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Analysis of School Food Safety Programs Based on HACCP Principles

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ABSTRACT

Purpose/Objectives

The purpose of this study was to determine how school districts have implemented food safety programs based on HACCP principles. Specific objectives included: 1. Evaluate how schools are implementing components of food safety programs and 2. Determine foodservice employees food-handling practices related to food safety.

Methods

The study included a national sample of 34 school districts in eight states, including 11 small, 9 medium, 6 large, and 8 mega districts. Six researchers collected data on-site in each of the school's food production facilities. Data collection instruments included a *Facility Observation Form*, a *Food Safety Observation Form*, and a *Hazard Analysis Critical Control Points (HACCP) Verification Checklist*. All instruments were pilot tested prior to use. The research protocol was reviewed and approved by the University's Institutional Review Board prior to data collection. Data were summarized using descriptive statistics. A recent health inspection report was collected from each school and qualitative data were also compiled.

Results

Of 34 schools visited, food safety plans were available in 33 schools, although few were customized to the specific school. Most of the recommended standard operating procedures related to HACCP were used. However, researchers found few records of corrective actions. The health inspection scores for most schools were high, which reflects that food safety practices had been adequately operationalized. Overall, school facility observations were positive. Approximately 60% of employees failed to wash their hands as recommended by the *2009 Food Code*. Most employees washed their hands before preparing food, but many times, improper hand washing procedures were used.

Applications to Child Nutrition Professionals

School foodservice employees performed well, but there are opportunities for food contamination to occur. Directors and managers can utilize this data to evaluate their food safety programs and practices

to assure they are achieving their intended goal to serve safe and wholesome food to schoolchildren.

Keywords: HACCP, food safety, school foodservice, employee behaviors, facility

INTRODUCTION

Breakfasts, lunches, and snacks are provided in more than 101,000 schools across the United States through various Child Nutrition Programs. Each day, these programs provide more than 10 million children with breakfast and 31 million children with lunch (U.S. Department of Agriculture [USDA], 2013).

While the goal of these programs is to provide safe and nutritious food, actions during the preparation and service of food can negatively impact the safety of food served. According to The Centers for Disease Control and Prevention, between 1998 and 2008, 286 foodborne illness outbreaks were directly attributed to food prepared in schools, yielding 17,266 illnesses, with a median of 38 illnesses per outbreak (Gould et al., 2013).

In the early 2000s, a plethora of research focused on the readiness of various foodservice operations to implement a Hazard Analysis and Critical Control Point (HACCP) system, including schools (Giampaoli, Sneed, Cluskey, & Koenig, 2002; Henroid & Sneed, 2004; Hwang, Almanza, & Nelson, 2001; Youn & Sneed, 2003), restaurants (Almanza & Ghiselli, 1998; Roberts, Barrett, & Sneed, 2005; Roberts & Sneed, 2003), assisted living facilities (Sneed, Strohbahn, & Gilmore, 2007), and college and university dining centers (Riggins, Roberts, & Barrett, 2005). Hwang et al. (2001) explored the factors that impacted Indiana school foodservice managers' intention to implement a HACCP system. Only 13.7% of respondents knew about and planned to implement a HACCP program, while 33% knew nothing about HACCP.

A 2002 study found that 30% of school foodservice managers had reported implementing a HACCP program (Giampaoli et al., 2002). Youn and Sneed (2003) found that 22% of school foodservice managers indicated they had implemented a HACCP program. Approximately, 6% of schools had procedures in place for taking swabs of equipment to determine bacterial count, whereas almost 70% had procedures to take and record the temperatures of all potentially hazardous foods as they flowed through the operation.

Henroid and Sneed (2004) explored the readiness of school foodservice managers to implement a HACCP system. The on-site observations focused on HACCP prerequisite programs and found that multiple areas were over 90% in-compliance. These included adequate cooking, adequate warewashing facilities, adequate lighting, and proper dry storage areas. However, the majority of items were found to be inadequate, as only 30% of schools checked food temperatures prior to service and only 27.5% utilized calibrated thermometers to check temperatures.

The U.S. Congress passed the Child Nutrition and WIC Reauthorization Act of 2004 to ensure that all children who participate in Child Nutrition Programs receive safe food. Included in the Act was the requirement that schools establish a food safety system based on HACCP principles. Currently, school food service programs are required by federal law to comply with HACCP principles.

Stinson, Carr, Nettles, and Johnson (2011) reported results of a survey of 2,716 school nutrition directors

and managers conducted to determine the status of HACCP implementation in school nutrition programs since the 2004 mandate. Researchers found that only 63.5% of district directors had implemented HACCP in the district's foodservice operations, while 70.3% of school managers indicated they have completed the implementation process. Results also indicated that the implemented HACCP programs did not contain all the components required for a program, as outlined by the USDA guidance document (USDA Food and Nutrition Service, 2005).

Since that time, no research has focused on evaluating the status of these programs. Thus, the purpose of this study was to determine how school districts have implemented food safety programs based on HACCP principles. Specific objectives for this study were to: 1.) Evaluate how schools are implementing requirements for food safety programs, including using standard operating procedures; grouping menu items; identifying and documenting control measures and critical limits; using monitoring procedures; identifying corrective actions; and keeping records and 2.) Determine foodservice employees' food-handling practices related to food safety.

METHODOLOGY

Study Sample

The study sample included 34 school districts of various sizes (mega, large, medium, and small). Mega districts were those with more than 40,000 students, large districts had 20,000 to 39,999 students, medium districts had 2,500 to 19,999 students, and small districts had fewer than 2,500 students. To ensure geographic representation, one state was selected from each of the seven USDA regions based on whether or not that state had a mega district. Small districts were over-sampled because most U.S. school districts are small (National Center for Education Statistics, 2013). The goal was to include one mega, one large, one medium, and two small districts in each state sampled.

Once mega districts were identified, a list of the schools in each state was requested from the state agency director. School districts within a 100-mile radius of the mega district were categorized into the aforementioned size classifications. Individual schools were selected by taking the fourth school in the district's list of schools.

The final sample included school districts in eight states, with 11 small districts in six states, nine medium districts in seven states, six large districts in six states, and eight mega districts in seven states. The district selected for the Southeast region did not have two small neighboring districts that fit the criteria for the study so two medium schools were visited. The Western region did not have any large neighboring districts so two medium districts were visited. No large districts that fit the study's criteria were willing to participate in the state selected from the Mid-Atlantic region, so a large district was visited in a neighboring state. Time constraints limited the number of schools that could be visited in the Northeast and Western region, so a second trip to another area in the Western region took place and included a second mega district, a medium district, and a small district.

Data Collection Instruments

Researchers developed three forms for collecting data. A *HACCP Verification Checklist* determined how schools were implementing the food safety program. This form gathered data related to training, standard operating procedures, and other HACCP-related principles.

The *Food Safety Observation Form* was developed to examine the food handling practices of employees related to hand washing, food handling, and cleaning and sanitizing. Practices were noted as either in-compliance or out-of-compliance with the *2009 FDA Food Code (Food Code)* (U.S. Food and Drug Administration, 2009).

The *Facility Observation Form* was used when recording general food safety practices related to hand washing, food storage, temperature control (including cooling), protection from contamination, and dish washing. A space for general comments was also included.

The *Food Safety Observation* and *Facility Observation Forms* were used to document employee behaviors and operational characteristics of each operation. While there were 34 schools included in the observations, observations within each category may exceed 34 as employees may have performed each behavior more than once during the observation. For example, employees would likely wash their hands more than once during the observation period, or in the case of a facility issue, a school may have had more than one hand sink.

A research protocol document and timeline were developed to provide guidelines on each form and the process for collecting data. The research protocol was reviewed and approved by the Kansas State University Institutional Review Board (IRB) prior to data collection.

Data Collection

Six researchers, each with foodservice and observational research experience, collected the data. To test and validate the instruments, researchers visited local school kitchens in pairs and independently collected data using the forms. At the end of the observations, each pair of researchers compared their observations with one another and discussed differences between their observations. All researchers later reconvened to discuss challenges in the research process and changes needed in the data collection forms.

For most of the states, one discrete school was scheduled for each of five school days in the week. Researchers arrived at the school by 8:00 am and stayed to observe through the lunch period, including clean-up.

Data Analysis

Descriptive statistics were used to calculate means and percentages using IBM SPSS (Version 19.0).

Qualitative data noted by researchers during the observations were compiled. After data collection, all six researchers discussed general observations made while visiting schools to identify common and unique issues.

RESULTS AND DISCUSSION

Characteristics of the Schools

A total of 34 schools were visited, of which four used traditional HACCP and 29 used the process approach, where food is categorized into one of three general categories (no cook, same day, complex) based on how many times the menu item moves through the temperature danger zone. One school did not have a food safety program. Most schools had conventional foodservice systems (n=20), while one was a commissary, three were ready-prepared, six were assembly serve, three were combined conventional and commissary, and one was a combined commissary and assembly serve system.

When asked about training provided to employees, 31 school managers indicated they provided training on personal hygiene and proper cleaning and sanitizing. Slightly fewer managers (n=29) indicated they offered training sessions for employees on the proper use of chemicals.

Twenty-seven of the kitchens had product and traffic flows that would minimize the risk of cross contamination. Typically, the operations with flow issues were small operations with inadequate space for preparing and serving the number of meals required.

A master sanitation schedule was posted and followed by 13 schools. This represents a best practice that other schools should use. Twenty-three schools had written procedures in place for cleaning and sanitizing equipment.

Table 1. *Standard Operating Procedures included in School Food Safety Programs (n=34)*

Standard Operating Procedure	Number*		
	Yes	No	Not Applicable
Calibration of thermometers	31	2	--
Personal hygiene	30	3	--
Cleaning and sanitizing	30	3	--
Holding hot and cold potentially hazardous foods	30	3	--
Hair restraints	29	4	--
Washing hands	29	4	--
Cooking potentially hazardous foods	28	5	2
Receiving deliveries	28	5	--
Using suitable utensils when handling ready-to-eat foods	28	5	1
Serving food	28	5	--
Reheating potentially hazardous foods	27	6	--
Storing and using poisonous or toxic chemicals	26	7	--
Cooling potentially hazardous foods	25	6	--
Employee health and illness	25	8	--
Date marking ready-to-eat, potentially hazardous foods	22	11	--
Preventing cross contamination during storage and preparation	21	12	--

Controlling time and temperature preparation	19	14	1
Washing fresh fruits and vegetables	17	15	--
Handling a food recall	16	17	--
Using time as a control	11	21	--

*The number did not always equal 34 because some schools did not have SOPs. One school did not have SOPs available.

HACCP Programs

All but one of the 29 schools using the process approach had grouped menu items into one of the three processes: no cook, same day, or complex. Most of the standard operating procedures (SOPs) recommended in the USDA Guidance Document (USDA Food and Nutrition Service, 2005) were used in the schools observed (Table 1). SOPs relating to calibration of thermometers, personal hygiene, cleaning and sanitizing, holding hot and cold potentially hazardous foods, hair restraints, and washing hands were found in 29 or more of the 34 schools. Date marking, washing fresh fruits and vegetables, and preventing cross contamination during storage and preparation are SOPs that were observed less often and more schools should consider implementing these.

Some SOPs would not be needed in all operations (such as using time as a control), which may explain lower numbers for those items. None of the SOPs included any place for signatures or the date of when the SOP was developed, reviewed, or last revised. Only half of the schools had a SOP for handling a food recall.

All food safety plans had established monitoring procedures (Table 2). Twenty-nine of the facilities provided training to employees on monitoring critical limits. Most schools (n=32) had procedures in place for maintaining monitoring records. Managers reported that they maintain these records from one month to seven years, with five years being the mode (n=12).

Researchers found essentially no records of corrective actions for the schools visited, although there were recorded deviations from the standard. Researchers noted that the space provided for corrective action on monitoring forms was not sufficient to fully document a corrective action.

Some state agencies have developed a standardized food safety plan for statewide use. One limitation of this approach is that plans are often not customized to meet the unique food production and service needs of each school. For example, SOPs for six schools did not align with food production and service needs of the school. In one instance, a school had a detailed SOP for the transportation of food; however all food was cooked on-site and none was transported to other schools within the school district.

In some instances, foodservice managers had difficulty locating the food safety program documents for their respective school. One e-mailed a copy of the plan to the researcher after the site visit because the plan was at the corporate headquarters. Many school foodservice managers did not know if they had a food safety program based on HACCP. In some situations, the written copy of the food safety program was kept at a district foodservice office. At one school, it was on an intranet site, which meant

employees could not access or use it easily for day-to-day activities.

Facility and Employee Observations

Most (36 of 39) of the employee hand washing facilities were conveniently located and accessible for employees (Table 3). Most (34 of 39) were supplied with water at the appropriate temperature. Several schools lacked dedicated hand washing sinks. One researcher noted that three of the five schools visited did not have any dedicated hand washing sinks, thus hand washing and fruit and vegetable preparation were observed occurring in the same sink.

Table 2. Number of Schools that Include Specific Monitoring Procedures in the School Food Safety Plan, Document Monitoring, and Document Corrective Actions (n=34)*

Item Monitored	In Plan			Documented			Corrective Action		
	Yes	No	N/A	Yes	No	N/A	Yes	No	N/A
Receiving temperatures of food	25	8	0	10	24	0	2	26	6
Temperatures of refrigerators and freezers	27	6	0	33	1	0	4	17	13
End-point cooking temperatures	22	10	1	25	6	3	11	14	9
Cooling time/temperature of foods	21	10	2	4	20	10	1	22	11
Dry storage temperature log	13	19	1	14	18	2	27	0	7
Holding temperature log	18	14	1	21	12	1	3	23	8
Serving temperature log	16	17	0	20	13	1	4	23	7
Food transportation log	7	14	12	6	12	16	0	16	18
Calibration log	21	12	0	10	20	4	6	22	6
Damaged/discarded products log	11	22	0	6	26	2	4	27	3
Sanitizer concentrations or temperatures	16	17	0	10	24	0	3	26	5
Dish machine temperatures	16	6	11	9	9	16	3	10	21
Microbial tests	1	31	1	1	32	1	1	0	33

*The total number of responses may not add to 34 if an observation could not be made.

Two of the most problematic areas related to facilities included ensuring food is covered and labeled before holding/storing; only 29 of 46 observations were in-compliance. Cold food holding was also an issue; only 18 of 38 observations were in-compliance.

Temperatures in most refrigerated storage units (38 of 42) were in-compliance, with food held below 41°F, while the temperature for dry storage was often out-of-compliance. Although not a food safety issue, the recommended temperature for dry storage areas is between 50°F and 70°F.

Only 16 of 30 schools were in-compliance with this standard.

Two observed activities were in-compliance 100% of the time. Researchers saw no evidence of pests (34 total observations) and food was covered when transported off property (10 total observations).

Employees generally performed well. Of particular interest, 100% of the observations were in-compliance in two areas: no employee exhibiting symptoms of illness or having an unprotected wound in the food production facility and properly cooking raw animal products.

Table 3. *Facility and Employee Observations*

Observed Activity	Total Observations ^a	Number	
		In-Compliance	Out-of-Compliance
Facility Observations			
No evidence of pests	34	34	0
Food is covered when transported off property	10	10	0
Hand washing facilities supplied with hand cleanser / disposable towels / hand drying devices	39	38	1
Hand washing facilities conveniently located and accessible for employees	39	36	3
Refrigerated storage at 41°F or below	42	38	4
Food is protected from environmental contamination/cross contamination	38	34	4
Dishwasher reaches the proper temperature	19	15	4
Water at the hand washing facility is a comfortable temperature	39	34	5
Hot food held at 135°F or higher	37	31	6
Only foods and items used in food production are located within cold and dry storage areas (no personal belongings)	37	29	8

All food product stored is 6' off the floor	36	27	9
Frozen storage at 0°F or below	35	25	10
Milk stored at 41°F or less	37	27	10
Dry storage areas maintained between 50°F–70°F	31	16	15
Food is covered and labeled properly before holding or storing	46	29	17
Cold food held at 41°F or less such as deli sandwich, chilled protein or protein salad, mixed salad [i.e. coleslaw, potato salad], fresh cut produce [i.e. tomatoes, melons]	38	18	20
Employees do not contact ready-to-eat foods with bare hands	135	124	11
No food employees exhibiting illness symptoms or having an unprotected wound requiring exclusion or restriction observed in the food preparation areas of the facility	129	129	0
Food contact surfaces and utensils are clean to sight and touch and sanitized before use	110	86	24
Employee uncovered beverages and foods excluded from the food production area	95	91	4
Check internal temperature of food by inserting the thermometer stem or probe into the thickest part of the product	80	64	16
Sanitizing solutions are changed as needed	69	32	37
Separate wiping cloths are used for food and nonfood surfaces	68	29	39
Wash, rinse, sanitize, and air-dry thermometers before and after use	62	35	27
Check temperature of food at the completion of cooking	47	29	18
Dishes/Utensils washed & sanitized using proper manual procedure	43	25	18
Check temperature of food at the completion of reheating	36	31	5

Dishes/Utensils washed & sanitized using properly operated dish machine	28	26	2
Raw animal products are cooked to required temperatures	4	4	0
Time/temperature control: food that is cooked and cooled on premises is rapidly reheated to 165°F for 15 seconds for hot holding	2	1	1

a Denotes actual observed behaviors and operational characteristics and may exceed 34. For example, employees washed their hands more than once or schools had more than one hand sink.

More challenges were observed in behaviors related to sanitizing work surfaces. Approximately 53% of observations showed that the solution in sanitizer buckets were not changed as required. Researchers observed a lack of work surface sanitation, which could lead to cross contamination.

Behaviors that were in-compliance with identified standards more than 90% of the time included employees excluding uncovered food and beverages from the production area (96%), dishes and utensils washed and sanitized using a properly operating dish washing machine (93%), and employees not contacting ready-to-eat foods with their bare hands (92%).

Employee Hand Washing Behaviors

Results for employee hand washing behaviors are summarized in Table 4. A total of 575 hand washing observations from 34 schools were recorded. The Food Code (U.S. FDA, 2009) requires that employees wash their hands for a minimum of 20 seconds using soap and water and thoroughly dry their hands using an approved method, such as disposable towels or a heated-air or high velocity hand drying device. Further, the Food Code requires that employees wash their hands immediately before engaging in food preparation; before donning new gloves or changing gloves; after soiling hands during preparation or service, after handling soiled equipment, dishes, or utensils; after touching body parts, coughing/sneezing, blowing nose, or eating and drinking; and when switching between handling raw animal foods and ready-to-eat foods.

In only 21% of the observations did employees wash their hands properly and when required. In 19% of observations, employees washed their hands, but did not wash their hands according to recommended procedures. Approximately 60% of employees failed to wash their hands as recommended by the Food Code (U.S. FDA, 2009), even though the district's SOP was consistent with the food code.

Employees generally performed hand washing well when switching between handling raw animal products and ready-to-eat foods. For this activity, in four of six observations employees properly washed their hands at the correct time and used the correct method. Only one employee washed his/her hands improperly, and another employee failed to wash his/her hands when required.

The practice that had the highest out-of-compliance percentage was hand washing after touching body parts, coughing/sneezing, blowing nose, or eating and drinking. For this particular activity, less than 4% of employees were observed washing their hands properly and when required, 15% washed their hands but did so improperly, and 81% failed to wash their hands. Most employees engaged in some sort of hand washing before preparing food, but many times, the hand washing was done improperly. For

example, the employee might not utilize soap or would not wash their hands for the specified time (20 seconds).

In the "other" category, 100% of employees failed to wash their hands when required. Observations in this area included employees failing to wash hands after picking up trash and debris off the floor and using hot pads over hands/gloves when handling ready-to-eat food.

Observed Activity	Total Observations	Number (%)*		
		Employee observed washing hands properly and when required	Employee observed washing hands improperly	Employee observed failing to wash hands when required
Immediately before engaging in food preparation	137	51 (37.2)	30 (21.9)	56 (40.9)
Before donning new gloves or changing gloves	144	39 (27.1)	31 (21.5)	74 (51.4)
After soiling hands during food preparation or service activities	104	18 (17.3)	20 (19.2)	66 (63.5)
After handling soiled equipment, dishes or utensils	97	7 (7.2)	17 (17.5)	73 (75.3)
After touching body parts, coughing/sneezing; blowing nose; eating or drinking	79	3 (3.8)	12 (15.2)	64 (81.0)
Switching between handling raw animal foods and ready-to-eat foods	6	4 (66.7)	1 (16.7)	1 (16.7)
Other **	8	0 (0)	0 (0)	8 (100.0)
Total Observations	575	122 (21.2)	111 (19.3)	342 (59.4)

*Percentages may not add up to 100% due to rounding errors.

**Other times when employees failed to wash hands included after picking up trash or debris off the

floor, after using hot pads with hands (or gloved hands) when handling ready-to-eat foods.

Health Department Inspection Reports

The most recent health inspection report was collected for each school (Table 5). Many schools performed very well for the routine inspections; 24 of 34 had scores of 91 or higher. Thirteen schools had a perfect score. Ten schools had violations, but no overall inspection score was recorded. The largest number of violations (n=6) was related to floor construction, maintenance, and cleanliness. Two of the 34 schools had violations related to food contamination, food contact surfaces, and cold food holding. Because of the limited number of health inspection reports and the high scores, it is difficult to identify any trends in violations among the schools visited. This sample indicates that schools perform well on regulatory health inspections.

Table 5. *Violations Identified in School Health Inspections (n=34)*

Violations	Frequency
Floors: constructed, drained, clean, good repair, covering installation, dustless cleaning methods	6
Potentially hazardous food meets temperature requirements during storage, preparation, display, service and transportation	4
Thermometers provided/accurate/properly calibrated (+/- 2°F)	4
Hand washing stations: number, convenient, accessible, designed, installed	3
Non-food contact surfaces of equipment and utensils clean	3
Food contamination prevented during storage, preparation, display, handling, other	2
Food contact surface of equipment and utensils cleaned/ sanitized/good repair	2
Food properly labeled; original container; records; code date limits	2
Toxic or poisonous items; medicines; first aid materials: stored; labeled, used	2
Walls, ceiling, attached equipment; constructed good repair, clean surfaces, dustless cleaning methods	2
Equipment design/good repair	2
Kitchenware and food contact surfaces of equipment properly washed, rinsed, sanitized and air-dried. Sanitizer solution provided and maintained as required.	1
Fruits and vegetables washed prior to preparation or service	1
Food protected from potential contamination by employees and consumers	1

Warewashing facilities: designed, constructed, maintained, installed, located, and operated. Accurate thermometers, Chemical test papers	1
Refuse, recyclables, and returnable. Outdoor/indoor storage area approved. Receptacles provided; covered. Approved refuse disposal methods.	1
Manual warewashing and sanitizing	1
Plumbing installed/proper backflow devices	1
Presence of insects/rodents-outer openings protected, no birds, turtles, other animals	1
Certified food handler/manager	1
Non-food contact surfaces: designed, constructed, maintained, installed, located	1
Cooling methods. Facilities to maintain product temperature. Plant food cooking	1
Lighting, ventilation adequate. Lights shielded. Ventilation systems (filters), clean, operated	1
Toilet rooms enclosed, self-closing doors, fixtures, good repair, clean; Hand cleanser, sanitary towels/hand drying devices provided, proper waste receptacles, tissue	1
Grease trap trip ticket/food establishment permit/food manager or handler-certificate	1

The health inspection reports often did not reflect the number of violations observed in this study. We were not doing a regulatory inspection, but rather we targeted observations on the food safety program, facility resources, and employee behaviors.

Conclusions and Application

The Child Nutrition and WIC Reauthorization Act of 2004 required that all schools implement food safety programs based on HACCP principles. Since that time, only one survey study has focused on evaluating how these programs have been implemented across the U.S. The purpose of this study was to determine how school districts have implemented these programs.

Food production and delivery systems in schools varied widely. In some schools, food is prepared and served on site, some receive food from a school district central kitchen, and some receive prepared food from an outside caterer. These variations mean one generic food safety program is not adequate, but rather each operation needs a customized food safety program designed for the unique features of each operation. For example, in one state every school had identical SOPs, even though not all schools had the same production and delivery system.

Schools should be encouraged to customize food safety programs to their own operations. While many operations are similar, no statewide program can be designed for all school foodservice operations.

Moreover, programs need documents that actually can be used in an operation. Because these programs

take time to develop, researchers suggest an online system to assist staff at individual schools in developing their programs. Such a system could use a series of questions, and based on responses to the questions, SOPs would be generated. These SOPs may need slight modification for the specific school operation, but the system would minimize irrelevant procedures in the plan. The system could also generate resources like logs, reminder signs, instructions for common tasks, and basic training.

The model SOP for responding to a food recall should be reviewed and distributed to school foodservice directors. Only 16 of the 34 schools included in this sample had the SOP detailing how to respond to a food recall in their plan. Schools must be better informed about required actions to take when a food is recalled.

Simplified food safety resources could be created to accompany the *Guidance for School Food Authorities: Developing a School Food Safety Program Based on the Process Approach to HACCP Principles* (USDA, 2005). For example, one resource might focus on food safety needs for schools where food is just heated and served. Another resource could focus on food safety practices needed if schools receive food from an outside caterer.

This research suggests that the majority of needed improvements to school food safety programs are related to employee behaviors rather than facilities or general operations. For example, the most frequent out-of-compliance facility observations were related to food being covered and labeled properly before storage and cold food being held at 41°F or less. While violations were not very frequent, many of these items could easily be at 100% in-compliance if the HACCP program were functioning properly. Documentation in schools was minimal, and there was virtually no documentation of corrective actions. Refrigerated storage facilities could easily be maintained at 41°F or below if proper corrective action were taken when staff noted that the refrigeration unit did not meet the critical control point in the food safety plan. This applies to other items, such as hot food holding, excluding non-food items from food production areas, frozen storage at 0°F or below, etc. These results do conflict with other studies that have explored health inspection results in schools, where facility issues were found to be the most prevalent (Kwon, Roberts, Sauer, Cole, & Shanklin, 2014; Kwon, Roberts, Sauer, Cole, & Shanklin, 2013). Future studies may wish to explore more precisely differences and correlations between on-site observations and health inspection reports to improve the safety of food in schools.

The health inspection scores for most schools were generally very high, which reflects well on food safety practices. In some school districts, foodservice managers and employees noted frequent turnover among health inspectors. The employees were bothered with inconsistencies in inspections and that different inspectors had different focuses. They indicated that this made it difficult to interpret the results and decide on actions to take.

Observations of food handling revealed limited sanitizing of work surfaces, lack of adequate hand washing, and improper glove use. Schools should have dedicated hand sinks. Further, employees need to understand the food safety risks of using the same sink for hand washing and washing ready-to-eat foods such as fresh produce. Hand washing education should be emphasized for school foodservice employees. Hand washing is often not done at appropriate times or using appropriate techniques, which can result in cross contamination.

Food safety should continue to be emphasized at all levels. Results of this study show that school foodservice operations perform well in many areas, but there are several opportunities for food to

become contaminated during production and service in schools. Further development of the food safety programs based on HACCP principles is needed. Some employees, managers, and directors may believe that they have met the requirement of the law simply because they have a written food safety program.

Others may believe that because they have a "clean" kitchen there are no food safety risks. Thus, the continued role of HACCP programs needs to be stressed.

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