

# Development and assessment of pilot food safety educational materials and training strategies for Hispanic workers in the mushroom industry using the Health Action Model

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## Abstract

Evaluation of program impact is needed to show the worth of a program. There are few studies of training program impact on food safety behaviors within food production and processing settings. Our research objectives were to develop, implement and evaluate a pilot food safety educational program for Hispanic workers in the mushroom industry using the results of a needs assessment and elements from the knowledge and motivational systems of the Health Action Model (HAM). The impact of three independent variables was tested in the pilot test: (1) The food safety educational lessons (knowledge system); (2) the supervisors acting as role models and food safety rules encouragers (motivational system – expectancy & instrumentality); and (3) a monetary incentive (motivational system – valence). The dependent variables (behaviors), included three different handwashing opportunities plus jewelry and hairnet usage. The educational lessons alone produced a significant increase in knowledge and handwashing after using the restroom. With supervisor post lesson enforcement, handwashing before work and after breaks also increased significantly. No effect of the monetary incentive was observed. Thus, training must be followed by supervisory personnel enforcement of behavioral rules. Management support of the supervisory role will increase the success in any food safety program within the industry. Based on these findings the HAM model can serve as a guide to develop customized food safety educational materials at a variety of different settings and target audiences in food production facilities. Published by Elsevier Ltd.

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## 1. Introduction

Worker mishandling of food is one of the major causes of foodborne disease outbreaks (WHO, 2000). Because outbreaks often lead to severe economic losses and even bankruptcy, food handler training is an important business strategy for managing food safety risks. However, there is no evidence that worker practices improve when training

programs provide only information (Rennie, 1994). Several studies have demonstrated that increasing knowledge does not necessarily lead to changes in behaviors (Clayton, Griffith, Price, & Peters, 2002; Ehiri, Morris, & McEwen, 1997; Rennie, 1994, 1995). To be effective, training programs should be based on appropriate adult education theory (Rhodes, 1988). They should incorporate activities that support skills development relevant to real life situations in which the workers can put information into practice (Edmunds, Lowe, Murray, & Seymour, 1999; Kowalski & Vaught, 2002). For example, a training session that raises awareness of the possibility that *E. coli* bacteria may accumulate under fingernails should also demonstrate the correct handwashing procedure and require the learner

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to practice until he or she can successfully demonstrate that procedure. Such training sessions then become active learning sessions. Adequate resources and a receptive management culture also are fundamental to applying good food safety practices. These authors believe that an effective food safety program should be relevant to the situation, teach skills, promote active learning, increase risk perception and consider the work environment. Program evaluation is also a critical part of a food safety-training program since it allows the implementers to assess its effectiveness.

There are few studies of how training programs impact food safety behaviors within food production and processing settings. Most of these studies describe the program implementation or training strategies utilized, but do not focus on program evaluation (Boccas et al., 2001; Fenton, 2005; Gall et al., 2004; Harris, Marks, Ten Eyck, Booren, & Ryser, 2004; Hicks et al., 2004; Rushing, Angulo, & Beuchat, 1996). In contrast, several studies conducted within the foodservice and hospitality industries have evaluated pre- and immediate post-intervention knowledge and self-reported behaviors among workers who have attended food safety workshops (Capunzo et al., 2005; Costello, Gaddis, Tamplin, & Morris, 1997; Ehiri et al., 1997; Hennum, Lawrence, & Snyder, 1983; Kirby & Gardiner, 1997; Martin, Knabel, & Mendenhall, 1999; McElroy & Cutter, 2004; Rennie, 1994; Smith & Shillam, 2000).

For effective food safety programs, evaluation must be based on careful planning. Several studies have concluded that observing workers during day-to-day operations is important for planning and evaluating training programs (Clayton et al., 2002; Redmond & Griffith, 2003). Studies to assess *consumer* food safety behaviors have similarly used direct observations of food handlers (Daniels, Daniels, & Noonan, 2001; Jay, Comar, & Govenlock, 1999; Toshima et al., 2001; Worsfold & Griffith, 1997). These studies often find that self-reported behaviors obtained through surveys do not always match behaviors obtained through direct observations. Direct observations should provide more accurate and reliable assessment of actual food safety practices in a food industry setting. In addition, good programs need a sound theoretical framework.

## 2. Theoretical basis

Coleman and Roberts (2005) questioned the ability of current food safety training programs used to alter behavior. To increase training program effectiveness, one must first understand the current food handler's behavior and how this behavior interacts with their beliefs and levels of knowledge. This can be facilitated by use of theory-based models in the development of educational materials (National Cancer Institute, 2005). Several authors (Ehiri et al., 1997; Rennie, 1995; Seaman & Eves, 2006; Stanton, Black, Engle, & Pelto, 1992) have urged research into design, implementation and evaluation of food safety programs using models and theories that have been widely

applied in other health education fields (Janz & Becker, 1984; Jenner, Watson, Miller, Jones, & Scott, 2002; Townsend et al., 2003). Although some research studies in consumer food safety education have used educational theories for developing and assessing food safety programs (Athearn et al., 2004; Hanson & Benedict, 2002; Schafer, Schafer, Bultena, & Hoiberg, 1993; Takeuchi, Edlefsen, McCurdy, & Hillers, 2005) none have been applied in industry settings.

Ehiri et al. (1997) and Seaman and Eves (2006) suggested that the Health Action Model (HAM), developed by Tones (Tones, Tilford, & Robinson, 1990) and adjusted by Rennie (1995) for use in the food safety field, could contribute to the development and application of effective food safety-training programs. Seaman and Eves (2006, p. 12) stated that "The Health Action Model probably gives the most thorough description of factors that may influence behavior change following training, including hygiene training." The HAM conceptually incorporates the Health Belief Model and Ajzen and Fishbein's "Theory of Reasoned Action" (Tones et al., 1990). For use in food safety research, Rennie (1995) adjusted the definitions of its five constructs or systems, all of which influence behavior, as follows: (a) knowledge system: baseline food safety knowledge; (b) normative system: worksite norms and rules; (c) motivational system: motivational elements in the company; (d) belief system: values and beliefs of the target audience; and (e) worksite environmental system: worksite physical conditions (Nieto-Montenegro, Brown, & LaBorde, 2006).

The normative system influences both the motivational system and the belief system (Tones et al., 1990). The motivational system can also influence both the belief system and the outcome of the belief system, or behavioral intent. If the relevant skills and knowledge and the appropriate environment are present, then behavioral intent can lead to action. Thus, the belief system is interrelated with the normative system, the motivational system and baseline knowledge. HAM takes into account the social and environmental factors that surround the worker (Tones et al., 1990). These factors can facilitate or hinder actions, depending on the resources available to change these conditions. For example, despite behavioral intent, workers will not wash their hands if handwashing facilities are not available. Worsfold, Griffith, and Worsfold (2004) demonstrated in an Environmental Health Officers survey that environmental factors such as supervisory support were considered to be key when implementing a food safety program in the industry. Hennum et al. (1983) demonstrated that management has a key role during the implementation and follow-up of a food safety program.

The motivational system appears critical to influencing behavioral intent, as demonstrated in some nutrition education interventions (Gribble, Falciglia, Davis, & Couch, 2003; Miller, Edwards, Kissling, & Sanville, 2002). Expectancy theory (ET), as defined by Vroom (Campbell & Pritchard, 1983; Tubbs, Boehne, & Dahl,

1993) can increase the specificity of the HAM construct of motivational system. Motivation is an internal process that activates, guides and maintains behavior over time (Baron & Kalsher, 1997). ET is used in industrial and organizational psychology and adult education to motivate people (Baron & Kalsher, 1997; Burns, 1995; Goad, 1982). Company motivational practices can affect directly employees' beliefs and can lead to adoption of behaviors supporting food safety practices. ET includes three concepts: valence, instrumentality and expectancy (Smith & Shillam, 2000). Expectancy is the belief that extra effort will lead to improved performance (A worker would wash their hands when required by supervisors). Instrumentality is the belief that good performance will be noticed or rewarded (The supervisor will notice the workers action and reward (i.e., praise his effort).). Valence is the value placed on the rewards offered (An economic incentive with value to the worker might be offered to encourage handwashing at work.). These three affective elements include values and beliefs that support the core belief system as well as influence behavioral intent (Tones et al., 1990).

Although Rennie (1995), Ehiri et al. (1997), and Seaman and Eves (2006) did propose a HAM framework for food hygiene education, no research using this model in a food industry setting has been published to date. An opportunity to test the HAM plus ET arose when the Pennsylvania mushroom industry requested a food safety education program to be implemented industry-wide. For the purpose of this work, the modified version of HAM (HAM plus ET) will be called HAM. As this endeavor was implemented, the objectives were:

- To develop a pilot food safety educational program for Hispanic mushroom workers using the results of a needs assessment (Nieto-Montenegro et al., 2006) and
- To implement and evaluate the effectiveness of this pilot program plus elements from the knowledge and motivational systems of the HAM in the mushroom industry.

### 3. Methodology

The Pennsylvania State University Office of Research Protections approved all the materials and procedures used in this study.

#### 3.1. Research framework – the HAM system

The educational program, the delivery method, and pilot test methodology were based on a needs assessment designed around the modified version of the Health Action Model (HAM) which was implemented at 12 cooperating mushroom companies (Nieto-Montenegro et al., 2006).

Fig. 1 describes the model and indicates the two key components addressed. The educational program (interactive lessons) addressed the *knowledge system* including

skills. Post lesson activities were designed to influence the *motivation system* at selected worksites as described later.

#### 3.2. Program materials

##### 3.2.1. Lessons development and program delivery

Five lesson modules, each 35–45 min long, were developed, based on specific learning objectives derived from the needs assessment (Nieto-Montenegro et al., 2006). Each lesson in the program included visual aids and a script outlining presentation content with the specific learning objectives (available upon request). Risk perception and principles of adult education were introduced through discussion topics, demonstrations, and hands-on activities. Drafts of scripts and visuals were prepared in English to match learning objectives, reviewed by two food science professionals and then revised. The visual aids were created using a clip art website, pictures of actual staged situations within the mushroom industry and Photoshop® elements 2.0 (Adobe Systems Inc., San Jose, CA). These pictures were obtained by the author during previous visits to the plants and used with permission of the participating companies. Materials were converted to Spanish and pre-tested using visual aids as PowerPoint® slides vs. 12" × 18" color posters with two different groups of mushroom workers: 11 workers from a mushroom packing facility, and 14 harvesters from a mushroom farm. Feedback was provided using scripted questions. The main objectives of this test were to: (1) determine if the teaching methodologies were appropriate in the mushroom industry setting; (2) ensure that the lesson lengths and the resources needed to deliver the lessons were suitable and available for the final pilot test; and (3) obtain participant's feedback about the lesson presentation and visuals. Based on the results, two lessons were combined and revisions were made to the lesson visuals to produce the final draft for pilot testing.

The final draft included four lessons (1. Foodborne outbreaks traced to produce; 2. Mushroom contamination; 3. Personal hygiene I; 4. Personal hygiene II; and Handwashing at work) to be delivered orally using PowerPoint® slides as visual aids. Each lesson included one or more hands-on activities and discussion sessions to create a learning environment for worker participation to develop skills to apply daily at work. For instance, the use of 3M Petri Film for microbial growth shocked participants and evoked curiosity about microbes in general. It was also effective to demonstrate handwashing efficacy along with Glo-germ™ (lotion with fluorescent particles), which was used to demonstrate how hands could transfer contaminants to the mushroom surfaces as well as the efficacy of handwashing. The presence of common physical contaminants in mushrooms (hairs, foreign objects), personal hygiene, and handwashing were given extra emphasis in the food safety lessons based on deficiencies noted in the baseline observations. Discussions were generated around foodborne illness experience, inappropriate behavior in the worksite and controlling physical contaminants using



it means a specific physical place where mushrooms are *picked* or *packed*. To test different variables, the mushroom companies were purposefully assigned to four different tracks (A, B, C, and D) based on (a) the number of workers in the packing and picking facilities in order to achieve about 120 worker per track; (b) the environmental conditions (visible handwashing stations in the packing plants); (c) willingness of supervisors and management to work with the researchers; (d) having a combination of one or more mushroom packing-houses and one mushroom farm crew (called picking facility or site) per track; and (e) having a packing and picking site from the same company in close proximity to each other.

Cooperativeness of management and supervisors was a key factor in assignment. One company, Yellow 7, was assigned to the control track for two reasons, (a) it had met GMP standards more thoroughly than the other companies and was likely to have reasonably good compliance; and (b) the management would only agree to participate if placed in the control group.

In the pilot evaluation, the impact of three independent variables [(1) the effect of the food safety lessons on knowledge score; (2) altering employee motivation through increasing expectancy (supervisors were to encourage and enforce the desired behaviors and were to also act as role models by practicing the behavior themselves, thereby increasing the expectancy) and instrumentality (supervisors were to praise workers when they perform the desired

behavior); and (3) altering the employee motivational valence by offering an economic incentive] on the dependent variables [three different handwashing opportunities, jewelry and hairnet usage] was examined. For comparison, a control group received no treatment. The tracks and variables are shown in Fig. 2A.

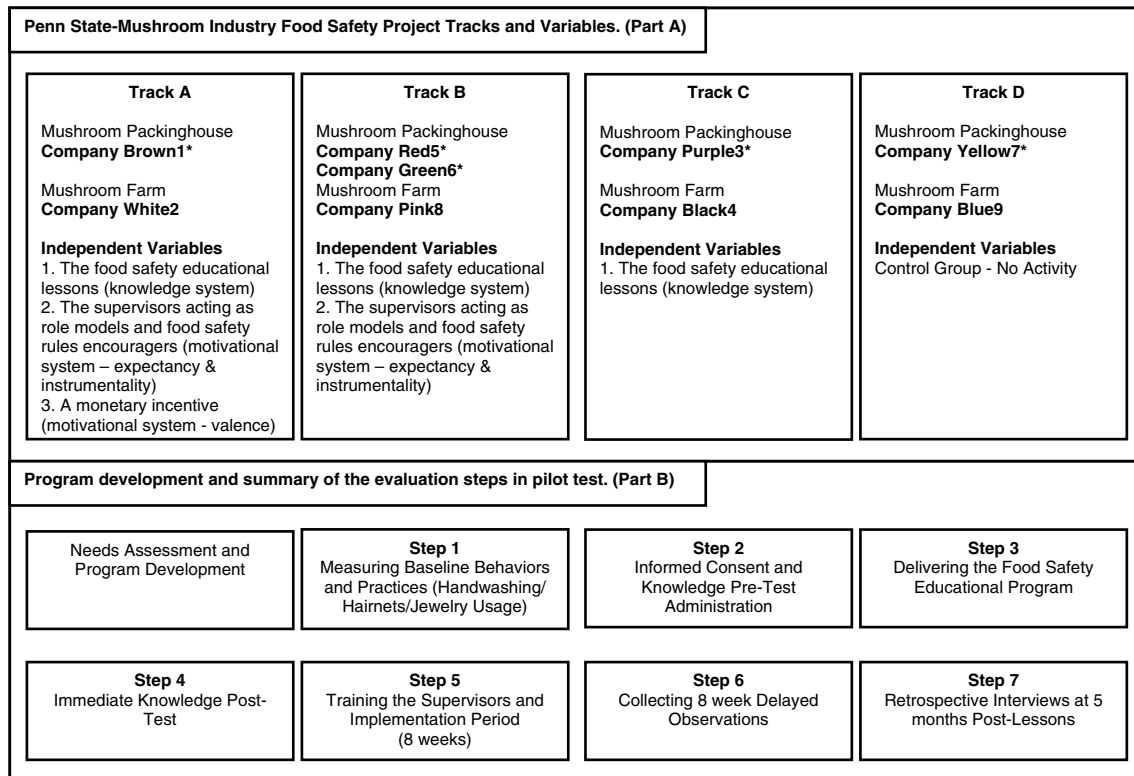
3.4. Steps in pilot test (refer to Fig. 2B)

3.4.1. Step 1 – Measuring baseline behaviors and practices

Direct observation at each participating company was used to record baseline food safety practices (hairnets and personal adornment usage) and employee handwashing practices. The procedure for conducting the observations is described in Section 3.5.

3.4.2. Step 2 – Obtaining informed consent and administering the knowledge pre-test

Each participating worksite provided a list of eligible workers. Companies required the workers to attend the food safety-training, but did not require participation in the evaluation (pre- and post-testing). Workers were invited to participate in the pilot study and each volunteer signed an informed consent form before completing a pre-knowledge test administered orally in Spanish through a face-to-face interview. The interviewer read each question to the respondent, and recorded their answer on an answer sheet.



\* Denotes visible handwashing station

Fig. 2. Summary of the testing tracks and the evaluation steps in the pilot test.

### 3.4.3. Step 3 – delivering the lessons

The instructor visited each facility to ensure that conditions were adequate for program delivery. Each of the lessons (average length 34 min) was administered in sequence and a minimum of a week apart to workers in tracks A–C. For packing companies in tracks A and B where supervisors were involved, special lesson sessions were held for the supervisors separate from workers. The supervisors received the exact same lessons as their co-workers but the last session included an extra section described below in step 5. The control group in track D received the lessons after the delayed post-evaluation was completed. One instructor delivered all the lessons orally in Spanish and consistently across tracks. A 4-week delay occurred between lesson 2 and 3 because of mushroom production demands during the Thanksgiving-Christmas holiday season. All the lessons were conducted during working hours and the group size per lesson ranged from 1 to 18 workers.

During the final lesson, an economic incentive was presented to packing company workers in track A to encourage desired handwashing practices. A raffle of 25 grocery store cards (\$20 each) was to be held 12 weeks after the post-test such that the increase in handwashing compliance at 8 weeks determined the number of cards in the raffle. Because it was impossible to monitor picker handwashing in this track, the same raffle was offered to these workers for increase in proper hairnet usage. Pickers and packers in Track A worked for the same company.

### 3.4.4. Step 4 – Assessing immediate post-knowledge and skill

The same knowledge test used in the pre-test was administered to the participating workers and supervisors at least 1 week after the last lesson, using the same methodology as in step 2. In addition, a skill (appropriate hairnet usage), was measured in the post-test, something not done in the pre-test. One researcher gave all the pre- and post-tests. At the end of this step, each company received a Penn State Certificate of Participation and each participating employee was presented with a certificate of completion endorsed by the Penn State University Department of Food Science and the American Mushroom Institute.

### 3.4.5. Step 5 – Training the supervisors and implementation period

The behavior implementation period was 8 weeks. During lesson 4, the supervisors at companies in tracks A and B received instructions on how to: (a) encourage compliance with desired food safety behaviors among the workers; (b) appropriately ask workers to follow a food safety rule; and (c) be a food safety role model. This additional discussion with the supervisors stressed the importance of compliance with three food safety behaviors: hairnet usage, jewelry usage, and handwashing practices at three different occasions: (1) before starting work; (2) after each break; and (3) after using the restroom and the role that supervisors play in having workers following the rules. Supervisors were also instructed to serve as role models by practicing

the desired behavior themselves at all times. Supervisors were asked to be blunt, but courteous when they asked a worker to follow the rules and were to focus on one behavior per week. A discussion was generated of ways to facilitate this process. Supervisors promised that workers would have the necessary supplies (soap, paper towels, hairnets, gloves, etc.) to perform the noted behaviors. Upper management was aware of the activities that were taking place and of the information that was being shared with the supervisors. The researchers did not suggest any policy changes in plant protocols.

An 8-week implementation period followed for all companies, with no further contact by the researcher for tracks C and D. However, the researcher held 15 min meetings bi-weekly with track A and B company supervisors for the first 6 weeks to reinforce efforts to insure worker compliance with program goals. After the initial two meetings, several supervisors requested handwashing posters. The researcher designed 12" × 18" posters and gave each company 10 that were displayed as handwashing reminders on the walls in the hallways, outside the restrooms, and near the time clock at each of the packing plants for the remaining 5 weeks of the study.

To ensure supervisor attention to motivation activities, upper management was asked to attend the last two supervisor meetings at all tracks A and B worksites where they directed the supervisors to promote handwashing and to enforce the hairnet and jewelry policy. However, the activities of supervisors and upper management were not monitored or observed during the 8-week period.

### 3.4.6. Step 6 – Collecting delayed observations data after the 8-week implementation period

A minimum of 8-weeks after the post-test, food safety practices (hairnets and personal adornment usage) at each company and handwashing practices at companies with observable handwashing stations were recorded. The observation procedure used is described in Section 3.5.

### 3.4.7. Step 7 – Retrospective interviews at 5 months post-lessons

Three months after the end of the 8-week implementation period, retrospective scripted interviews were conducted with a sample of five workers and at least one supervisor at each participating packing site, including the control, in tracks A–D. After signing an informed consent form, workers, and supervisors were interviewed individually and asked five open-ended questions. The interviews were conducted in Spanish and tape recorded.

The objectives were to determine: (a) worker and supervisor impressions of current food safety rules, i.e., what they were doing now regarding food safety rules (except in track D), (b) whether supervisors and management endorsed food safety rules, (c) worker recall of motivational activities conducted by supervisors or upper management during the 8-week implementation period; and (d) worker evaluation food safety practices now vs. prior

to the intervention. These data were collected to document any motivational activity and explore the effect of the pilot program  $\pm$  motivational factors on the company's food safety norms.

### 3.5. Pilot Program Instruments and Scoring

#### 3.5.1. Observation forms and procedures

The same experienced observer (Nieto-Montenegro, Brown, & LaBorde, 2004, 2006) conducted the observations at all companies, making sure workers were unaware they are being observed. To avoid changes in worker behavior and to obtain more reliable data, the observer provided a consistent explanation of his presence in the plant to workers. In addition, he performed several tasks while observing (i.e. counting mushroom boxes, looking at production details, sorting chemicals, writing reports in his laptop in the lunch room, etc.) or gave someone unfamiliar to the workers a tour of the company while collecting data.

(a) Hairnets and jewelry: Using an audit type protocol, the observer walked through the packing lines and/or farms until he observed all workers at that site, noting hairnet and jewelry compliance or non-compliance on a checklist. This observation procedure was repeated four times, each at a different time on one of four different days for each worksite (i.e. track A packers and pickers are considered two separate sites). Before starting the study, criteria for a properly worn hairnet and jewelry usage were established. For hairnets and jewelry, the researchers reported a non-compliance rate that was calculated as following:

- (1) *Hairnet usage*: Number of workers not wearing a hairnet appropriately/total number of workers observed.
- (2) *Jewelry usage*: Number of workers wearing any kind of jewelry besides a wedding band/total number of workers observed.

(b) Handwashing: The observer also collected handwashing frequency data from sites in each track that had a visible handwashing station outside the restrooms and the lunchrooms. Track B included two worksites with handwashing stations. The observer collected frequency of compliance when a pre-defined handwashing opportunity (a specific occasion where workers should wash their hands at the work site) occurred. In this case, three different occasions were defined: (1) before starting work; (2) after each break (morning or afternoon and lunch breaks); and (3) after using the restroom.

Each of these handwashing opportunities was analyzed independently from each other. In any given day, work started around 6 or 7 AM, with a mid-morning break (around 9:30 AM), a mid-afternoon break (around 2:30 PM) plus a lunch break (around noon). Exact times varied by company. In addition to their scheduled breaks, workers could use the restrooms while they are working. Due

to space limitations of the break facilities, all workers did not go on break at the same time. In general, breaks were taken in groups, depending on the total number of workers in the company (generally two or three groups were formed). However all workers got the same time of break described above. Hence, there could be two or three morning breaks, two lunch breaks, and two or three afternoon breaks, depending on the company.

Fig. 3 outlines the typical handwashing observation time slots for all worksites. To conduct the handwashing observations, the observer used two different approaches: (1) arriving at the worksite before the operations started, observing handwashing before start of work and staying until everyone had taken the morning and lunch breaks; and (2) arriving at the worksite in the morning, observing handwashing before start of work, then departing and returning right before lunch, and staying to observe everyone taking lunch and afternoon breaks. The observer also examined handwashing compliance rates of workers after using the restroom through the course of the day. The observer only noted if the employee did indeed wash his/her hands and did not evaluate the procedure used. However, the worker had to use soap and scrub their hands in order to record that action as a valid handwashing count. The observation procedure was conducted on three different days at each site. All workers present at the day of the visit were observed. Therefore, not everyone was evaluated since a small percentage of workers were on vacation

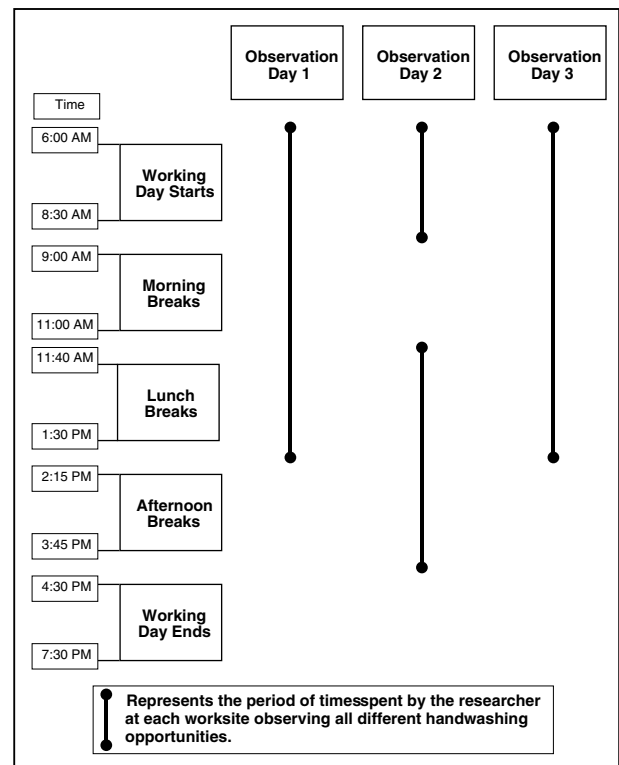


Fig. 3. An example of the typical handwashing observation time slots used by the researcher at each mushroom worksite.

or had a day off. Some who were observed had not participated in the educational program due to vacations or leaves of absence. The observation time slots were even across tracks. Therefore, the amount of time spent at all companies and the patterns of the observations were the same in all tracks.

The rate of handwashing compliance was calculated as followed:

*Before starting work:* Number of workers washing their hands/total number of workers arriving at work that morning.

*After breaks:* Number of workers washing their hands/total number of workers taking a break at that time.

*After using the bathroom:* Number of workers washing their hands/Number of workers using the restroom.

The rate is reported as compliance percentages. Only the observed workers, not the total number of workers working in that company, were included in the handwashing compliance results. None of the participating companies had access to the observation data collected, and workers involved in the observations were anonymous.

### 3.5.2. Knowledge instrument and skills testing

A survey instrument (available upon request) addressing knowledge of issues and concepts discussed in the lessons was developed, pre-tested for clarity and revised for use in individual face-to-face interviews. This knowledge test was used as an indicator of attention to the lesson content. Handwashing skills were observed in the last lesson and proper hairnet usage checked in the immediate post-test.

The instrument included 10 knowledge questions, each with five multiple-choice options, where one option – to avoid guessing – was ‘do not know’. The answers from each participant were compiled in a database and correct answers summed. A point was awarded for each question answered correctly; therefore the minimum possible score was 0 for no correct answers, and the maximum possible score was 10 for all correct answers. The instrument also included demographic questions.

### 3.5.3. Data management and analysis

The participant’s demographic information, along with the tests scores, were entered into a database, recoded, and transferred into SPSS 10 for Macintosh (SPSS Inc., Chicago, Ill.) for statistical analysis. The quantitative data collected were organized using descriptive statistics (i.e., frequencies, percentages, means and standard deviations). *t*-Tests, one-way ANOVA, and ANCOVA tests were used to determine if there were significant differences between different companies. The selected post-hoc tests were the Scheffe test when equal variances were present and the Games–Howell test when variances were not equal. Tapes of the retrospective interviews with workers and supervisors were transcribed verbatim and these qualitative data were used to develop thematic summaries for each company.

## 4. Results

### 4.1. Overall knowledge pre- and post-test

A total of 454 workers, including 23 supervisors, from nine different worksite locations completed the knowledge pre-test. A total of 373 workers completed both the pre- and then the post-knowledge tests for an experimental

Table 1  
Demographic information of matched data (pre–post-test)

Variable	# of Participants (percentage), N = 373
<b>COMPANY</b>	
<b>TRACK A</b>	
Brown 1	73 (19.6%)
White 2	18 (4.82%)
<b>TRACK B</b>	
Red 5	39 (10.5%)
Green 6	63 (16.9%)
Pink 8	12 (3.21%)
<b>TRACK C</b>	
Purple 3	61 (16.4%)
Black 4	24 (6.43%)
<b>TRACK D</b>	
Yellow 7	52 (13.9%)
Blue 9	31 (8.30%)
<b>JOB POSITION</b>	
Packers	288 (77.2%)
Pickers	85 (22.8%)
<b>YEARS WORKING for the COMPANY</b>	5.66 ± 5.61 (n = 370)
<b>AGE</b>	37.1 ± 12.8 (n = 361)
<b>SEX</b>	
Male	190 (50.9%)
Female	183 (49.1%)
<b>PREVIOUS FOOD SAFETY EDUCATION</b>	
Yes	218 (58.4%)
No	152 (40.8%)
Missing Data	3 (8.04%)
<b>ORIGIN</b>	
Guanajuato State	281 (75.3%)
Mexico State	21 (5.63%)
Other Mexico’s States	38 (10.2%)
USA	4 (1.07%)
Other Countries (PR and DR)	20 (5.36%)
Missing Data	9 (2.41%)
<b>EDUCATION</b>	
0 to 6 years	255 (68.4%)
6.1 to 19 years	63 (16.9%)
9.1 to 12 years	46 (12.3%)
Some College or Bachelor Degree	5 (1.34%)
Missing Data	4 (1.07%)
<b>INCOME PER WEEK – AFTER TAXES</b>	
\$300 or lower 1–5	152 (40.7%)
\$301–\$400 6–7	123 (33.0%)
\$401 or higher	56 (15.0%)
Missing Data	42 (11.3%)

mortality mean of 17.84% across all sites. Matched data were used for analysis and demographic characteristics of these participants are shown in Table 1.

Overall, participants' mean scores on the ten pre-test questions indicated deficiencies in food safety knowledge (mean  $5.91 \pm 1.68$ ), even though women attained a significantly higher mean pre-knowledge score than men ( $6.30 \pm 1.71$  vs.  $5.53 \pm 1.55$ ,  $p = 0.000$ ). One-way ANOVA tests indicated no significant differences in mean pre-test knowledge scores when controlling for educational level, previous food safety education, or income.

Analysis of covariance (ANCOVA), using the pre-test score of each individual as the covariate for their post-test score, was used to compare mean post-test knowledge scores for all experimental and the control companies (fixed factor). ANCOVA revealed a significant difference among worksite post-knowledge scores (Table 2). Subsequent pair-wise comparisons indicated a significantly greater score for each of the experimental worksites, as compared to the control worksite for both *pickers* and *packers*. Among *packers*, red 5 scored significantly but slightly higher than green 6 and yellow 7. Scores for brown

1, green 6 and purple 3 were not significantly different. Pair-wise comparison from the post-hoc analysis revealed no significant difference between any of the experimental picking worksites.

#### 4.2. Handwashing compliance rates

Handwashing compliance for the three handwashing opportunities that were evaluated before and after the 8-week implementation period are presented in Figs. 4–6. Only mushroom packing worksites had visible (outside the restrooms) handwashing stations.

##### 4.2.1. Handwashing “before start working”

The one-way ANOVA followed by post-hoc analysis indicated the control (yellow 7) had significantly greater handwashing rates than all the other sites before the intervention. Compliance pre-intervention at the control worksite was 81.21% compared to 5.86%, 10.96%, 10.42%, and 4.47% in brown 1, red 5, green 6, and purple 3, respectively.

One-way ANOVA also indicated a significant difference in handwashing compliance rates after the intervention. Pair-wise comparisons found no significant differences between green 6 and purple 3 worksites and between yellow 7 and red 5. These companies had the lowest and the highest handwashing compliance rates, respectively. Paired *t*-tests indicated a significant increase in handwashing compliance rates after the intervention for worksites brown 1 and red 5. Red 5 demonstrated the greatest increase in handwashing compliance. Experimental worksites green 6, purple 3 and the control worksite, yellow 7, demonstrated no significant change (see Fig. 4).

##### 4.2.2. Handwashing “after each break”

One-way ANOVA followed by post-hoc analysis indicated that the compliance rate in the control worksite was significantly higher than in the other worksites (78.48% in the control group vs. 15.78%, 29.01%, 12.5%, and 11.20% in brown 1, red 5, green 6, and purple 3 respectively).

One-way ANOVA of post-intervention compliance rates also demonstrated a significant difference. The post-hoc analysis found that worksite purple 3 had significantly lower handwashing compliance than worksites brown 1, red 5, and yellow 7, which had the highest post-intervention handwashing compliance rate “after each break.” No significant difference was found in the post-hoc analysis among the companies with highest compliance rates (brown 1, red 5, and yellow 7).

Paired *t*-tests indicated a significant increase in handwashing compliance post-intervention in worksites brown 1, red 5, and green 6. Brown 1 recorded the largest increase in handwashing compliance (see Fig. 5).

Worksite purple 3 and the control worksite did not exhibit any change in compliance rate after the intervention.

Table 2  
ANCOVA knowledge scores for mushroom *packers* and *pickers*

Track worksite	N	Pre-test score observed	Post-test score adjusted for pre-test (std error)
<b>PACKERS</b>			
Track A			
Brown 1	73	$5.70 \pm 1.63$	9.86 (0.158) <sup>a</sup>
Track B			
Red 5	39	$6.56 \pm 1.76$	9.96 (0.150) <sup>b,d,e</sup>
Green 6	63	$6.11 \pm 1.64$	9.59 (0.108) <sup>d,f</sup>
Track C			
Purple 3	61	$5.84 \pm 1.43$	9.29 (0.163) <sup>b,c</sup>
Track D			
Yellow 7	52	$6.79 \pm 1.55$	6.16 (0.166) <sup>a,c,e,f</sup>
ANCOVA – adjusting for pre-test score,			F = 51.5
F-value			Significant
			p = 0.000
<b>PICKERS</b>			
Track A			
White 2	18	$5.17 \pm 1.86$	9.31 (0.331) <sup>x</sup>
Track B			
Pink 8	12	$6.25 \pm 1.71$	9.75 (0.362) <sup>y</sup>
Track C			
Black 4	24	$5.13 \pm 1.36$	9.29 (0.319) <sup>z</sup>
Track D			
Blue 9	31	$4.71 \pm 1.44$	5.10 (0.286) <sup>x,y,z</sup>
ANCOVA – adjusting for pre-test score,			F = 30.19
F-value			Significant
			p = 0.000

a, b, ...<sup>n</sup> Same letter superscript denotes significant difference on posttest scores (pair-wise comparisons) among companies at the 0.05 level. Knowledge test scale: 0 = lowest score and 10 = highest score.

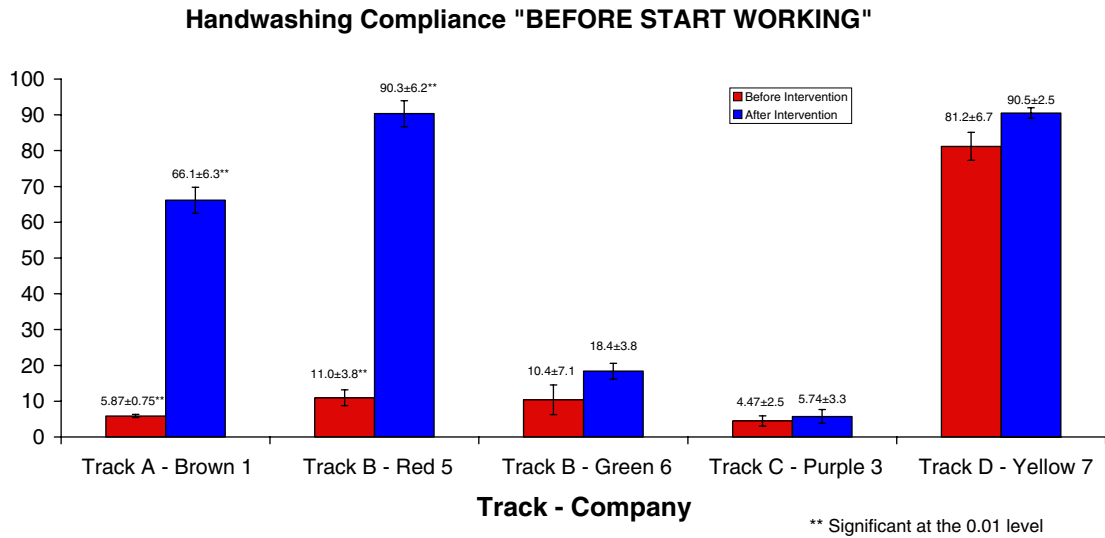


Fig. 4. Comparison of mean values for handwashing compliance rates handwashing “before start working”.

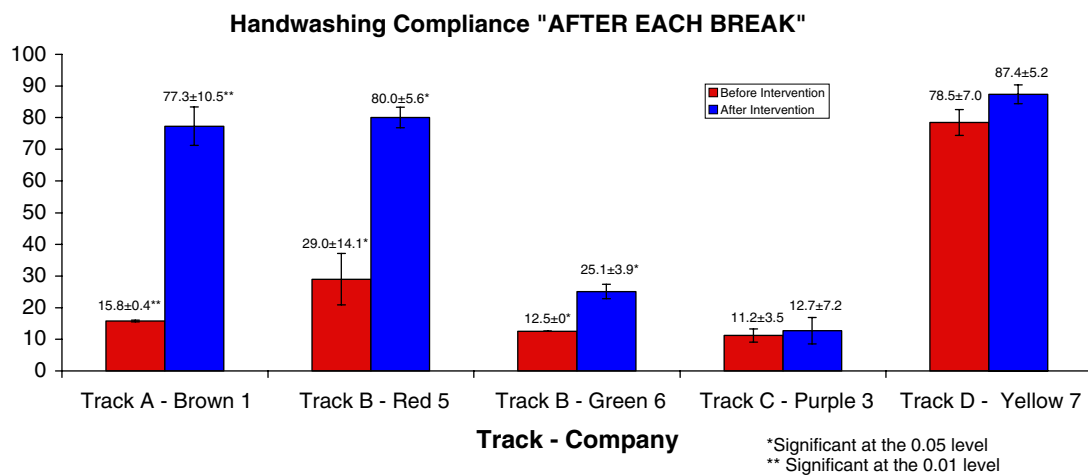


Fig. 5. Comparison of mean values for handwashing compliance rates handwashing “after each break”.

#### 4.2.3. Handwashing “after using the restroom”

One-way ANOVA indicated a significant difference in handwashing compliance among the different worksites before the intervention (see Fig. 6). The post-hoc analysis revealed a significant difference between the control worksite, yellow 7, and the experimental worksite, purple 3. Purple 3 also was significantly different from worksite brown 1.

One-way ANOVA indicated no significant differences among worksite compliance rates after the intervention. All worksites had very high handwashing compliance after the intervention. Paired *t*-test analysis indicated a significant increase in handwashing compliance post-intervention in worksites brown 1, green 6, and purple 3. Experimental worksite red 5 and control group yellow 7 demonstrated no change in compliance rate after the intervention. However these two companies were the ones with the highest handwashing compliance rates, both before and after the intervention.

#### 4.3. Hairnets usage non-compliance rate

Pre-intervention observations indicated that not all workers were wearing their hairnets properly. Therefore, during the post-test interview, every participating worker was asked to show how a hairnet should be worn. Every participant was able to demonstrate appropriate hairnet usage.

Table 3 includes the mean values for non-compliance rates of hairnet usage before and after the educational intervention. One-way ANOVA indicated significant differences in non-compliance rates before the intervention in both *packers* and *pickers*. For *packers*, the pair-wise comparisons demonstrated significant differences between the worksite purple 3 and the worksites red 5 and yellow 7. No other differences were found between packing worksites in the pair-wise comparisons for the pre-intervention data. For *pickers*, the pair-wise comparison before the

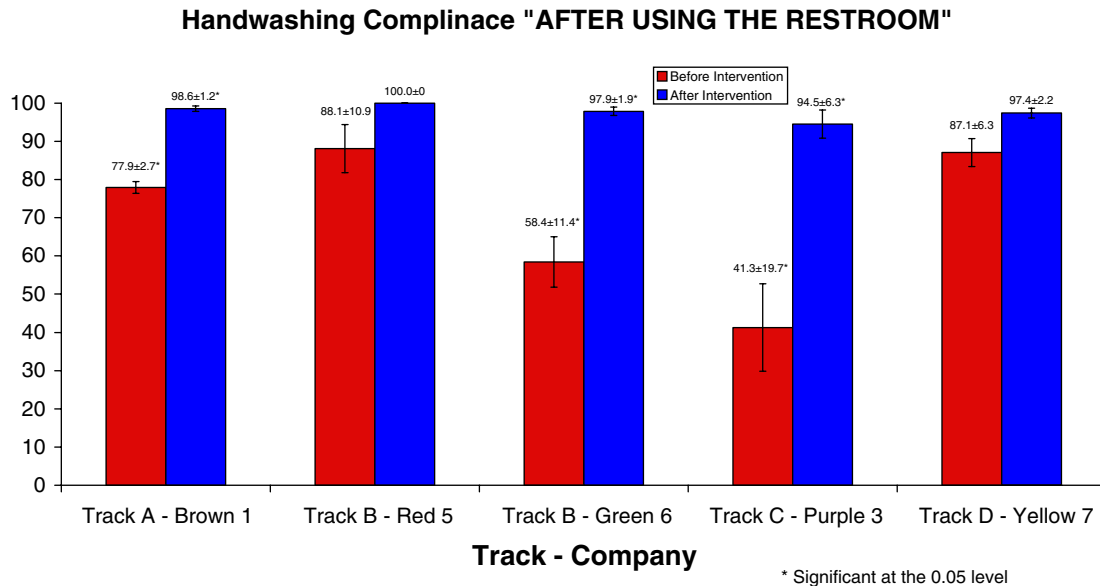


Fig. 6. Comparison of mean values for handwashing compliance rates handwashing “after using the restroom”.

Table 3  
Mean values for non-compliance rates of hairnet usage before and after the intervention

Track worksite	Mean values for % of non-compliance pre-intervention	Mean values for % of non-compliance post-intervention	Paired <i>t</i> -test <i>t</i> value ( <i>p</i> -value)
<i>Packers</i>			
Track A Brown 1	30.9 ± 12.9	5.30 ± 2.03 <sup>a,b</sup>	3.97* (0.029)
Track B Red 5	13.1 ± 6.38 <sup>a</sup>	9.94 ± 2.46 <sup>c</sup>	1.18 (0.323)
Track B Green 6	27.1 ± 8.30	11.9 ± 2.59 <sup>b,d,f</sup>	3.52* (.039)
Track C Purple 3	41.6 ± 8.94 <sup>a,b</sup>	34.2 ± 2.07 <sup>a,c,d,e</sup>	1.36 (0.267)
Track D Yellow 7	17.9 ± 6.55 <sup>b</sup>	6.18 ± 2.15 <sup>e,f</sup>	3.96* (0.029)
One-way ANOVA <i>F</i> -values	<i>F</i> = 6.27, significant <i>p</i> = 0.004	<i>F</i> = 109.3, significant <i>p</i> = 0.000	
<i>Pickers</i>			
Track A White 2	37.6 ± 3.67 <sup>c</sup>	9.52 ± 3.04	11.9* (0.001)
Track B Pink 8	40.4 ± 9.84 <sup>d</sup>	18.7 ± 5.21 <sup>g</sup>	8.63* (0.003)
Track C Black 4	35.1 ± 7.99 <sup>c</sup>	13.6 ± 6.80	2.93 (0.061)
Track D Blue 9	14.1 ± 3.10 <sup>c,d,e</sup>	5.82 ± 3.45 <sup>g</sup>	3.17* (0.050)
One-way ANOVA <i>F</i> -values	<i>F</i> = 12.5, significant <i>p</i> = 0.001	<i>F</i> = 5.19, significant <i>p</i> = 0.016	

<sup>a,b,c,d,e,f,g</sup> Same letter superscript denotes significant difference on “hairnet usage non-compliance rates” (pair-wise comparisons) among companies at the 0.05.

\* Pre- and Post-hairnet usage non-compliance rates were significantly different at the 0.05 level when compared through a paired *t*-test.

intervention revealed that the non-compliance rates were significantly different between the worksite blue 9 (control group) and each of the other picking worksites (white 2, pink 8 and black 4). The site blue 9 had a significantly lower non-compliance rate than the other sites.

At post-intervention, one-way ANOVA revealed significant differences between worksites for both *packers* and

*pickers*. For *packers*, the post-hoc analysis revealed that worksite purple 3 had the highest non-compliance rate of hairnet usage and it was significantly different from that of the other worksites. In addition, worksite green 6 was significantly different than worksites brown 1 and yellow 7. For *pickers*, the only significant difference in the post-hoc analysis was between worksites pink 8 and blue 9.

Paired *t*-tests revealed significant decreases in post-intervention non-compliance rates for the *packers* in worksites brown 1, green 6 and yellow 7. There was no difference in the worksite red 5. For the *pickers*, significant decreases were also found in non-compliance rates in worksites white 2, pink 8, and blue 9.

#### 4.4. Jewelry usage non-compliance rate

Table 4 includes the mean values for non-compliance rates of jewelry usage before and after the educational intervention. One-way ANOVA indicated significant differences in non-compliance rates before the intervention for both *packers* and *pickers*. For *packers*, pair-wise comparisons demonstrated no significant differences between worksite purple 3 and green 6, which had higher non-compliance rates. There were significant differences between these two worksites and the worksites brown 1, red 5, and yellow 7, when compared individually. For *pickers*, the pair-wise comparison indicated a significant difference between worksite black 4 and each of the other worksites. Company black 4 had the highest non-compliance rate score among the *pickers* before the intervention occurred. At post-intervention, one-way ANOVA revealed significant differences among *packer* and *picker* worksites. For *packers*, the pair-wise comparison revealed significant differences between worksite purple 3, which had the highest

non-compliance rate and each of the other worksites. For *pickers*, worksite black 4 and the other worksites were significantly different when compared individually. Again, worksite black 4 had a highest non-compliance rate. For *packers*, *t*-tests revealed a significant decrease in non-compliance after the intervention for worksite brown 1 and green 6. The decrease in green 6 was greater than in brown 1. In contrast, *t*-tests revealed no significant change in any of the *pickers'* non-compliance rates after the intervention.

#### 4.5. Summary of results and retrospective interviews

For the *Controls –Track D* (*packer-yellow 7* and *picker-blue 9*), no lessons were given and no work with supervisors was done. Pre-knowledge for *yellow 7* and *blue 9* was comparable to that in other tracks and did not change significantly immediately post-lessons. Other findings include:

- Handwashing compliance in *yellow 7* was high initially and did not change significantly over the period of observation for any of the three handwashing opportunities.
- However, *yellow 7* and *blue 9* hairnet usage non-compliance did drop significantly. Non-compliance with jewelry usage rules was low at pre-measurement and did not change significantly by post-measurement.

Table 4  
Mean values for non-compliance rates of jewelry usage before and after the intervention

Track worksite	Mean values for % of non-compliance Pre-intervention	Mean values for % of non-compliance post-intervention	Paired <i>t</i> -test <i>t</i> value
<i>Packers</i>			
Track A			
Brown 1	4.25 ± 1.25 <sup>a,b,c,d</sup>	1.83 ± 1.35 <sup>a,b</sup>	3.95* (0.029)
Track B			
Red 5	0.00 ± 0.00 <sup>b,c,g</sup>	0.66 ± 1.32 <sup>c,f</sup>	−1.00 (0.391)
Green 6	34.1 ± 2.71 <sup>c,g,h</sup>	14.4 ± 2.77 <sup>b,d,f,g</sup>	12.16* (0.001)
Track C			
Purple 3	37.0 ± 9.37 <sup>a,e,f</sup>	29.4 ± 4.28 <sup>a,c,d,e</sup>	1.28 (0.289)
Track D			
Yellow 7	0.68 ± 1.35 <sup>d,f,h</sup>	0.00 ± 0.00 <sup>e,g</sup>	1.00 (0.391)
One-way ANOVA <i>F</i> -values	<i>F</i> = 70.75, significant <i>p</i> = 0.000	<i>F</i> = 109.35, significant <i>p</i> = 0.000	
<i>Pickers</i>			
Track A			
White 2	11.5 ± 3.39 <sup>i</sup>	3.03 ± 3.50 <sup>h</sup>	2.62 (0.079)
Track B			
Pink 8	11.8 ± 5.27 <sup>j</sup>	5.15 ± 4.16 <sup>i</sup>	2.428 (0.093)
Track C			
Black 4	34.0 ± 7.84 <sup>i,j,k</sup>	32.9 ± 4.04 <sup>h,i,j</sup>	0.253 (0.816)
Track D			
Blue 9	5.55 ± 6.17 <sup>k</sup>	0.00 ± 0.00 <sup>j</sup>	1.80 (0.169)
One-way ANOVA <i>F</i> -values	<i>F</i> = 18.07, significant <i>p</i> = 0.000	<i>F</i> = 80.49, significant <i>p</i> = 0.000	

<sup>a,b,...,n</sup> Same letter superscript denotes significant difference on “hairnet usage non-compliance rates” (pair-wise comparisons) among companies at the 0.05.

\* Pre- and Post-jewelry usage NON-compliance rates were significantly different at the 0.05 level when compared through a paired *t*-test.

- The retrospective interviews revealed that company yellow 7 had a personal hygiene enforcement program implemented before the research began. This explains why the levels of handwashing compliance were high in yellow 7 and blue 9. Management had appointed quality control (QC) workers to do checks and enforcement so supervisors did not have to handle both food safety enforcement and work on orders, which often conflict. Even though yellow 7 and blue 9 were not the same company they belonged to the same organization, which had a similar food safety culture.

For companies in Track C (packer-purple 3 and picker-black 4) the lessons were delivered but no other form of intervention took place.

- Pre-knowledge for purple 3 and black 4 were comparable to those of their other tracks. Both purple 3 and black 4 demonstrated a significant knowledge gain immediately after the intervention.
- Handwashing compliance in purple 3 was low initially and did not change significantly at post-observation for “after each break” and “before starting work.” Handwashing compliance did increase significantly “after using the restroom.”
- Hairnet and jewelry non-compliance rates at purple 3 and black 4 did not change significantly 8 weeks after the program. Both purple 3 and black 4 non-compliance rates were among the highest across tracks.
- The retrospective interviews revealed lack of management commitment and little enforcement. One supervisor was in charge of both food safety enforcement and the mushroom orders. According to employees, mushroom orders took priority. Although there was a significant improvement in handwashing “after using the restroom” in purple 3 and a non-significant drop in non-compliance in hairnet usage among workers in black 4, there were no other effects of the lessons on food safety practices.

For companies in Track B (packers red 5 and green 6 and picker pink 8) the lessons were given, plus the supervisors were trained to encourage food safety rule compliance.

- Pre knowledge for packers and pickers was comparable to that in other tracks. Knowledge did increase significantly after the intervention at all sites.
- Handwashing compliance was initially low for handwashing “after each break” and “before starting work.” After receiving the program, red 5 demonstrated significant increases in these handwashing compliance rates. Green 6 demonstrated significant but low improvement only for handwashing after each break. At red 5, initial handwashing compliance “after using the restroom” was very high and no significant increase was observed after the intervention. Green 6 demonstrated a significant increase in handwashing “after using the restroom.”
- Red 5 hairnet and jewelry non-compliance rates were initially low and did not change significantly after the program. Green 6 demonstrated a significant decrease in

initial non-compliance rates for both hairnet and jewelry usage. Finally, pink 8 demonstrated a significant decrease in non-compliance rates for hairnets but not for jewelry. Pre-jewelry usage was low prior to the start of the educational intervention.

- The retrospective interviews revealed that, in red 5, one key person in upper management was committed to making the food safety program a success. Her quality control (QC) team to whom she delegated enforcement aided her in this. The QC team had completed the lessons and supervisory training gaining the knowledge and skills to motivate workers to follow rules. The QC staff enforced the rules and made workers aware of infractions. Workers reported realizing the risks and reasons for doing things and apparently altered their behavior. Workers and supervisors reported that commitment to food safety grew during the training, reached a peak over the subsequent 8 weeks and remained at high levels five months post-training. In Green 6, management implemented changes immediately after training by assigning a supervisor to enforce food safety rules. However, based on the interviews, the supervisor commitment diminished after the 8-week implementation period. At five months post-lessons, although some food safety rules were enforced periodically, there was less commitment to enforcement than immediately after the lessons.

For companies in Track A (packer brown 1 and picker white 2) the lessons were delivered plus the supervisors were trained to encourage food safety rule compliance and an economic incentive was offered to workers.

- Pre-knowledge for brown 1 and white 2 were comparable to other tracks. Knowledge did increase significantly after the intervention.
- At brown 1, initial handwashing compliance was low “after each break” and “before starting work” while rates “after using the restroom” were high. After the lessons were completed, brown 1 demonstrated significant increases in handwashing compliance in all three opportunities.
- At brown 1, hairnet and jewelry non-compliance rates decreased significantly after the program. A high hairnet non-compliance rate was reduced to low levels. Jewelry usage was initially low and still lower after the program. The workers at white 2 also demonstrated a significant decrease in hairnet and jewelry usage non-compliance rates.
- The retrospective interviews revealed brown 1 management had placed low emphasis on personal hygiene prior to the lessons but had delegated responsibility to supervisors to increase worker compliance after the lessons. However, management commitment became stronger after the 8-week observation period, as compared to immediately after the lessons. Actions implemented by supervisors immediately after the lessons did not work as well as desired. Five months post-lessons, supervisor enforcement was stronger and compliance had improved.

## 5. Discussion

This educational program focused on two aspects of the HAM. The first was to change baseline food safety knowledge and five personal behaviors through information and skills taught in the lessons across the three experimental tracks. The second was to alter the motivational system in tracks A and B by instructing supervisors to influence expectancy (extra effort will lead to better performance) and instrumentality (insuring that good performance by workers will be noticed and rewarded). An economic incentive (chance at winning a raffle) was provided for the track A employees as an attempt to alter the valence (perceived value) of the rewards for good behavior.

### 5.1. Lesson impact

To determine if employees understood the lessons, knowledge gain was evaluated. The employees had low educational attainment (majority at or below 6th grade level) and low literacy skills. The ANCOVA revealed that knowledge scores of experimental *pickers* and *packers* significantly improved while those of control workers did not. It appears that *pickers* and *packers* can learn food safety principles, regardless of their job assignment.

In addition, employees with low educational attainment demonstrated significant knowledge gain. Other cross sectional consumer surveys, regardless of ethnic mix, indicate that low level of education is related to low food safety knowledge scores (Altekruse, Yang, Timbo, & Angulo, 1999; Meer & Misner, 2000; Williamson, Gravani, & Lawless, 1992; Woodburn & Raab, 1997). The current study indicates that a well-designed (inclusion of adult education concepts and skill based program) and structured educational program (series of interconnected sessions) can be effective with a low literacy audience. It is hypothesized that the discussions, activities and hands-on training included in this food safety program may have played a key role in knowledge gain. Pink 8, where most workers were women, demonstrated the highest adjusted post-knowledge score among the pickers. Other food safety surveys have found higher knowledge scores for women than for men (Altekruse, Street, Fein, & Levy, 1996; Altekruse et al., 1999; Nieto-Montenegro, Gómez-Bueno, & Valenzuela, 2000; Patil, Cates, & Morales, 2005).

Delivered without any prescribed changes in the motivational system, the lessons affected handwashing “after using the restroom” and hairnet usage, based on the significant improvement in handwashing behavior in track C, purple 3, and a nearly significant improvement in hairnet usage in track C, black 4. In addition, handwashing ‘after using the restroom’ and non-compliance rates in hairnet (and jewelry) usage also improved significantly in green 6, track B, where supervisor support was poor. Handwashing and hairnet usage were emphasized in the lessons with hands-on activities and practice. The lesson emphasis on handwashing may have connected to the continuous public

health messages in Mexico to wash one’s hands after using the restroom, making it easier for workers to move from intent to action (Curtis, Scott, & Cardosi, 2005). However, it is clear that the lessons by themselves cannot lead to alterations in behaviors that are less ingrained and familiar to workers, such as handwashing after breaks.

The significant alteration in handwashing behavior observed in track C was not due to an observation Hawthorne effect, since similar changes did not occur “before starting work” or “after taking a break” when the observer was visible to workers. The extent of any Hawthorne effect is most likely shown by the slight shift upward in handwashing compliance “after using the rest room” in track D, yellow 7. The extent of change in track C, purple 3 is 5 times that of track C, yellow 7.

The program also incorporated information about the risks of foodborne outbreaks traced to food production facilities. Although it is not clear that this information influenced behavior, in the retrospective interviews, workers remembered the example used and knew this could affect them. In track B, red 5, workers and supervisors reported that this example was used very effectively by the QC team to provide instant reminders of the unpleasant consequences of laxity in food safety behaviors.

Clayton et al. (2002) concluded that training by itself will not lead to behavioral change and that food safety-training must incorporate a risk-based approach to highlight the level of risk associated with the food business. The current educational program described the consequences of a foodborne outbreak, particularly loss of jobs, as well as increased consumer risk perception. This can threaten the job security valued by the mushroom workers (Nieto-Montenegro et al., 2006).

### 5.2. General supervisory commitment

The importance of supervisory support and enforcement is clearly illustrated in track B. Management commitment and support are both key in the implementation of any food safety program (Coleman & Roberts, 2005; Hennum et al., 1983; Kirby & Gardiner, 1997; Seaman & Eves, 2006). Clayton et al. (2002) mentioned that food safety must be an organizational issue within the company and management must allocate resources to food safety. The improvements in the two, less familiar handwashing behaviors in red 5 contrasts with the poor improvement in green 6 and reflects the difference in supervisory commitment. In addition, the supervisory load was handled in a more equitable manner in red 5 than in green 6. The success in red 5 may reflect the separation of responsibilities for mushroom orders and enforcement.

#### 5.2.1. Expectancy – supervisory enforcement and role modeling

Track B, red 5 illustrated how supervisor commitment and QC follow-through on *enforcement* are necessary elements in maintaining high rates of compliance. In red 5,

handwashing rates ‘before starting work’ and ‘after taking a break’ post program were the second highest compared to the controls. These compliance changes appear to reflect at least partially how the QC team served as re-enforcers of the behaviors. Behavioral theory states that if a re-enforcer follows a desired behavior, that behavior is more likely to happen again and if there is no re-enforcer, the desired behavior is less likely to recur (Stanton et al., 1992). Environmental cues are a discriminative stimulus (i.e., provides information about what to do) and indicate to a person when a behavior must be followed (Stanton et al., 1992). In the retrospective interviews, workers reported enforcement reminders and warnings that seemed to inspire compliance. Appearance of the QC members may have served as a cue for workers to perform the expected behavior, so that handwashing at red 5 became a habit. These findings are consistent with Ehiri et al. (1997) who suggested that a food safety educational program would more effective if it is followed by ‘strong management controls’.

The necessity of continuous enforcement was evident in track B, green 6. Immediately after the training, management assigned the QC-supervisor to enforce and to correct worker behavior. However, 8 weeks later, handwashing behavior ‘before starting work’ had not improved while that ‘after each break’ improved marginally. In the retrospective interviews, workers reported there was no enforcement or plan in place to encourage behavior change, so workers compliance decreased.

*Role modeling* was not reported in track A, brown 1. Conversely, supervisors in track B, red 5 reported they served as role models demonstrating correct behaviors and workers verified this observation in retrospective interviews. In track B, green 5, even though the supervisors received training, it appears supervisors performed no behavioral role modeling as this was not mentioned in the retrospective interviews. This may have contributed to the lack of improvement in handwashing at less obvious times (after the break and before work). Because hairnet usage and jewelry usage improved in brown 1 and green 6 but not in red 5, the effect of role models vs. enforcement is not clear. However, since initial non-compliance rates for hairnet and jewelry usage were very low, management may have focused on handwashing compliance instead, resulting in no change in the former.

There is little empirical data about management practices in the food industry that could increase compliance at the workplace where enforcement may not be done at the individual level (Mitchell, Fraser, & Bearon, 2007). However, virtual teams that were self-directed have been compared to teams where management enforced behavioral controls and no difference in performance was evident between the two groups (Piccoli, Powell, & Ives, 2004). In contrast, Worsfold et al. (2004) reported that 86% of environmental health officers surveyed agreed that it is not necessary for enforcement officers to assess the effectiveness of training by questioning staff at places where there is a food safety management system in place. This suggests that the

need for commitment of upper management may vary with the workplace. In the commercial food sector, manager training and involvement can be effective in reducing food safety problems but it is necessary to set realistic expectations for implementation of new food safety practices (Egan et al., 2007). However, the necessity of management backup has not been rigorously tested in the food production and processing arena.

### 5.2.2. Instrumentality – recognition of good behavior

Retrospective interviews indicated that in track D controls, most of the emphasis appeared to be on enforcement rather than instrumentality (the idea that good behavior would be noted). In track B, red 5, and track A, brown 1, where supervisor training was provided and appeared to be adopted, workers reported that supervisors (brown 1) and QC staff (red 5) reminded workers of the rules. In track A, brown 1, workers indicated the management offered ‘polite reminders’ and ‘advice’ right after the lessons but found that this was ineffective in ensuring compliance. Since both red 5 and brown 1 were focusing on enforcement rather than recognition of good behavior for 5 months after the lessons, it appeared the companies did not successfully adopt workers recognition for appropriate behavior (i.e., instrumentality).

### 5.2.3. Valence – use of an economic incentive

The economic incentive had no effect on worker behavior in track A, brown 1. Any effect was overshadowed by similar or bigger changes in other tracks that did not offer an economic incentive. It is possible that a more immediate economic incentive (i.e. gift cards awarded weekly) was needed. The incentive was not awarded until 10 weeks after the program ended. Indeed, no mention was made of this event in the retrospective interviews, indicating that the incentive made little impression on the workers. Monetary incentives have been found to increase household use of preventive health care services (Morris, Flores, Olinto, & Medina, 2004) or to encourage completion of a multi-dose vaccine treatment among drug users (Seal et al., 2003). However, incentives did not have an impact on program participation among people who were being rehabilitated from drug usage (Jones, Haug, Stitzer, & Svikis, 2000). Since these studies used different methods for allocation of the incentive, it is not clear how an economic incentive may affect a person’s behaviors.

### 5.3. Overall patterns

Summarizing, track C indicated that while the lessons inspire changes in familiar behavior, more is needed to ensure consistent change in unfamiliar behaviors. Food safety programs must take into account the motivational system at the worksite (Ehiri et al., 1997; Rennie, 1995; Seaman & Eves, 2006) as well as the provision of skills and knowledge. Track B, with the contrasting results in red 5 and green 6 demonstrated the importance of combining

expectancy, wherein supervisors enforce the rules, with the skills and knowledge provided by the lessons. Track A reaffirmed the importance of combining expectancy with the lessons and indicated that our economic incentive had no visible impact compared to the other supervisor activities in this and in other tracks. Results in tracks A–C distinguish the effects of the lessons from that of supervisory enforcement.

The retrospective interviews also highlighted the different trajectories of adoption of lesson principles and management buy-in. In track B, worksite red 5 bought into lesson principles and enforcement immediately after the lessons and commitment remained high at 5 months after the lessons. In track A, commitment to food safety behaviors was higher at 5 compared to 2 months after the lessons. The reasons for the change in this track are unclear but could be attributed to the management needing time to reflect on food safety importance and react. Ultimately, other unreported trends or activities across the mushroom industry might have influenced adoption of stronger enforcement methods and the commitment seen at 5 months post program.

Finally the packer worksites, where supervisory staff-in-charge of enforcement were women (red 5 and yellow 7), had significantly higher handwashing rates and significantly lower non-compliance rates for jewelry and hairnet usage than other worksites with male supervisors. Women possess higher food safety knowledge and have better food safety practices than men (Altekruse et al., 1996, 1999; Nieto-Montenegro et al., 2000; Patil et al., 2005). Perhaps, women were better role models than men or women took the food safety program more seriously than men. These concepts could be explored in further research.

## 6. Conclusions

Incorporating adult education principles, hands on activities and skill building in the lessons resulted in both knowledge gain and significant improvement in the more familiar handwashing activity at the worksite where only instruction took place. The lessons were necessary to ensure the workers knew the reasons for and had the skills needed. Skill provision is key when teaching food safety but applying this skill under unfamiliar circumstances appears to require reinforcement.

Training must be followed by the involvement of the supervisory personnel in enforcement of behavioral rules. Management support of this supervisory role will increase the success of activities that enforce and promote the use of the skills that have been taught. Supervisory enforcement should be assigned to a person within a company who is only responsible for this and other quality control duties. This person should serve as a role model and must have a fair method of enforcing rules using courteous communication with the other workers.

Within the motivational system, *expectancy* (as enforcement and role modeling) seems to be more effective in the

mushroom industry. *Instrumentality* was not evident in supervisory actions as reported by both supervisors and workers. This may reflect the cultural expectations of the Hispanic workers when employed in a hierarchical unit. The monetary incentive (*valence*) had no effect. However this might be due to the way the incentive was offered. It was impossible to control the supervisors' activities. Although efforts were made to provide consistent training and follow-up visits to encourage uniform efforts with the workers, many other businesses related concerns and prejudices about worker supervision overshadowed these efforts.

The HAM was useful to identify the different factors affecting food safety behaviors within this food industry setting and to expose connections between the various players in the worksite. This model therefore can be used in different food industry scenarios to develop food safety-training programs for other production and processing situations. The research design focusing on the knowledge and motivational systems was unable account for all outcomes. Further work should examine the normative system and learn more about the environmental system at each work place. An alteration of the worksite normative system might be the most important step towards proper workers' food safety behaviors within an industry.

Handwashing compliance is the most important single practice to avoid foodborne outbreaks while hairnet and jewelry usage are important practices to avoid physical contamination in food products that could become aesthetic adulterants or possible hazards to consumers (Olsen, 1998; Valdes-Biles & Ziobro, 2000). Hairnet and jewelry usage are some of the easiest behaviors to monitor and can serve as indirect indicators of management commitment to a food safety program. Supervisors who are unable to enforce hairnet and jewelry usage at their worksites may find enforcing handwashing compliance more difficult. A successful food safety program requires many resources including planning and training time, follow-up activities and adequate day-to-day supplies (hairnets, soap, paper towels, adequate toilets, etc.). Lack of resources will impede food safety compliance. In order to succeed on implementing a food safety program, upper management should be fully committed to these efforts. Monitoring simple food safety behaviors such hairnet and jewelry usage by upper management can be seen as indirect indicators of management commitment to fully implement a food safety program.

This work has limitations. The same observer, who also delivered the lessons, conducted all the observations, which might have affected worker behavior. However, steps were taken to minimize this. The research design did not include methodology to document supervisor's activities so the degree of enforcement was based on the set of retrospective short interviews at each worksite, a type of formative evaluation. Future work with HAM should include more formative evaluation to determine the supervisory activities at each worksite and their effect on the normative system.

Although they served as a reference, the use of controls with already high levels of the desired behaviors is another limitation. This limited the ability to clearly define the impact of our manipulation of the knowledge and motivational systems. The lack of visible handwashing stations at picker sites prevented evaluation of the program impact on handwashing practices of mushroom pickers. Future research should evaluate this aspect of their food safety behavior.

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