

# EVALUATING THE IMPACT OF FOOD SAFETY MESSAGING POSTERS ON OBSERVED EMPLOYEE FOOD SAFETY BEHAVIOR: A MIXED METHODS APPROACH

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## ABSTRACT

This study examined changes in retail foodservice employees' food safety behaviors after food safety messaging poster implementation in eight foodservice sites serving older adults. Microbial, observational, and interview data were collected at each site on three occasions: pre-, short term post-, and long term- post poster intervention. Based on observational data, no significant changes in compliance rates were found upon short term post-intervention. Increased compliance was observed in two facilities and decreased compliance in two other facilities at long term post-intervention. Factors that appeared to impact intervention included: involvement of employees in poster implementation, food safety training, and poster rotation.

**Keywords:** food safety training, safe food handling, observational study, mixed methods

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## INTRODUCTION

Foodborne pathogens are estimated to cause 47.8 million illnesses, 127,839 hospitalizations and 3,037 deaths annually in the United States (Scallan, Griffin, Angulo, Tauxe, & Hoekstra, 2011; Scallan et al., 2011). Given Americans' increased consumption of food away from home (United States Department of Agriculture & Economic Research Service, 2014), the risks of illness associated with unsafe food handling practices among retail foodservice employees is present. In fact, 75% reported foodborne illness outbreaks between 1998 and 2008 were attributed to foods purchased from a retail foodservice establishment (Gould, Walsh, Vieira, Herman, Williams, Hall, & Cole, 2013). Foodservice employees' health and hygiene, and unsafe food handling practices have been identified as two (of nine) contributing factors of restaurant-associated foodborne illness (Gould, Rosenblum, Nicholas, Phan, & Jones, 2013). This highlights the important role foodservice employees have on maintaining food safety.

Some individuals are more vulnerable to foodborne illness than others, including people with compromised immune systems, pregnant women, children, and older adults (McCabe-Sellers, &

Beattie, 2004). Research has shown older adults are susceptible to various foodborne illnesses (McCabe-Sellers, & Beattie, 2004; Nielsen et al., 2010; Weinberger et al., 2004), and more likely to die after having infections such as *Escherichia coli* O157:H7 (Gould, Demma, Jones, Hurd, Vugia, Smith, Shiferaw, Segler, Palmer, Zansky, & Griffin, 2009). Contributing factors to the high risk of foodborne illness among older adults include compromised immune systems, decreased gastric motility, prevalence of malnutrition, and living environments (e.g., long term care facilities) (Smith, 1998). Vulnerable populations (e.g., older adults) should avoid high risk foods such as unwashed fresh vegetables, including unwashed leafy greens (Lund & O'Brien, 2011).

Foodborne illnesses have been associated with a variety of commodities including fresh produce (e.g., leafy greens). Globally, leafy greens have been ranked a high priority commodity of concern due to risk of microbiological hazards related to high volume production, high number of foodborne illness outbreaks associated with leafy greens, and complex growing and processing conditions (Food and Agriculture Organization of the United Nations & World Health Organization, 2008). Based on Foodborne Disease Outbreak Surveillance System data from 1998-2008, about half of domestically acquired foodborne illnesses in the United States were associated with plant commodities (Painter, Hoekstra, Ayers, Tauxe, Braden, Angulo, & Griffin, 2013). More specifically, an estimated 22.3% (n=2,152,652) of foodborne illnesses were attributed to leafy greens (Painter et al., 2013). Increased consumption of fresh produce – and leafy greens in particular, the tendency for leafy greens to be consumed raw (e.g., ready-to-eat salads), and unsafe food handling practices may be potential contributors to illnesses linked to leafy greens.

Foodservice employees' shortcomings related to safe food handling practices are well-documented (Food and Drug Administration, 2000; Food and Drug Administration, 2009; Strohbahn, Sneed, Paez, & Meyer, 2008). Targeted interventions and training to improve foodservice employees' food handling practices have been created, implemented, and evaluated in a variety of foodservice environments. Research suggests the one-size-fits-all approach to training is not effective for a diverse foodservice workforce; therefore, multiple methods should be used to deliver food safety messages (Roberts, Arendt, Strohbahn, Ellis, & Paez, 2012). Use of minimal text posters may be one strategy to educate, remind, and cue employees to follow safe food handling practices when producing and serving potentially risky food items, such as leafy greens.

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### Statement of Purpose

The purpose of this research project was to examine leafy green handling practices of retail foodservice employees serving older adults; and to use that information to develop, implement, and evaluate a food safety messaging intervention to improve safe food handling practices. The study was multifaceted, involving microbiological analysis of leafy greens and contact surfaces (data not presented); development and evaluation of food safety messaging and implementation materials; analysis of observed employee food safety behaviors; and analysis of interviews with employees about their food safety behaviors. The focus of this manuscript is to answer the research questions: 1) Did observed employee food safety behaviors improve post-intervention (after food safety messaging posters were implemented)? 2) What factors contributed to changes in observed food safety behaviors post-intervention? Both observational and interview data were integrated to address these research questions. Other findings from the research project, such as the microbial data, are reported elsewhere.

## MATERIALS AND METHODS

### Research design

A three-phase design was implemented to address the overall goal of developing effective food safety messaging for use in retail foodservice environments. In the first phase, a convenience sample of foodservice operations serving the elderly located in two states were visited (n=8). At that first visit, observations (of both employees and operations) were made and interviews were conducted. Observations were done when the employee was preparing and serving raw leafy green menu items, Validated assessment forms (Sneed, Strohbehn, & Gilmore, 2004; Strohbehn et al., 2008) which included 134 items, were used to record data about operational aspects (i.e. food safety messaging, standard operating procedures regarding leafy greens, facility design and equipment), however emphasized employee behavior when preparing leafy greens (i.e. hand hygiene, glove use, utensil use). Employees (n=16) were interviewed about their observed food handling behaviors. Researchers used an interview guide, however additional questions were asked during the interviews based on observed behaviors. For example, if an employee washed heads of lettuce before cutting them, the researcher asked why the lettuce was washed before cutting. Likewise, if a behavior was observed that was not in compliance, the researcher asked employees why an action was not taken. Researchers hand recorded responses.

Additionally, microbial data of both leafy greens and contact surfaces were collected but results are reported elsewhere. In brief, all samples were negative for *Listeria monocytogenes*, *Escherichia coli* O157 and *Staphylococcus aureus* tests; aerobic plate counts and coliform counts were not significantly different before and after intervention ( $P < 0.05$ ). After intervention, fecal coliforms counts in samples of leafy greens from hospitals and restaurants were significantly lower than before intervention ( $P < 0.0004$ ) (Roy, Shaw, Rajagopal, Strohbehn, Arendt, & Sauer, 2016).

Informed by the first phase results, the second phase involved development, evaluation and dissemination of visual-based, minimal-text, food safety messaging posters to each of the eight sites. The posters conveyed both leafy green handling and general food safety messages; the full set of posters can be viewed and downloaded from [www.iowafoodsafety.org](http://www.iowafoodsafety.org). The effectiveness of the intervention (i.e. food safety messaging poster implementation) was assessed in the third phase by collecting microbial, observational and interview data again at each of two post-intervention visits. The short term post-intervention visit occurred one month after poster implementation and the long term post-intervention visit occurred after three months

of poster implementation. Comparisons were made between pre-intervention (phase one) data and post-intervention (phase three) data to assess effectiveness of the food safety messaging intervention.

### Site and participant selection

A purposeful sample of eight foodservice operations (two hospitals, two long term care facilities, two assisted living facilities, two restaurants) were included in the study. Matched facilities in two Midwestern states (i.e. one hospital in each state) were selected. Visits coincided with menus where at least one raw leafy green product was served to ensure researchers could observe and interview employees who prepared and served leafy greens. Employees who participated in the study were responsible for handling leafy greens (n=16). Foodservice managers (n=11) were also interviewed on two occasions post-intervention (at one month and after three months). Institutional Review Board approval and human subject consent was obtained for this study.

### Data analysis

Compliance rates were examined to determine whether observed food safety behaviors improved post-intervention. Rates were computed as the number of observational items (i.e. behaviors) in compliance divided by the total number of items observed at each visit. In effect, when converted to a percentage, rates indicate percentage of food safety behaviors observed in compliance. The rates were computed for each site visit (pre-intervention, short-term post-intervention, long term post-intervention) at each of the eight sites (A-H). Chi-square was used to examine differences in compliance rates pre-intervention versus compliance rates short term post-intervention; and compliance rates pre-intervention versus compliance rates long-term post intervention. Statistical Analysis Software (SAS 9.4) was used to run the analyses.

Data from interviews were compiled and then hand coded independently by three researchers. Three researchers agreed upon codes and themes before final analyses were completed. Interview and other observational data are integrated in the following report of results.

## RESULTS

### Participant and site characteristics

Efforts were made to interview the same employees at each of the three visits, but because research design requiring coordination of site visits with the menu offerings, time frame constraints for visits, and employee turnover, this was not always possible. Table 1 depicts participants, identified by code names, and their demographic characteristics. Sixteen foodservice employees participated in the study, six of whom were interviewed and observed at more than one site visit. Most employees (n=13; 81.25%) worked full time. Employees represented a wide range of experience in foodservice operations, ranging from less than one year to 37 years of experience (average 15.4 years). Time worked in the current operation varied greatly as well, with employment at the current site ranging from two months to 32 years, with an average of 9.1 years tenure.

### Statistical analyses

Figure 1 illustrates trends in compliance rates between pre-intervention, short term post-intervention, and long term post-intervention visits at each of the eight facilities involved in the study. No significant differences were noted in compliance rates short term post-intervention as compared to pre-intervention (Table 2). Statistically significant differences in compliance rates between pre-intervention and long term post-intervention visits were noted for four facilities (Table 3). Positive change (or increased compliance)

**Table 1: Study Participant Demographic Data**

Site	Pre-intervention				Short term post-intervention				Long term post-intervention			
	Name <sup>1</sup>	Status	Foodservice experience (years)	Tenure (years)	Name <sup>1</sup>	Status	Foodservice experience (years)	Tenure (years)	Name <sup>1</sup>	Status	Foodservice experience (years)	Tenure (years)
A	Abbie	FT	37	32	Mary	FT	21	11	Abbie	*	*	*
B	Buelah	FT	17	14	Buelah	*	*	*	Yvonne	FT	19	19
C	Candy	FT	27	22	Kate	PT	8	2	Kate	*	*	*
D	Daisy	FT	10	3	John	FT	5	.67	John	*	*	*
E	Elena	FT	7	0.8	Elena	*	*	*	Elena	*	*	*
F	Fiona	FT	10	6	David	FT	25	20	Donna	FT <sup>2</sup>	10	5
G	Gayle	FT	25	3	Gayle	*	*	*	Gayle	*	*	*
H	Hailey	FT	22	7	Kyle	PT	2	.5	Denise	PT	< 1	.17

<sup>1</sup>Pseudonyms have been used to maintain the privacy of the respondents  
<sup>2</sup>FT = full time, PT = part time; \*employee interviewed at previous site visit.

was observed in two facilities and negative change (decreased compliance) was observed in two facilities. In the next section, each of these cases are discussed in depth.

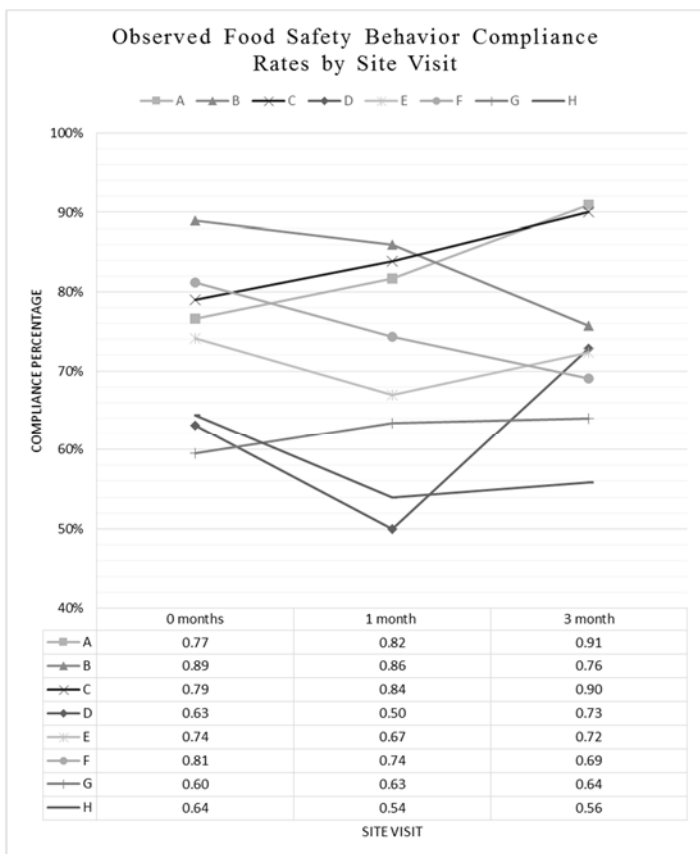
**Integration of observational and interview data**

Significant changes post-intervention (compared to pre-intervention) were noted for four sites: A, B, C, and F. The following discussion integrates the statistical results with qualitative results (e.g., interview and observation) to address the research questions.

**Site A:** For Site A (a hospital), the long term post-intervention compliance rate (91%) was significantly higher than the pre-intervention compliance rate (77%,  $p=0.019$ ). Two different employees were interviewed and observed at Site A. Specifically, “Abbie” participated during the pre-intervention and long term post-intervention site visit; while “Mary” participated in the second site

visit. Both had substantial experience working in foodservice (37 years and 21 years, respectively) and had worked at Site A for more than ten years (32 years and 11 years, respectively). Abbie had received more formal food safety training through the ServSafe® Certification program and experience as a certified dietary manager whereas Mary was not ServSafe® Certified, but had participated in the organization’s food safety training. Though there was a small change between pre-intervention (when Abbie was observed) and short term post-intervention compliance rates (when Mary was observed), it was not significant (0.77, 0.82, respectively;  $p=0.4640$ ). Note the same person was observed at pre-intervention and long term post-intervention visits which yielded a significant positive change in compliance rates. Also, a change in management occurred after the short term post-intervention site visit. This occurred after poster implementation.

The foodservice manager implemented the food safety messaging posters by first discussing the posters with employees at an in-service meeting, and then receiving employee input as to which posters should be displayed in the facility. When interviewed about the posters, this manager indicated “Posters are nice and look nice... employees helped pick the posters to display. They [employees] felt involved.” The act of involving stakeholders in making decisions that potentially impact them is termed participatory decision making. Participatory decision making has been widely studied across disciplines (Ananda, 2007; Irvin, & Stansbury, 2004; Parchman, Zeber, & Palmer, 2010; Severt, Xie, & Dipietro, 2007). Organizations are complex systems in a constant state of change because they must adapt and evolve in response to both internal and external forces. Participatory decision making can be a vehicle to enhance existing connections between people and tasks, as well as establish new connections (Ashmos, Duchon, McDaniel, & Huonker, 2002). The byproducts of establishing these connections between people and tasks include the exchange of specialized information as well as



**Figure 1:** Observed food safety behavior compliance rates by site visit

**Table 2: Analysis of Pre-Intervention and Short Term Post-Intervention Compliance Rates**

Site	Pre-intervention	Short term post-intervention	Chi Square	p-value
	compliance rate	compliance rate		
A	0.77	0.82	0.5362	0.4640
B	0.89	0.86	0.4451	0.5047
C	0.79	0.84	0.8669	0.3518
D	0.63	0.50	3.7148	0.0539
E	0.74	0.67	1.4928	0.2218
F	0.81	0.74	1.5677	0.2105
G	0.60	0.63	0.3710	0.5424
H	0.64	0.54	2.5356	0.1113

**Table 3: Analysis of Pre-Intervention and Long Term Post-Intervention Compliance Rates**

Site	Pre-intervention compliance rate	Long term post-intervention compliance rate	Chi square	p-value
A	0.77	0.91	5.5229	0.0188*
B	0.89	0.76	6.0188	0.0142*
C	0.79	0.90	5.2941	0.0214*
D	0.63	0.73	2.3478	0.1255
E	0.74	0.72	0.1007	0.7510
F	0.81	0.69	4.5672	0.0326*
G	0.60	0.64	0.5099	0.4752
H	0.64	0.56	1.6997	0.1923

\*Statistically significant at  $p < .05$  level

commentary and discussion of the meaning of that information – both of which contribute to an amplified effect of the information (Ashmos et al., 2002).

When the Site A foodservice manager involved employees in the implementation of food safety messaging posters, employees were provided the opportunity to make connections with each other, and with the information (food safety messages). Involving employees in selection of the posters likely yielded discussion of the food safety messages, thereby amplifying the impact of the information as compared to if posters had been hung without discussion. Additionally, Abbie’s food safety training may have provided a foundation for knowledge, and the posters served as a reminder for safe food handling practices. These factors may have contributed to the significant positive change in behavior compliance noted at the long term post-intervention visit.

**Site B:** Conversely, for Site B (a long term care facility), the long term post-intervention compliance rate (76%) was significantly lower than the pre-intervention compliance rate (89%,  $p=0.014$ ). The negative change in compliance rates may be attributed to changes in personnel during the study – including the employee interviewed/observed and the manager. Posters were displayed on the communications and safety bulletin board and remained there throughout the study period. Managers at participating sites were asked by the research team to rotate food safety messaging posters as a strategy to call attention to posters and increase exposure to different food safety messages. This strategy was not implemented at Site B.

At the initial visit, there appeared to be a positive food safety culture established as evidenced by daily “safety huddles” with all kitchen employees. The term “organizational culture” refers to the shared beliefs and values which govern the way things are done in an organization (Ungku Zainal Abidin, Arendt, & Strohbehn, 2014); in foodservice operations, food safety culture refers to “the way we do things [food safety] around here” (Yiannis, 2009, p. 12) and is a component of the cultural constructs of the organization. Yiannis, vice president of food safety at Walmart, noted “There is no question that an organization’s culture influences how it does safety. The organization’s culture will influence how individuals within the group think about safety, their attitudes toward safety, their willingness to openly discuss safety concerns and share differing opinions, and, in general, the emphasis they place on safety” (Yiannis, 2009, p. 13).

Leadership plays a crucial role in establishing and maintaining a positive food safety culture as it is best implemented when initiated

at the top and flows down (Yiannis, 2009). Before the short term post-intervention visit, Site B had a change in foodservice managers. The food safety messages were implemented at this site, the then-manager called attention to the posters during the safety huddle. Four posters were implemented and remained on display through the duration of the study. Though the compliance rate did not improve short term post intervention, the positive food safety culture was maintained despite the change in management personnel as evidenced by no significant change between pre-intervention and short term post-intervention visits (89% at pre-intervention, 86% at short term post-intervention,  $p=0.5047$ ). It is possible the newer manager at this site did not effectively maintain the previously established food safety culture, or the manager’s focus was elsewhere. Either of which may have impacted the long term significant decrease in observed food safety behavior compliance rate.

Perhaps a more plausible explanation is that the negative change in compliance rates may be attributed to observation of different employees. “Buelah,” was interviewed/observed during pre-intervention and short term post-intervention visits, while “Yvonne” was interviewed/observed during the long term post-intervention visit. No significant change was noted between the two visits at which Buelah was observed/interviewed. Buelah was a full time employee: 17 years of experience in foodservice; 14 years of experience in current operation; 17 years of experience handling leafy greens; and ServSafe® certified. It was apparent Buelah had internalized knowledge gained from formal food safety training and that the knowledge she had served as a form of motivation for safe food handling behaviors. When asked why gloves were used when handling leafy greens, she said, “For [this state], prepared food/ready-to-eat food, you must use gloves,” and that “It is a ready-to-eat food so we need to use gloves.” Buelah exhibited awareness for cross contamination as she was observed cleaning the sink before washing leafy greens in a colander. When asked about this procedure, she indicated lots of different foods were handled in that work area, so she washed sink as a precaution. Research has shown formal food safety training courses can have positive impact on attitudes, awareness (knowledge), and appreciation for food safety behaviors, though these benefits may or may not translate to actual behaviors (Brannon, York, Roberts, Shanklin, & Howells, 2009). Based on Buelah’s rationale for following certain safe food handling behaviors, the formal training she received appeared to have a positive impact on her behaviors.

The behavior compliance rate was significantly lower at the long term post intervention visit, when Yvonne was observed/interviewed. Yvonne was a full time employee with 19 years of experience in long term care, and 10 years of experience at the current operation. Yvonne had no formal food safety training; her coworker taught her how to handle leafy greens when she first started. Yvonne had several years of experience working in non-commercial foodservice operations, however this experience may not have had an impact on food safety behaviors in the absence of formal food safety training. Experience alone may not yield sufficient knowledge or appreciation for handling food safely (Brannon et al. 2009). On two separate occasions, when Yvonne was asked why safe food handling behaviors were followed it was indicated she simply followed the instructions of management. Specifically, when asked why gloves were worn Yvonne reported, “They told me to – I don’t know why.” And when asked about cleaning and sanitizing procedures, Yvonne said, “Supervisor told me about this.”

**Site C:** Implementation of the food safety messaging posters appeared effective at Site C. Compliance rates post-intervention were

significantly better than compliance rates pre-intervention at Site C, an assisted living facility. The long term post-intervention compliance rate (90%) was significantly higher than the pre-intervention compliance rate (79%,  $p=0.021$ ). Contrary to Site A, which utilized participatory decision making during the implementation process, this positive outcome was achieved without managers taking any additional measures during poster implementation. That is, posters were simply selected by the manager and displayed in the facility, without announcement or employee input.

“Candy” was interviewed and observed at the pre-intervention visit whereas “Kate” was interviewed at both short and long term post-intervention visits. Candy was a full time employee who had worked at the operation for 22 years, with a total of 27 years foodservice experience. Her responsibilities since hire included preparing leafy greens. Candy was ServSafe® certified, and had also received basic food safety training as part of her Certified Dietary Manager requirements. Kate was a part time employee who had been working in various foodservice operations (e.g., restaurants, university dining, retirement community) for eight years. She had received ServSafe® certification as part of a college class.

Studies have shown foodservice managers and employees with food safety certifications, such as ServSafe®, had greater knowledge than those without food safety certifications (Brown et al., 2014; Lynch, Elledge, Griffith, & Boatright, 2003). Though knowledge does not always result in desired behaviors, knowledge can serve as a motivator for behaviors. Furthermore, combining ServSafe® training with food safety interventions has been shown to yield better employee food safety behaviors, as illustrated in a recent study. York et al. (2014) investigated the relative effectiveness of ServSafe® training, a targeted on-site intervention (including providing thermometers, incentive program, and persuasive signs), and a combination of both ServSafe® training and the intervention. When examining overall food safety behavior compliance rates, the group of employees who received the ServSafe® training only performed similarly to the group who received the intervention only. However, the group that received both Servsafe® training and the intervention had a higher compliance rate score than the intervention only group (York et al, 2014). These results illustrated the effectiveness of combining an on-site intervention with formal food safety training methods.

Similar to the York, et al. (2014) study, the combination of Site C participants’ ServSafe® certification training and the food safety messaging intervention may have contributed to the positive changes in food safety compliance rates observed.

**Site F:** Despite implementation of the food safety messaging posters, food safety behavior compliance rates decreased post-intervention at Site F, a long term care facility. Specifically, the long term post-intervention compliance rate (69%) was significantly lower than the pre-intervention compliance rate (81%,  $p=0.033$ ). This decline in compliance rates may be due to participant changes during the study.

Three different employees from Site F participated in the study: “Fiona” during pre-intervention visit, “David” at short term post-intervention visit; “Donna” at long term post-intervention visit. Fiona was a full time employee with 10 years foodservice experience. She had worked in the current operation for six years and had been responsible for preparing leafy greens throughout the duration. Fiona received some general training when she started and stated the following, “...about how to handle things. Mostly, how to keep

lettuce looking fresh and stuff for the customer. We talk about food safety about once a year. It’s really important.” David was a full time employee with 25 years foodservice experience. He had worked at the current operation for about 20 years and had been responsible for preparing leafy greens during that entire time. David had not received training specifically for produce handling; he said, “We pretty much just know what to do, you know keep stuff clean and don’t make people sick.” There was a decline in compliance rate between the pre-intervention visit with Fiona (0.81) and the short term post-intervention visit with David (0.74), however this change was not significant ( $p=0.215$ ).

At the long term post-intervention visit, the foodservice manager commented, “several new staff were hired since your last visit.” Donna, who participated in the long term post-intervention visit, was one of those newer employees. She was a full time employee with 10 years of experience in foodservice and had worked at the operation about two months when she participated in the study. She had been responsible for preparation of leafy greens since her hire. When asked about food safety training, Donna indicated she had “a little training in her Certified Dietary Manager courses.”

The lower compliance rates post-intervention may be attributed to employee turnover without opportunity for food safety specific on the job training upon hire. Also, because Donna had not worked in the operation throughout the duration of the study, her exposure to the food safety messaging posters may not have been as great. The effect associated with the novelty of “new” posters being hung may not be as great because posters were already implemented upon hire.

**Other sites:** Compliance rates for Sites D and H (both restaurants) were consistently among the lowest in comparison to other sites. This may be attributed to lack of knowledge about safe handling of leafy greens, and lack of motivation to change food safety behaviors. Employees (n=5) from these two sites indicated a lack of training on how to handle leafy greens. “Hailey,” who worked at Site H, reported, “on the first day we get some general sanitation training. We don’t really do anything specific to produce, it is broad.” “John” and “Daisy,” from Site D, were taught how to handle leafy greens by a previous chef. A manager at Site D commented the poster content showed “some discrepancy with current thinking” particularly related to the practice of re-washing bagged lettuce. At the initial site visit, an employee was observed rewashing bagged leafy greens. Despite implementation of task-specific food safety messaging poster (i.e. Bagged Leafy Greens Do’s and Don’ts) in the facility, an employee was observed improperly re-washing bagged leafy greens at the long term post-intervention visit as well. Though the intervention directly addressed a misconception presumably passed from one employee to another via informal on-the-job training, behavior change was not realized. Managers play an essential role in training, monitoring, and enforcing employees’ safe food handling behaviors (Food and Drug Administration, 2009). These management roles are increasingly important when employee turnover is evident as well.

In addition to Sites D and H, food safety messaging posters did not appear to change observed food safety compliance rates long term at Site E (a hospital) or G (an assisted living facility). Though the difference was not significant, compliance rates decreased post-intervention for each of these sites despite the fact the same employees were observed throughout the duration of the study. Researchers noted employees who participated in consecutive site visits appeared more familiar with the protocol, comfortable with researchers, and relaxed at the latter site visits. Characteristic of the

Hawthorne effect, employees' participation in the study itself may have altered their behaviors – especially at the initial site visit. Knowing they were being observed, employees may have behaved differently at the initial site visit thereby not accurately reflecting day-to-day behaviors. However, as the study progressed and employees became more relaxed with the research protocol, their observed food safety behaviors may have been more reflective of the norm.

## DISCUSSION

The purpose of this inquiry was to examine changes in employee food safety behavior after food safety messages were implemented in foodservice operations serving older adults. Significant changes were detected for four of the foodservice operations; two of which were positive and two negative. Coupling statistical (chi square) data with qualitative observational and interview data for each of the four cases showing significant changes yielded several implications for industry professionals.

In the case of Site A, positive changes in employee food safety behaviors were observed post-intervention. The then-manager involved employees in the selection and implementation of posters. This participatory decision making process may have amplified the impact of the food safety messages. The effect of letting employees connect with the messages, and each other in the participatory decision making process may have negated the potential effect of having change in management during the study (assuming the change in management may have negatively impacted compliance rate). Therefore, we suggest industry professionals involve employees in this process as it appeared to heighten interaction with the subject matter, and with each other, which can support positive behavioral outcomes. The effect of peer interactions on food safety behaviors in the workplace has not been reported in the literature, and poses an opportunity for future research.

Study findings illustrate the fact that no single intervention will remedy all deficits in employee food safety behaviors. Visual-based, minimal-text, food safety messages can serve as tools for education and/or re-iteration. As illustrated in the case of Site C, even if employees have received food safety training previously, onsite food safety messaging interventions can still be helpful to influence food safety behaviors. Posted food safety messages serve as reminders of previous knowledge in the case of foodservice employees who have formal food safety training. Future studies may investigate whether the impact of the food safety messages differ among employees with previous formal food safety training and those without previous training. Food safety messages provide visual cues when strategically placed in food preparation areas. Further, the visual-based nature of the posters allowed for those with limited literacy to understand the message. Researchers suggested periodic rotation of the posters to ensure food safety messages did not become ordinary (and ineffective) to employees. Periodic poster rotation can help keep employees' attention, capitalizing on the effect of the visual cue.

The same participant was observed/interviewed at all three site visits for only two sites (E and G). This added complexity to the comparison of pre-intervention and post-intervention food safety compliance rates given that variability in the data may be attributed to employee-related factors as opposed to the intervention itself. Because site visit schedules were driven by facility menus and inability to coordinate employee schedules or control turnover, researchers could not ensure consistency in employee participation at any given site. However, researchers have considered differences among study participants in the report of results in an effort to minimize this limitation.

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