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6200 Aurora Ave., Suite 200W, Des Moines, IA 50322-2864

Robson A. M. Machado[1]* and Catherine N. Cutter[1]

[1]Dept. of Food Science, 202 Rodney A. Erickson Food Science Building, The Pennsylvania State University, University Park, PA 16802, USA

Training Hard-to-Reach Pennsylvanian Cheesemakers about Food Safety, Using a Low-tech Training Tool

ABSTRACT

Consumers' interests in local foods have helped direct-to-consumer marketing, such as farmers' markets or on-farm sales, to soar in the United States in the past several decades. With the increase in sales and economic importance of this sector, public health agencies and academia have begun to focus on the food safety risks associated with this relatively unregulated side of the food industry. Small-scale dairy farms are one such source of local food. However, little is known about food safety- and sanitation-related knowledge, behavior, attitude, and skills of farmstead cheesemakers in the U.S. Investigating this gap and proposing solutions to close it is important, given that dairy farm and processing environments may be responsible for contamination of raw milk, cheese, and other dairy products with foodborne pathogens. To address these issues, a customized counter-top food safety and sanitation training program for farmstead cheesemakers was developed, disseminated, and evaluated. Seventeen farmstead cheesemakers from across Pennsylvania agreed to participate and were divided randomly into a control group (n = 7; no treatment) and two treatment groups (n = 5 each). To address whether storytelling could affect the outcome of the food safety training, a video vignette was designed and administered to one of the treatment groups. Both treatment groups received a pre-test, followed by the counter-top training, and then a post test three weeks later. Pre- and post-tests addressed food safety knowledge, attitudes, and behavior, as well as an evaluation of handwashing skills. As expected, the counter-top training significantly ($P < 0.05$) increased participants' food safety knowledge (by 18%), and handwashing skills also improved (25%), while no change was observed for those attributes in the control group. Unfortunately, changes in food safety attitude and behavior were not observed for either of the treatment groups. Additionally, storytelling with the use of video vignette did not impact any of the attributes studied, although its use was perceived as beneficial by participants. The results demonstrated that a combination of counter-top food safety training with a handwashing activity could result in significant gains in cheesemakers' food safety knowledge and handwashing skills. The information from this study may provide researchers and/or regulators with information that can be used to improve the delivery of food safety information to this audience.

*Author for correspondence: *(currently affiliated with The University of Maine)* Phone: +1 207.581.3144; Fax: +1 207.581.1636; Email: robson.machado@maine.edu

INTRODUCTION

With the "go local" movement, interest in agricultural products from small farms and local producers has increased. There was a large (218%) increase in direct-to-consumer marketing—the main sales outlet for the small farmer—from $551 million in 1997 to $1.2 billion in 2007 *(20)* in the United States, followed by an another significant increase (8%), to $1.3 billion, in 2012 *(4)*. One of the factors driving this trend is the perception by consumers that local foods are "fresher, safer, and support family farmers," in contrast to foods that are "industrially produced," or those that support large corporations, and are perceived to be "unhealthy" *(28)*. These local food sources, such as farmers markets and on-farm sales, are undoubtedly a major source of revenue for farmers and provide a choice of foods for consumers. In recognition of the increasing importance of these sources, public health agencies and academia have begun to focus on the inherent food safety risks associated with this relatively unregulated side of the food industry *(10, 29, 36)*.

Interest has also grown in identifying food safety risks associated with foods produced from small farms, including farmstead cheese processors. The American Cheese Society states that for cheese to be classified as "farmstead," it must be made with milk from the farmer's own herd, or flock, on the farm where the animals are raised *(8)*. In this study, for lack of a better term, participating farms will be referred to in general as farmstead farms, even if some of the farms bought their milk from other local dairy farms. In Pennsylvania, farmstead cheese production on family owned/operated dairy farms typically seems to utilize farmers' markets, on-farm sales, and other direct-to-consumer approaches as their primary sales outlets *(19)*. These farms employ a small number of people who are involved in the cheesemaking procedures on site and are inspected twice a year by the Pennsylvania Department of Agriculture (PDA) or a local health department *(7)*.

Previously, publications have addressed needs assessment *(19)* and microbiological aspects *(18)* of farmstead cheesemaking. However, there is no research addressing food safety knowledge, behavior, attitudes, and skills of farmstead cheesemakers in the U.S. There is some evidence that food handlers in small food businesses lack basic knowledge of food hygiene *(37)*. A recent comprehensive-needs assessment *(19)* indicated that basic food safety and sanitation gaps exist for farmstead cheese processors, even though most participants (65%) reported having sufficient knowledge, as well as positive behavior and attitudes about food safety and sanitation.

These gaps may be addressed through educational training. For decades, the retail food industry has used employee food safety education and training as critical components of ensuring a successful and safe retail food business *(29)*. Effective food safety training has been shown to increase food safety-related knowledge and attitudes while improving skills and behaviors of employees *(21, 33)* and may even improve inspection outcomes in restaurants *(22)*. The evidence of the efficacy of well-established food safety training methods is vast. However, retail food safety training programs, such as ServSafe® or SafeMark©, may not be appropriate to address the unique food-safety and sanitation needs of this audience in Pennsylvania or of similar audiences across the country.

Given the lack of food safety and sanitation training for this audience, the purpose of this study was to develop and evaluate the impact of a customized food safety and sanitation-training program on the knowledge, attitudes, behavior, and skills of farmstead cheesemakers in Pennsylvania.

MATERIALS AND METHODS

The experimental design was previously reported by these authors *(18)*. Briefly, out of 55 small dairy plants in PA that were potential participants, 17 agreed to participate in this study. The majority of participants were located between the central and southeastern areas of PA, in the Lancaster County region, with one participant based in the northwestern area. This distribution of participants matches the distribution of small dairy farms in the state *(14)*. This study used an adaptation of a pre-test/post-test, experimental control group design *(12)*. The participating dairy plants (n = 17) were randomly assigned (RA) to either the control group (n = 7), the treatment 1 group (×1; n = 5) or the treatment 2 group (×2; n = 5) by a true experimental design. Random assignment to the control and treatment groups was done using the tool "Integer Set Generator" available at Random.org *(6)*.

An assessment was developed for food safety and sanitation knowledge, attitudes, behavior and skills and administered as a pre-test (E1) to treatment groups 1 and 2 *(Fig. 1)*. Following the training intervention, the same assessment was administered as a post-test (E2 and E3) for treatment groups 1 and 2, respectively. The same assessment was given to the control group labeled pre-test (E4) and post-test (E5) with no training intervention, in an effort to assess the impact of training on the two treatment groups. Demographic questions were included in the pre-tests (E1 and E4), and a program evaluation was included in the post-tests for treatment groups only (E2 and E3).

There were a total of 31 individual participants, as follows: control group (n = 12), treatment group 1 (n = 9) and treatment group 2 (n = 10) *(Table 1)*. Three participants in the control group and three participants in treatment 2 group did not have their handwashing skills assessed because of technical problems during the recording of handwashing skills. One participant in the control group partially filled out the behavior portion of the survey and was excluded from the analysis of that attribute.

The experimental design used controls for all internal validity threats (history, maturation, testing, instrumentation,

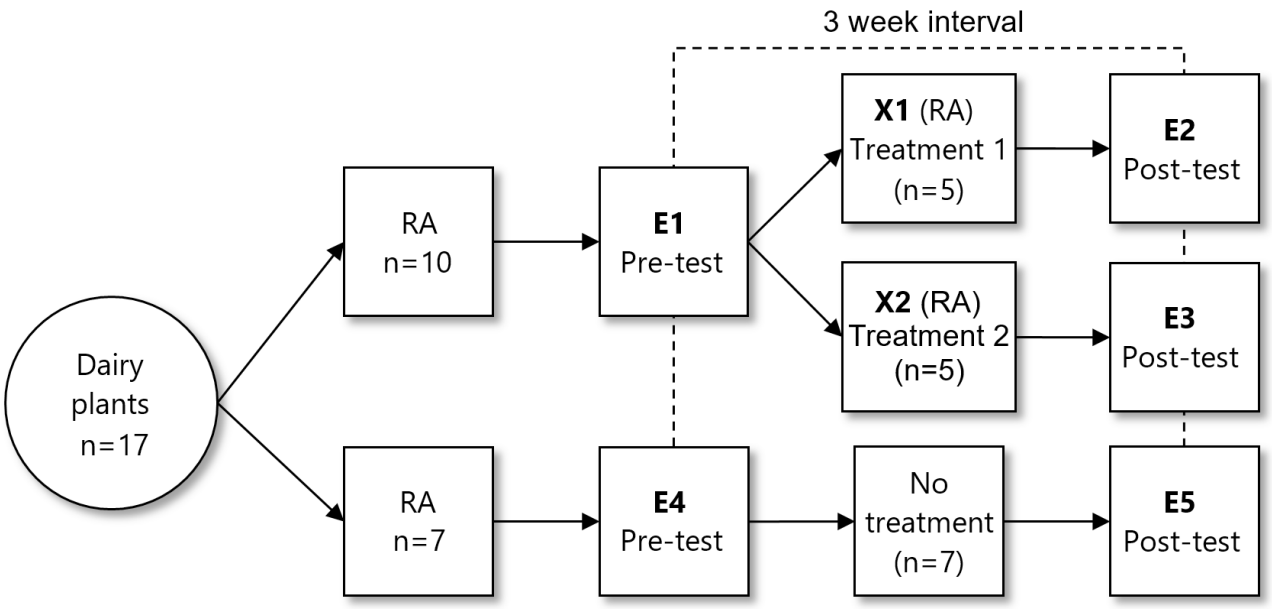

Figure 1. Pre-test/post-test experimental control group design (RA = Random assignment)

regression, selection, mortality, and interactions), as proposed by Campbell and Stanley *(12)*. A fixed and short time interval between pre- and post-tests for both treatment and control groups helped to minimize interaction and maturation threats to internal validity. An interval of three weeks was used to permit travel and visits to all 17 farms.

The first module of the training covered basic food safety and sanitation as they applied to small cheese producers, while the second module covered personal hygiene and included a step-by-step demonstration on proper handwashing. The training was delivered to the treatment groups using a counter-top flip-chart format *(24, 27)*. The training was the same for both treatment groups, except that for participants in treatment group 2, a video vignette was shown before the training. The counter-top training tool was designed as a flip-chart with photos and illustrations on the side facing the trainees and text to be read on the side facing the trainer *(26)*. Trainees were instructed to interrupt the session at any time if they had any questions. The delivery of the training alone (disregarding the video vignette in ×2) usually took between 45 min and one hour, depending on the questions and discussions with participants.

The video vignette, used before the delivery of the training to treatment group 2 (×2), consisted of a mock news excerpt describing a foodborne listeriosis outbreak involving cheese. The script for the video vignette was based on a real outbreak involving a cheese company in Kenton, DE *(5)*. In the vignette, a journalist covering the news interviews a physician to ask about the disease listeriosis, and a food safety specialist discusses the causes of the outbreak and what could have been done to avoid it. The video/screenplay had a total run time of six minutes and 34 seconds and was shown just before the counter-top training was delivered.

For farms in treatment groups 1 and 2, the pre-tests (E1) and trainings (×1 and ×2) were done on the same day. The first part of the assessment involved the handwashing skill evaluation, in which participants were asked to wash their hands while being recorded for later assessment. After the skill recording, participants filled out the survey, answering questions on demographics as well as on food safety knowledge, behavior, and attitudes. After the participants completed the survey, the training was delivered as described earlier. On the visit for the post-tests (E2 and E3), the same sequence (skill assessment, followed by post-survey) was carried out, without the demographic portion of the survey or the training. Similarly, participants in the control group followed the same steps on visits for pre-test (E4) and post-test (E5), but no training was delivered at either visit. For the surveys and the handwashing recordings (via a smartphone), a coded system was used to avoid identification of participants. Results from the surveys were compiled using Microsoft Excel® 2013, and responses were transformed into scores or percentages, where appropriate. All the methodology applied received approval from Penn State Office of Research Protection (PSU-IRB #2291).

Questions in the pre- and post-test were built on the basis of the methodology described by Witkin and Altschuld *(38)* to assess cheesemaker knowledge, attitudes, and behaviors regarding food safety and sanitation. The survey was reviewed by Penn State faculty and by Extension specialists for grammar, clarity, and time required for completion. Based on the feedback, questions were revised, with the final

TABLE 1. Dairy plants' group assignment, number of individual participants per dairy plant, and number of participants per group

Dairy	Assignment	Number of individual participants per attribute		
Plant		Knowledge and attitude	Behavior	Skill (handwashing)
1	Control	3	3	3
2	Control	1	1	1
3	Control	2	1	2
4	Control	2	2	1
5	Control	1	1	1
6	Control	2	2	1
7	Control	1	1	0
		Total participants: **n = 12**	**n = 11**	**n = 9**
8	Treatment 1	1	1	1
9	Treatment 1	3	3	3
10	Treatment 1	1	1	1
11	Treatment 1	1	1	1
12	Treatment 1	3	3	3
		Total participants: **n = 9**	**n = 9**	**n = 9**
13	Treatment 2	2	2	2
14	Treatment 2	3	3	2
15	Treatment 2	2	2	2
16	Treatment 2	2	2	1
17	Treatment 2	1	1	0
		Total participants: **n = 10**	**n = 10**	**n = 7**

survey consisting of 10 multiple-choice questions for the demographics portion; 16, 5-point Likert Scale questions for the attitude portion (anchors: Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, and Strongly Agree); and 10 multiple-choice and open-ended questions for the behavior portion. The 10 self-assessment behavior questions included three open-ended questions for numerical values and one question in which participants could choose more than one correct answer, with the remaining questions being single-answer, multiple choice. The knowledge portion of the survey had 10 multiple-choice questions, with eight questions having a single correct answer and two allowing more than one correct answer, for a total of 15 correct alternatives and a total possible score of 15 points. The demographics, behavior, and attitude questions were based on the survey used for an initial needs assessment *(19)*, while the knowledge questions were based on the training material and covered basic food safety, sanitation, and personal hygiene *(17)*. The survey was estimated to take cheesemakers 15 minutes to complete. A post-hoc reliability assessment was performed using Cronbach's alpha on the attitudinal questions of the survey. Cronbach's alpha is a measure of reliability or internal consistency, i.e., how well a test measures what it aims to measure *(34)*.

All participants agreed to the video recording of the handwashing activity on a smartphone. Participants were instructed to wash their hands the same way they do during cheesemaking. Recordings were taken via a close-up shot of the hands to avoid identification of participants and to be able to record the sounds made during the handwashing. Participants were judged to have finished washing their hands when they threw away disposable paper towels, stopped drying their hands using a non-disposable towel, or otherwise signaled that they were finished in the cases when they did not dry their hands.

A scoring system was used to evaluate the recorded handwashing skills. The system was adapted from other

TABLE 2. Steps evaluated during handwashing and points assigned

Step	Action (points awarded)
1. Wet hands	No (0); Partial/only backs or palms (1); All/both backs and palms (2)
2. Apply soap	No (0); Yes (2)
3a. Lather vigor	No vigor/no sound (0); Minimal vigor/barely audible (1); Vigorous/clearly audible (2)
3b. Lather time	5 seconds or less (0); 5 to 10 sec. (1); more than 10 sec. (2)
4. Rinse	No (0); Partial/only backs or palms (1); All/both backs and palms (2)
5. Dry	No (0); Partial/only backs or palms (1); All/both backs and palms (2)

systems used by medical professionals *(2)* and took into consideration the handwashing steps presented at the training. Five handwashing steps were evaluated, and points were assigned to different levels of completion of each step. Lather was the only step evaluated in two parameters (vigor and time) and had a maximum combined score of 4 points, 2 for vigor and 2 for time. Vigor was awarded 2 points for clearly audible lathering sound, 1 point for barely audible sound, and 0 for no sound. The level of sound was assessed qualitatively by a researcher using the same earphones, computer, and volume level. For lather time, 0 points were awarded for 5 seconds or less, 1 point for 5 to 10 seconds, and 2 points for more than 10 seconds. When only the hands' backs or palms were used during the steps 'wet hands,' 'rinse,' and 'dry,' a partial score of 1 was awarded. The criteria for scoring are presented in *Table 2*.

In addition to the scoring tool, four questions that were filled out before and after handwashing were exploratory and were not assigned any points; these assessed handwashing station characteristics: 1. Is hot water present at handwashing station? (Yes/No); Is soap available at handwashing station? (Yes/No); 3. What kind of towel is available? (Paper/Cotton/None/Other); 4. Is hand sanitizer available at handwashing station? (Yes/No). A fifth question, about total handwashing time, was determined by researchers when the video was evaluated. The recordings of the handwashing steps allowed a precise measurement of the total time of the handwashing process and the lathering time. Time was assessed with the Android 6.0 stopwatch option of the stock clock app on a Nexus 5× phone (LG Electronics, Seoul, South Korea). Participants in the treatment groups evaluated the program with six questions: two 5-point Likert scale questions and four single-answer, multiple-choice questions.

Statistical analysis

Pre- and post-test scores were compiled, and measures of central tendency and percent scores were calculated to determine changes in individual and overall participant performance between pre- and post-test assessments and among treatment groups. Two approaches were used. For the first approach, each participant was considered individually, while for the second, scores for participants from the same farm were averaged. A one-way ANOVA was used to compare the means among control, treatment 1, and treatment 2 groups for the different attributes. A paired Students *t*-test was used to detect significant differences in responses between pre- and post-test assessments. A two-sample Students *t*-test was used to determine significant differences between the two treatment groups in the pre-test when testing for the influence of demographic characteristics on the base level of the attributes measured. Post-hoc Cronbachs alpha reliability assessment was performed for the attitude assessment. ANOVA and Cronbachs tests were carried out using Minitab® 17 Statistical Software (Minitab Inc., State College, PA). Students *t*-tests were carried out using Microsoft® Office Excel® 2013 (Microsoft Corp., Redmond, WA).

RESULTS

Demographics

Participating farms' demographic characteristics are presented in *Table 3*. Significant findings included the following: more than 70% of farms define their operation as artisan and/or farmstead, based on the American Cheese Society definition *(8)*; 88% (15/17) of farms produce raw milk cheeses; and 73% (11/15) of farms indicated that they used raw milk and would not use pasteurized milk to make their cheese(s). Some participants reported other reasons for the use of raw milk in the open-ended option as follows: *"We do not have a pasteurizer yet, but are exploring getting one;" "Cheese [is] aged 60 days or more so the bacteria is gone. Better flavor. Fresh cheeses are pasteurized;" "Customers prefer raw cheese when available so I make raw when permitted (as in aged cheeses);" "I like to produce a product that is minimally manipulated – using the naturally occurring fauna that is present in the milk – but I also use pasteurized milk for fresh cheese;" "If we don't have enough time to pasteurize or if [the] pasteurizer isn't functioning correctly– back up [sic] plan;" and "Customers*

TABLE 3. Answers to demographic questions with the number of answers per item (#) and percentage

Question	#	%
1. Using the above definitions, please select the option that BEST describes your cheesemaking operation: (Check all that apply)		
Artisan (see the American Cheese Society (ACS) definition above)*	12	71
Farmstead (see the ACS definition above)	13	76
Specialty (see the ACS definition above)	8	47
Cheesemaking cooperative	0	0
Commodity producer	1	6
I do not know.	0	0
	n** = 17	
2. Do you produce raw milk cheese(s)?		
No	2	12
Yes	15	88
I do not know.	0	0
	n = 17	
2b. If YES, what percentage of your cheese is made from raw milk?		
< 25%	2	13
25% – 50%	2	13
51% – 75%	1	7
76% – 99%	2	13
100%	8	53
I do not know.	0	0
	n = 15	
3. What are the reasons you do not use pasteurized milk? (Check all that apply)		
I do not have a pasteurizer and there is no milk processing plant close to my farm to pasteurize my milk.	0	0
It's expensive to send my milk for pasteurization.	0	0
There is no milk processing plant close to my farm for me to buy pasteurized milk.	0	0
Buying pasteurized milk is more expensive.	0	0
I prefer to use raw milk and would not use pasteurized milk anyway.	11	73
I do not know.	0	0
Other: (please specify)	4	27
	n = 15	
4. How many pounds of cheese do you produce annually?		
< 1,000 lbs	0	0
1,001 – 5,000 lbs	8	47
5,001 – 10,000 lbs	1	6
10,001 – 20,000 lbs	0	0
20,001 – 50,000 lbs	0	0
50,001 – 100,000 lbs	7	41

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TABLE 3. Answers to demographic questions with the number of answers per item (#) and percentage (cont.)

Question	#	%
100,001 – 500,000 lbs	1	6
500,001 – 1,000,000 lbs	0	0
> 1,000,000 lbs	0	0
I do not know.	0	0
	n = 17	
5. How do you sell your cheese? (Check all that apply)		
Direct sales to retailers	10	59
Direct sales to restaurants	6	35
Through distributors	11	65
At farmers' markets	6	35
Through my own store (separated from farm)	3	18
On farm sales	10	59
Through my own website	3	18
At regional festivals and shows	2	12
Through other websites	0	0
Other: (please specify)	3	18
I do not know.	0	0
	n = 17	
6. Do you have written Standard Operating Procedures (SOPs) for the cheesemaking operations?		
No	8	47
Yes, but just one general SOPs for all cheeses	1	6
Yes, and I have separate SOPs for different kinds of cheeses	1	6
No, I only use a cheesemaking worksheet or other written recipe	6	35
Other: (please specify)	1	6
I do not know.	0	0
	n = 17	
7. Does your cheesemaking operation currently have a HACCP (Hazard Analysis Critical Control Point) or HARPC (Hazard Analysis Risk-based Preventive Controls) plan in place?		
No	14	82
Yes	2	12
I do not know.	1	6
	n = 17	
8. How long have you been making cheese?		
Less than 1 year	2	7
1 to 3 years	4	14
4 to 10 years	16	55
More than 10 years	6	21
I do not know.	1	3
	n = 29†	

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TABLE 3. Answers to demographic questions with the number of answers per item (#) and percentage (cont.)

Question	#	%
9. Do you have any food safety training?		
No	11	38
Yes. Please specify:	18	62
I do not know.	0	0
	n = 29†	
10. Do you have any sanitation training?		
No	16	55
Yes. Please specify:	13	45
I do not know.	0	0
	n = 29†	

*Definition: the cheese must be made with milk from the farmer's own herd, or flock, on the farm where the animals are raised.

**indicates the total number of farms, not answers, since it was a "check all that apply" question.

†indicates the questions that were answered by all participants, not individual farms.

want raw milk cheese." For the raw milk cheese processors in Pennsylvania who participated in the research, an average of 76% of the cheese was made from raw milk. Annual cheese production was 47,441 lbs on average, with most dairy plants producing either between 1,001 – 5,000 or 50,001 – 100,000 lbs. The main sales outlets were through distributors, on-farm sales, and direct sales to retailers. Two farmers reported also selling their products through CSA (Community Supported Agriculture), while another had a third party sell their cheese at shows and festivals. Only two farms had written sanitation standard operating procedures (SSOPs) and a hazard analysis critical control points (HACCP) plan in place. Most participants reported 4 to 10 years (55%; 16/29) or more than 10 years (21%; 6/29) of cheesemaking experience, with 62% (18/29) of all participants reporting some food safety training. For those reporting food safety training, 39% (7/18) reported training at some cheese making course or class, 22% (4/18) reported participating in different dairy-related Penn State Extension programs, 22% (4/18) reported taking part in trainings while working in the food retail industry, 11% (2/18) mentioned training from PDA inspectors, while 6% (1/18) just described some good manufacturing practices instead of properly identifying their training source. The 18 participants who reported any food safety training scored significantly higher ($P < 0.05$) in the pre-test knowledge assessment (10.3/15; 68.7%) than the 11 participants who reported no previous food safety training (7.5/15; 50%). Attitude scores were also higher for the trained participants in the pre-test (61.2/80; 76.5%) than for non-trained participants (57.5; 71.2%). No significant differences between trained and non-trained personnel were observed in the measured behavior traits or handwashing skills during pre-test assessments.

Knowledge assessment

Average knowledge scores for individuals in the pre-test were 9.3 (62%), 9 (60%), and 9.3 (62%) for the control, treatment 1 (T1), and treatment 2 (T2) respectively, with no significant difference among these scores ($P > 0.05$). Post-test average knowledge score for individuals in the control group (8.8; 59%) was significantly lower ($P < 0.05$) than for individuals in treatments 1 and 2, both with a score of 11.9 (79%), and there were no significant differences among the treatments' post-test scores ($P > 0.05$). Comparisons of pre- and post-tests results showed significant changes only in the treatment groups, both for individuals and farms. Results are summarized in *Table 4*.

Attitude assessment

Cheesemakers responded to 16 5-point Likert scale questions in the attitudinal portion of the survey. The coefficient of reliability (Cronbach's alpha) for the attitude questions was 0.68 in the pre-test and 0.65 in the post-test when calculated for all the participants, results that were marginally below the optimal threshold of 0.70 *(25)*. Comparisons among the pre-test attitude score averages

TABLE 4. Average number and percent of correct knowledge questions (score) on pre- and post-test, change in score, and percent change in score for cheesemakers in the control, treatment 1 (T1), and treatment 2 (T2) groups for individual participants and farms

Groups	Participants per group (n)	Pre-test score (max = 15)	Percent score	Post-test score (max = 15)	Percent score	Change in score	Percent change in score
Control	12	9.3[a]	62	8.8[a]	59	-0.5	-3
T1	9	9.0[a]	60	**11.9[b]**	79	2.9	19
T2	10	9.3[a]	62	**11.9[b]**	79	2.6	17
Groups	**Farms per group (n)**	**Pre-test score (max = 15)**	**Percent score**	**Post-test score (max = 15)**	**Percent score**	**Change in score**	**Percent change in score**
Control	7	9.6[a]	64	9.2[a]	61	-0.4	-3
T1	5	9.8[a]	65	**12.2[b]**	81	2.4	16
T2	5	9.0[a]	60	**11.7[b]**	78	2.7	18

Note: Different lower case letters on the same row represent significant difference between total average pre- and post-test scores by Students paired *t*-test analysis ($P < 0.05$).

TABLE 5. Average and percent attitude score on pre- and post-test, change in score, and percent change in score for cheesemakers in the control, treatment 1 (T1), and treatment 2 (T2) groups for individual participants and farms

Groups	Participants per group (n)	Pre-test score (max = 80)	Percent score	Post-test score (max = 80)	Percent score	Change in score	Percent change in score
Control	12	59.0[a]	74	**62.5[b]**	78	3.5	4
T1	9	63.4[a]	79	65.1[a]	81	1.7	2
T2	10	57.9[a]	72	**64.8[b]**	81	6.9	9
Groups	**Farms per group (n)**	**Pre-test score (max = 80)**	**Percent score**	**Post-test score (max = 80)**	**Percent score**	**Change in score**	**Percent change in score**
Control	7	58.8[a]	74	**63.0[b]**	79	4.1	5
T1	5	63.5[a]	79	66.1[a]	83	2.6	3
T2	5	57.9[a]	72	**64.7[b]**	81	6.9	9

Note: Different lower case letters on the same row represent significant difference between total average pre- and post-test scores by Students paired *t*-test analysis ($P < 0.05$).

for individuals in all the groups demonstrated a significant difference ($P < 0.05$) between treatments 1 and 2, while the control group was not significantly different from either of the treatment groups ($P > 0.05$). There were no significant differences among the groups for the post-test attitude mean scores ($P > 0.05$). Results are summarized in *Table 5*.

Handwashing skill assessment

Hot water and soap were present at all handwashing stations, and only 2 of the 17 stations had non-disposable towels. No station had hand sanitizer available. Average handwashing scores for individuals in the pre-test were 8/12 (67%) for control, 7.6/12 (63%) for treatment 1, and 7.7/12 (64%) for treatment 2, with no significant difference

among these scores ($P > 0.05$). Total times in seconds for individuals on the pre-test for the handwashing were 27.4, 24.6, and 20.5 for the control, treatment 1, and treatment 2, respectively, with no significant difference among these scores ($P > 0.05$). Post-test average score for individuals in the control group (7.6/12; 63%) was significantly lower ($P < 0.05$) than scores for treatment 1 (10.1/12; 84%) and treatment 2 (11.2/12; 93%). There was no significant difference between the treatments' post-test scores ($P > 0.05$), but treatment 2 scores were 10% higher than treatment 1, indicating a possible effect of the video shown to treatment 2. When the data were grouped by farm, treatment 2 scored significantly higher ($P < 0.05$) than control and treatment 1 *(Table 6a)*. Total time for individuals on the post-test for the control group (24.9 sec) was significantly lower ($P < 0.05$) than for treatment 1 (37.3 sec) and treatment 2 (38.9 sec), with no significant difference between the treatments ($P > 0.05$). Results are summarized in *Tables 6a and 6b*.

TABLE 6a. Average and percent handwashing score on pre- and post-test, change in score, and percent change in score for cheesemakers in the control, treatment 1 (T1), and treatment 2 (T2) groups for individual participants and farms

Groups	Participants per group (n)	Pre-test score (max = 12)	Percent score	Post-test score (max = 12)	Percent score	Change in score	Percent change in score
Control	9	8.0[a]	67	7.6[a]	63	-0.4	-4
T1	9	7.6[a]	63	**10.1**[b]	84	2.6	21
T2	6	7.7[a]	64	**11.2**[b]	93	3.5	29
Groups	**Farms per group (n)**	**Pre-test score (max = 12)**	**Percent score**	**Post-test score (max = 12)**	**Percent score**	**Change in score**	**Percent change in score**
Control	6	7.9[a]	66	7.4[a]	62	-0.4	-4
T1	5	8.5[a]	71	10.7[a]	89	2.2	18
T2	3	7.7[a]	64	**11.2**[b]	93	3.5	29

Note: Different lower case letters on the same row represent significant difference between total average pre- and post-test scores by Students paired *t*-test analysis ($P < 0.05$).

TABLE 6b. Average and percent handwashing time on pre- and post-test, and change in time for cheesemakers in the control, treatment 1 (T1), and treatment 2 (T2) groups for individual participants and farms

Groups	Participants per group (n)	Pre-test handwashing time (sec)	Post-test handwashing time (sec)	Change in time (sec)
Control	9	27.4[a]	24.9[a]	-2.5
T1	9	24.6[a]	**37.3**[b]	12.7
T2	6	20.5[a]	**38.9**[b]	18.4
Groups	**Farms per group (n)**	**Pre-test handwashing time (sec)**	**Post-test handwashing time (sec)**	**Change in time (sec)**
Control	6	28.4[a]	25.8[a]	-2.6
T1	5	25.7[a]	**38.9**[b]	13.2
T2	3	20.5[a]	**38.9**[b]	18.4

Note: Different lower case letters on the same row represent significant difference between total average pre- and post-test times by Students paired *t*-test analysis ($P < 0.05$).

Behavior assessment

For the 10 behavior questions, no significant difference ($P > 0.05$) was found between pre- and post-test assessments for any of the groups in any of those questions, either for individuals or when the data were grouped by farm. Hair protection use was common, with more than 70% of participants in all groups reporting using it most of the time or all of the time. Most participants in all groups also reported using protective clothing during cheesemaking. Separate shoes for use inside the cheesemaking room was reported by 73% of participants in the control group, 44% in the treatment 1 group, and 60% in treatment 2 group, with no changes between pre- and post-test in all groups. Overall, behavior before and after the training was the same. Additional results are shown in *Table 7*.

Evaluation

Overall, evaluation of the program was positive, with most participants (64%) either reporting learning "Quite a bit" or "Very much" for all the topics covered during the training. When asked how much participants believed that the training helped them improve their knowledge, behavior, attitude, or skills regarding food safety and sanitation, most reported "Some improvement" (59%) or "A lot of improvement" (26%). The majority of participants reported the countertop/flip-chart training tool as "Very effective" as a training delivery method. Regarding perceived long-lasting changes in knowledge, behavior, attitude, and skills, 87% responded either "Definitely yes" or "Probably yes." Most participants (86%) exposed to the video vignette before the training reported that it "Definitely" or "Probably" helped them pay more attention to the training. When asked why did they think the video vignette helped them pay more attention to the training, some answered *"Focused on actual hands on [sic] contamination," "I learned a lot of information that I did not realize contributes to contamination," "Not good to get foodborne illness,"* and *"It showed what to do." Additional results are shown in Tables 8 to 10*.

DISCUSSION

It has been estimated that U.S. organizations spent $164.2 billion on employee learning and development in 2012 *(3)*. Food safety training has been adopted universally in an effort to comply with U.S. food safety regulations and to ensure the safety of U.S. consumers who purchase foods. Food safety training has been targeted toward employees of food service establishments, since most food-related illness is associated with catering or food service establishments *(32)*. In contrast, fewer training programs have been aimed at niche audiences with specific characteristics *(23, 26, 29, 30)*. If the public interest in foods from local sources continues to grow *(29)*, the need for food safety training tailored to farmers and other local food producers will grow as well *(29)*.

In this study, an approximately 1-hour long counter-top food-safety training program that was tailored to farmstead cheesemakers and offered at their farms in Pennsylvania was developed, delivered, and evaluated. The results demonstrated that the combination of a counter-top training program with a hands-on handwashing activity, with or without the exhibition of a video vignette, resulted in a significant gain in knowledge and handwashing skills. However, changes in attitude and behavior were not detected in this study. An increase in knowledge without a measurable, significant change in attitude and behavior has been reported before *(23, 27, 29, 33)*. Change in knowledge is usually the first step in the knowledge-attitude-behavior (KAB) model, wherein an increase in knowledge leads to changes in attitude, culminating in changes in behavior *(11)*. The model has been criticized for the weak correlation sometimes found between changes in knowledge and changes in behavior, especially if training efforts focus only on changing knowledge in the hope that this change alone will be the catalyst for changes in attitudes and behavior *(9)*. However, when training, based on the model, incorporates aspects of not just knowledge, but also attitudes and behavior, it has shown to be an appropriate approach for educational interventions *(31)*.

The findings indicate a significant increase in knowledge for the treatment groups (average 18% increase). However, there were no significant differences related to the use of a video vignette involving a real foodborne outbreak associated with cheese. It was not determined if the video vignette helped participants perform better in the knowledge assessment, possibly because of the small sample size. However, use of the video vignette positively influenced participants who viewed it, with 86% (6/7) reporting that the video vignette definitely or probably helped them pay more attention to the training *(Table 10)*. These results are aligned with results of other attempts to use vignettes and storytelling as tools for food safety information delivery *(13)*. One possible reason that an effect of the video vignette was not observed was that all problems and situations presented in the video vignette were also covered in the training. The small number of participants did not allow for a group for which the video vignette alone was used as a source of information.

Comparison of the pre-test results among groups showed that there was a significant difference between the treatment groups for the attitude portion of the survey. Also, the scores for the control group were significantly different between pre- and post-test. These results were probably unreliable, since suboptimal Cronbach's alpha test results were achieved for the construct used for the attitude assessment. A low Cronbach alpha value indicates a low reliability and higher possibility of measurement error *(34)*. Another factor to consider in the analysis is that changes in attitude are harder to attain than changes in knowledge *(27)* and that there

TABLE 7. Responses and percentage for the behavior portion of the survey for the control and treatments 1 and 2 groups

Questions	Control (n = 11)				Treatment 1 (n = 9)				Treatment 2 (n = 10)			
	Before		After		Before		After		Before		After	
	%	(#)	%	(#)	%	(#)	%	(#)	%	(#)	%	(#)
1. During a cheesemaking session, how many times do you think you wash your hands (please estimate)?	17.7	(15.2)	21.5	(28.5)	4.6	(3.1)	5.6	(3.5)	8.2	(4.8)	8.8	(8.7)
2. During a cheesemaking session, how many times do you think you leave and return to the cheesemaking room (please estimate)?	5.4	(4.2)	8.9	(9.0)	2.6	(1.8)	3.0	(3.3)	5.1	(4.0)	4.6	(4.3)
3. How frequently do you use hair protection (ex., hairnet, cap, bandana when making cheese)?												
	%	(#)	%	(#)	%	(#)	%	(#)	%	(#)	%	(#)
a) All the time	45	(5)	55	(6)	56	(5)	67	(6)	80	(8)	80	(8)
b) Most of the time	27	(3)	18	(2)	22	(2)	11	(1)	20	(2)	20	(2)
c) Some of the time	0	(0)	0	(0)	0	(0)	11	(1)	0	(0)	0	(0)
d) Never	27	(3)	27	(3)	22	(2)	11	(1)	0	(0)	0	(0)
4. How frequently do you use a beard net when making cheese?												
a) I don't have a beard	91	(10)	91	(10)	44	(4)	33	(3)	60	(6)	60	(6)
b) All the time	0	(0)	0	(0)	22	(2)	22	(2)	10	(1)	10	(1)
c) Most of the time	0	(0)	9	(1)	0	(0)	11	(1)	0	(0)	10	(1)
d) Some of the time	9	(1)	0	(0)	11	(1)	11	(1)	20	(2)	10	(1)
e) Never	0	(0)	0	(0)	22	(2)	22	(2)	10	(1)	10	(1)
5. Do you wear protective clothing (e.g., apron, overalls, etc.) inside the cheesemaking room?												
a) No, I wear my street clothes. (Proceed to question 6)	45	(5)	45	(5)	22	(2)	33	(3)	11	(1)	10	(1)
b) Yes (Please answer 5a)	55	(6)	55	(6)	78	(7)	67	(6)	89	(8)	90	(9)
5a. If yes, what kind of protective clothing do you use?												
a) Apron	44	(4)	43	(3)	29	(2)	50	(3)	45	(5)	50	(6)
b) Overalls	0	(0)	0	(0)	14	(1)	0	(0)	0	(0)	0	(0)
c) I wear designated clothing that I only use inside the cheesemaking room	44	(4)	43	(3)	57	(4)	50	(3)	27	(3)	25	(3)
d) Other. Please specify: _____	11	(1)	14	(1)	0	(0)	0	(0)	27	(3)	25	(3)

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TABLE 7. Responses and percentage for the behavior portion of the survey for the control and treatments 1 and 2 groups (cont.)

Questions	Control (n = 11)				Treatment 1 (n = 9)				Treatment 2 (n = 10)			
	Before		After		Before		After		Before		After	
	%	(#)	%	(#)	%	(#)	%	(#)	%	(#)	%	(#)
6. Do you have separate shoes/boots for use exclusively inside your cheesemaking room?												
a) Yes (Proceed to question 7)	73	(8)	73	(8)	44	(4)	44	(4)	60	(6)	60	(6)
b) No (Please answer 6a)	27	(3)	27	(3)	56	(5)	56	(5)	40	(4)	40	(4)
6a. Do you use a foot and/or boot bath/wash to sanitize your boots every time you enter the cheesemaking room?												
a) I use a foot/boot bath that I step into every time I enter the cheesemaking room.	25	(1)	25	(1)	0	(0)	0	(0)	0	(0)	0	(0)
b) I wash and sanitize my shoes/boots every time I enter the cheesemaking room.	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	25	(1)
c) I do not have any measures in place related to shoes/boots inside the cheesemaking room.	75	(3)	75	(3)	100	(5)	100	(5)	100	(4)	75	(3)
7. On a cheesemaking day, do you milk your own animals before making cheese?												
a) No, I buy my milk. (Proceed to question 8)	27	(3)	27	(3)	0	(0)	0	(0)	50	(5)	40	(4)
b) No, someone else milks the animals and I make the cheese. (Proceed to question 8)	45	(5)	45	(5)	22	(2)	22	(2)	10	(1)	10	(1)
c) Yes (Please answer 7a)	27	(3)	27	(3)	78	(7)	78	(7)	40	(4)	50	(5)
7a. If Yes, please choose the option that better describes what you do regarding your clothing:												
a) After I milk the animals, I change into clean clothes to make cheese, but I do not use protective clothing (e.g., apron, overalls, etc.).	33	(1)	33	(1)	57	(4)	57	(4)	25	(1)	0	(0)
b) After I milk the animals, I change into clean clothes to make cheese, and I also use protective clothing (e.g., apron, overalls, etc.).	0	(0)	0	(0)	14	(1)	29	(2)	50	(2)	80	(4)

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TABLE 7. Responses and percentage for the behavior portion of the survey for the control and treatments 1 and 2 groups (cont.)

Questions	Control (n = 11)				Treatment 1 (n = 9)				Treatment 2 (n = 10)			
	Before		After		Before		After		Before		After	
	%	(#)	%	(#)	%	(#)	%	(#)	%	(#)	%	(#)
c) I use protective clothing (e.g., apron, overalls, etc.) while milking to keep my street clothes clean for cheesemaking.	33	(1)	33	(1)	14	(1)	0	(0)	0	(0)	0	(0)
d) I use the same clothes for milking the animals and making cheese.	33	(1)	33	(1)	14	(1)	14	(1)	0	(0)	0	(0)
e) I use the same clothes for milking the animals and making cheese, but I use protective clothing (e.g., apron, overalls, etc.) for cheesemaking.	0	(0)	0	(0)	0	(0)	0	(0)	25	(1)	20	(1)
8. How often do you taste the curds during your cheesemaking sessions?												
a) Every session (Please answer 8a)	36	(4)	27	(3)	22	(2)	11	(1)	10	(1)	10	(1)
b) Most sessions (Please answer 8a)	9	(1)	18	(2)	11	(1)	33	(3)	30	(3)	10	(1)
c) Some sessions (Please answer 8a)	45	(5)	45	(5)	56	(5)	44	(4)	50	(5)	60	(6)
d) Never (Proceed to question 9)	9	(1)	9	(1)	11	(1)	11	(1)	10	(1)	20	(2)
8a. Do you wash your hands after tasting the curds?												
a) Always	40	(4)	40	(4)	25	(2)	50	(4)	22	(2)	50	(4)
b) Most times	30	(3)	30	(3)	38	(3)	13	(1)	11	(1)	0	(0)
c) Sometimes	20	(2)	20	(2)	38	(3)	38	(3)	33	(3)	25	(2)
d) Never	10	(1)	10	(1)	0	(0)	0	(0)	33	(3)	25	(2)
9. Please choose the option below that best describes how you cut and pack cheese for sale (Check all that apply):												
I clean all cutting and packing equipment before use (e.g., scales; knives; cutting board; cutting wires; vacuum packer; etc.)	24	(8)	21	(7)	24	(6)	23	(6)	38	(8)	21	(6)
I sanitize all cutting and packing equipment before use (e.g., scales; knives; cutting board; cutting wires; vacuum packer; etc.)	12	(4)	12	(4)	20	(5)	23	(6)	5	(1)	17	(5)

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TABLE 7. Responses and percentage for the behavior portion of the survey for the control and treatments 1 and 2 groups (cont.)

Questions	Control (n = 11)				Treatment 1 (n = 9)				Treatment 2 (n = 10)			
	Before		After		Before		After		Before		After	
	%	(#)	%	(#)	%	(#)	%	(#)	%	(#)	%	(#)
I clean all cutting and packing equipment after use (e.g., scales; knives; cutting board; cutting wires; vacuum packer; etc.)	27	(9)	30	(10)	20	(5)	23	(6)	19	(4)	24	(7)
I use gloves, but I don't wash my hands before putting them on.	6	(2)	6	(2)	4	(1)	0	(0)	10	(2)	0	(0)
I use gloves and wash my hands before putting them on.	12	(4)	12	(4)	0	(0)	12	(3)	10	(2)	24	(7)
I don't use gloves, but I wash my hands.	18	(6)	18	(6)	32	(8)	19	(5)	19	(4)	14	(4)
		(SD)		(SD)		(SD)		(SD)		(SD)		(SD)
10. During a cheesemaking session, how many times do you think you sanitize your hands and arms (by dipping them into sanitizer; please estimate)?	14.7	(30.0)	11.8	(24.6)	3.4	(3.1)	3.4	(2.9)	9.0	(12.1)	11.6	(16.8)

number of responses; average; SD standard deviation.

could be a ceiling effect—when participants scores are high in the pre-test—since, when grouped, participants scored an average of 75% in the attitude pre-test. Ideally, the questions should have been fine-tuned in a pilot test. Unfortunately, because of the small size of the population and even smaller number of participants in the research, a pilot test was not carried out. An out-of-state pilot test was not feasible because of travel constraints, and given the uniqueness of the small dairy farm population of Pennsylvania, with its large number of cheesemaking dairy farms run by plain sect families (Amish or Mennonite) *(14)*, data from an out-of-state pilot could be inappropriate. The lack of a pilot test is a limitation of this study's design. Based on the findings, no significant improvement ($P > 0.05$) in self-reported measurable behavior (handwashing, hand sanitizing, and leaving the cheesemaking room during cheesemaking) was detected. A possible reason for the lack of significant results in this area could be the large variations of responses, with some participants reporting handwashing during the cheesemaking session at 30 to 50 times, while others reported 1 to 3 times, as an example. Even when cheesemakers were compared individually before and after the training, no clear trend in improvement of those measurable behaviors was observed (data not shown). Changes in hair protection, protective clothing, and separate shoe use were minimal and not related to participation in the training. One of the positive changes in behavior correlated to the training was the increase in the number of participants who washed their hands after tasting curds. Positive behavior increased from 25% (2/8) to 50% (4/8) in treatment group 1 and from 22% (2/9) to 50% (4/8) treatment group 2, with no change in the control group (40%; 4/10). Another positive change was the increase in the number of participants sanitizing all cutting and packing equipment, from 20% (5/25) to 23% (6/26) in treatment group 1 and from 5% (1/21) to 17% (5/29) in treatment group 2, with no changes in the control group (12%; 4/33).

TABLE 8. Participants' responses and percentage for when asked how much they felt they have learned from the training, in different topics (n = 17)

Topic	None		Very little		Some		Quite a bit		Very much	
	(%)	#	(%)	#	(%)	#	(%)	#	(%)	#
Cleaning and sanitizing steps	(0)	0	(0)	0	(18)	3	(59)	10	(24)	4
TACT*	(0)	0	(6)	1	(12)	2	(59)	10	(24)	4
Cross-contamination (shoes)	(0)	0	(0)	0	(29)	5	(59)	10	(12)	2
Cross-contamination (clothes)	(0)	0	(6)	1	(35)	6	(53)	9	(6)	1
Cross-cont. (cutting/packing)	(0)	0	(0)	0	(24)	4	(53)	9	(24)	4
Cross-cont. (transporting)	(6)	1	(6)	1	(35)	6	(47)	8	(6)	1
Handwashing steps	(0)	0	(0)	0	(24)	4	(47)	8	(29)	5
Hair net and beard net utilization	(6)	1	(6)	1	(53)	9	(35)	6	(0)	0
Eating in the processing area	(0)	0	(6)	1	(35)	6	(53)	9	(6)	1
Leaving the cheesemaking room	(0)	0	(6)	1	(35)	6	(53)	9	(6)	1
Use of gloves	(12)	2	(6)	1	(29)	5	(41)	7	(12)	2
Average percent	**(2)**		**(4)**		**(30)**		**(51)**		**(13)**	

* TACT = Temperature, Action, Concentration, and Time.
# number of responses.

TABLE 9. Participants' responses and percentage for when asked how much the training helped them to improve their food safety and sanitation in different topics (n = 17)

Attribute	No improvement		Some improvement		A lot of improvement		A great deal of improvement	
	(%)	#	(%)	#	(%)	#	(%)	#
Knowledge (what you know)	(0)	0	(71)	12	(24)	4	(6)	1
Behavior (how you act)	(6)	1	(59)	10	(24)	4	(12)	2
Attitude (what you think or feel)	(18)	3	(47)	8	(35)	6	(0)	0
Skill: handwashing	(0)	0	(71)	12	(18)	3	(12)	2
Skill: vat cleaning	(24)	4	(47)	8	(30)	5	(0)	0
Average percent	**(9)**		**(59)**		**(26)**		**(6)**	

number of responses.

Use of gloves following handwashing also increased from 0% (0/25) to 12% (3/26) in treatment group 1 and from 10% (2/21) to 24% (7/29) in treatment group 2, with no changes in the control group (12%; 4/33). The number of participants who used gloves without first washing their hands also decreased in the treatment groups, but not in the control group. Increased proper glove use during cutting and packing is essential, since this is the last step in the cheese production where contamination might reach the product and is likely to reach consumers. Also, bare hand contact with ready-to-eat foods has been linked to foodborne disease outbreaks (*35*). Although glove use is deemed a good practice when handling food, researchers have shown that food handlers are less likely to wash their hands when needed, especially when using gloves (*15*). Because of these findings, the correct use of gloves should always be associated with proper handwashing practices.

TABLE 10. Participants' responses and percentage when asked how much the training helped them to improve their food safety and sanitation in different topics (n = 17)

Question	Not at all effective		Not very effective		Somewhat effective		Very effective	
	(%)	#	(%)	#	(%)	#	(%)	#
How effective was the countertop/flip-chart training tool as a delivery method for food safety training?	(0)	0	(0)	0	(24)	4	(76)	13
How effective was the handwashing activity to improve your handwashing technique?	(0)	0	(6)	1	(47)	8	(47)	8
	Definitely no		Probably no		Probably yes		Definitely yes	
	(%)	#	(%)	#	(%)	#	(%)	#
Do you think that any improvements to your food safety knowledge, behavior, attitude, and skills (if any) will be maintained over time?	(0)	0	(12)	2	(47)	8	(71)	7
Do you think that the video vignette/case study helped you pay more attention to the training?*	(0)	0	(14)	1	(43)	3	(43)	3

*Only participants that viewed the video vignette answered this question (n = 6).
number of responses.

Although no increase in handwashing frequency was detected, the handwashing performance of participants after the training in the treatment groups was significantly better than the performance of those in the control group. There was an increase in both score and time. This finding could be related to the extensive, multiple mentions and description of the steps involved in proper handwashing and the handwashing activity during the training. In the activity, after going over the proper steps for handwashing, researchers would ask participants to execute each one of the steps, while also mentioning aloud each one of the steps and their instructions. Handwashing training has been shown to be a good way to improve handwashing performance *(23, 32)*, and Lillquist et al. showed that training with hands-on handwashing activity was superior to lecture-style training *(16)*. In this study, although not statistically significant, both score and time for handwashing increased in the treatment group that was exposed to the video vignette (3.5 points, 18.4 seconds) and were higher than those for treatment group 1 (2.6 points and 12.7 seconds). Because of time constraints, the same researcher who delivered the training scored the handwashing skills. This is a limitation of this study, and future studies using a similar approach should use multiple scorers.

Self-reported food safety training in the demographic portion of the survey was a good predictor of knowledge and attitude scores, indicating that prior exposure to any kind of food safety training had positive effects on knowledge and attitudes. These findings reinforce the belief that appropriate food safety training can improve food safety performance, as has been reported before in retail food establishments *(1)*.

While the results of this study revealed positive gains in knowledge about food safety and sanitation and performance improvement in handwashing skills, further evaluation of the training program is needed to measure possible effectiveness for behavior and attitude changes that could not be detected or did not occur, possibly because of the small sample size. Also, short-term (3–6 months) and long-term (1–2 years) post-test assessments could reveal whether the gains were maintained and if the increase in knowledge was followed by later changes in attitude and behavior. The results of this study and a cheesemaker food safety and sanitation training program may be of interest to food safety educators, Extension educators, and local and/or public health agencies in the U.S. who are looking for ways to reach this underserved audience.

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REFERENCES

1. Allwood, P. B., T. Jenkins, C. Paulus, L. Johnson, and C. W. Hedberg. 2004. Hand washing compliance among retail food establishment workers in Minnesota. *J. Food Prot.* 67:2825–2828.
2. Anonymous. 2009. Measuring hand hygiene adherence: Overcoming the challenges. The Joint Commission. Oakbrook, IL. Available at: https://www.jointcommission.org/assets/1/18/hh_monograph.pdf. Accessed 23 October 2017.
3. Anonymous. 2013. $164.2 billion spent on training and development by U.S. companies. Assoc. Talent Dev. Available at: https://www.td.org/Publications/Blogs/ATD-Blog/2013/12/ ASTD-Releases-2013-State-of-the-Industry-Report. Accessed 23 October 2017.
4. Anonymous. 2014. 2012 Census of agriculture highlights: Farmers marketing. Available at: https://www.agcensus.usda.gov/Publications/2012/Online_Resources/Highlights/ Farmers_Marketing/Highlights_Farmers_Marketing.pdf. Accessed 23 October 2017.
5. Anonymous. 2014. Multistate outbreak of listeriosis linked to Roos Foods Dairy Products. Available at: https://www.cdc.gov/listeria/outbreaks/cheese-02-14/index.html. Accessed 23 October 2017.
6. Anonymous. 2015. Random.org. Available at: www.random.org. Accessed 12 May 2015.
7. Anonymous. 2015. The Pennsylvania Code. 7 Pa. Code § 59a.
8. Anonymous. 2016. American Cheese Society – Cheese glossary. Available at: http://www.cheesesociety.org/i-heart-cheese/cheese-glossary/. Accessed 23 October 2017.
9. Baranowski, T., K. W. Cullen, T. Nicklas, D. Thompson, and J. Baranowski. 2003. Are current health behavioral change models helpful in guiding prevention of weight gain efforts? *Obes. Res.* 11:23S–43S.
10. Behnke, C., S. Seo, and K. Miller. 2012. Assessing food safety practices in farmers' markets. *Food Prot. Trends* 32:232–239.
11. Bettinghaus, E. P. 1986. Health promotion and the knowledge-attitude-behavior continuum. *Prev. Med.* 15:475–491.
12. Campbell, D., and J. Stanley. 1963. Experimental and quasi-experimental designs for research. Rand-McNally, Chicago, IL.
13. Chapman, B., T. MacLaurin, and D. Powell. 2011. Food safety infosheets — Design and refinement of a narrative-based training intervention. *Brit. Food J.* 113:160–186.
14. Cross, J. A. 2006. Restructuring America's dairy farms. *Geogr. Rev.* 96:1–23.
15. Green, L. R., C. A. Selman, V. Radke, D. Ripley, J. C. Mack, D. W. Reimann, T. Stigger, M. Motsinger, and L. Bushnell. 2006. Food worker hand washing practices: An observation study. *J. Food Prot.* 69:2417–2423.
16. Lillquist, D. R., M. L. McCabe, and K. H. Church. 2005. A comparison of traditional handwashing training with active handwashing training in the food handler industry. *J. Environ. Health* 67:13–16.
17. Machado, R. A. M. 2016. The effect of an educational intervention on small cheese operations: an exploratory study (Doctoral dissertation). The Pennsylvania State University, University Park, PA. Available at: https://etda.libraries.psu.edu/catalog/29590.
18. Machado, R. A. M., and C. N. Cutter. 2017. Sanitation indicators as a tool to evaluate a food safety and sanitation training program for farmstead cheese processors. *Food Control* 78:264–269.
19. Machado, R. A. M., R. Radhakrishna, and C. N. Cutter. 2017. Food safety of farmstead cheese processors in Pennsylvania: An initial needs assessment. *Food Prot. Trends* 37:88–98.
20. Martinez, S., M. Hand, M. Da Pra, S. Pollack, K. Ralston, T. Smith, S. Vogel, S. Clark, L. Lohr, S. Low, and C. Newman. 2010. Local food systems: Concepts, impacts, and issues. USDA Econ. Res. Rep. Available at: https://www.ers.usda.gov/publications/pub-details/?pubid=46395. Accessed 23 October 2017.
21. Medeiros, C. O., S. B. Cavalli, E. Salay, and R. P. C. Proença. 2011. Assessment of the methodological strategies adopted by food safety training programmes for food service workers: A systematic review. *Food Control* 22:1136–1144.
22. Murphy, K. S., R. B. DiPietro, G. Kock, and J. (Stephen) Lee. 2011. Does mandatory food safety training and certification for restaurant employees improve inspection outcomes? *Int. J. Hosp. Manag.* 30:150–156.
23. Nieto-Montenegro, S., J. L. Brown, and L. F. LaBorde. 2008. Development and assessment of pilot food safety educational materials and training strategies for Hispanic workers in the mushroom industry using the Health Action Model. *Food Control* 19:616–633.
24. Nieto-Montenegro, S., J. L. Brown, and L. F. LaBorde. 2008. Development and assessment of pilot food safety educational materials and training strategies for Hispanic workers in the mushroom industry using the Health Action Model. *Food Control* 19:616–633.
25. Radhakrishna, R. B. 2007. Tips for developing and testing questionnaires/instruments. *J. Ext.* 45:1–5.
26. Richard, A. E. 2011. Development and implementation of a "counter-top" training program to increase retention of food safety knowledge, alter behavior, improve attitude and increase skills of Spanish-speaking retail employees. The Pennsylvania State University.
27. Richard, A. E., J. L. Brown, R. B. Radhakrishna, E. P. Yoder, S. Niet-Montenegro, and C. N. Cutter. 2013. Development and implementation of a "counter-top" training program to increase retention of food safety knowledge, alter behavior, improve attitude and increase skills of spanish-speaking retail employees. *Food Prot. Trends* 33:10–19.
28. Roininen, K., A. Arvola, and L. Lähteenmäki. 2006. Exploring consumers' perceptions of local food with two different qualitative techniques: Laddering and word association. *Food Qual. Prefer.* 17:20–30.
29. Scheinberg, J. A. 2015. A comprehensive food safety assessment of farmers' markets in Pennsylvania. The Pennsylvania State University.
30. Scheinberg, J., R. Radhakrishnam, and C. N. Cutter. 2013. Food safety knowledge, behavior, and attitudes of vendors of poultry products sold at Pennsylvania farmers' markets. *J. Ext.* 51:1–18.
31. Schrader, P. G., and K. A. Lawless. 2004. The knowledge, attitudes, & behaviors approach: How to evaluate performance and learning in complex environments. *Perform. Improv.* 43:8–15.
32. Soon, J. M., and R. N. Baines. 2012. Food safety training and evaluation of handwashing intention among fresh produce farm workers. *Food Control* 23:437–448.
33. Soon, J. M., R. Baines, and P. Seaman. 2012. Meta-analysis of food safety training on hand hygiene knowledge and attitudes among food handlers. *J. Food Prot.* 75:793–804.
34. Tavakol, M., and R. Dennick. 2011. Making sense of Cronbach's alpha. *Int. J. Med. Educ.* 2:53–55.
35. Todd, E. C. D., J. D. Greig, C. A. Bartleson, and B. S. Michaels. 2007. Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 3. Factors contributing to outbreaks and description of outbreak categories. *J. Food Prot.* 70:2199–2217.
36. Vandeputte, E., L. Pivarnik, J. Scheinberg, R. Machado, C. Cutter, and I. Lofgren. 2014. Use of a phone application to assess food safety practices at farmer's markets (813.6). *FASEB J.* 28:813.6.
37. Walker, E., C. Pritchard, and S. Forsythe. 2003. Food handlers' hygiene knowledge in small food businesses. *Food Control* 14:339–343.
38. Witkin, B. R., and J. W. Altschuld. 1995. Planning and conducting needs assessments: A practical guide. Sage Publications, Thousand Oaks, CA.