

FOOD DEFENSE PRACTICES IN SCHOOL NUTRITION PROGRAMS

Kevin Sauer, PhD, RDN, LD, FAND; Kevin Roberts, PhD; Paola Paez, PhD; Kerri Cole; Carol Shanklin, PhD, RD

ABSTRACT

PURPOSE/OBJECTIVES

The purpose of this study was to assess the current practices used in school nutrition programs to prevent intentional acts of food contamination or tampering with food.

METHODS

A convenience sample of school districts (n=2023) was randomly selected, representing two states from each of the seven USDA regions. School food authorities from 320 districts in 14 states participated in a live structured interview guided by a questionnaire consisting of 31 questions concerning food defense practices. The researchers conducted the interviews with videoconferencing technology or telephone and entered responses directly into an online survey to collect the data. Descriptive statistics included frequencies, percentages, and means.

RESULTS

Results suggest that many school nutrition programs have room to improve food defense programs, practices, and understanding about food defense in their districts. Almost 68% of districts and 66% of school nutrition programs reported not having a food defense plan. While the opportunity for improvement was evident in several areas, some practices to prevent an intentional food defense incident were also reported. Training was reported as lacking by 44% of the sample.

APPLICATION TO CHILD NUTRITION PROFESSIONALS

Results from this study can be used to bring awareness about food defense practices in the school environment, especially where practices may not be evident through existing food safety plans. It is important that school nutrition programs follow recommended standards to reduce risks and develop best practices for overall safety. Stakeholders involved in school nutrition programs can support the prevention of intentional food contamination by advocating for district and staff training and by calling attention to practices that might represent a high risk for the school nutrition program.

KEYWORDS: food defense, intentional contamination of food, food tampering, school nutrition programs

INTRODUCTION

Food defense describes the protection of the nation's food supply from deliberate or intentional acts of contamination or tampering (United States Department of Agriculture [USDA] Food Safety and Inspection Service, 2019). Food defense plans in Child Nutrition Programs are not required by the USDA, but are recommended to support a comprehensive food protection program (USDA Food and Nutrition Service [FNS], 2007, 2012). Food defense plans are multifaceted, encompassing many internal and external stakeholders, including the school nutrition team, maintenance and security staff, and administrative and instructional staff. External stakeholders include local and state police, fire fighters, and vendors.

Studies about food defense practices conducted in schools have sought to determine specific areas of potential risk, identify practices implemented, and assess preparedness against intentional contamination (Klitzke et al., 2014, 2016; Klitzke & Strohbehn, 2015; Olds & Shanklin, 2014; Story et al., 2007; Xirasagar et al., 2010a, 2010b; Yoon & Shanklin, 2007a, 2007b, 2007c). Research methods used in these studies included surveys (mail and online), interviews, focus groups, observations, and analysis of documents.

Past research focused on child nutrition programs found that respondents indicated low concern for food terrorism or tampering at the schools, and few respondents perceived risks with current production systems (Klitzke et al., 2014, 2016; Klitzke & Strohbehn, 2015; Story et al., 2007; Yoon & Shanklin, 2007a, 2007b, 2007c). The greatest perceived risk for intentional food contamination was with the supply chain prior to arrival at the foodservice operation (Klitzke et al., 2014). Areas that were identified as risks for a potential attack were unidentified staff, delivery personnel, and/or unauthorized access to cafeteria; central kitchens; service lines; storage areas; and delivery areas (Klitzke et al., 2016; Yoon & Shanklin, 2007b).

Food defense practices in schools not frequently implemented were locking storage and delivery areas, securing chemicals, reviews of employees' criminal background reports, using a surveillance system, communicating with vendors/suppliers, posting delivery schedules with information related to delivery personnel, and restricting access (Story et al., 2007). In contrast, the practices reported as most frequently implemented were having an emergency response team, purchasing of food and supplies from a reputable supplier with permits and licenses, inspecting food packages, and restricting access to food and other storage areas. (Klitzke & Strohbehn, 2015; Story et al., 2007; Yoon & Shanklin, 2007a, 2007b, 2007c).

Klitzke and Strohbehn (2015) noted that only 14% (78 of 543) of school nutrition programs in seven northern states reported having a food defense plan. Barriers to implementing a plan included lack of awareness and concern related to food terrorism, lack of motivation, cost, and the perception that food defense is solely the foodservice director's responsibility (Klitzke & Strohbehn, 2015; Klitzke et al., 2014, 2016). Respondents were more likely to have a food defense plan or perform food defense practices if they perceived such practices as important (Yoon & Shanklin, 2007a), an employee was assigned to implement or monitor food these practices (Yoon & Shanklin, 2007b), and/or employees were trained (Klitzke & Strohbehn, 2015).

The purpose of this study was to assess current practices used by school nutrition programs to prevent deliberate or intentional acts of food contamination or tampering with food. A structured

phone interview, guided by a questionnaire, was used to gather information concerning food defense practices from a national sample of school food authorities. The methodology allowed for in-depth examination of these practices specifically in schools. The research protocol was approved by the University Institutional Review Board.

METHODS

Sample Selection

To ensure a representative national sample, 14 states, two from each of the seven USDA FNS regions, were selected based on random number assignment, in fall of 2018. A census of districts for each state was identified from the National Center for Education Statistics website (<https://nces.ed.gov/ccd/districtsearch/>). Recent studies (Boutros et al., 2019; Grisamore & Roberts, 2014; Roberts et al., 2018) have yielded response rates between 10% to 14%, thus the goal was to select 145 districts from each state to achieve a minimum sample size of 280 districts (20 districts per state). A total of 2023 districts were included in the final sample.

For this study, districts were categorized by student enrollment: mega districts had over 40,000 students, large districts had from 20,000 to 39,999 students, medium districts had from 2,500 to 19,999 students, and small districts had fewer than 2,500 enrolled students. In order to ensure districts of all sizes were included, and because there are a limited number of mega and large districts in each state, all mega and large school districts were invited to participate. The remaining participants were randomly selected and, when possible, divided equally between medium and small districts. Contact information for the school food authority (SFA) in each district was obtained from the respective USDA FNS Regional Offices.

Instrument

To develop a comprehensive questionnaire, previous research and resources were reviewed. The USDA FNS (2012) Food Defense Plan was first referenced and then compared to other relevant instruments (Klitzke et al., 2016; Olds & Shanklin, 2014; Strohbehn et al., 2007; USDA Food Safety and Inspection Services, 2019; USDA FNS, 2007, 2012; Xirasagar et al, 2010a; Yoon & Shanklin, 2007a). Overlapping questions, questions about items not under the control of the SFA, or questions specifically related to food safety were excluded from the questionnaire. Probing questions were included to obtain more detailed responses.

The audio/video technology, interview processes, and questions were pre-tested remotely among the researchers prior to pilot testing as to simulate the final process as much as possible. For pilot testing, nine SFAs completed the interview and provided feedback on the clarity of the questionnaire and time required to complete it. The pilot test resulted in minor grammatical changes to the questionnaire, and the methodology for the main study was slightly revised to allow for video or phone communication. The districts nor data used for the pilot test were included in the final data collection or results.

The final instrument included 10 sections: general facilities and personnel security, foodservice areas, food and supplies, external vendors, internal systems, water and ice supply, personnel training, food defense plan, suppliers, and general information about the school nutrition program and demographic information about the interviewee. Most questions utilized common Likert scales and opportunities to provide comment or clarity about the selection. Responses to interview questions addressed during the interviews were entered by the researchers directly into Qualtrics, an online survey and data management system.

Data Collection

An email invitation was sent to SFA's representing the 2023 districts, on behalf of the researchers, explaining the purpose of the project. Upon agreement to participate, a calendar invitation was sent with additional information about the interview process. A reminder email was sent the day before the scheduled interview.

Approximately seven to 10 days after the initial invitation, an attempt was made via telephone to contact each SFA who had not responded to the initial email. Two weeks after the original invitation, any SFA who had not yet replied was sent a final email request. If an SFA declined to participate, they were immediately removed from the sample and an alternate was selected.

Data Analysis

The data set was imported from the Qualtrics survey system into SPSS v. 25 and was utilized to calculate frequencies, percentages, and means. Responses indicating “*not sure*” and “*not applicable*” were not coded or used in calculations.

RESULTS AND DISCUSSION

Response rate and sample description

A total of 320 interviews were completed, representing 16% of the sample (n=2023), which exceeds the response rates for recent similar studies (Boutros et al., 2019; Grisamore & Roberts, 2014; Roberts et al, 2018). School districts from each of the seven USDA FNS regions were represented in the results.

Table 1 summarizes the backgrounds of the respondents and operational descriptions. Of the 320 responses, the majority (77%) of respondents identified as school nutrition directors/general managers, 62% had worked in foodservice for more than 20 years, and 68% had worked in their current position for more than four years. Almost half (46%) of the sample reported a district enrollment of 2,500 to 19,999 students, with 33% of districts having fewer than 2,500 students. Most of the school nutrition programs were self-operated (n=261).

General facilities and personnel security

On a scale from *always* to *never*, respondents indicated that school district grounds were always secured during the day (60%) and after hours or weekends (51%), school buildings were secured during the day (84%) and after hours or weekends (79%), access to chemical supplies was restricted (60%), terminated employees lost access to the facilities (77%), and all keys were marked as do not duplicate (71%). Additionally, 62% of respondents indicated they never allowed vendor access to their facilities outside of typical business hours. When food deliveries were allowed after hours (n=114), common products delivered included dairy (24%), bread (10%), broadline or grocery orders (7%), or produce (3%).

Foodservice areas

The results for questions related to the security of foodservice areas within the school buildings are summarized in Table 2. Greater than two-thirds of all respondents always followed the applicable practices outlined in Table 2, with the exception of securing the foodservice area

Table 1. Sample and Operational Demographics (N=320)

	Number (%) ^a		Number (%) ^a
Title of person interviewed		District enrollment	
School Nutrition Director / General Manager	247 (80.3)	Less than 2,500 (Small)	105 (32.8)
School Nutrition Manager / Supervisor	26 (8.1)	2,500 – 19,999 (Medium)	157 (49.1)
School/District Administrative Personnel	21 (6.7)	20,000 – 39,999 (Large)	30 (9.4)
School Nutrition Coordinator / Head Cook	13 (4.1)	40,000 or more (Mega)	25 (7.8)
School Nutrition Administrative Assistant	13 (4.1)	Average number of lunches served daily	
Nutrition Specialist / Dietitian	2 (1)	Less than 1,000	79 (24.7)
		1,000-4,999	144 (45.0)
		5,000-9,999	32 (10.0)
		10,000-14,999	16 (5.0)
		15,000-19,999	14 (4.4)
		20,000 or more	24 (7.5)
Years in current position		Number of school nutrition employees	
Less than 1 year	27 (8.4)	Less than 10	51 (15.9)
1-3 years	73 (22.8)	10 – 24 employees	58 (18.1)
4-7 years	103 (32.2)	24 – 25 employees	80 (25.0)
8-12 years	44 (13.8)	50 – 74 employees	38 (11.9)
13-20 years	40 (12.5)	75 – 99 employees	13 (4.1)
Over 20 years	30 (9.4)	100 –149 employees	15 (4.7)
		Greater than 150	61 (19.1)
Years in foodservice		Self-operated vs. contract	
Less than 1 year	5 (1.6)	Self-operated	261 (81.6)
1-3 years	5 (1.6)	Contractor	56 (17.5)
4-7 years	19 (5.9)		
8-12 years	26 (8.1)		
13-20 years	64 (20.0)		
Over 20 years	198 (61.9)		

^a Percentages and totals may not equal 320 or 100% due to non-responses.

during the school day to prevent entry by unauthorized persons. Only 58% indicated this was always done.

A Likert scale (*never, rarely, sometimes, often, always, not sure*) was used to assess how access was restricted to foodservice areas. Of the 320 respondents, about 50% of the respondents indicated they locked foodservice areas; 28% indicated they always locked doors considered external to the immediate foodservice area; only 6% reported they locked internal doors, except during service; and 7% stated they locked internal doors when staff were not present. Thirty respondents (9%) indicated they did not lock internal doors.

The majority of respondents (87%) reported restricting access to internal cold or frozen storage areas, and 84% reported restricting access to dry storage areas. The majority of respondents (64%) reported not having external storage areas and of those that did have, 86% said they restrict access. Slightly less than half of the respondents (49%) restricted access to their ice

Table 2. Foodservice Area Security (N=320)

	Frequency of Responses (%) ^a							Mean ± SD ^b
	<i>Never</i>	<i>Rarely</i>	<i>Sometimes</i>	<i>Often</i>	<i>Always</i>	<i>Not Sure</i>	<i>Not Applicable</i>	
Secures the foodservice area after hours and on weekends to prevent entry by unauthorized persons.	2 (0.6)	2 (0.6)	14 (4.4)	20 (6.3)	279 (87.2)	2 (0.6)	1 (0.3)	4.8 ± 0.6
Has a secured entrance for employees.	6 (1.9)	4 (1.3)	14 (4.4)	11 (3.4)	283 (88.4)	1 (0.3)	1 (0.3)	4.8 ± 0.8
Prohibits personal items (like purse, phone, etc.), outside foods, and medications in foodservice production areas.	17 (5.3)	5 (1.6)	21 (6.6)	27 (8.4)	247 (77.2)	2 (0.6)	1 (0.3)	4.5 ± 1.1
Has an emergency lighting system in the foodservice area.	24 (7.5)	2 (0.6)	21 (6.6)	17 (5.3)	214 (66.9)	41 (12.8)	1 (0.3)	4.4 ± 1.2
Secures the foodservice area during the school day to prevent entry by unauthorized persons.	13 (4.1)	10 (3.1)	37 (11.6)	72 (22.5)	187 (58.4)	0 (0)	1 (0.3)	4.3 ± 1.1
Restricts access to external School Nutrition Program cold or frozen food storage areas to designated employees only.	0 (0)	1 (0.3)	6 (1.9)	10 (3.1)	100 (31.3)	1 (0.3)	201 (62.8)	4.8 ± 0.6
Restricts access to internal School Nutrition Program cold or frozen areas to designated employees only.	3 (0.9)	3 (0.9)	12 (3.8)	23 (7.2)	277 (86.6)	0 (0)	2 (0.6)	4.8 ± 0.6
Restricts access to the School Nutrition Program dry storage areas to designated employees only.	3 (0.9)	0 (0)	10 (3.1)	30 (9.4)	269 (84.1)	0 (0)	4 (1.3)	4.8 ± 0.6

^a Percentages and totals may not equal 320 or 100% due to non-responses.

^b Responses were coded as *never* = 1, *rarely* = 2, *sometimes* = 3, *often* = 4, *always* = 5. *Not sure* and *not applicable* responses were not included in the overall mean and standard deviation calculation.

machines, 29% monitored their water supply, and slightly more than half of the respondents (51%) said that monitoring the water supply was not applicable to them. When questioned about who, outside of school foodservice staff, had access to internal and external storage areas, respondents indicated custodians and maintenance staff had the greatest access, respondents indicated custodians and maintenance had the greatest access to the internal cold, frozen, and dry storage areas, followed by building principals.

Results for questions related to the monitoring of specific foodservice areas are summarized in Table 3. Of all monitoring activities addressed in the interviews, the majority were always monitored. Most (73%) reported requiring an authorized employee to be present in the foodservice area when the area was not locked. About 65% of the respondents indicated that the use of foodservice areas for special/public events, without a foodservice staff member being present, was prohibited.

When asked about how foodservice areas were monitored for signs of suspicious activity or unauthorized entry, respondents reported often or always utilizing a camera (48%) or an alarm (44%); yet more than 37% indicated that an alarm was never used. When using cameras, the most common location of cameras was at exterior entrances or the loading dock (40%), followed by the dining areas (39%), serving lines (27%), and in the kitchens (13%). Other common areas where cameras were located included interior doors to foodservice areas (12%), outside areas (12%), building hallways (11%), at the cash register or point-of-sale systems (10%), and production areas (9%).

Food and supplies

Results for questions related to the handling of food and supplies are summarized in Table 4. The majority of respondents (98%) purchased food ingredients, food products, packaging materials, and other foodservice supplies from approved vendors and more than half of the respondents (56%) indicated they rejected unscheduled deliveries. Approximately 64% of respondents were not aware if their supplier had a food defense plan in place. As a follow-up question, respondents were asked about the type of supplier utilized. The majority of respondents reported using national (60%) and regional (57%) suppliers, while about one-third (30%) reported using local suppliers.

All school nutrition programs either *always* or *often* addressed recalls within 12 hours of receiving notification, and 75% of the respondents felt *very* or *extremely confident* when addressing a food recall due to intentional contamination. When asked what type of products were recalled most often in the last 12 months, almost half (48%) involved romaine lettuce. Others indicated that recall notifications were received on chicken (22%) or beef products (6%). Almost a quarter of the sample (24%) indicated they had not been involved in a recall within the last 12 months, while nine respondents (3%) were unsure if their school district was involved in a recall.

For districts that transport food and food packages between school buildings, central kitchens, or district warehouses (n=236), the majority (60%) always inspected packages for evidence of tampering. A majority (63%) of these respondents indicated they never tracked district delivery trucks in real time with deliveries between school buildings. When asked how delivery trucks

Table 3. Monitoring of Foodservice Areas (N=320)

	Frequency of Responses (%) ^a							Mean ± SD ^b
	<i>Never</i>	<i>Rarely</i>	<i>Sometimes</i>	<i>Often</i>	<i>Always</i>	<i>Not Sure</i>	<i>Not Applicable</i>	
Monitors the main service line for signs of suspicious activity or unauthorized entry.	0 (0)	1 (0.3)	14 (4.4)	40 (12.5)	263 (82.2)	1 (0.3)	1 (0.3)	4.8 ± 0.5
Monitors the food preparation area for signs of suspicious activity or unauthorized entry.	1 (0.3)	4 (1.3)	13 (4.1)	43 (13.4)	254 (79.4)	1 (0.3)	4 (1.3)	4.7 ± 0.6
Monitors the equipment for signs of suspicious activity or unauthorized entry.	0 (0)	6 (1.9)	19 (5.9)	44 (13.8)	249 (77.8)	1 (0.3)	1 (0.3)	4.7 ± 0.7
Monitors the inside storage for signs of suspicious activity or unauthorized entry.	1 (0.3)	6 (1.9)	16 (5.0)	50 (15.6)	242 (75.6)	1 (0.3)	4 (1.3)	4.7 ± 0.7
Monitors the student dining area for signs of suspicious activity or unauthorized entry.	1 (0.3)	6 (1.9)	25 (7.8)	35 (10.9)	237 (74.1)	5 (1.6)	11 (3.4)	4.6 ± 0.7
Monitors the self-service bar for signs of suspicious activity or unauthorized entry.	1 (0.3)	3 (0.9)	18 (5.6)	47 (14.7)	187 (58.4)	0 (0)	64 (20.0)	4.6 ± 0.7
Monitors the outside storage for signs of suspicious activity or unauthorized entry.	1 (0.3)	2 (0.6)	10 (3.1)	23 (7.2)	92 (28.8)	1 (0.3)	189 (59.1)	4.6 ± 0.8
Monitors the receiving docks for signs of suspicious activity or unauthorized entry.	3 (0.9)	4 (1.3)	36 (11.3)	53 (16.6)	212 (66.3)	2 (0.6)	10 (3.1)	4.5 ± 0.8
Requires that at least one authorized employee is present in the foodservice area at all times when the area is not locked.	16 (5.0)	7 (2.2)	23 (7.2)	31 (9.7)	235 (73.4)	2 (0.6)	6 (1.9)	4.5 ± 1.1

Table 3. *Monitoring of Foodservice Areas (N=320)*

	Frequency of Responses (%) ^a							Mean ± SD ^b
	<i>Never</i>	<i>Rarely</i>	<i>Sometimes</i>	<i>Often</i>	<i>Always</i>	<i>Not Sure</i>	<i>Not Applicable</i>	
Prohibits foodservice areas from being used for special events/public events unless foodservice staff are present to monitor/supervise.	18 (5.6)	6 (1.9)	41 (12.8)	42 (13.1)	207 (64.7)	1 (0.3)	4 (1.3)	4.3 ± 1.1
Monitors the areas using security cameras.	58 (18.1)	26 (8.1)	77 (24.1)	19 (5.9)	134 (41.9)	5 (1.6)	1 (0.3)	3.5 ± 1.5
Monitors the areas using an alarm system.	120 (37.5)	12 (3.8)	35 (10.9)	18 (5.6)	124 (38.8)	10 (3.1)	1 (0.3)	3.0 ± 1.8

^a Percentages and totals may not equal 320 or 100% due to non-responses.

^b Responses were coded as *never* = 1, *rarely* = 2, *sometimes* = 3, *often* = 4, *always* = 5. *Not sure* and *not applicable* responses were not included in the overall mean and standard deviation calculation.

Table 4. Food and Supplies (N=320)

	Frequency of Responses (%) ^a							Mean ± SD ^b
	<i>Never</i>	<i>Rarely</i>	<i>Sometimes</i>	<i>Often</i>	<i>Always</i>	<i>Not Sure</i>	<i>Not Applicable</i>	
Purchases all food ingredients, food products, packaging materials, and other foodservice supplies only from approved vendors.	0 (0)	1 (0.3)	0 (0)	3 (0.9)	313 (97.8)	1 (0.3)	2 (0.6)	5.0 ± 0.2
Rejects unscheduled deliveries.	4 (1.3)	15 (4.7)	36 (11.3)	31 (9.7)	180 (56.3)	14 (4.4)	40 (12.5)	4.4 ± 1.0
Addresses a recall situation within 12 hours.	0 (0)	0 (0)	0 (0)	16 (5.0)	297 (92.8)	2 (0.6)	5 (1.6)	5.0 ± 0.2
Verifies external deliveries against purchase orders.	0 (0)	1 (0.3)	7 (2.2)	26 (8.1)	285 (89.1)	0 (0)	1 (0.3)	4.9 ± 0.4
Rejects products that have been opened or otherwise compromised.	0 (0)	0 (0)	5 (1.6)	30 (9.4)	280 (87.5)	0 (0)	2 (0.6)	4.9 ± 0.4
Inspects food packages for evidence of tampering upon delivery.	1 (0.3)	1 (0.3)	13 (4.1)	47 (14.7)	255 (79.7)	2 (0.6)	1 (0.3)	4.7 ± 0.6
Inspects food packages for evidence of tampering for intra-school deliveries.	1 (0.3)	2 (0.6)	8 (2.5)	28 (8.8)	192 (60.0)	5 (1.6)	84 (26.3)	4.8 ± 0.6
Verifies inter-school deliveries against order	6 (1.9)	4 (1.3)	8 (2.5)	25 (7.8)	187 (58.4)	3 (0.9)	87 (27.2)	4.7 ± 0.8
Secures school delivery trucks when not being loaded or unloaded.	8 (2.5)	6 (1.9)	10 (3.1)	27 (8.4)	152 (47.5)	20 (6.3)	97 (30.3)	4.5 ± 1.0
Rejects unscheduled deliveries.	6 (1.9)	21 (6.6)	30 (9.4)	25 (7.8)	105 (32.8)	6 (1.9)	127 (39.7)	4.1 ± 1.2
Designates employees trained on food defense to deliver the food.	48 (15.0)	10 (3.1)	20 (6.3)	14 (4.4)	132 (41.3)	14 (4.4)	82 (25.6)	3.8 ± 1.7
Tracks school delivery trucks in real time while en route.	148 (46.3)	4 (1.3)	6 (1.9)	9 (2.8)	43 (13.4)	12 (3.8)	98 (30.6)	2.0 ± 1.7

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were tracked, 17% of those who used delivery trucks also used GPS, while others reported using scheduled delivery times, delivery locks, computer programs, or phones.

Personnel training

Approximately one-third (n=96) of all school nutrition programs interviewed reported that there had been no training among foodservice staff on food defense topics; while 33.1% reported training all staff on food defense practices. When asked why training was not provided specifically on this topic, 14 respondents indicated that food safety training always included food defense. Fewer than 10 respondents indicated they had not considered the need for food defense training. The majority of districts (63%) reported that food defense training was not provided to non-foodservice staff, such as custodial staff and administrators. Others who were trained included members of administration (23%), custodians/maintenance (8%), and teachers (7%). Topics included access to the kitchen, food safety information, and general policies and procedures.

Food defense planning

Of the 320 respondents, 68% reported that the district did not have a district-wide food defense plan to protect food available to students beyond the school nutrition program's control, such as vending machines, fundraisers, classrooms, and events. Only 9% of respondents indicated that they had a district-wide food defense plan, and 24% were unsure if a food defense plan existed for their district.

Most respondents (66%) reported not having a food defense plan specific to the school nutrition program, however, 30% of participants did while 4% were not sure. When asked why a food defense plan was not available, the most common answer was that the respondent had simply never thought about it.

Only 20 of the 230 districts reported having a food defense team. Of these, 100% included the school nutrition director, 75% included administrators, 55% included school or community police, and 50% included school nurses. Others included school maintenance staff (45%), teachers (30%), parents (30%), local public health officials (25%), and fire department representatives (10%).

If an act of intentional contamination or tampering were to occur, 45% of all 320 respondents indicated they would remove or discard the product in question, 40% indicated they would contact administration, and 27% indicated they would contact the school nutrition director. When respondents were asked about the most important practice they would do in their district to prevent an act of intentional contamination, 28% indicated training and education, and the same percentage indicated keeping the space and operation secure. Slightly fewer (25%) indicated monitoring and 17% indicated simply being aware of what was occurring in their district.

The results of this study suggest that many school nutrition programs have room to improve food defense practices and plans. Almost 66% of school nutrition programs reported not having a food defense plan, similar to findings previously reported (Klitzke et al., 2014; Story et al., 2007). Some of the school nutrition programs had implemented components of a food defense plan as part of their overall food safety program and were *confident*, *very confident*, or *extremely confident* that their program or district could respond to a food defense related incident. Yoon

and Shanklin (2007) reported that on-site foodservice operators who were more cautious about possible food terrorism threats performed specific food biosecurity preventive measures more often. One could conclude that school nutrition programs mostly rely on existing HACCP-based food safety guidelines to ensure that potential intentional contamination situations are under control.

Operationally, while there is some potential for intentional contamination, some practices are in place to help prevent an intentional food contamination incident. Most of the respondents indicated that practices are always followed that help to prevent an intentional contamination in the foodservice areas. These include inspections of food packages as well as restricting access to production and storage areas, food storage areas, and chemical use; similar results were reported by Story et al. (2007). Previous research has noted that one of the least implemented practices was the use of a surveillance system, which differs from what is found in this study where almost half of the programs use a camera or an alarm for surveillance (Story et al., 2007; Klitzke & Strohbehn, 2015; Yoon & Shanklin, 2007a, 2007b, 2007c).

Food defense training for school personnel is lacking. Many respondents view food safety and food defense as co-aligned topics. When asked what type of food defense topics are included in training, food safety topics were often identified, even when reminded of the differences between the two topics. Other researchers have reported similar findings (Klitzke et al., 2014; Story et al., 2007; Klitzke & Strohbehn, 2015). Many respondents reported that training is not conducted because it is a low priority, it is not necessary, or it is not a requirement. This research suggests that formal training in food defense be reprioritized for school nutrition programs.

The flow of food defined for this study progressed from growth, harvest, manufacturing, packaging, storage, and transportation, and has inherent means and policies to control intentional food contamination (USDA Food Safety and Inspection Service, 2019). In this study, nearly all respondents reported using approved vendors but were unaware if their suppliers had a food defense plan. Previous studies reported purchasing from approved vendors as one of the most common practices and variable levels of communication with vendors (Story et al., 2007; Klitzke & Strohbehn, 2015; Yoon & Shanklin, 2007a, 2007b, 2007c). It is imperative that school nutrition programs link to existing standards to provide a continuum of risk reduction and best practices for overall safety.

Most of the respondents (70%) reported not monitoring delivery trucks in real time while en route with deliveries between school buildings. To reduce the risk of tampering or intentional contamination of food, school nutrition programs should consider implementing a system to monitor delivery trucks in real time, such as GPS or scheduled delivery logs.

CONCLUSIONS AND APPLICATIONS

These findings can be used to bring renewed awareness to the school environment about food defense practices, especially practices that are not established with existing food safety plans. School administrators can support the prevention of intentional food contamination by advocating for district and staff training and by calling attention to practices that might represent a high risk for the school nutrition program, such as not having a food defense plan in place or lack of knowledge of suppliers food defense plans or practices. This study also highlights the

importance of providing specific food defense training for school nutrition professionals and others in the school system.

LIMITATIONS AND FUTURE RESEARCH

Limitations

While the data collection process involved one-on-one interviews, participants can still be prone to selective memory, attribution, and exaggeration. The strategic use of probing questions allowed for detailed responses and clarification. Further research should explore direct observational methods that do not rely on self-reported data (Kormos & Gifford, 2014). Food defense could be a sensitive or confusing topic, which might have influenced the willingness of respondents to disclose information.

Recommendations for future research

While overall practices suggest that risks pertaining to food defense are present, additional insight could be gained from on-site observations to audit practices outlined in this study. Practices deemed strong, and those where opportunities for improvement were evident, could be explored to determine if risk for intentional contamination has truly been minimized to the best extent possible. Behavioral assessment research could be conducted on food defense practices, especially those that overlap with existing food safety standards, to determine the strength of minimizing risk at the level of actual employee behaviors versus assumed or sought-after behaviors.

Research about food defense practices conjoined with existing food safety training strategies and relevant behavioral interventions to enhance training efficiency could be conducted. On-site simulations related to food defense can be used to determine the district's state of readiness and awareness to a response situation and serve as a possible training strategy for school nutrition personnel. Said research in this area could focus on the readiness of school nutrition staff or a broader array of stakeholders in the school environment. A clear delineation between food safety and food defense is warranted in training school nutrition personnel. While the topics are co-aligned, specific plans should be implemented to protect the food supply within the district from intentional contamination.

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BIOGRAPHY

Kevin Sauer, PhD, RDN, LD, FAND is a Professor in Food, Nutrition, Dietetics and Health and Co-Director for the Center for Food Safety in Child Nutrition Programs. Kevin Roberts, PhD is a Professor in Hospitality Management and Co-Director for Center for Food Safety in Child Nutrition. Paola Paez, PhD is a Research Associate Professor for the Center for Food Safety in Child Nutrition Programs. Kerri Cole is a Project Coordinator for the Center for Food Safety in Child Nutrition Programs. Carol Shanklin, PhD, RD is a Professor and the Dean of Graduate School. All authors are from Kansas State University in Manhattan, Kansas.