

Food Safety Training Requirements and Food Handlers' Knowledge and Behaviors

VALERIE K. PILLING,¹ LAURA A. BRANNON,¹ CAROL W. SHANKLIN,^{2*} KEVIN R. ROBERTS,³ BETSY B. BARRETT,³ and AMBER D. HOWELLS³

¹Kansas State University, 492 Bluemont Hall, Manhattan, KS 66506, USA; ²Kansas State University, 103 Fairchild Hall, Manhattan, KS 66506, USA; ³Kansas State University, 104 Justin Hall, Manhattan, KS 66506, USA

SUMMARY

Very little research has evaluated how different types of food safety training requirements in foodservice establishments affect food handlers' performance. Foodservice employees ($n = 242$) from randomly selected restaurants from three Midwestern states within a 300-mile radius of the research institution completed a survey to assess their food safety knowledge and important behavioral antecedents (e.g., attitudes, intentions) related to food safety. Employees' compliance with three important food safety behaviors (handwashing, use of thermometers, and proper handling of food and work surfaces) was observed. This study evaluated the effectiveness of two alternative food safety training requirements by comparing knowledge, behavioral antecedents, and behavioral compliance rates between two groups of food handlers: a group from restaurants in which food safety training is mandatory for all food handlers and a group from restaurants in which only shift managers must be knowledgeable about food safety. Mandating training for all food handlers was associated with improved compliance with some food safety behaviors; however, requiring that shift managers be knowledgeable about food safety appears to contribute similarly to employees' knowledge, behavioral antecedents, and compliance with regard to the three important food safety behaviors observed.

INTRODUCTION

Food safety is a vital issue in the United States, given that foodborne illnesses contribute to millions of illnesses and thousands of deaths annually (4, 19). Food safety, specifically in restaurants, is becoming a key public health priority because of the increased number of meals eaten outside the home (20) and the fact that a large proportion (59%) of reported foodborne illness originates in restaurants (5).

Foodservice employees are a crucial link between food and consumers; thus managers must ensure that food handlers are practicing proper food safety techniques. However, research consistently shows that foodservice employees are not performing up to standards (10, 11). In fact, shortcomings related to time/temperature control, improper hygiene, and cross contamination contribute most significantly to foodborne illnesses (8, 10, 11, 21), and these problems are all related to foodservice employees' noncompliance with important food safety guidelines (10, 11).

A peer-reviewed article

*Author for correspondence: 785.532.6191; Fax: 785.532.2983
E-mail: shanklin@ksu.edu

Lack of food safety knowledge or training may cause foodservice employees' noncompliance with food safety guidelines. Research suggests that food safety training may increase knowledge (15) and that higher knowledge and more favorable attitudes toward food safety may be associated with better restaurant inspection scores (6). However, increased knowledge does not always translate into improved behaviors (13). Several studies that have attempted to evaluate the effectiveness of food safety training on behavior in foodservice establishments have yielded inconsistent conclusions; many studies find that training is effective (7, 9, 14, 17, 18), while others draw the opposite conclusion (3, 13, 16, 24).

Cotterchio, Gunn, Coffill, Tormey, and Barry (9) investigated the effects of foodservice manager training on the restaurant's overall inspection scores. Establishments whose managers were mandated to participate in the training and certification program showed improved inspection scores, as did establishments whose managers voluntarily participated in the program. Establishments in the control group, in which no manager received training, showed no improvements in inspection scores. The authors concluded that training was an effective way of improving compliance with food safety guidelines. It should be noted that the mandated group was required to participate either because of unsatisfactory inspection scores, resulting in suspension of the establishments' food licenses, or because of being linked to cases of foodborne illness. Therefore, these restaurants had substantial room for improvement and had strong incentive to improve inspection scores. While overall inspection scores improved and the number of critical violations decreased, not all problem areas were corrected by the training.

Cohen, Reichel, and Schwartz (7) investigated the effectiveness of an in-house food safety training program for mid-level managers and food handlers in a large catering company. The food safety training was implemented because of reduced microbiological quality of food over a three-month period. The training program was considered a success, because many of the departments exhibited improved microbiological quality of the

food; however, some of the departments did not show improvements.

Kneller and Bierma (14) found that restaurant inspection scores in one county improved after a food safety certified staff member joined the restaurants' personnel. The improvement was beyond what was projected based on inspection trends prior to the certified staff members' employment at the restaurants. Mathias, Sizio, Hazlewood, and Cocksedge (17) investigated the relationship between food safety education and inspection scores and found that restaurants with trained foodservice managers and employees had better inspection scores. Also, McElroy and Cutter (18) evaluated the effectiveness of a state-mandated training program by obtaining self-reports of foodservice employees' behavior change after training. The authors identified the training program as a success because participants reported being more likely to implement food safety practices after training.

On the other hand, Wright and Feun (24) compared restaurants with and without trained and certified managers, both before and after the experimental group received training. No differences in inspection scores were found between the groups at either time. Casey and Cook (3) discovered that inspection scores improved in both experimental (managers were trained and certified) and control groups; however, differences between the improvement scores were not significant. Mathias, Riben, et al. (16) reported no significant relationship between inspection scores in a restaurant and the number of employees who had received food safety training. Also, Howes, McEwan, Griffith, and Harris (13) found that even when foodservice employees have gained the knowledge necessary to perform proper food safety practices through training, the knowledge does not always lead to behavioral change.

Many of these studies investigated the effects of training of the manager on restaurant inspection scores (9, 14, 24). More research is needed to evaluate the effectiveness of training on knowledge and behaviors of foodservice employees who have direct contact with food. Although Cohen, Reichel, and Schwartz (7) investigated the effects of training both food-service managers and employees, they did so within only one establishment. Training managers versus training all

food handlers has important implications for foodservice establishments, because training all food handlers is more costly because of the direct costs (the training itself, compensation of employees' time at training) and the indirect costs (employee turnover). Getting all food handlers to attend food safety training may be difficult, especially if the training is not held at the establishment during normal work hours. Research is needed to investigate the benefits of training all food handlers compared to training only shift managers to be knowledgeable about food safety. The purpose of this study is to address this gap in the literature and investigate the effects of training foodservice employees.

Previous research has not investigated the effect of mandatory training of shift managers and food production employees on food safety knowledge and behaviors in multiple restaurants. No past research has compared the effects of having shift managers knowledgeable about food safety versus having all food handlers attend mandatory training on food handlers' food safety knowledge and behaviors. Also, previous research has not used the Theory of Planned Behavior (TpB), which focuses on important contributors to behavior, including the behavioral antecedents of attitudes, subjective norms, perceived control, and intentions related to the behavior (1). According to the Theory of Planned Behavior (TpB), the most proximal behavioral antecedent is intention for the behavior, and intentions are predicted from attitudes, subjective norms, and perceived control (1). Attitudes are evaluations of likely outcomes of performing the behavior, subjective norms are perceptions of important others' opinions of performing the behavior, and perceived control includes perceptions of ability to perform the behavior. The current study investigates the effects of food safety training by comparing knowledge, behavioral antecedents, and behaviors of food handlers from restaurants in which only shift managers must be knowledgeable about food safety and food handlers from restaurants in which food safety training is mandatory for all food handlers. The research focuses on three behaviors which contribute most significantly to incidences of foodborne illnesses: handwashing, use of thermometers, and proper handling of food and work surfaces (11).

TABLE 1. Knowledge scores of foodservice employees in restaurants in which only shift managers must be knowledgeable of food safety (n = 114) and employees in restaurants in which all food handlers must be trained (n = 128)

Behavior	Training Requirements	
	Shift Managers	All Food Handlers
	Means ± Standard Deviations	
Handwashing	15.48 ± 1.92	14.72 ± 2.24*
Using Thermometers	14.27 ± 2.07	12.82 ± 2.90***
Properly Handling Food and Work Surfaces	13.80 ± 1.54	13.57 ± 2.13
Composite	43.54 ± 3.94	41.11 ± 5.92***

Note: Maximum scores possible are 18 for individual behaviors and 54 for composite score.

* $P < .05$; *** $P < .001$.

METHODS

Foodservice employees (n = 242) whose jobs directly involved food preparation tasks served as participants in the study. The study included a random sample of restaurants in Kansas, Iowa, and Missouri and included foodservice establishments with different food safety training requirements based on different city, county, or state regulations. Some establishments were required to have shift managers knowledgeable about food safety (though not necessarily having completed a formal training course or certification), whereas some establishments were required to have all food handlers take a formal food safety training course. Managers of randomly selected restaurants within a 300-mile radius of the university were contacted to request their participation. In Kansas and Iowa, establishments were randomly selected from lists of establishments licensed to serve food, which were provided by the state licensing agencies. In Missouri, establishments were randomly selected from the telephone directory within the designated radius of the research institution. Eligible restaurants included chain and independently-owned operations, as well as both quick- and full-service establishments. In exchange for their employees' participation, managers were offered free food safety training for their food production employees at a later date. Participation prior to the food safety training involved having each food-

service employee complete a food safety knowledge assessment and a questionnaire based on the Theory of Planned Behavior as well as allowing a research assistant to observe the employees' food preparation behaviors in the kitchen during peak business hours.

Pilot tests

The questionnaire was pilot tested to ensure sufficient internal reliability for each of the direct measures included in the Theory of Planned Behavior (i.e., attitudes, subjective norms, perceived control, intentions) for the three behaviors. Internal consistency estimates ranged between .65 and .90. The observation form was also pilot tested with all research assistants involved in the data collection to ensure adequate inter-rater reliability; the average reliability between two assistants observing the same employees at the same time was .71. The questionnaire and observation form are described below.

Questionnaire

Employees indicated their willingness to participate by completing the questionnaire. The cover page of the questionnaire informed the participants that the study was being conducted to better understand foodservice employees' beliefs about food safety and that their responses would be used to improve

compliance with food safety practices in restaurants. The questionnaire contained three sections.

The first section was a knowledge assessment created by the researchers. It assessed knowledge specifically related to the three food safety behaviors of interest: handwashing, use of thermometers, and proper handling of food and work surfaces. The knowledge assessment consisted of nine questions (three for each food safety behavior) with six response options for each question. The instructions directed the participant to circle *all* response options they believed to be correct, stressing that it was acceptable to circle more than one. Each response option was treated as a true/false item, resulting in the equivalent of 54 questions (18 for each behavior). Participants could obtain six points per question if they circled only all of the correct response options.

The second section of the questionnaire assessed the TpB components. This section directly assessed intentions, attitudes, subjective norms, and perceived control for each of the three food safety behaviors. This section was counterbalanced and contained approximately 50 items. The measures of attitude included items such as "For me to use a thermometer to properly check the temperature of food is" (1 = extremely bad, 7 = extremely good). For subjective norms there were questions like "Most of the workers at this restaurant with whom I am acquainted properly wash their hands at work on a regular basis" (1 = definitely false, 7 =

TABLE 2. Behavioral antecedents of foodservice employees in restaurants in which only shift managers must be knowledgeable of food safety (n = 114) and employees in restaurants in which all food handlers must be trained (n = 128)

Behavioral Antecedents	Training Requirements	
	Shift Managers	All Food Handlers
Handwashing	Means ± Standard Deviations	
Attitudes	6.66 ± 0.54	6.51 ± 0.91
Subjective Norms	6.41 ± 1.00	6.03 ± 1.39
Perceived Control	6.62 ± 0.66	6.50 ± 0.91
Intentions	6.52 ± 0.87	6.35 ± 1.15
Using Thermometers		
Attitudes	6.44 ± 0.71	6.31 ± 0.94
Subjective Norms	5.96 ± 1.21	5.80 ± 1.35
Perceived Control	6.56 ± 0.72	6.40 ± 0.88
Intentions	6.14 ± 1.21	6.11 ± 1.27
Properly Handling Food and Work Surfaces		
Attitudes	6.70 ± 0.54	6.41 ± 0.96*
Subjective Norms	6.46 ± 1.00	5.93 ± 1.46**
Perceived Control	6.54 ± 0.74	6.41 ± 0.94
Intentions	6.71 ± 0.84	6.35 ± 1.43*

Note: Range of scale items is 1 to 7, with higher numbers indicating more positive attitudes and subjective norms or higher perceived control and intention.

* $P < .05$; ** $P < .01$.

definitely true). An example of a perceived control belief was “For me to properly handle food and work surfaces at work is” (1 = extremely difficult, 7 = extremely easy). Intention was measured for each behavior with items such as “I plan to properly wash my hands at work on a regular basis” (1 = strongly disagree, 7 = strongly agree) and “I will make an effort to properly wash my hands at work on a regular basis” (1 = strongly disagree, 7 = strongly agree).

The third section of the questionnaire contained demographic items. It included questions about gender, age, and years of experience working in foodservice.

Behavioral observations

The second aspect of participation involved observation of the foodservice employees by a researcher in the kitchen during food preparation tasks. The observations were conducted in three-

hour sessions during peak service hours. During the course of the observations, six 20-minute sessions were spent watching the employees, with ten-minute breaks between sessions to help avoid observer fatigue. A maximum of four food handlers were observed simultaneously.

Food handlers were observed only for the three behaviors (i.e., handwashing, use of thermometers, and handling food and work surfaces). However, several specific behaviors within each were observed, which included items about using the correct procedures and performing the behaviors at the appropriate times. For example, for handwashing, food handlers were observed for correct procedure (e.g., vigorously scrub hands for at least 20 seconds, clean between fingers) and washing hands at suitable times (e.g., when shift begins, before putting on clean gloves).

Researchers used observation forms to record behaviors. The observation form listed the behaviors being observed, with

a column to denote that the employee performed the behavior when they should have (or that they did it correctly) and a column to record if they did not take action when they should have (or that they did not use correct technique). A separate observation form was used for each 20-minute observation session. These records were combined over the six sessions to calculate compliance rates for each specific behavior and composite compliance rates for the three general food safety behaviors of interest.

RESULTS

Participants

Of the participating sample of foodservice employees, 68.1% were male and 31.9% were female. There were similar numbers of participants from restaurants in which only shift managers must be knowledgeable about food safety (47.1%) and participants from restaurants

TABLE 3. Behavioral compliance scores of foodservice employees in restaurants in which only shift managers must be knowledgeable of food safety (n = 114) and employees in restaurants in which all food handlers must be trained (n = 128)

Behavior	Training Requirements	
	Shift Managers	All Food Handlers
	Mean Compliance Percent ± Standard Deviation	
Handwashing		
Wash hands when starting shift	50.00 ± 51.45	72.73 ± 45.58
Wash hands when returning to the work area (after smoking, eating, chewing gum or tobacco, bussing tables, or using bathroom)	43.76 ± 40.48	52.60 ± 40.20
Wash hands before putting on clean gloves	37.46 ± 33.62	47.33 ± 40.79
Wash hands when food preparation tasks are interrupted or changed	35.59 ± 37.24	39.36 ± 40.72
Wash hands before and after handling raw food	20.41 ± 35.35	10.43 ± 23.85
Wash hands after handling chemicals that could contaminate food	18.27 ± 38.44	19.44 ± 36.34
Wash hands after sneezing, coughing, or using a handkerchief/tissue	12.50 ± 31.08	8.33 ± 20.41
Wash hands after touching anything else that may contaminate hands (unsanitized equipment, work surfaces, cleaning cloths, drinking straw)	11.35 ± 23.68	10.23 ± 21.91
Wash hands after touching body parts	5.74 ± 19.05	2.66 ± 15.65
Wash hands after touching clothing/apron	0.80 ± 4.12	1.37 ± 6.82
Handwashing Procedure		
Dry hands and arms with a single-use paper towel or warm-air hand dryer	97.60 ± 9.87	89.03 ± 27.87**
Rinse hands thoroughly under running water	94.83 ± 21.61	91.27 ± 26.76
Clean between fingers	44.63 ± 42.99	43.52 ± 46.28
Vigorously scrub hands for at least 20 seconds	33.53 ± 40.83	37.72 ± 45.93
Vigorously scrub arms above wrists for at least 20 seconds	26.56 ± 38.41	29.43 ± 42.09
Clean under fingernails	11.92 ± 31.11	32.65 ± 45.75***
Using a Thermometer		
Food stored on the hot line is at least 135°F	100.00 ± 0.00	100.00 ± 0.00
Check internal temperature of food by inserting the thermometer stem or probe into the thickest part of the product	66.67 ± 49.24	58.33 ± 50.00
Food stored on the cold line is 41°F or less	66.67 ± 57.74	--
Wash, rinse, sanitize, and air-dry thermometer before and after use	40.00 ± 51.64	0.00 ± 0.00*
Check temperature of food at the completion of reheating	22.22 ± 44.10	0.00 ± 0.00
Check temperature of food at the completion of cooking	16.61 ± 36.59	8.89 ± 26.63
Properly Handling Food and Work Surfaces		
Leftovers labeled and dated	100.00 ± 0.00	--
Separate raw products from ready-to-eat products	83.33 ± 38.35	83.33 ± 40.82
Food contact surfaces are free of dust, dirt, and food particles	79.60 ± 32.02	78.45 ± 36.97
Food is covered and labeled properly before holding or storing	77.13 ± 38.78	79.96 ± 35.75
Wiping cloths are stored in a sanitizing solution	64.15 ± 46.39	84.21 ± 37.46
Food is covered when transported	59.39 ± 45.97	78.90 ± 36.73*
Separate wiping cloths are used for food and nonfood surfaces	29.63 ± 46.53	100.00 ± 0.00***
Wash, rinse, and sanitize food contact surfaces anytime begin working with another type of food or ingredients	17.77 ± 35.06	31.39 ± 42.76
Wash, rinse, and sanitize food contact surfaces after touching anything that might contaminate the food-contact surfaces	12.59 ± 32.01	18.57 ± 36.55

Note: A "--" indicates the behavior was not observed so a comparison cannot be made between the groups.

* $P < .05$; ** $P < .01$; *** $P < .001$.

in which all food handlers are required to be trained (52.9%). The average age of participants was 28.8 years, although ages ranged from 15 to 79. Participants had an average of 7.5 years of experience working in the food service industry. Of 1,298 restaurants contacted, 31 managers agreed to participate.

Knowledge

A Multivariate Analysis of Variance (MANOVA) was conducted to determine if there were significant differences in food safety knowledge between those food handlers in restaurants in which all food handlers are required to be trained and those in restaurants in which only shift managers must be knowledgeable about food safety. The independent variable was training policy status, with two levels: all food handlers must be trained and only shift managers must be knowledgeable. The dependent variables were knowledge scores related to each of the three food safety behaviors and a composite food safety knowledge score.

The MANOVA indicated a significant difference ($P < .001$). Food handlers in restaurants in which all food handlers were required to be trained had lower composite knowledge scores ($P < .001$), lower handwashing knowledge scores ($P < .05$), and lower thermometer usage knowledge scores ($P < .001$) than the food handlers from restaurants in which only shift managers must be knowledgeable about food safety. The two groups did not differ in their knowledge related to proper handling of food and work surfaces (Table 1).

Behavioral antecedents

A series of three MANOVAs were conducted to investigate the differences between the two groups on the TpB components (i.e., attitudes, subjective norms, perceived control, intention). A MANOVA was conducted for each of the three food safety behaviors (Table 2).

The MANOVAs for the TpB components related to handwashing and for use of thermometers were not significant. However, the MANOVA for the TpB components for proper handling of food and work surfaces was significant ($P < .05$). Food handlers in restaurants in which all food handlers are required to be trained had less favorable attitudes ($P < .05$), less favorable subjective norms ($P < .01$), and lower intentions ($P < .05$)

for proper handling of food and work surfaces than food handlers in restaurants in which only shift managers must be knowledgeable about food safety.

Observed behaviors

Independent samples t-tests were conducted on the 31 specific behaviors observed in the restaurant kitchens and composites of the three behaviors of interest to compare the compliance rates of the two groups. Of the 31 specific behaviors observed, the groups differed in their compliance rates on only five of those behaviors. Among the composite compliance scores, only the composite related to proper handling of food and work surfaces was significant ($P < .01$). The food handlers from restaurants in which all food handlers are required to be trained had better compliance with this behavior in general (Table 3).

Proper handling of food and work surfaces

Two of the nine behaviors related to proper handling of food and work surfaces were observed to have different compliance rates between the two groups. The food handlers in restaurants in which all food handlers are required to be trained were significantly more likely to cover food when transporting it ($P < .05$) and to use separate wiping cloths for food and nonfood surfaces ($P < .001$).

Handwashing

Group differences were found for only two of the 16 observed handwashing behaviors, and both of these related to *how* to perform handwashing properly. Food handlers in restaurants in which all food handlers were required to be trained had higher compliance rates for cleaning underneath their fingernails when washing hands ($P < .001$); however, these food handlers had lower compliance rates for drying hands and arms with a single-use paper towel or warm-air hand dryer after washing hands ($P < .01$).

Use of thermometers

There was one group difference among the six behaviors related to using thermometers. Food handlers in restaurants in which only shift managers must be knowledgeable about food safety were

more likely to wash, rinse, and sanitize the thermometers before and after use ($P < .05$).

CONCLUSIONS AND APPLICATIONS

The results suggest that having shift managers knowledgeable about food safety yields approximately the same results as having all food handlers trained. Having mandatory training for all food handlers is not consistently associated with improved knowledge, behavioral antecedents, or behaviors. However, training all food handlers may provide benefits in some specific areas of food safety.

The group results showed inconsistencies between the three behaviors. For handwashing, food handlers from restaurants in which only shift managers must be knowledgeable about food safety had more knowledge of the proper way to perform the behavior, and these food handlers had higher compliance with drying their hands thoroughly after washing, but they had lower compliance with cleaning underneath their fingernails when washing their hands, compared to the food handlers from restaurants with mandatory training for all food handlers. There were no differences between the two groups for any of the TpB components (i.e., attitudes, subjective norms, perceived control, intention) and most of the specific handwashing behaviors (14 out of the 16 specific behaviors) showed no differences between groups.

For thermometer use, food handlers from restaurants in which only shift managers must be knowledgeable about food safety had higher knowledge scores and higher compliance with washing, rinsing, and sanitizing thermometers before and after use, compared to food handlers from restaurants requiring training for all food handlers. However, the two groups did not differ in terms of the TpB components or compliance with five of the six specific observed behaviors related to using thermometers.

For proper handling of food and work surfaces, food handlers from restaurants in which only shift managers must be knowledgeable about food safety had more positive behavioral antecedents (better attitudes, subjective norms, and intention) for performing the behavior, but they had lower compliance for two

behaviors (covering food when it was being transported and using separate wiping cloths for food and nonfood surfaces). However, the two groups did not differ in their knowledge of the behavior or compliance with seven of the nine observed behaviors.

Food safety training is designed to increase employee knowledge of proper food safety practices, as has been confirmed by previous research (15). Lynch, Elledge, Griffith, and Boatright (15) compared managers' knowledge based on the type of training (from health department, corporate training, no training) they had received. They found that overall knowledge tended to be high (87.2%) regardless of the type of training, and training did increase knowledge levels. However, in the current study, the food handlers from restaurants in which training was mandatory for all food handlers had lower knowledge for the three food safety behaviors, although the difference between the groups did not reach significance for proper handling of food and work surfaces. Further, the overall knowledge of all food handlers combined was moderately high (78.7%), although not as high as Lynch et al. (15) reported. Perhaps this inconsistency was found because Lynch et al. (15) focused on foodservice managers, and the current study investigated foodservice employees. Another possible explanation for the discrepancy is the use of different knowledge assessment measures. Lynch et al. (15) assessed general knowledge of food safety, whereas the assessment used in the current study focused on handwashing, use of thermometers, and proper handling of food and work surfaces. Results of the current study suggest that making food safety training mandatory for all food handlers does not contribute to better knowledge of these three important food safety behaviors. In fact, having a manager knowledgeable about food safety is associated with better knowledge for the food handlers.

Mandatory training for all food handlers also does not improve important behavioral antecedents of food safety. There were no differences between the groups for the behavioral antecedents of two of the three broad food safety behaviors, and the behavioral antecedents for proper handling of food and work surfaces were better for the group from

restaurants in which only shift managers must be knowledgeable about food safety. Therefore, mandatory training for all food handlers was associated with neither improved knowledge nor improvements in behavioral antecedents for important food safety behaviors.

Food safety training is ultimately expected to improve food handlers' compliance with food safety guidelines. Past research suggests that this is an unrealized goal (3, 13, 16, 24). The two employee groups in this study had similar levels of behavioral compliance related to most of the specific behaviors observed, including five of the six thermometer-related behaviors, 14 of the 16 handwashing behaviors, and seven of the nine surfaces behaviors. Even when there were significant differences in the behaviors between the two groups, the direction of the change was not consistent. The current study suggests that instituting mandatory training for all food handlers is not consistently associated with improved employee behavior. However, in some instances it does appear to offer additional benefits compared to requiring only shift managers to be knowledgeable about food safety (e.g., cleaning under fingernails, covering food when it is being transported, using separate wiping cloths for food and nonfood surfaces).

Instituting mandatory food safety training for all food handlers does not appear necessary to ensure food handlers' knowledge, behavioral antecedents, or behaviors related to these three food safety behaviors important to avoidance of foodborne illnesses. Having a knowledgeable shift manager has a generally positive influence on these things. This may be because managers pass on food safety training to their employees, although perhaps not in a formal setting. Although it appears that food handlers' improved compliance with a few specific food safety behaviors may be associated with attending mandatory training classes, the knowledgeable shift manager may be an excellent source for food safety information. One possible explanation for the current results is that food handlers from restaurants in which only shift managers are required to be knowledgeable about food safety issues have better knowledge of food safety because the knowledgeable shift managers feel a greater sense of obligation to instruct food handlers

about food safety. Although the other employee group received a mandatory training class early in their employment in the restaurant, it could be that, because all managers and food handlers in that establishment are trained, no specific manager feels a sense of personal responsibility for monitoring food handlers and instructing them on food safety. However, this is speculative, given that the current study can offer no supporting evidence that the knowledgeable shift managers actually train the untrained food handlers in their establishments.

The discrepancy between the groups in food safety knowledge may be further compounded by the poor quality of food safety training offered by some local health departments. For example, some mandatory classes sponsored by local health departments are only 2 hours long and are used by the jurisdictions as a way to increase revenue. The training obtained in such classes, which is considered sufficient for food handlers to work in restaurants, is much different from the training that would be received in a four or eight-hour ServSafe® course. Although training from local health departments may not be as comprehensive as a ServSafe® course, it may give managers a false sense of security that their food handlers have learned all they need to know about food safety when, in reality, they have not. This study may show equivalent results between the group only mandated to have shift managers knowledgeable about food safety and the group mandated to have all food handlers trained because the quality of the mandatory training provided to the food handlers is so poor that the food handlers learn little from it (and thus, have not really been trained at all). Given the lack of a control group in this study, the accuracy of this statement cannot be determined.

Food handlers showed higher compliance with regard to a few specific behaviors when they had received mandatory training. There may be some aspects of the mandatory training class that food handlers have an easier time internalizing that are lacking in the instruction that may be provided by the knowledgeable shift manager. For example, the ServSafe® training guide suggests including a hands-on GloGerm® exercise in which employees apply to their hands an

invisible powder that glows under black light. After washing, they can see first hand under the black light, the places microorganisms would still exist if hands are not washed effectively (e.g., under fingernails). This type of demonstration may help food handlers internalize the importance of cleaning under fingernails, a behavior that was identified in this study to have a higher compliance rate among the food handlers from restaurants in which food safety training is mandatory for all food handlers. Possibly, the other two behaviors related to proper handling of food and work surfaces have higher compliance because of the specific lessons included in the mandatory training. Shift managers within the establishments that do not have mandatory training for all food handlers should identify areas of formal food safety training that may help them convey important lessons about food safety to their employees (such as cleaning under fingernails, covering food when transporting it, and using separate cloths for food and nonfood surfaces).

It should be noted that compliance with many of the specific food safety behaviors is quite low. Research must identify barriers existing between food handlers and their performance of important food safety behaviors. Past research indicates that food handlers identify barriers such as inadequate resources or supplies, lack of training, lack of reminders, time constraints, and negative consequences of performing the behaviors (2, 12, 22, 23). Food handlers must perceive a reduction in these barriers to comply with food safety guidelines. Training must focus not only on providing knowledge, but also on educating managers and food handlers on how to reduce the barriers they perceive. Removing some barriers, such as providing proper resources and supplies for performing the behaviors (e.g., adequate soap, paper towels, sanitizer) and providing training and reminders about properly performing the behaviors (including when to perform them) is the responsibility of the managers. The managers could also address time constraints and negative consequences. For example, managers should incorporate food safety behaviors into the food handlers' job, stressing that it is a requirement for employment, rather than something that distracts from their performance requirements (i.e., preparing food quickly).

LIMITATIONS

While it is useful to compare the two employee groups and to evaluate the differences in their knowledge, behavioral antecedents, and behaviors, it would be even more useful if there had been a control group (restaurants that do not require anybody to receive training or to be knowledgeable about food safety training). With the results of this study, the effectiveness of two types of food safety training requirements could be compared. However, conclusions about the effects of training in general cannot be made. Future research should determine if either of these types of training requirements is beneficial compared to no training.

The current research spanned three states and includes a more representative sample than many studies that have investigated food safety within one establishment or with restaurants within one county, but the response rate for participation was quite low. Of 1,298 restaurants contacted, only 31 restaurants agreed to participate. The managers who declined participation stated they did not have enough time to participate in a three-year research study. However, because the manager made the decision to participate or decline, the actual food handlers who participated should not be significantly different from those whose managers declined.

This study compared two groups of food handlers based on the type of mandatory training requirements (shift managers versus all food handlers) in the restaurants. It did not investigate further into the type of training the food handlers had received. Food handlers in either group could have received food safety training beyond the requirements of the local regulations. This study also did not make a distinction between different types of classes required when all food handlers are mandated to be trained. Some food handlers could have received a two-hour class and others may have attended a four or eight-hour class. Some food handlers may have received ServSafe® training, and others may have received training sponsored by a local health department. Future research should investigate the effects of different lengths of training and differently sponsored training classes on food handlers' knowledge and behaviors.

REFERENCES

1. Ajzen, I. 1991. The theory of planned behavior. *Organizational Behavior and Human Decision Processes* 50:179–211.
2. Brannon, L. A., V. K. Pilling, K. R. Roberts, C. W. Shanklin, and A. D. Howells (in press.) Appreciation of food safety practices based on level of experience. *J. Foodsrv. Bus. Res.*
3. Casey, R., and C. Cook. 1979. Assessment of a food service management sanitation course. *J. Env. Health* 41(5):281–284.
4. Centers for Disease Control and Prevention. 2005. Foodborne illness: Frequently asked questions. Available at: http://www.cdc.gov/ncidod/dbmd/diseaseinfo/files/foodborne_illness_FAQ.pdf. Accessed July 1, 2007.
5. Centers for Disease Control and Prevention. 2006. Preliminary FoodNet data on the incidence of infection with pathogens transmitted commonly through food – 10 states, United States, 2005. *MMWR*. 55(14). Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5514a2.htm?s_cid=mm5514a2_e. Accessed November 29, 2006.
6. Cochran-Yantis, D., P. Belo, J. Giampaoli, L. McProud, V. Everly, and J. Gans. 1996. Attitudes and knowledge of food safety among Santa Clara County, California restaurant operators. *J. Foodsrv. Systems* 9:117–128.
7. Cohen, E., A. Reichel, and Z. Schwartz. 2001. On the efficacy of an in-house food sanitation training program: Statistical measurements and practical conclusions. *J. of Hosp. and Tourism Res.* 25(1):5–16.
8. Collins, J. E. 1997. Impact of changing lifestyles on the emergence/reemergence of foodborne pathogens. *Emerg. Infect. Dis.* 3:471–479.
9. Cotterchio, M., J. Gunn, T. Coffill, P. Tormey, and M.A. Barry. 1998. Effect of a manager training program on sanitary conditions in restaurants. *Public Health Reports* 113:353–358.
10. Food and Drug Administration. 2000. Report of the FDA retail food program database of foodborne illness risk factors. Available at: <http://vm.cfsan.fda.gov/~dms/retrsk.html>. Accessed July 1, 2007.

11. Food and Drug Administration. 2004. FDA report on the occurrence of foodborne illness risk factors in selected institutional foodservice, restaurant, and retail food store facility types. Available at: <http://www.cfsan.fda.gov/~acrobat/retrsk2.pdf>. Accessed June 25, 2006.
12. Green, L. R., and C. Selman. 2005. Factors impacting food workers' and managers' safe food preparation practices: A qualitative study. *Food Prot. Trends* 25:981–990.
13. Howes, M., S. McEwen, M. Griffith, and L. Harris. 1996. Food handler certification by home study: Measuring changes in knowledge and behavior. *Dairy Food Env. Sanit.* 16:737–744.
14. Kneller, P., and T. Bierma. 1990. Food service certification measuring the effectiveness of a state program. *J. of Env. Health* 52(2):292–294.
15. Lynch, R. A., B. L. Elledge, C. C. Griffith, and D. J. Boatright. 2003. A comparison of food safety knowledge among restaurant managers, by source of training and experience, in Oklahoma County, Oklahoma. *J. of Env. Health* 66(2): 9–14.
16. Mathias, R. G., P. D. Riben, E. Campbell, M. Wiens, W. Cocksedge, A. Hazelwood, B. Kirschner, and J. Pelton. 1994. The evaluation of the effectiveness of routine restaurant inspections and education of food handlers: Restaurant inspection survey. *Can. J. Public Health* 85(Suppl. 1):S61–S66.
17. Mathias, R. G., R. Sizio, A. Hazelwood, and W. Cocksedge. 1995. The effects of inspection frequency and food handler education on restaurant inspection violations. *Can. J. Public Health* 86(1):46–50.
18. McElroy, D. M., and C. N. Cutter. 2004. Self-reported changes in food safety practices as a result of participation in a statewide food safety certification program. *Food Prot. Trends* 24:150–161.
19. Mead, P. S., L. Slutsker, V. Dietz, L. F. McCaig, J. S. Bresee, C. Shapiro, P. M. Griffin, and R. V. Tauxe. 1999. Food-related illness and death in the United States. *Emerg. Infect. Dis.* 5:607–625.
20. National Restaurant Association. 2006. News release: Increased restaurant industry sales, employment growth predicted in 2007 by National Restaurant Association Economic Forecast. Available at: <http://www.restaurant.org/press-room/pressrelease.cfm?ID=1348>. Accessed May 4, 2007.
21. Olsen, S. J., L. C. MacKinon, J. S. Goulding, N. H. Bean, and L. Slutsker. 2000. Surveillance for foodborne disease outbreaks – United States, 1993–1997. *MMWR*. 49(SS-5):1–51.
22. Pilling, V. K., L. A. Brannon, K. R. Roberts, C. W. Shanklin, and A. D. Howells. In press. Using the theory of planned behavior to elicit restaurant employee beliefs about food safety: Using surveys versus focus groups. *J. Foodsrv. Bus. Res.*
23. Pilling, V. K., L. A. Brannon, C. W. Shanklin, A. D. Howells, and K. R. Roberts. In press. Identifying specific beliefs to target to improve restaurant employees' intentions for performing three important food safety behaviors. *J. Am. Diet. Assoc.*
24. Wright, J., and L. Feun. 1986. Food service manager certification: An evaluation of its impact. *J. Env. Health* 49(1):12–15.