirty (10.8% n = 11/102)
	(DCO) Type of vending surface (n = 102)		<ol style="list-style-type: none"> 1. Wood (48%; n = 49/102) 2. Metal (12.7%; n = 13/102) 3. Plastic (18.6%; n = 19/102) 4. Wood and Plastic (2.9%; n = 3/102) 5. Metal and Plastic (14%; n = 13.7/102) 6. Wood Metal and Plastic (2%; n = 2/102) 7. Other (2%; n = 2/102)
	(DCO) Condition of vendor clothing (n = 102)		<ol style="list-style-type: none"> 1. Clean (86.3%; n = 88/102) 2. Slightly soiled (6.9%; n = 7/102) 3. Dirty (2.9%; n = 3/102) 4. Unknown (3.9%; n = 4/102)
	(DCO) Presence of vendor hair coverings (n = 102)		<ol style="list-style-type: none"> 1. Hair covering present (23.5%; n = 24/102) 2. No hair covering present (76.4%; n = 78/102)
Farmers' market vendor self-reported behaviors survey questions (SB)	(SB) "Do you clean or sanitize your food stand and/or deli cases with any of the following before each market day?" (n = 36)		<ol style="list-style-type: none"> 1. Soap and water (25%; n = 9/36) 2. Chlorine/Bleach (19.4%; n = 7/36) 3. Sanitizing Wipes (27.8%; n = 10/36) 4. Other store bought cleaner (2.8%; n = 1/36) 5. I cover my food stand with a clean tablecloth or disposable covering (63.8%; n = 23/36) 6. I do not clean my food stand (5.5%; n = 2/36) 7. I do not know (2.8%; n = 1/36)
	Observation, Survey Question, or Inspection item	Part 1: Frequency of Non-Compliance^{a,b,c}	Part 2: Reason for Non-Compliance^{a,b,c}
PA State Sanitarian surveys; Reported observations from state inspections (Part I: Frequency of non-compliance; Part II: Reason for non-compliance)	(Inspection item) "discharge from eyes, nose, and mouth" (Part I: n = 42 Part II: n = 32)	Almost never (88.1%; n = 37/42) Rarely (2.4%; n = 1/42) Sometimes (4.8%; n = 2/42) Often (2.4%; n = 1/42) Usually (0%) Almost Always (2.4%; n = 1/42)	<ol style="list-style-type: none"> 1. I have never observed this inspection item to be out of compliance (78.1%; n = 25/32) 2. Discharge from eyes, nose, and mouth is observed during food preparation or processing (0%) 3. Other (18.8%; n = 6/32) 4. I do not know (3.1%; n = 1/32)

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TABLE 2. Farmers' market vendor self-reported survey responses, direct concealed observations, and PA State Sanitarian reported observations related to vendor hygiene and vending area conditions (cont.)

Needs Assessment Tool	Observation, Survey Question, or Inspection item	Part 1: Frequency of Non-Compliance ^{a,b,c}	Part 2: Reason for Non-Compliance ^{a,b,c}
PA State Sanitarian surveys; Reported observations from state inspections (Part I: Frequency of non-compliance; Part II: Reason for non-compliance)	(Inspection item) "food contact surfaces cleaned and sanitized" (Part I: n = 44 Part II: n = 40)	Almost never (6.8%; n = 3/44) Rarely (22.7%; n = 10/44) Sometimes (38.6%; n = 17/44) Often (18.2%; n = 8/44) Usually (4.5%; n = 2/44) Almost Always (9.1%; n = 4/44)	1. I have never observed this inspection item to be out of compliance (2.5%; n = 1/40) 2. Foods are placed into secondary containers that are not clean and/or sanitized (22.5%; n = 9/40) 3. Foods are placed directly onto primary retail displays that are not clean and/or sanitized (20%; n = 8/40) 4. Utensils, cooking tools, or other food contact surfaces are not properly cleaned and/or sanitized (75%; n = 30/40) 5. Vendors are unaware of the requirements to clean and sanitize food contact surfaces (30%; n = 12/40) 6. Vendors are unaware of how to properly clean and sanitize food contact surfaces (37.5%; n = 15/40) 7. Other (10% n = 4/40) 8. I do not know (0%)
	(Inspection item) "personal cleanliness" (Part I: n = 43 Part II: n = 39)	Almost never (34.9%; n = 15/43) Rarely (25.6%; n = 11/43) Sometimes (7%; n = 3/43) Often (20.9%; n = 9/43) Usually (9.3%; n = 4/43) Almost Always (2.3%; n = 1/43)	1. I have never observed this inspection item to be out of compliance (15.4%; n = 6/39) 2. Vendors clothing appears soiled or is dirty (38.5%; n = 15/39) 3. Vendors exhibit poor hygienic practices leading to an uncleanly appearance (43.6%; n = 17/39) 4. Other (28.2%; n = 11/39) 5. I do not know (2.6%; n = 1/39)
	(Inspection item) "food contact surfaces cleanable, properly designed, and used" (Part I: n = 43 Part II: n = 39)	Almost never (25.6%; n = 11/43) Rarely (30.2%; n = 13/43) Sometimes (34.9%; n = 15/43) Often (4.7%; n = 2/43) Usually (0%) Almost Always (4.7%; n = 2/43)	1. I have never observed this inspection item to be out of compliance (15.4%; n = 6/39) 2. Food & non-food contact surfaces are made of material that is not cleanable (i.e., wood), and are not covered by a clean cloth or disposable clean covering (71.8%; n = 28/39) 3. Other (17.9%; n = 7/39) 4. I do not know (2.6%; n = 1/39)

^aSum of response rate may be greater than 100% due to rounding.

^bResults include multiple responses per survey question.

^cInspection items refer to those items present on the Pennsylvania Department of Agriculture Food Establishment Inspection Report. Surveys of PA State Sanitarians listed exact inspection item statements and asked PA State Sanitarians to rank the frequency an inspection item had been observed to be "out of compliance" during inspections of farmers' market vendors in Part I (Likert scale), and Part II (multiple choice) was a follow up question asking why the non-compliance generally occurred. Response rates varied between Parts I and II within each question because of incomplete responses or no responses for each question per participant.

TABLE 3. Farmers' market vendor self-reported responses, direct concealed observations, and PA State Sanitarian reported observations related to disposable glove use

Needs Assessment Tool	Observation, Survey Question, or Inspection item		Observation or Survey Response ^{a,b}
Farmers' market vendor direct concealed observations (DCO)	(DCO) Disposable glove use (n = 102)		<ol style="list-style-type: none"> 1. No gloves used (74.5%; 76/102) 2. Gloves present and used (20.6%; n = 21/102) 3. Gloves present, not used (2.9%; n = 3/102) 4. Cold weather glove (2.0%; 2/102)
	(DCO) Behaviors performed without changing gloves among glove users (n = 23)		<ol style="list-style-type: none"> 1. Handling raw TCS foods then RTE foods (8.7%; n = 2/23) 2. Handling money then a food item (21.7%; n = 5/23) 3. Combination of previous two items (4.3%; n = 1/23) 4. Touching noticeably unclean surface then food (8.7%; n = 2/23) 5. No improper glove use observed (56.5%; n = 13/23)
Farmers' market vendor self-reported behaviors survey questions (SB)	(SB) "Do you use disposable gloves to handle foods you sell at farmers' markets?" (n = 38)		<ol style="list-style-type: none"> 1. Yes (34.2%; n = 13/38) 2. No (65.8%; n = 25/38)
	Observation, Survey Question, or Inspection item	Part I: Frequency of Non-Compliance ^{a,b,c}	Part 2: Reason for Non-Compliance ^{a,b,c}
PA State Sanitarian surveys; Reported observations from state inspections (Part I: Frequency of non-compliance; Part II: Reason for non-compliance)	(Inspection item) "No bare hand contact with RTE foods or approved alternative methods properly followed" (Part I: n = 43 Part II: n = 41)	<p>Almost never (7%; n = 3/43)</p> <p>Rarely (11.6%; n = 5/43)</p> <p>Sometimes (48.8%; n = 21/43)</p> <p>Often (25.6%; n = 11/43)</p> <p>Usually (4.7%; n = 2/43)</p> <p>Almost Always (2.3%; n = 1/43)</p>	<ol style="list-style-type: none"> 1. I have never observed this inspection item to be out of compliance (2.4%; n = 1/41) 2. Bare hand contact is observed with RTE foods, with no use of proper handwashing (58.5%; n = 24/41) 3. Vendors are unaware that bare hand contact is not approved when handling RTE foods (39%; n = 24/41) 4. Vendors have disposable gloves but do not use them or use them improperly (61%; n = 25/41) 5. Other (7.3%; n = 3/41) 6. I do not know (0%)

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TABLE 3. Farmers' market vendor self-reported responses, direct concealed observations, and PA State Sanitarian reported observations related to disposable glove use (cont.)

Needs Assessment Tool	Observation, Survey Question, or Inspection item	Part 1: Frequency of Non-Compliance ^{a,b,c}	Part 2: Reason for Non-Compliance ^{a,b,c}
PA State Sanitarian surveys; Reported observations from state inspections (Part I: Frequency of non-compliance; Part II: Reason for non-compliance)	(Inspection item) "gloves used properly" (Part I: n = 43 Part II: n = 42)	Almost never (9.3%; n = 4/43) Rarely (18.6%; n = 8/43) Sometimes (39.5%; n = 17/43) Often (18.6%; n = 8/43) Usually (7%; n = 3/43) Almost Always (7%; n = 3/43)	<ol style="list-style-type: none"> 1. I have never observed this inspection item to be out of compliance (4.8%; n = 2/42) 2. If gloves are in use, they are not changed after touching raw foods and before RTE foods (50%; n = 21/42) 3. If gloves are in use, they are not changed after handling money and before touching other foods (73.8%; n = 31/42) 4. If gloves are in use, they are not changed after touching the face or body and before touching other foods (61.9%; n = 26/42) 5. Other (21.4%; n = 9/42) 6. I do not know (9.5%; n = 4/42)

^aSum of response rate may be greater than 100% because of rounding.

^bResults include multiple responses per survey question.

^cInspection items refer to those items present on the Pennsylvania Department of Agriculture Food Establishment Inspection Report. Surveys of PA State Sanitarians listed exact inspection item statements and asked PA State Sanitarians to rank the frequency an inspection item had been observed to be "out of compliance" during inspections of farmers' market vendors in Part I (Likert scale), and Part II (multiple choice) was a follow up question asking why the non-compliance generally occurred. Response rates varied between Parts I and II within each question because of incomplete responses or no responses for each question per participant.

handwashing also were reported by PA state sanitarians, with 39% (16/41) of PA state sanitarians reporting that vendors' hands were not clean or properly washed "often-almost always," and a majority cited the lack of available hand washing stations or the use of hand sanitizer, in place of handwashing, as the most common reasons for non-compliance (Table 4). When farmers' market vendors were asked to describe their handwashing stations, 30.6% (11/36) self-reported that they have a handwashing station, while 47.2% (17/36) reported that they do not have one, primarily because they are not required to (Table 4). Surveyed vendors also were asked about their hand washing habits at the markets, in which 40% (14/35) self-reported using hand sanitizer in place of handwashing when they do not have time or facilities for washing their hands (Table 4).

The display and packaging of foods were found to vary widely among observed farmers' market vendors. High-risk food display activities generally encompass instances

where unpackaged foods are placed directly onto uncovered vending surfaces or exposed to cross-contamination. The most common displayed foods that were observed to be unpackaged and stored on uncovered vending surfaces were fresh produce, followed by raw meats and fish stored directly on ice, then apples (Table 5). Approximately 34.9% (15/43) of PA state sanitarians also reported that the inspection item "Food separated and protected" was "almost never" or "rarely" observed (Table 5). Packaging methods used by vendors also varied from vendor to vendor, and in some cases, individual vendors used multiple methods for different foods. Only 10.8% (11/102) of the DCOs found vendors who pre-packaged all of their food products (Table 5). The use of a plastic bag at time of sale was observed during 32.4% (33/102) of the DCOs. Likewise, surveyed vendors who were asked whether they pre-packaged raw produce, meats, or other raw foods reported that some (25.8%; 8/31) do not pre-package those types of foods, while few (12.9%; 4/31) pre-

TABLE 4. Farmers' market vendor self-reported responses, direct concealed observations, and PA State Sanitarian reported observations related to high risk food handling habits and handwashing habits

Needs Assessment Tool	Observation, Survey Question, or Inspection item	Observation or Survey Response ^{a,b}
Farmers' market vendor direct concealed observations (DCO)	(DCO) Vendor handwashing habits (n = 102)	<ol style="list-style-type: none"> 1. No handwashing observed or no behavior requiring handwashing (42.2%; n = 43/102) 2. No handwashing observed after a behavior requiring handwashing (52.9%; n = 54/102) 3. Handwashing observed after a behavior requiring handwashing (4.9%; n = 5/102)
	(DCO) Behaviors performed when handwashing was required and not performed among non-glove users (n = 54)	<ol style="list-style-type: none"> 1. Handling money then food (87%; 47/54) handling money then food items (65.6%; n = 40/61) 2. Touching exposed body/face then food items (1.9%; n = 1/54) 3. Combination money and body/face then food items (1.9%; n = 1/54) 4. Combination eating and money then food items (3.7%; n = 2/54) 5. Combination handling raw TCS foods then money then food items (3.7%; n = 2/54) 6. Combination sneezing/coughing and money then food items (1.9%; n = 1/54)
	(DCO) Presence of hand sanitizer in the vending area (n = 102)	<ol style="list-style-type: none"> 1. Present (3.9%; 4/102) 2. Not Present (96%; 98/102)
Farmers' market vendor self-reported behaviors survey questions (SB)	(SB) "If you do not use disposable gloves at farmers' markets, do you use another technique to avoid touching foods with your bare hands?" (n = 29)	<ol style="list-style-type: none"> 1. No (17.2%; n = 5/29) 2. All of my food is pre-packaged (55.2%; n = 16/29) 3. I reach inside a clean plastic bag, grab the food items, and then turn the bag inside out (13.8%; n = 4/29) 4. I use tissue paper or other paper/plastic to pick up raw foods (3.5%; n = 1/29) 5. I use tongs or another utensil to handle raw foods (24.1%; n = 7/29) 6. I wash my hands routinely so I don't worry about touching foods with my bare hands (6.9%; n = 2/29) 7. Other (6.9%; n = 2/29)
	(SB) "Please select the following responses that best describes your handwashing station?" (n = 36)	<ol style="list-style-type: none"> 1. I provide my own handwashing station at my farmers' market stand (30.5%; n = 11/36) 2. I share a handwashing station with another vendor (5.6%; n = 2/36) 3. I use a handwashing station or sink provided by the market, which is for vendors only (2.8%; n = 1/36) 4. I use a sink at the market, which is located in a public restroom (2.8%; n = 1/36) 5. I am not required to have a handwashing station, so I don't have one (47.2%; n = 17/36) 6. I do not know (11.1%; n = 4/36)

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TABLE 4. Farmers' market vendor self-reported responses, direct concealed observations, and PA State Sanitarian reported observations related to high risk food handling habits and handwashing habits (cont.)

Needs Assessment Tool	Observation, Survey Question, or Inspection item	Observation or Survey Response ^{a,b}	
Farmers' market vendor self-reported behaviors survey questions (SB)	(SB) "Please select the following responses that best describe your hand-washing habits at the farmers' market?" (n = 35)	<ol style="list-style-type: none"> 1. I wash my hands at the beginning of the day before handling any food items and periodically throughout the day (37.1%; n = 13/35) 2. I wash my hands often whenever I feel I've made them unclean (34.3%; n = 12/35) 3. I use hand sanitizer or sanitizing wipes when I don't have time or access to wash my hands (40%; n = 14/35) 4. I don't have time to wash my hands often, but I'm only handling pre-packaged foods (14.3%; n = 5/35) 5. I do not know (8.6%; n = 3/35) 	
	(SB) "Please select the following responses that best describes when you might wash your hands or use hand sanitizer at the farmers' market" (n = 33)	<ol style="list-style-type: none"> 1. I wash my hands/use hand sanitizer before touching any food items IF I have touched my face or body (27.3%; n = 9/33) 2. I wash my hands/use hand sanitizer before touching any food items IF I have touched an unclean surface (36.4%; n = 12/33) 3. I wash my hands/use hand sanitizer before touching any food items IF I have touched raw meat, eggs, or poultry (24.2%; n = 8/33) 4. I wash my hands/use hand sanitizer before handling food items IF I have handled money (24.2%; n = 8/33) 5. I don't wash my hands often because I use disposable gloves (9.1%; n = 3/33) 6. I don't wash my hands often because I only sell pre-packaged foods (36.4%; n = 12/33) 7. I do not know (15.2%; n = 5/33) 	
PA State Sanitarian surveys; Reported observations from state inspections (Part I: Frequency of non-compliance; Part II: Reason for non-compliance)	(Inspection item) "Proper eating, tasting drinking, or tobacco use" (Part I: n = 42 Part II: n = 39)	Part I: Frequency of Non-Compliance ^{a,b,c}	Part 2: Reason for Non-Compliance ^{a,b,c}
		Almost never (38.1%; n = 16/42) Rarely (23.8%; n = 10/42) Sometimes (26.2%; n = 11/42) Often (9.5%; n = 4/42) Usually (2.4%; n = 1/42) Almost Always (0%)	<ol style="list-style-type: none"> 1. I have never observed this inspection item to be Out of Compliance (15.4%; n = 6/39) 2. Eating, tasting, or drinking is observed during food preparation or processing (33.3%; n = 13/39) 3. Eating, tasting, or drinking is observed while handling food products at retail (41%; n = 16/39) 4. Vendors are unaware that eating, tasting, drinking, or tobacco is unhygienic at the retail environment (25.6%; n = 10/39) 5. Other (7.7%; n = 3/39) 6. I do not know (5.1%; n = 2/39)

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TABLE 4. Farmers' market vendor self-reported responses, direct concealed observations, and PA State Sanitarian reported observations related to high risk food handling habits and handwashing habits (cont.)

Needs Assessment Tool	Observation, Survey Question, or Inspection item	Observation or Survey Response ^{a,b}	
		Part 1: Frequency of Non-Compliance ^{a,b,c}	Part 2: Reason for Non-Compliance ^{a,b,c}
PA State Sanitarian surveys; Reported observations from state inspections (Part I: Frequency of non-compliance; Part II: Reason for non-compliance)	(Inspection item) "Hands clean and properly washed" (Part I: n = 41 Part II: n = 40)	Almost never (14.6%; n = 6/41) Rarely (9.8%; n = 4/41) Sometimes (36.6%; n = 15/41) Often (29.3%; n = 12/41) Usually (7.3%; n = 3/41) Almost Always (2.4%; n = 1/41)	1. I have never observed this inspection item to be out of compliance (7.5%; n = 3/40) 2. Vendors do not have access to a handwashing station (47.5%; n = 19/40) 3. Vendors use hand sanitizer in place of handwashing (45%; n = 18/40) 4. Vendors are unaware handwashing is required or necessary (30%; n = 12/40) 5. Other (0%) 6. I do not know (0%)
	(Inspection item) "No bare hand contact with RTE foods or approved alternative method properly followed" (Part I: n = 43 Part II: n = 41)	Almost never (7%; n = 3/43) Rarely (11.6%; n = 5/43) Sometimes (48.8%; n = 21/43) Often (25.6%; n = 11/43) Usually (4.7%; n = 2/43) Almost Always (2.3%; n = 1/43)	1. I have never observed this inspection item to be out of compliance (2.4%; n = 1/41) 2. Bare hand contact is observed with RTE foods, with no use of proper handwashing (58.5%; n = 24/41) 3. Vendors are unaware that bare hand contact is not approved when handling RTE foods (39%; n = 16/41) 4. Vendors have disposable gloves but do not use them or use them improperly (61%; n = 25/41) 5. Other (7.3%; n = 3/41) 6. I do not know (0%)
	(Inspection item) "Contamination prevented during food preparation, storage, and display" (Part I: n = 42 Part II: n = 40)	Almost never (9.5%; n = 4/42) Rarely (26.2%; n = 11/42) Sometimes (42.9%; n = 18/42) Often (11.9%; n = 5/42) Usually (4.8%; n = 2/42) Almost Always (4.8%; n = 42)	1. I have never observed this inspection item to be out of compliance (5%; n = 2/40) 2. Contamination is observed or likely during food preparation due to lack of glove use or no handwashing (55%; n = 22/40) 3. Food items are stored or displayed improperly leading to potential cross-contamination (65%; n = 26/40) 4. Vendors are unaware of practices to prevent contamination during food preparation, storage, and display (45%; n = 18/40) 5. Other (5%; n = 2/40) 6. I do not know (0%)

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TABLE 4. Farmers' market vendor self-reported responses, direct concealed observations, and PA State Sanitarian reported observations related to high risk food handling habits and handwashing habits (cont.)

Needs Assessment Tool	Observation, Survey Question, or Inspection item	Observation or Survey Response ^{a,b}	
		Part 1: Frequency of Non-Compliance ^{a,b,c}	Part 2: Reason for Non-Compliance ^{a,b,c}
PA State Sanitarian surveys; Reported observations from state inspections (Part I: Frequency of non-compliance; Part II: Reason for non-compliance)	(Inspection item) "In-use utensils; properly stored" (Part I: n = 43 Part II: n = 42)	Almost never (20.9%; n = 9/43) Rarely (18.6%; n = 8/43) Sometimes (41.9%; n = 18/43) Often (11.6%; n = 5/43) Usually (2.3%; n = 1/43) Almost Always (2.3%; n = 1/43)	1. I have never observed this inspection item to be out of compliance (14.3%; n = 6/42) 2. In-use utensils are improperly stored leading to potential contamination of foods (59.5%; n = 25/42) 3. Vendors are unaware of proper methods to store in-use utensils (47.6%; n = 20/42) 4. Other (9.5%; n = 4/42) 5. I do not know (0%)

^aSum of response rate may be greater than 100% because of rounding.

^bResults include multiple responses per survey question.

^cInspection items refer to those items present on the Pennsylvania Department of Agriculture Food Establishment Inspection Report. Surveys of PA State Sanitarians listed exact inspection item statements and asked PA State Sanitarians to rank the frequency an inspection item had been observed to be "out of compliance" during inspections of farmers' market vendors in Part I (Likert scale), and Part II (multiple choice) was a follow up question asking why the non-compliance generally occurred. Response rates varied between Parts I and II within each question because of incomplete responses or no responses for each question per participant.

package raw produce and even fewer (9.7%; 3/31) pre-package raw meats or poultry (Table 5). It is important to note that 38.7% (12/31) of the vendors did not sell raw food products.

Because of the increase in TCS foods sold at farmers' markets, vendors must have the ability to store temperature-sensitive foods properly at the farmers' markets. In fact, 69.6% (71/102) of the vendor observations involved instances requiring cold storage of food products at the farmers' market (Table 6). Interestingly, 40.8% (29/71) of the DCOs found that vendors used electrically powered cold storage units, while 26.8% (19/71) of the DCOs found vendors using portable coolers with ice, 16.9% (12/71) used a deli-case filled with ice, and 9.9% (7/71) used portable coolers with no ice (Table 6). A majority of surveyed vendors (88.5%; 23/26) self-reported using portable coolers with ice to store temperature-sensitive foods (Table 6). Cold storage devices themselves were not generally found by PA state sanitarians to be a common non-compliance issue; however, improper thermometer usage was common (Table 6). Among the 71 DCOs of vendors using cold storage devices,

only 12.7% (9/71) had a thermometer on site or in the cold storage unit (18). In contrast, 62.5% (15/24) of surveyed vendors self-reported that they use a thermometer at the farmers' market. However, when asked the frequency of their thermometer calibration, 8.7% (2/23) reported that they did not know how to calibrate a thermometer and 13% (3/23) never calibrated their thermometers.

DISCUSSION

The results of this comprehensive needs assessment revealed important gaps in farmers' market vendor retail food safety behaviors, knowledge, and attitudes. The use of a 3-way needs assessment, consisting of DCOs, self-reported vendor surveys, and PA state sanitarians surveys, provided a view of actual farmers' market vendor behaviors during normal market conditions, behaviors during health inspections, and self-reported behaviors of vendors. In other words, the results demonstrate that farmers' market vendors say and do one thing, when in actuality they are observed doing something else, further increasing the validity of the

TABLE 5. Farmers' market vendor self-reported responses, direct concealed observations, and PA State Sanitarian reported observations related to packaging, labeling, and food display

Needs Assessment Tool	Observation, Survey Question, or Inspection item	Observation or Survey Response ^{a,b}	
Farmers' market vendor direct concealed observations (DCO)	(DCO) Presence of unpackaged foods placed directly onto uncovered vending surfaces (n = 102, if Yes n = 44)	<ol style="list-style-type: none"> 1. Yes (27.5%; n = 28/102) 2. No (72.5%; n = 74/102) 3. If Yes – Produce (50%; n = 22/44) 4. If Yes – Breads (2.3%; n = 1/44) 5. If Yes – Apples (11.4%; n = 5/44) 6. If Yes – Mushrooms (6.8%; n = 3/44) 7. If Yes – Raw meat/poultry (18.2%; n = 8/44) 8. If Yes – Raw Fish (11.4%; n = 5/44) 	
	(DCO) Packaging methods at the farmers' market (n = 102)	<ol style="list-style-type: none"> 1. Use a plastic bag at time of sale only (32.4%; n = 33/102) 2. Food items are pre-vacuum packaged (6.9%; n = 7/102) 3. Some food items are pre-packaged (56.9%; n = 58/102) 4. Food items are pre-packaged in other packaging (3.9%; n = 4/102) 	
Farmers' market vendor self-reported behaviors survey questions (SB)	(SB) "If you sell raw produce, meats, or other raw foods, which foods are pre-packaged before selling them at farmers' markets?" (n = 31)	<ol style="list-style-type: none"> 1. Raw produce (fruits/vegetables) (12.9%; n = 4/31) 2. Meat and/or poultry (9.7%; n = 3/31) 3. Other raw foods (12.9%; n = 4/31) 4. I don't pre-package any raw produce, meats, or other raw foods (25.8%; n = 8/31) 5. I do not sell raw produce, meat, poultry, or other raw foods (38.7%; n = 12/31) 6. I do not know (0%) 	
PA State Sanitarian surveys; Reported observations from state inspections (Part I: Frequency of non-compliance; Part II: Reason for non-compliance)	Observation, Survey Question, or Inspection item	Part 1: Frequency of Non-Compliance ^{a,b,c}	Part 2: Reason for Non-Compliance ^{a,b,c}
	(Inspection item) "Food in good condition, safe, and unadulterated" (Part I: n = 44 Part II: n = 38)	Almost never (27.3%; n = 12/44) Rarely (38.6%; n = 17/44) Sometimes (20.5%; n = 9/44) Often (6.8%; n = 3/44) Usually (6.8%; n = 3/44) Almost Always (0%)	<ol style="list-style-type: none"> 1. I have never observed this inspection item to be out of compliance (18.4%; n = 7/38) 2. Food is in poor condition (28.9%; n = 11/38) 3. Food is unsafe or adulterated (34.2%; n = 13/38) 4. Other (28.9%; n = 11/38) 5. I do not know (5.3%; n = 2/38)

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TABLE 5. Farmers' market vendor self-reported responses, direct concealed observations, and PA State Sanitarian reported observations related to packaging, labeling, and food display (cont.)

Needs Assessment Tool	Observation, Survey Question, or Inspection item	Observation or Survey Response ^{a,b}	
		Part 1: Frequency of Non-Compliance ^{a,b,c}	Part 2: Reason for Non-Compliance ^{a,b,c}
PA State Sanitarian surveys; Reported observations from state inspections (Part I: Frequency of non-compliance; Part II: Reason for non-compliance)	(Inspection item) "Food separated and protected" (Part I: n = 43 Part II: n = 25)	Almost never (13.9%; n = 6/43) Rarely (20.9%; n = 9/43) Sometimes (51.2%; n = 22/43) Often (7%; n = 3/33) Usually (4.7%; n = 2/43) Almost Always (2.3%; n = 1/43)	1. I have never observed this inspection item to be out of compliance (8%; n = 2/25) 2. Food is in poor condition (12%; n = 3/25) 3. Food is unsafe or adulterated (28%; n = 7/25) 4. Other (64%; n = 16/25) 5. I do not know (4%; n = 1/25)

^aSum of response rate may be greater than 100% because of rounding.

^bResults include multiple responses per survey question.

^cInspection items refer to those items present on the Pennsylvania Department of Agriculture Food Establishment Inspection Report. Surveys of PA State Sanitarians listed exact inspection item statements and asked PA State Sanitarians to rank the frequency an inspection item had been observed to be "out of compliance" during inspections of farmers' market vendors in Part I (Likert scale), and Part II (multiple choice) was a follow up question asking why the non-compliance generally occurred. Response rates varied between Parts I and II within each question because of incomplete responses or no responses for each question per participant.

assessment. The results also demonstrate that DCOs mirror PA state sanitarian inspection results and observations. The use of DCOs and additional survey methods provide a realistic, valid, and practical assessment of food safety practices of vendors at farmers' markets. Overall, both the DCOs and PA state sanitarian survey results did not reveal a high percentage of instances of poor vendor personal hygiene. In contrast, an observational assessment of farmers' markets in Rhode Island found that 80.8% (21/26) of the vendors had unclean clothing (25). These results suggest that differences in food safety oversight or size and popularity of farmers' markets among U.S. states could influence efforts made by vendors to maintain good personal hygiene at the farmers' market. Because of the increase in TCS and RTE foods sold at farmers' markets, and the increase in regulatory oversight of those vendors in PA, the increased use of disposable gloves was expected. In reality, disposable glove use at PA farmers' markets remains low, even among vendors who sell unpackaged RTE foods. DCOs found only ~24% of the vendors had disposable gloves present at a vending stand, regardless of the foods sold. This observation was

further substantiated by surveyed vendors, who reported that ~34% used disposable gloves, despite the fact that a majority of surveyed vendors sold TCS and RTE foods at the same stand. Within the group of vendors observed to be using disposable gloves, slightly less than one-half were found to use them improperly. The handling of money and unpackaged foods without changing gloves in between tasks was the most common improper glove-use behavior. PA state sanitarians also noted that more often than not, disposable gloves were found to be used improperly during inspections, with the handling of money being the most common reason for non-compliance. These results may suggest that there is a general lack of understanding among vendors on when to use disposable gloves, when to change gloves, and what kinds of behaviors are unacceptable while wearing gloves.

Like disposable glove use, handwashing at farmers' markets is seldom observed. While the majority of improper handwashing behaviors observed by researchers and also noted by PA state sanitarians consisted of the handling of money (~87%) and then touching unpackaged foods, the overall lack of proper handwashing facilities observed at farmers'

TABLE 6. Farmers' market vendor self-reported responses, direct concealed observations, and PA State Sanitarian reported observations related to cold storage and thermometer use

Needs Assessment Tool	Observation, Survey Question, or Inspection item	Observation or Survey Response ^{a,b}
Farmers' market vendor direct concealed observations (DCO)	(DCO) Cold storage of foods which require cold storage (n = 102)	<ol style="list-style-type: none"> 1. Yes (66.7%; n = 68/102) 2. No (2.9%; n = 3/102) 3. NA (30.4%; n = 31/102)
	(DCO) Presence of thermometers in cold storage containers (n = 102)	<ol style="list-style-type: none"> 1. Yes (8.8%; n = 9/102) 2. No (60.8%; n = 62/102) 3. NA (30.4%; n = 31/102)
	(DCO) Types of cold storage used by vendors (n = 71)	<ol style="list-style-type: none"> 1. Cooler with ice (26.8%; n = 19/71) 2. On ice in a deli-case (16.9%; n = 12/71) 3. Cooler with no ice (9.9%; n = 7/71) 4. Electric refrigerator or freezer (40.8%; n = 29/71) 5. Combination cooler with ice and cooler with no ice (2.9%; n = 2/71) 6. Combo refrigerator/freezer and deli case with ice (2.9%; n = 2/71)
Farmers' market vendor self-reported behaviors survey questions (SB)	(SB) "If you sell food items that require cold storage, how do you store them at farmers' markets?" (n = 26)	<ol style="list-style-type: none"> 1. In a cooler with ice or ice packs (88.5%; n = 23/26) 2. In a cooler with NO ice or ice packs (food is already frozen) (7.7%; n = 2/26) 3. In a non-refrigerated deli case, but foods are packed on ice (3.8%; n = 1/26) 4. I do not know (3.8%; n = 1/26)
	(SB) "If you sell food items that require cold storage do you use a thermometer at farmers' markets to check the temperature of the foods?" (n = 24)	<ol style="list-style-type: none"> 1. Yes (62.5%; n = 15/24) 2. No (25%; n = 6/24) 3. No, but all of my foods are stored on ice, so I know they are cold enough (8.3%; n = 2/24) 4. I do not know (4.2%; n = 1/24)
	(SB) "If you use a thermometer at farmers' markets, how often do you calibrate it?" (n = 23)	<ol style="list-style-type: none"> 1. I don't use a thermometer (30.4%; n = 7/23) 2. Before each market day (8.7%; n = 2/23) 3. Once every few months (8.7%; n = 2/23) 4. I've never calibrated it (13%; n = 3/23) 5. I don't know how to calibrate (8.7%; n = 2/23) 6. I do not know (26%; n = 6/23) 7. Other (4.3%; n = 1/23)

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TABLE 6. Farmers' market vendor self-reported responses, direct concealed observations, and PA State Sanitarian reported observations related to cold storage and thermometer use (cont.)

Needs Assessment Tool	Observation or Survey Response ^{a,b}		
	Observation, Survey Question, or Inspection item	Part 1: Frequency of Non-Compliance ^{a,b,c}	Part 2: Reason for Non-Compliance ^{a,b,c}
PA State Sanitarian surveys; Reported observations from state inspections (Part I: Frequency of non-compliance; Part II: Reason for non-compliance)	(Inspection item) "Proper cooling methods used and adequate for temperature control" (Part I: n = 41 Part II: n = 36)	Almost never (39%; n = 16/41) Rarely (14.6%; n = 6/41) Sometimes (31.7%; n = 13/41) Often (4.9%; n = 2/41) Usually (7.3%; n = 3/41) Almost Always (2.4%; n = 1/41)	1. I have never observed this inspection item to be out of compliance (33.3%; n = 12/36) 2. Containers used to cool or keep foods cold are not adequate or working properly (36.1%; n = 13/36) 3. Temperature control is inadequate due to the lack of a temperature monitoring device available (41.7%; n = 15/36) 4. Vendors are unaware of the requirements for proper cooling methods and temperature control (22.2%; n = 8/36) 5. Vendors are unaware of how to properly cool and control the temperature of stored foods (36%; n = 13/36) 6. Other (8.3%; n = 3/36)
	(Inspection item) "Thermometer provided and accurate" (Part I: n = 40 Part II: n = 39)	Almost never (12.5%; n = 5/40) Rarely (10%; n = 4/40) Sometimes (50%; n = 20/40) Often (17.5%; n = 7/40) Usually (7.5%; n = 3/40) Almost Always (2.5%; n = 1/40)	1. I have never observed this inspection item to be out of compliance (5.1%; n = 2/39) 2. No thermometer is available or used by vendors (66.7%; n = 26/39) 3. Thermometers are used by vendors but are inaccurate (33.3%; n = 13/39) 4. Thermometers are available but vendors are not using or reading them properly (25.6%; n = 10/39) 5. Thermometers used by vendors are not able to be calibrated (20.5%; n = 8/39) 6. Vendors are unaware of the requirements to use a thermometer (30.8%; n = 12/39) 7. Vendors are unaware of how to properly use a thermometer (17.9%; n = 7/39) 8. Other (7.7%; n = 3/39) 9. I do not know (2.6%; n = 1/39)

^aSum of response rate may be greater than 100% because of rounding.

^bResults include multiple responses per survey question.

^cInspection items refer to those items present on the Pennsylvania Department of Agriculture Food Establishment Inspection Report. Surveys of PA State Sanitarians listed exact inspection item statements and asked PA State Sanitarians to rank the frequency an inspection item had been observed to be "out of compliance" during inspections of farmers' market vendors in Part I (Likert scale), and Part II (multiple choice) was a follow up question asking why the non-compliance generally occurred. Response rates varied between Parts I and II within each question because of incomplete responses or no responses for each question per participant.

markets in PA was also concerning. Other studies have found similar results related to handwashing. Behnke et al. reported that among 18 observed RTE farmers' market vendors in Indiana, handwashing was observed only twice among 417 instances in which it was required (7). Touching personal belongings, clothing, and money, and then handling RTE foods, was identified as the most significant violation. Vandeputte et al. also observed that the majority (93%; 13/14) of farmers' market vendors observed in Rhode Island did not have handwashing facilities available, and none of the vendors were observed to wash their hands during market hours (25). Similarly, among 17 farmers' market cheese vendors observed in Ontario, Canada, 88% of vendors did not wash their hands before or after serving patrons cheese, even though 76% of vendors had a handwashing sink on the premises (23). These results suggest that the lack of handwashing at farmers' markets by vendors may not be specific to Pennsylvania but could be considered a nationwide issue.

Another factor that may contribute to this situation is that vendors could be following the same general hygiene and food-handling practices that they use on the farm. Harrison et al. found that among 226 surveyed farmers in three southern U.S. states, only 67% and 64% reported having a handwashing and/or bathroom facility near the field and packing shed, respectively, while 50% harvested crops with bare hands and only 41% offered sanitation training for workers (13). Because of the wide range of environmental conditions encountered at farmers' markets in PA and the observed lack of proper handwashing and disposable glove use at farmers' markets, good display and packaging methods could alleviate many of the food safety risks observed at farmers' markets. Fortunately, a majority of DCOs found food display surfaces to be clean, although ~27% of observations found unpackaged foods placed directly on uncovered vending surfaces, with a majority of those surfaces being wood. PA state sanitarians also reported a high percentage of non-compliance caused by vending surfaces being made of uncleanable surfaces like wood, which are not covered. Similar results were observed by Teng, Wilcock, and Aung, who found that 29% of cheese vendors at Ontario farmers' markets had obvious signs of vending area uncleanliness, although 94% used cleanable vending surfaces (23).

Risks associated with unclean vending surfaces also can be exacerbated by the lack of pre-packaging of TCS and RTE foods placed directly on those surfaces. In this study, only ~10% of the vendors pre-packaged 100% of their food products. Interestingly, an analysis of packaging methods used by vendors who were observed to perform improper handwashing or glove use behaviors found that vendors who pre-packaged 100% of their food products were least likely to perform improper handwashing or glove use behaviors. The use of pre-packaging at farmers' markets has the potential to alleviate the risks of vendors not utilizing proper hand-washing and proper disposable glove use. Future training and food safety education for vendors could focus on providing inexpensive and convenient methods of pre-packaging foods for sale at farmers' markets.

As farmers' markets and vendors have evolved over the past decade, the types of foods offered by vendors that require cold storage also has increased. In response, many vendors are using commercial-like electrically powered refrigeration and freezer devices; however, the use of portable coolers remains most popular. While DCOs and PDA inspection results have revealed few issues related to the type of cold storage units used by vendors, an overall lack of thermometer use at farmers' markets was identified in this study. Among DCOs, only ~9% of the vendors have a thermometer on site or in the cold storage unit. A majority of PA state sanitarians also indicated that non-compliance was "sometimes – almost always" issued for thermometers not being available or used by vendors. In a related study, only 16% of cheese purchased from Ontario farmers' market vendors was found to be held properly, below 5°C, with temperatures ranging from 14 to 21°C (23). Based on these results, thermometer use at farmers' markets is rare, even among vendors storing cold foods.

CONCLUSIONS

Through the use of DCOs, a self-reported vendor survey, and a PA state sanitarians survey, important gaps in retail food safety behaviors at farmers' markets were identified. Specifically, vendors were found to demonstrate insufficient or high-risk behaviors in the areas of handwashing, personal hygiene, and cross-contamination. Overall, observations of vendor-related food safety behaviors and PA inspector-reported inspection outcomes were similar, while vendor self-reported behaviors were counter to those behaviors observed by the researchers. Based on these outcomes, it can be concluded that farmers' market vendors in PA would greatly benefit from training programs customized for vendors to address food safety risks and requirements specifically associated with farmers' markets.

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