IMPLEMENTATION OF FOOD DEFENSE BEST PRACTICES IN NORTHERN U.S. SCHOOL NUTRITION PROGRAMS: A CASE STUDY

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ABSTRACT

One act of intentional contamination of school meals can quickly harm many children. Food defense guidelines for schools exist; yet previous research has found communication, utility security, and physical security practices are infrequently implemented. A multi-site case study approach obtained a 360-degree assessment of food defense practices in five school districts. Meal production and service were observed, a food defense checklist was completed, and key stakeholders were interviewed. Qualitative analysis of interviews revealed lack of awareness, lack of concern, conflicting priorities, and isolation of foodservice from other school operations impaired food defense implementation. School security measures protected children, but not food.

Keywords: food defense, food terrorism, food tampering, school administration, emergency response planning

INTRODUCTION

Acts of terrorism have become common occurrences throughout the world. Although most terrorist attacks currently involve explosive devices, researchers have predicted that terrorism may spread to new targets, including the food supply (Khan, Swerdlow, & Juranek, 2001; Mohtadi & Murshid, 2009; Radosvljevic & Belojevic, 2009). Terrorist targets were described by Radosavljevic & Belojevic (2009) as hard or soft depending on the level of sophistication needed to breach the target. Well-known venues that house important people and are well protected are considered hard targets, whereas soft targets are public places occupied by ordinary citizens. Schools are considered soft targets. An attack on school meals would cause great social disruption because a large number of families in a community would be affected by the event (Greene et al., 2004). Mohtadi and Murshid (2009) noted a trend away from attacks on airlines, military, and government targets, with a move to less protected targets. Experts consider the U.S. food industry to be a soft target, vulnerable to acts of intentional contamination with chemical, biological, radiologic, or nuclear weapons (Jackson, 2009; Khan, Swerdlow, & Juranek, 2001). The World Health Organization has urged its member states to recognize the potential for food to be deliberately contaminated, and therefore strengthen food production, processing, and preparation systems (World Health Organization [WHO], 2008).

Primary motivations behind terrorist attacks are disruptions of social life causing physical, psychological, or economic damage (Bruemmer, 2003; Elad, 2005; Sobel, Khan, & Swerdlow, 2002, WHO, 2008). The existence of a global food system means an attack contaminating a large batch of food product has the potential to affect a large number of people over a widely dispersed area. An attack on one batch of food produced in a single facility, such as a school, might even create wider social disruption than achieved by destroying the food processing facility itself.

Potential for intentional contamination of food with chemical or biological agents has led to establishment of food defense measures by industries associated with the food supply. For example, there is a 38-member industry work group sponsored by the National Center for Food Protection and Defense that includes representatives from national retail and grocery stores, restaurants, food processors, and food management companies (National Center for Food Protection and Defense, n.d.). Food defense is defined as the protection of food from intentional contamination. In recognition of this emerging threat, the U.S. government increased spending for food defense from $1 million in 2001 to $217 million in 2011 (Franco & Sell, 2010).

Food contamination threats may be presented from internal sources such as disgruntled employees or individuals within the organization seeking revenge or other notoriety (e.g. student pranks). Criminals, extortionists, and extremist special interest groups without a direct connection to the organization may also pose threats of intentional food contamination (Busta, 2010). An analysis of 365 confirmed incidents of malicious food contamination across the globe showed the majority occurred in the home or at work, and were perpetrated by relatives, co-workers, and/or acquaintances of the victims (Dalziel, 2009). However, of these incidents, 23.3% (n = 85) occurred in retail foodservice venues and contributed the highest average number of casualties (n = 39) per incident. A survey of 926 restaurant managers in South Carolina found that managers reported 29 alleged food tampering incidents in their restaurants (Xirasagar, Kanwat, Smith et al., 2010). Managers identified dissatisfied or terminated employees as probable perpetrators in 16 of the incidents. Sneed and Strohbehn (2008) identified concerns about food defense in retail foodservice operations as a trend with implications for food and nutrition professionals.

Food defense practices are designed to make targets less vulnerable. The United States Department of Agriculture Food and Nutrition Service (USDA-FNS) published A Biosecurity Checklist for School Food Service in 2004, which included 104 practices in 16 categories (USDA-FNS, 2004). These practices were reorganized into six major categories and updated to a total of 93 in 2012 (USDA-FNS, 2012). Research about the extent of implementation of food defense practices in schools is sparse. Yoon and Shanklin (2007) utilized the Biosecurity Checklist for School Food Service as a foundation for developing an abbreviated checklist of 35 practices divided into six categories: chemical use and storage, food handling, employee management, utility security, facility security, and communication. They surveyed foodservice directors in Kansas schools and found mean ratings for reported frequency of implementation in categories

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of chemical use and storage and food handling were less than 4.0 on a 5-point scale, indicating implementation most of the time. Practices related to employee management, utility security, and facility security had mean ratings between 3.0 and 4.0, indicating implementation some of the time. The communication category had a mean rating of 2.7, meaning the practices were reported as seldom implemented.

In a subsequent study, Yoon (2007) selected 12 of the 35 food defense practices and asked a national sample of foodservice directors from school districts with enrollments greater than 7500 students to rate the degree to which they were implemented. Five practices were identified as being implemented most of the time (greater than 6 on a 7-point scale where 1 = never and 7 = always): purchasing food from reputable suppliers, making security checks of employees prior to hiring, safely storing and using chemicals, assigning one person to verify and receive shipments, and inspecting packages for evidence of tampering. Clear identification of personnel, control of access to storage and production areas, and accounting for former employees' badges and uniforms had mean ratings between 5 and 6 on the 7-point scale. Practices with lowest mean ratings were restriction of access to air and utility systems, controlling access to the foodservice facility, and maintaining an updated contact list of local authorities (mean ratings ranged from 3 to 5). The mean rating of employee training about the food defense management plan was equivalent to not very frequently (between 3 and 5 on the 7-point scale).

There has been no known published research about food defense practices in schools since 2007 (Yoon; Yoon & Shanklin). The purpose of this study was to determine the extent to which best practices in food defense are currently implemented in U.S. schools. The objectives of this study were:
- To observe current implementation practices in five school districts of food defense best practices
- To investigate reasons why communication and physical security aspects of food defense have been identified as infrequently implemented in school foodservice operations

METHODS
This study used a holistic, case study approach with data from interviews, observations, and document reviews obtained during site visits to five school districts in 2012. School districts were recruited from four of seven states included in the USDA-Risk Management Agency's Northern Region. Yoon (2007) used this configuration of states when comparing regional differences in implementation of food defense practices. The number of responses from the northern region in her study was limited; thus the current study was planned to provide insight into practices in this geographic region. The Institutional Review Board of the Office of Responsible Research approved the study.

Sample
A convenience sample of five school districts was recruited to include maximum variation of student enrollment, type of food production system, location (urban, suburban, or rural), and credentials of the foodservice director. Selection included one school district in South Dakota, Iowa, and Wisconsin, and two school districts in Minnesota. These states were chosen because they could be reached by the primary investigator within a one-day drive and two of the states are located along the United States border with Canada.

A one-day site visit to each district was made to conduct a comprehensive assessment of food defense readiness. Three visits were made in May 2012 and two visits were completed in October

2012. The schedule for each visit included observations of breakfast and lunch production and service. In two of the districts, observation was allowed at two production sites for a total of seven sites observed. Five individuals holding four different positions within the district were interviewed at each site. Interviews were scheduled with the foodservice director and two foodservice production workers, a school administrator, and an individual representing an agency that would be called in the event of a crisis. In all cases, the administrator was a building principal.

The initial contact was made with foodservice directors in four of the districts; the remaining site was recruited through the district superintendent, who arranged all other interviews for that site. Emergency response officials were recruited by the foodservice director or the administrator; position titles varied by district and included a city fire chief, a county coroner, two security management officials and a School Resource (police) Officer.

Data Collection
Data collection was guided by three principles outlined by Yin (2009): use multiple sources of evidence, create a case study database, and maintain a chain of evidence.

Multiple sources of evidence: Data collected included observations of food production and service, interviews with key stakeholders, and food defense documents made available by the site.

Observations: Observations of two meal production and service periods were planned for each district. Food defense practices were assessed using a validated 32-item, 5-category checklist, Food Defense Checklist for Retail Foodservices, (Strohbehn, Sneed, Paez, & Beattie (2007).

Interviews: An interview guide was developed for each stakeholder group based on four topics in A Biosecurity Checklist for School Food Service (USDA-FNS, 2004): communication, handling a crisis, foodservice/food preparation areas, and water and ice supply. The interview guide was reviewed by a team of researchers with expertise in social sciences and foodservice management with modifications made based on their feedback. Open-ended questions about perceptions related to vulnerability of the foodservice operation, personal experiences with food tampering, barriers to food defense, importance of food defense, and communication about food defense were included in the guides for all stakeholders. Each interview was audio-recorded with permission.

Document review: The foodservice director was asked to make available for review the food defense plan, if one was in place.

Create study database: Yin's (2009) second identified principle for data collection was to create a case study data base. Reliability of case studies is enhanced with the use of a written protocol and development of a case study data base (Yin, 2009). The data collected from each school site were imported into QSR International's Nvivo 9 qualitative data analysis software. Digital copies of documents, scans of completed observation checklists, interview transcripts, and receipts documenting transcription service and travel were included in the data base.

Chain of evidence: All documents were coded for location and, in the case of interviews, individuals by group of stakeholder and interview item. Date, time, and interviewee code were included in recordings of each interview.

Data Analysis

Interview data: Digital recordings of the interviews were transcribed by an individual with human subjects in research training and previous experience transcribing research interviews. Transcripts from the first three site visits were reviewed independently by first and second authors, with each suggesting themes. Proposed themes were discussed via telephone conversation; a consensus of six themes and 10 sub-themes was reached. Transcripts of interviews with stakeholders at the final two sites were reviewed in late fall 2012. No new themes emerged from interviews at these sites, justifying cessation of data collection. Discussion about wording and organization of themes and subthemes continued until a list of four themes and 11 subthemes was finalized.

Procedures outlined were used to code transcript data. QSR International's Nvivo 9 qualitative data analysis software facilitated the process recommended by Maykut and Morehouse (1994) that meaningful content be extracted from transcripts and arranged into larger units of meaning. Interview transcripts were uploaded into the program and units of meaning highlighted. Highlighted text was coded according to themes and subthemes.

Observation data and document review: Observational data of foodservice operations during production and service of two meals were tallied and summarized. The kitchen manager or foodservice director was asked about practices that could not be directly observed. Pertinent information from interviews was also used to complete checklists. Food defense plans, if available, were reviewed for format and content.

RESULTS AND DISCUSSION

A profile of the participating districts and findings from interviews, observations and reviews of district food defense plans are presented below. Demographics for each site are shown in Table 1. Only one of the five districts had a food defense plan and a team of employees designated as responsible for it.

Profile of Districts

This convenience sample of districts represented small to mega districts with student enrollment ranging from approximately 2,000 students to over 43,000. Districts were located in rural, suburban, urban and metropolitan areas. Production systems also varied, with three using on-site preparation and service and two using either a central production facility or a commissary operation. A central food warehouse system was used by four of the five districts; only the medium sized district located in an urban area stored food at the on-site production location.

Summary of Interviews

Twenty-five interviews were conducted with district stakeholders. Five people were interviewed at each study site: a school principal, the district foodservice director, two production workers, and an individual with district and/or community security responsibilities. This last group is referred to as "emergency responders" in this paper. Four themes emerged from these interviews: 1) lack of awareness; 2) lack of concern; 3) food not considered as a potential danger; and 4) conflicting priorities and expectations influence food defense.

Lack of Awareness: Food defense was an unfamiliar concept among the stakeholder groups. Representative quotations for this theme are shown in Table 2. Principals confused food defense with the need for food and water supplies when sheltering students during an emergency, or with the need to maintain a safe environment in the school cafeteria. Emergency responders with work-related experience involving food tampering outside the school environment had not transferred the threat of intentional food contamination to the school setting. Production workers often related the concept of food defense to the need to check produce and food packaging for tampering, with several production workers identifying food safety training as their introduction to the concept of food defense.

The four stakeholder groups each identified different areas of vulnerability to acts of intentional food contamination in their districts. The responses of the principals reflected their concern with protection against intruders. Three of five principals were most concerned with the security of exterior doors; one stated that the cafeteria was the most vulnerable area and one thought the food was most vulnerable in the central kitchen. Foodservice directors saw food as most vulnerable outside of the food production areas. One foodservice director mentioned the serving line; two mentioned deliveries/loading dock and two of the foodservice directors believed the food was most vulnerable in the supply chain before it was delivered to the district.

Production workers identified vulnerabilities in their workplaces: delivery, the serving line, a large steam-jacketed kettle in the

Table 1: Demographics of Case Study					
Parameter	**Site A** small district rural area	**Site B** medium district suburban area	**Site C** medium district urban area	**Site D** medium district metropolitan area	**Site E** mega district metropolitan area
Student enrollment[a]	2,000	5,000	7,000	9,000	43,000
Primary production system	on-site	on-site	on-site	commissary	central
Storage system	central warehouse	central warehouse	onsite	central warehouse	central warehouse
Population[a]	10,000	22,000	50,000	57,000	285,000
Credentials of foodservice director	Some college	Bachelor's Degree	Graduate Degree, RD	Graduate Degree, RD, SNS	Bachelor's Degree, RD
Average number of breakfasts served daily[a]	950	300	2,100	1,000	18,000
Average number of lunches served daily[a]	1,700	3,000	3,800	5,000	31,000
Approximate ADP (lunch)	77%	64.5%	56%	54%	72%
Population below poverty level[b]	48%	6%	23%	5%	22%

Note: Data were collected at seven buildings in five districts
RD = Registered Dietitian, SNS = School Nutrition Specialist; ADP = average daily participation
[a]Rounded to protect identity
[b]Obtained from 2010 Census

Table 2: Sub-themes and Illustrative Quotations for the Theme of "A Lack of Awareness"	
Sub-theme	Sample illustrative quotations
Food defense is an unfamiliar term, but the concept is familiar	• [Under shelter-in-place] we would be self-sufficient here with the food and the water that we have in the building. No one would come in and nobody would go out. So it would be important to make sure that our food supply was safe. (principal) • … Such as dating and making sure seals are shut. Things like that, yes. We're all responsible for that and to report anything unusual. (production worker) • I would say that I've thought about it before but not in relationship to the school and I guess to our community as a whole. (emergency responder)
Experience with food tampering was uncommon	• … not specifically about terrorism type contamination, it's more about natural contamination. (production worker)
Different stakeholders are aware of different areas of vulnerability	• Because basically… I could go in the freezer and sprinkle something on whatever and … you're not able to see with the eye but it would still be very toxic to you. So am I wrong in thinking that… we're easy? (production worker)

production area, and unlocked storage areas. Another cook was concerned that identification badges weren't being worn by school staff. Three workers were unable to identify a vulnerable area and expressed confidence that kitchens were safe.

Lack of concern: Participants expressed beliefs that attacks on the food supply would occur in large cities, at nationally recognized locations, in other geographic locations such as the "East," or at other points in the supply chain, but not in their schools (Table 3). Although a number of production workers and administrators voiced a strong belief that food tampering would not happen in their school districts, this belief was in contrast with actual experiences reported by foodservice directors.

All participants were asked if they had experienced an incident of food tampering at work or in their personal lives. Four foodservice directors and two emergency responders reported experiences of food tampering, with two reporting two occurrences. Two emergency responders reported involvement with cases of intentional food contamination in non-school settings. Four of the incidents occurring in schools were perpetrated by students: BB gun pellets were added to a batch of mashed potatoes, a used condom was placed in a container of ranch salad dressing, urine was found on and around a salad bar, and a worm was placed on a pan of corn in the serving line.

The only food tampering cases involving employees occurred in the mega district with the central kitchen facility. A foodservice production employee was suspected when plastic bandages were

found in batches of cooked noodles on more than one occasion. The final school incident involved an "irritated" employee who knowingly performed an incomplete cleaning of a machine that had been used to process raw ground beef.

Food is not considered a potential danger: A third theme that emerged from the data is that food issues were viewed as being separate from school operations and that those issues were the responsibility of the foodservice director (Table 4). As a result, only one of five districts had a food related issue included in their crisis management plan. Principals and foodservice directors interviewed had no specific procedures for dealing with food tampering; only one district had procedures for handling food in which contamination was suspected. The two emergency responders reporting work-related experiences with food tampering expressed belief that it is a reasonable concern for schools, but the other three did not, suggesting awareness of a potential danger raised only through experiences. Emergency responders did not rule out a rural location or small district as too unimportant to be the target of terrorist attacks, expressing the view that an attack in the heartland of America would achieve terrorist goals of causing nationwide fear and disruption.

Conflicting priorities and expectations influence security: School administrators did not perceive that their goals of preventing entry of intruders, monitoring student safety in the cafeteria, or preventing theft and vandalism were helpful with food defense. The focus of school security measures was on protecting children from harm; when children were not present, security measures were loosened

Table 3: Sub-themes and Illustrative Quotations for the Theme of "A Lack of Concern"	
Sub-theme	Sample illustrative quotations
Food is most vulnerable to contamination before it arrives at the site.	• Attacking the food not the people? Once it's in our kitchen it would be pretty tough because you have to be authorized to be in the kitchen so it would have to be someone who is already working there. So I think [the risk] is slight. (production worker) • It would have to be before it came to this building. Everything we have is locked. (kitchen manager) • We have no control from where it comes from until the time it gets to us. But for here, everybody is conscious of what goes on with the food here but before it gets to us we have no idea. (school administrator)
Food is safe because co-workers are trustworthy	• I never thought of tampering before, you know. It's just kind of a family here. You just trust everyone. (production worker) • I think it's pretty much safe. Not 100% but pretty much. (production worker) • I can't think of a time we've had an intruder that wasn't either a student or a parent. (principal)
No one would want to attack *our* school	• The only time I really thought about terrorists was when I was in Mall of America, but I never really thought about food tampering or anything. (production worker) • … I always think it happens on the east coast because they're right there. They're more at risk than we would be. (production worker) • … [the risk of terrorist acts] is almost none in our area. I think in the nation it's different. But I think in our area almost none. (emergency responder)

Table 4: Sub-themes and Illustrative Quotations for the Theme of "Food not Considered a Potential Danger"

Sub-theme	Sample illustrative quotations
The foodservice operation is perceived as separate from school operations	• They have their own budget and operate out of it so [foodservice director] doesn't have to go through any hoops to get stuff … There is a separation. (emergency responder) • Yes, 'cause generally food service is dealt with separately, they have their own budget. (emergency responder)
The foodservice operation is responsible for food defense and the administration is responsible for security.	• It would be the district nutrition person and then directly in our building would be the kitchen manager. Everyone [is responsible for building security]. (principal, when asked who holds responsibility for food defense and for building security) • I think that's what we do. I think that's our job (production worker, in response to question about who is responsible for making sure no one contaminates the food)
Crisis management planning does not address food hazards.	• I met with [name], the fire chief, and the police chief, and HAZMAT was also there. So we talked through every scenario involving the school and the city, we talked about issues with trains coming through. Issues, since we're next to an Interstate, semis turning over, [gas station] that has petroleum that could cause a problem. So we talked about every scenario we could think of, gas leaks and what we would do in the building, how we would evacuate, if we would evacuate. (principal) • … so the notion of possibly doing one on food safety and food contamination, purposeful contamination would be intriguing. I never thought of that. (principal)

(Table 5). There was lack of understanding that building security practices, enforced 24 hours a day, maintain the safety of food as well as the safety of children and facilities. Emergency response planning is recommended by the U.S. Department of Education (2011) and the U.S. Department of Homeland Security (2010) for all school districts; however food tampering was not identified as an event in existing plans of the five districts in this study.

Because public schools are partially funded by community property tax dollars, school administrators felt obligated to consider the values and desires of the community. Two districts reported community groups expected to be able to use school kitchens for events not related to the child nutrition program: District policies required a foodservice employee be present, however this policy was not enforced during the summer in one of the schools where observation occurred.

Summary of Observations

Seven foodservice operations were observed during the five district case study visits. One central kitchen, a private school served by the central kitchen, and five on-site production facilities were observed. Food preparation was observed at five of seven facilities visited, and only lunch service was observed at the remaining two sites. Breakfast service was observed in four service sites and lunch service was observed in four sites. At each site, it was noted whether practices were implemented, not implemented, not observed or not applicable. At four sites the need to schedule interviews at times convenient for administrators and emergency responders reduced the time available for observation.

Implementation of the listed 11 practices were observed in at least one site. Receiving entrances were locked at one site, as were chemical storage cabinets. All seven sites issued employees photo identification badges. Two schools had secured and controlled access to food product storage areas and six sites monitored self-service stations at all times. A summary of observations is shown in Table 6.

CONCLUSIONS AND APPLICATIONS

Findings from this case study review of five school districts found that schools indeed have security measures in place that could strengthen food defense, but administrators lack an understanding of the broader utility of these practices. In this purposive sample of five districts, foodservice directors were not routinely involved in discussions about school security, which prevented security resources from being used effectively to mitigate threat of intentional food contamination. Findings showed there is a need for all school district administrators and emergency responders to be educated about the topic and encouraged to recognize their roles in maintaining food defense. Awareness of food defense did not appear to be related to size of school district or type of production system. Further, responses to risk perception questions indicated a general lack of concern about food tampering and food terrorism. Currently, food defense was viewed as the responsibility of the child nutrition program whereas it is a safety issue in which district-wide precautions, similar to fire safety or building security, should be taken.

The best practice is to control access to food and chemical storage areas; observations showed there is limited implementation of this

Table 5: Sub-themes and Illustrative Quotations for Theme "Conflicting Priorities and Expectations Influence Security"

Sub-theme	Sample illustrative quotations
Security is designed to protect children, not food	• School security is more important for students. So what we can do is monitor, keep an eye [out]… and do the best that we can. (foodservice director) • First of all, the cameras are more meant for after the fact. And it's meant for security and it's also, in the middle school, it's used for student issues so there is nobody monitoring the cameras until there is an incident. (principal)
Community expectations can impede food defense	• It's actually been kind of a push to get this level of security to this point because we suggested it in the past, again there's financial things and that's not how we operate attitude. You know, small town and so just getting the outside door secured is a big step. (security consultant) • Well the barrier is just ecology. Ecology and cost. So there's a cost to all the disposable items we would use [to provide individual sealed portions of foods currently served on self-serve bars] and there's a huge concern for the community and the citizens in this area that we behave responsibility for the environment, so we try to be environmentally friendly and that means using the least disposable products. (foodservice director)

Food defense practice	Practice implemented	Practice not implemented	Not observed	Not applicable
Emergency contact list is available to all employees.	2	1	3	1[a]
The outside of facility is adequately lighted.	2	0	5	
Employees issued photo ID badges	7[b]		0	
Exterior doors from public areas are locked at all times (except for main entrance)	4	3	0	0
Receiving entrances are locked.	1	6	0	
Customers are restricted from entering storage and preparation areas.	5	2	0	
Storage is provided for employees' personal items so that these are not allowed in preparation areas.	4[c]	2	1	
Self-service stations are monitored at all times by foodservice employees.	6	0	0	1[d]
Access to all food product storage areas is secured and controlled.	2	4	1	
Chemicals are stored in a locked cabinet.	1	6	0	
Outside air intake fenced and locked.	3	0	4	

Note: Practices from Food *Defense Checklist for Retail Foodservices,* (Strohbehn, Sneed, Paez, & Beattie, (2007)
[a]One Food Service Director instructed employees to contact their supervisor in the event of an emergency and did not make emergency contacts available
[b]Badges available but not worn
[c]One not used by employees due to remote location and lockers provided in production area at one site
[d]No food served at central kitchen

food defense practice. In observations at all seven buildings, it was found employee photo identification badges were issued; yet these were not always worn. Employees know who their coworkers are and exterior doors from public areas do provide some limiting of access from nonemployees. Further, when school employees are empowered to challenge unauthorized visitors, their monitoring can keep areas secure; however, employees are not always present and available to monitor storage areas, loading docks, and exterior entrances. In addition, intentional contamination of food may not always be initiated by an outsider; screening of potential employees is a critical part of the hiring process.

Stakeholders' beliefs about the vulnerability of their school foodservice operations to incidents of food tampering are inconsistent with reported food tampering experiences. Interviewees reported six incidents of food tampering in schools; each occurred while it was under the control of the foodservice operation. Interview findings indicated a belief that food was not vulnerable once it was delivered to the kitchen. Interviewees expressed beliefs that intentional contamination would occur elsewhere, not locally, yet an incident of food tampering was reported in four of the five school districts in this study. Although all food tampering incidents were handled internally, food tampering by students was treated as a prank. Employees were suspected in two of the incidents. These past food tampering incidents, although not resulting in harm, point out vulnerabilities that exist within child nutrition programs and indicate not only a need for school districts to practice good hiring procedures but also to include food tampering in crisis management plans.

Results of this study showed current crisis management planning activities failed to identify food-related emergencies as a threat. These results suggest that an effective threat appraisal should include multiple stakeholder groups, including production workers. Because of the potential for widespread effects, there is a need for school personnel and emergency responders to agree on procedures for responding to acts of food tampering that occur in schools. Findings indicated a need to identify district level avenues of communication about food defense among stakeholders. District emergency response planning and training activities offer an opportunity to open or strengthen communication between the foodservice operation, school administration, and community emergency response teams. In situations where community expectations may conflict with food

defense practices, inclusion of multiple perspectives will ensure children are protected.

Although production workers and foodservice directors interviewed identified the food supply chain and food deliveries as vulnerable to food tampering, access to the building via receiving entrances was unrestricted in six sites. Training is needed to make personnel at all points in the flow of food aware of the risk of intentional contamination of food during transit, whether food is arriving from a vendor or from a centralized warehouse or production kitchen.

The food tampering experiences related by the interviewees suggest a need to challenge stakeholders' assertions that intentional food contamination would only happen somewhere else, that food is most vulnerable to attack before it arrives to the school district, and that co-workers are unlikely to be perpetrators of food tampering. There is a need for administrators and foodservice personnel to receive training to increase their level of awareness and concern for a threat of food tampering at multiple points of the flow of food.

ServSafe® (National Restaurant Association Education Foundation, 2012) and the district's HACCP-based food safety plan can prepare foodservice production workers to maintain food defense within their realms of responsibility. Inclusion of food defense practices into an existing HACCP plan will allow for integration of efforts to protect the safety of food while in the district's custody and provide a communication tool with written standard operating procedures within the district. Districts' food safety trainings and HACCP plans should be expanded with input from all district stakeholders to include food defense. Further, a board-level food safety policy that addresses protection from both intentional and unintentional food contamination is recommended. Board level policies provide "vision and structure" for an organization and can guide development of standard operating procedures. A Model District Food Safety Policy is available on the Iowa State University HACCP web site at www.iowahaccp.iastate.edu. In-service trainings might include a self-audit of the district's food defense practices using one of multiple checklists such as those from USDA, National Food Service Management Institute, or Iowa State University.

Practices that achieved district goals of physical security and loss prevention were frequently implemented, but as noted by

interviewees; these practices were not recognized as food defense measures. District administrators must be made aware of the threat of intentional food contamination and the risk of catastrophic consequences so district security measures already in place can be effectively used for food defense. Inclusion of food defense awareness into staff trainings will broaden effectiveness of controls. It was noted in one case where an organized group attempted to contaminate food in a school cafeteria, perpetrators were stopped because school personnel were observant (Carus, 2009). Thus, food defense is part of a district's effort to protect children during the school day.

The purpose of this study was to determine the extent to which food defense best practices are currently implemented in U.S. schools, with specific objectives of observing current implementation in five school districts and to investigate reasons why communication and physical security are aspects infrequently implemented. Use of a qualitative approach with structured assessment tools helped meet these objectives. Findings from this study contribute to the limited body of knowledge regarding implementation of food defense practices in schools.

Limitations of the Study

Although the study was limited to five case districts, the rigor was strengthened by using methods recommended by Yin (2009), including multiple sources of evidence, creating a case study database, and maintaining a chain of evidence. The combination of structured interview guides, digital recordings, transcriptions of interviews, observations based on a standard food defense checklist, and documenting food defense practices or lack thereof provided a durable body of evidence.

Case study visits were made during the months of May and October of two different academic years, which may have led to differences in the data collected due to staff turnover or implantation of new procedures. All interviews were conducted by the primary researcher using an interview guide with structured questions, but as interviews progressed, the use of follow-up questions by the primary investigator increased. Merriam (2009) explained that it is common for interviewers to become less dependent on the interview guide as they become more comfortable with the interview process and content. The knowledge and experience gained by the primary investigator from the first three site visits enhanced the quality of the data.

Recommendations for Further Research

This study points to a need to open avenues of communication between administrators, emergency responders, and foodservice directors with the purpose of achieving strong food defense within districts with the least expenditure of resources. Production workers are the main line of defense in the kitchen and storeroom settings; it is their vigilance that maintains food defense in these areas. Production workers' understanding of food defense threats, knowledge of practices to reduce the threat, and motivation to perform food defense practices is not known.

Central kitchen production systems use economies of scale to reduce production costs of school meals. This type of system has characteristics making it possible for an incident of food tampering to affect a large number of children during a short period of time. Production workers in central kitchens have no contact with their customers, the school children, and may feel a different level of motivation to maintain food defense compared to workers in on-site kitchens who interact with children daily. Research is needed to assess employees' motivations to maintain food safety and defense in

this setting; particularly to assess the workplace culture and employee job satisfaction in central kitchens. A disgruntled employee working in a central kitchen has the potential to harm many students or cause widespread damage to the reputation of the child nutrition program.

The results of this study indicated that other stakeholder groups, not just child nutrition program personnel, are viewed as having responsibilities to maintain food defense or responding to a food tampering incident in a district. Yet principals and other administrators had limited understanding of the scope of food defense, perceiving it as a responsibility that could be assumed by the foodservice director alone. School nurses have responsibilities to identify student illnesses, custodians may require access to food production and storage areas; yet these employees are not under the authority of the foodservice director. Thus, research is needed to determine the levels of awareness and importance that district administrators, school nurses, and other noncertified staff hold regarding food defense practices, and to determine how food defense practices are included in job preparation training materials.

Emergency responders, principals, foodservice directors, and production workers in this study demonstrated knowledge and expertise that contributed to a safe school environment for students. Research funds could support pilot projects that develop and assess the effectiveness of various communication tools to increase awareness of food defense among broader populations of district stakeholders.

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