



## Review of Food Safety Violations: Urban School Foodservice

### ABSTRACT

In the United States over 29 million elementary and high school students, a potentially higher risk population, consume school lunches each day, and the need for proper food safety is paramount. Though numerous interventions have been implemented in school foodservice, foodborne illness continues to be an issue in the United States. Ultimately, an understanding of recurring food safety violations would inform development of targeted food safety training interventions that could mitigate the number of foodborne illness outbreaks. The aim of this study was to analyze food safety violation trends from 2010 to 2019 in a large urban school system to explore research and educational opportunities. Over 20% of food safety inspections resulted in failure; 9.0% of all violations were critical, 11.9% were serious, and 79.1% were minor. These findings underscore the need to reevaluate current food safety educational interventions and food safety handling practices. Key critical and serious violation trends were lack of food safety knowledge, lack of temperature controls throughout the food preparation process, and

lack of appropriate supplies. Recurring minor violations pertained to cleanliness of the facility (ventilation, flooring, walls, ceiling, and food and non food-contact surfaces).

### INTRODUCTION

According to the National School Lunch Program, nearly 500,000 school foodservice employees at approximately 100,000 schools serve lunches to 29.6 million elementary and high school students each day in the United States (36). The National School Lunch Program provides nutritionally balanced, low-cost, or free lunches to children each school day. Yet, the average school foodservice employee has limited education and often no formal culinary arts training for serving safe and palatable foods that meet nutrition guidelines (25, 31). In accordance with the U.S. Department of Agriculture (USDA) (35) professional standards, all school foodservice employees are required to complete annual training: 6 h for full-time employees and 4 h for part-time employees. Potential USDA training topics include nutrition, operations (food production, service, purchasing, receiving, and food safety), administration (free and reduced-

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price meal benefits, human resources, and facility planning), and communications and marketing (35).

The impacts of foodborne illnesses are significant, and surveillance reports have highlighted the significant health burden on children. According to the Centers for Disease Control and Prevention (CDC) Foodborne Disease Outbreak Surveillance System, between 2000 and 2010 foodborne outbreaks in schools accounted for 3.8% ( $n = 464$ ) of all outbreaks and 8.2% ( $n = 20,667$ ) of all illnesses reported (38). Of the 464 outbreaks reported, 49.2% involved food handling by a school foodservice worker (38). In 2005, within the Chicago area school districts four laboratory-confirmed outbreaks occurred. In two outbreaks, the same school was affected by improper temperature controls, which allowed fruit juice and pineapple fruit cups served at lunch to become contaminated with high levels of yeast, and 46 individuals became ill (39). A foodborne outbreak of norovirus infection in August 2005 was linked to a welcome-back breakfast at another school where 30 students contracted the virus (15), and an outbreak of *Salmonella* Enteritidis infection that was laboratory confirmed affected five students in one school (15).

CDC (6) data indicate that between 2009 and 2018 114 outbreaks of foodborne illness occurred in elementary and high schools and in colleges and universities, affecting 5,799 students and resulting in 246 hospitalizations. However, these numbers could be an undercount. Painter et al. (23) found that many small foodborne illness outbreaks are not detected or investigated. In 2009, a confirmed outbreak of norovirus infection was associated with contaminated ice and lemonade in an Illinois school (12). Venuto and Garcia (38) found that over 56% ( $n = 4,285$ ) of all foodborne illnesses were associated with norovirus and foodservice worker practices. A major foodborne illness outbreak in 2012 was caused by *Salmonella* Enteritidis and affected students at six schools that utilized the same foodservice company (16). One student was hospitalized, four others sought care at an emergency room, and eight others visited a health care provider. Cremon et al. (9) found that children with *Salmonella*-induced gastroenteritis were more likely than adults to develop long-term health consequences such as irritable bowel syndrome.

Foodborne illnesses in children are associated with several factors. Compared with adults, children are more vulnerable to foodborne illness partly because their immune systems are not fully developed, they have a lower body mass, and they produce less stomach acid (9). Children also have no control over the food handling practices used to produce school meals (6).

Research has also identified major problems with current school food service systems, such as inadequate time to prepare food and perform proper food safety practices (32), poor workforce retention, lack of equipment for scratch cooking (33), and lack of culinary skills for serving palatable

foods that meet nutrition guidelines (25). These issues are reflected in low levels of student acceptance of served foods (40). Flure et al. (11) identified school foodservice employee professional development as critical to school meal program success. Previous research has indicated an urgent need for training on school food hygiene and safety practices (4) and culinary skills (31). In a systematic review of foodservice training modalities, Reynolds and Dolasinski (27) found that training consisting of lectures with basic visual aids is the industry norm and noted a lack of novel approaches. Training methods that take these factors into consideration could increase employee confidence, motivation, and the likelihood of putting knowledge and skills into practice (31).

However, tremendous barriers exist for conducting training for school foodservice employees, including lack of physical space. Lee et al. (19) found that attendance barriers such as timing and limited funds for travel and pay are perpetual concerns. Tabak and Moreland-Russell (33) recognized that the labor shortages and the burdens of job duties added to the lack of time for training. According to the CDC (5), the three most common food safety errors contributing to unsafe food and foodborne illness are poor food handling practices, poor personal hygiene, and cross-contamination.

In a recent evaluation of food safety knowledge and microbial status of food-contact surfaces in schools, significantly higher microbial counts on food-contact surfaces were found among kitchens in which the level of food safety knowledge among workers was low (14). Jones et al. (17) conducted a needs assessment of statewide training in California, and over half of foodservice directors identified food safety training as a critical need.

Lee and Liu (18) conducted a statewide review of school foodservice health inspection reports in Missouri to identify areas for improvement. The top three critical violations were food temperature control for potentially hazardous foods, improper equipment usage, and misuse of poisonous and toxic materials. The top three noncritical violations were improper equipment usage, inadequate physical facilities, and inadequate equipment for holding food at a given temperature.

Although the concept of identifying food safety violations in school foodservice is not new, little research has been conducted on school food safety violations over a period of time to identify reoccurring food safety violations and trends. After trends are identified, targeted training interventions can be developed to mitigate foodborne illness outbreaks. The aim of the present study was to analyze food safety violations trends between 2010 and 2019 in a large urban school system to explore research and educational opportunities. The three research objectives regarding school foodservice operations were (i) determine the percentages of food inspections in which the schools pass or fail; (ii) determine the rates of the most and least common food safety violations by category

(critical, serious, or minor); and (iii) identify key violation trends between 2010 and 2019.

## MATERIALS AND METHODS

### Establishing the data set

The Food Protection Division of the Chicago Department of Public Health (CDPH) health inspection website (7) was utilized to obtain school food safety inspection reports for the 2010 to 2019. Health inspections were performed by health department personnel following state laws and regulations. Within the CDPH, annually over 199,000 foodservice establishments received routine health inspections. To ensure that only elementary through high school foodservice inspections were included in the final data set for analysis, several filters were implemented (Figure 1). The initial filter stage included keywords: K-12, private school, public school, charter school, and routine inspection only. Through this initial filter 1,356 schools were identified with a total 13,077 inspections between 2010 and 2019. To better identify trends throughout these 10 years, a final filter was used. Schools with less than 8 of 10 health inspections reported during the 10-year period were removed from the final data set, resulting in the removal of 120 schools for a final data set of 1,236 schools and 11,930 inspections.

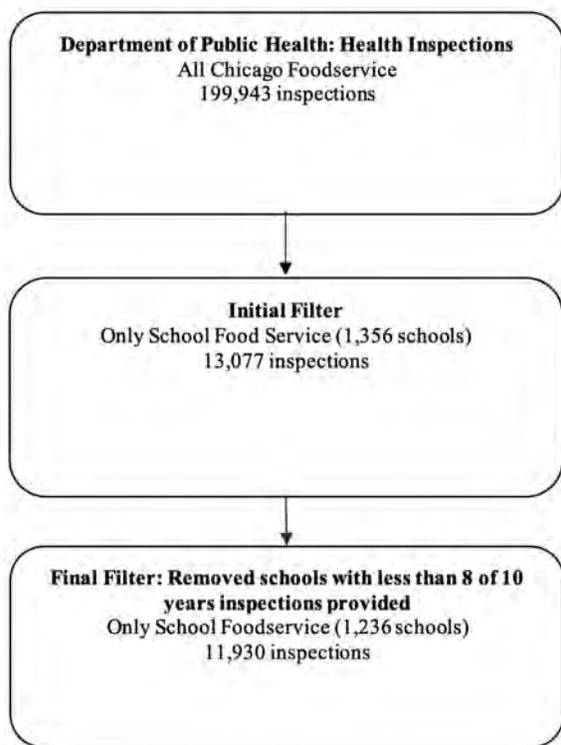


Figure 1. Flow diagram of school foodservice health inspection selection.

### Data analysis

Health inspection data on school foodservice operations from January 2010 through December 2019 were collected and analyzed for this study. Only routine inspections were included because follow-up inspections or those triggered by complaints could duplicate violation reports. The final data set was analyzed with Excel (Microsoft, Redmond, WA). Analyses were conducted for the frequency of each violation (45 total violations as identified by the CDPH) during the 10-year period and the percentage of each violation within the three categories: critical (14 violations), serious (15 violations), and minor (16 violations). Descriptive statistics were reported on the pass and fail rates, violations per inspection, number of violations per year, and average number of violations per inspection. All violations from school foodservice operations were coded and reviewed by multiple research assistants.

### Violation categories

The CDPH established three violation categories: critical, serious, and minor. The critical violation category contains 14 violations, such as (i) inadequate storage temperatures, (ii) inappropriate food handling practices, (iii) improper personal hygiene, (iv) rodent and/or insect infestation, and (v) lack of hot running water. These violations create an immediate health hazard that carries a greater risk of causing foodborne illness. Critical violations identified during an inspection must be corrected immediately. When the school fails to do so, it fails the inspection, receives a citation, and has its foodservice license suspended.

The serious violation category contains 15 violations, such as (i) potentially hazardous food improperly thawed, (ii) reserving food previously served to another customer (except for packaged food in its original unopened packages), and (iii) food not properly protected from contamination during storage, preparation, display, service, and transportation. These types of violations create a potential health hazard if not corrected in the timeframe specified by the CDPH. When not immediately corrected, serious violations identified during an inspection will cause the school to fail the inspection. However, when all serious violations are immediately corrected the school will be recorded as passing the inspection but with conditions.

The minor violation category contains 16 violations, such as (i) poorly constructed, unclean, or dilapidated walls, ceilings, or floors, (ii) improper storage of soiled and clean linens, coats, and aprons, and (iii) unauthorized personnel in the food preparation area. These types of violations are less likely than critical or serious violations to contribute to food contamination or illness and do not pose an immediate threat to public health. Citations are not issued for minor violations. However, minor violations that are not corrected within the timeframe specified by the CDPH are upgraded to serious violations, and the inspection is recorded as failed.

The full list and description of each of the 45 violations is provided as an Appendix. Between 2010 and 2019, 1,236 schools fit the research criteria with 11,930 food safety inspections performed.

## RESULTS

### Descriptive characteristics

Of the 11,930 inspections conducted, 20.2% were recorded as failed ( $n = 2,415$ ), 8.7% as passed conditionally ( $n = 1,031$ ), and 71.1% as passed ( $n = 8,484$ ) (Table 1).

Within the 11,930 inspections, 32,873 food safety violations were identified. An average of 2.59 violations were identified per inspection. Table 2 provides the number of inspections and violations by year.

Over the 10-year period, the 45 violations occurred 1 to 5,570 times. Of the 32,873 food safety violations identified, 9.0% were critical ( $n = 2,962$ ), 11.9% were serious ( $n = 3,910$ ), and 79.1% were minor ( $n = 26,001$ ). A summary of the violation categories per year is given in Table 3.

**TABLE 1. Ten-year inspection summary ( $n = 11,930$ )**

Inspection result	<i>n</i>	%
Pass	8,484	71.1
Pass with conditions	1,031	8.7
Fail	2,415	20.2

**TABLE 2. Number of inspections and violations by year**

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Inspections	1,336	1,368	1,153	1,148	1,133	1,153	1,204	1,150	1,214	1,071
Violations	4,040	4,379	3,524	3,273	3,179	3,045	2,895	2,772	2,777	2,989
Average no. of violations per inspection	3.02	3.20	3.06	2.85	2.81	2.64	2.40	2.41	2.29	2.79

**TABLE 3. Ten-year violation summary by category ( $n = 32,873$ )**

	<i>n</i>		
	Critical	Serious	Minor
2010	77	224	3739
2011	89	281	4009
2012	103	293	3128
2013	64	253	2956
2014	93	268	2818
2015	132	351	2562
2016	128	430	2337
2017	115	380	2277
2018	452	376	1949
2019	709	54	226

### Most frequent food safety violations

The five most frequent food safety violations per category (critical, serious, and minor) were identified by summing the 10-year total for each violation. The most common critical violations were management and employee food safety knowledge ( $n = 601$ ), facilities to maintain proper storage temperature ( $n = 358$ ), potentially hazardous food exceeding temperature during preparation ( $n = 274$ ), adequate hand washing sinks ( $n = 251$ ), and procedures for responding to vomit and diarrhea ( $n = 115$ ). The most common serious violations were evidence of rodents or insects ( $n = 1,199$ ), adequate dish washing facilities ( $n = 496$ ), outside waste and grease trap stored and sealed properly ( $n = 375$ ), certified food manager on site ( $n = 320$ ), and toilet room clean and supplied ( $n = 163$ ). The most common minor violations were walls, ceilings, and attached equipment clean ( $n = 5,570$ ), ventilation clean ( $n = 4,930$ ), flooring clean ( $n = 4,846$ ), food- and non food-contact surfaces clean ( $n = 3,050$ ), and premises maintained and litter free ( $n = 2,697$ ). *Table 4* provides details for the five most frequent violations per category by year.

### Least frequent food safety violations

The five least frequent food safety violations per category (critical, serious, and minor) were also identified by summing the 10-year total for each violation. The least common critical violations were proper eating, drinking, tasting, or tobacco use ( $n = 3$ ), wash and rinse water clean and proper temperature ( $n = 7$ ), water source safe, hot and cold, and under city pressure ( $n = 8$ ), source of cross-contamination controlled ( $n = 11$ ), and person in charge present and performs duties ( $n = 32$ ). The least common serious violations were adequate number of inside trash containers ( $n = 1$ ), toxic items properly stored and labeled ( $n = 8$ ), proper disposal of previously served food ( $n = 20$ ), food-contact surfaces cleaned and sanitized ( $n = 20$ ), and inspection report summary displayed and visible to all customers ( $n = 25$ ). The least common minor violations were only authorized personnel in food preparation areas ( $n = 54$ ), contamination prevented during food display ( $n = 77$ ), ice dispenser clean ( $n = 96$ ), food in original container properly labeled ( $n = 226$ ), and refrigeration and metal stem thermometers provided ( $n = 510$ ). *Table 5* provides details for the five least common violations per category by year.

## DISCUSSION

All foodservice establishments are inspected for proper food safety practices, and the goal of these inspections is to ensure safe food handling and to identify deficits. The foodservice establishments most common inspected are restaurants, and these inspections are important for ensuring the safety of customers. In the present study, the “customers” were elementary and high school students, who are more vulnerable to foodborne illnesses due to lower body mass

and lack of control over food preparation (9). Thus, vigilant food handling practices are paramount for ensuring student safety. Food safety inspections in school foodservice are important for identifying violations and developing targeted interventions (18). The aim of this study was to analyze food safety violation trends between 2010 and 2019 in a large urban school system to explore research and educational opportunities.

Over the 10-year period covered by the study, over 20% of the nearly 12,000 inspections were identified as failures. Common reasons for a school food service to fail a food safety inspection are lack of temperature controls, major rodent or insect infestations, and lack of cleaning facilities and equipment (7). The identification of and corrective actions for these critical violations are crucial for ensuring safe food handling practices. Identification of these types of violations also is important for educating food handling employees and directors. Seiver and Hatfield (30) detailed the importance of health inspections for educating and increasing the awareness of restaurant employees, thus encouraging them to comply with proper food safety practices. The results of the present study revealed a slight downward trend in the number of overall violations per inspection over the 10-year period, predominantly due to the decrease in minor violation citations in later years.

The CDPH (7) has identified three types of food violations that can be detected in an inspection: critical violations, serious violations, and minor violations. Over the 10-year study period, 9.0% of all violations were identified as critical. This percentage is consistent with previous research in school foodservice settings (18). Critical violations pose an imminent threat to food safety and must be corrected immediately. Examples of these violations are (i) inadequate storage temperatures, (ii) inappropriate food handling practices, (iii) improper personal hygiene, (iv) major rodent and/or insect infestation, and (v) lack of hot running water. In the present study, the five critical violations most often cited over the 10-year period were lack of manager and employee food safety knowledge, improper temperature controls, lack of hand washing sinks, and lack of written cleaning procedures. These findings are consistent with previous food safety inspection research, in which recurrent violations were associated with critical aspects of food holding temperature, hygiene practices, sanitization, and hygiene facilities (26). Lee and Lui (18) identified improper temperatures and management and personnel knowledge as among the five most common critical violations.

Although overall food safety violations trended downward over the 10-year period, the majority of the critical violations trended upward during this same period, meaning the number of these violations increased yearly. Thus, the current training practices and interventions in use have not been effective for reducing these critical violations. Lack of management and employee food safety knowledge was

**TABLE 4. Five most frequent violations per category**

Violation description	<i>n</i>										
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total <sup>a</sup>
	<b>Critical</b>										
Management and employee food safety knowledge	11	18	16	53	49	44	78	100	74	158	601*
Facilities to maintain proper storage temp	11	5	5	5	16	20	18	109	91	78	358
Potentially hazardous foods exceeding temp during preparation	16	7	16	6	4	11	11	15	96	92	274
Adequate hand washing sinks	13	18	14	18	29	29	30	27	25	48	251
Procedures for responding to vomit and diarrhea	8	12	7	3	2	10	9	5	38	21	115
	<b>Serious</b>										
Evidence of rodents or insects	106	121	154	101	97	117	133	131	104	135	1,119
Adequate dish washing facilities	23	38	34	38	46	49	87	76	58	47	496
Outside waste, grease trap stored and sealed	17	25	22	18	24	62	49	55	47	56	375
Certified food manager on site	19	24	17	22	30	35	45	43	33	52	320*
Toilet room clean and supplied	7	10	15	10	18	26	29	18	16	14	163
	<b>Minor</b>										
Walls, ceilings, attached equipment clean	748	785	612	563	552	520	469	484	384	453	5,117
Ventilation clean	631	707	573	527	504	484	504	440	451	109	4,930
Flooring clean	610	710	518	555	489	424	443	439	285	373	4,846
Food and non food-contact surfaces clean	425	452	346	333	314	304	221	243	202	210	3,050*
Premise maintained and litter free	387	416	325	308	302	234	214	179	145	187	2,697

<sup>a</sup>Asterisks indicate statistical significance ( $P < 0.01$ ).

**TABLE 5. Five least frequent violations per category**

Violation description	n										
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
<b>Critical</b>											
Proper eating, drinking, tasting, or tobacco use	0	0	0	0	0	0	0	1	0	2	3
Wash and rinse water clean and proper temp	0	0	0	0	2	1	1	1	2	0	7
Water source safe, hot and cold, under city pressure	3	3	1	0	0	0	0	0	1	0	8
Source of cross-contamination controlled	0	2	1	0	0	3	2	0	2	1	11
Person in charge present and performs duties	1	0	3	0	4	2	1	6	8	7	32
<b>Serious</b>											
Adequate no. of inside trash containers	0	0	0	0	0	0	1	0	0	0	1
Toxic items properly stored and labeled	0	1	0	0	0	1	1	2	1	2	8
Proper disposal of previously served food	2	0	2	0	0	3	4	3	6	0	20
Food-contact surfaces cleaned and sanitized	0	0	0	0	0	1	0	0	7	12	20
Inspection report summary displayed and visible to all customers	2	0	2	0	0	3	4	3	6	5	25
<b>Minor</b>											
Only authorized personnel in food-prep area	6	8	8	4	8	3	1	5	6	5	54
Contamination prevented during food display	1	1	0	2	1	0	1	0	24	47	77
Ice dispenser clean	16	12	10	10	10	8	8	12	7	3	96
Food in original container properly labeled	29	26	25	37	44	32	12	9	12	0	226
Refrigeration and metal stem thermometers provided	76	83	61	48	49	42	30	33	40	48	510

the most common violation. This violation and the serious violation of certified food manager on site are potentially correlated, meaning that when a certified food manager is on site management and employees are more likely to use proper food safety behaviors during an inspection. This hypothesis is supported by the fact that one of the least frequent violations over the 10-year period was the person in charge was present and performing duties. The presence of a food safety certified manager who is communicating and overseeing employees is critical for ensuring proper food handling behaviors. Murphy et al. (22) explored the relationship between mandatory food safety training certification and inspection results at restaurants ( $n = 907$ ) in Orange County, Florida. Results indicate that mandatory food safety certification training may help to reduce violations during food safety inspections. Arendt et al. (3) found that the manager's leadership and effective communication were important for assuring safe food handling practices.

This upward trend in critical food safety violations also could be due to increased scrutiny by health inspectors across the 10-year period. An understanding of how health inspections and health inspectors evolve over time can help to put this trend into context. Petran et al. (24) compared routine food safety inspection data conducted at outbreak restaurants with data from routine food safety inspections conducted at nonoutbreak restaurants and found that significantly more violations were recorded at restaurants that had been associated with outbreaks. The majority of these violations were related to contamination in the facility and to food handling procedures. Thus, health inspectors need to ensure proper knowledge levels.

Educational interventions can increase food safety knowledge (8, 13, 20). Reviews of food safety training topics from 2004 to 2009 (21) and 2013 to 2018 (27) have revealed that the topics most commonly covered were personal hygiene, food safety best practices, and hazard analysis critical control points. In a recent study, school foodservice employees reported barriers to following proper food handling practices that were related to the need for more time and adequate access to resources, equipment, and facilities (1). Attention to an organization's food safety culture, that is, the organizational and environmental aspects affecting food safety, is also a critical step for improving food safety practices. Da Cunha (10) highlighted how a proactive food safety culture and behavior-based strategies can improve food safety practices in foodservice facilities. Reynolds et al. (29) found that a positive food safety culture, including open communication and manager and coworker support, directly affected foodservice employees' positive food safety practices.

In the final phase of a 10-year study, the U.S. Food and Drug Administration (FDA) found a low level of compliance with food safety practices in foodservice establishments, including time and temperature abuse,

poor personal hygiene, and cross-contamination (37). In the present study, two of the five most common critical recurring violations were associated with improper temperature controls: lack of facilities to maintain proper storage temperatures and potentially hazardous food exceeding acceptable temperatures during preparation. In a previous study in which foodservice employees were observed, participants followed the FDA Food Code recommendations for temperature controls only 50% of the time (2). Procedures for responding to vomit and diarrhea were lacking in the present study, consistent with previous research (28). Prior research on foodservice in childcare settings revealed that improving written policies for food preparation can prevent the spread of foodborne illnesses to children (28).

Recurring serious violations identified during the 10-year study period were associated with lack of cleaning equipment (dish washing, outside waste, and toilet room supplies) and evidence of rodent or insect infestations. These types of violations create a potential health hazard when not corrected in the timeframe specified by the CDPH. Serious violations identified during an inspection and not immediately corrected result in a failed inspection. Lee and Liu (18) reported a similar lack of cleaning equipment identified during Missouri school foodservice inspections.

The most commonly cited minor violations of the study period were associated with lack of cleaning procedures for walls, ceiling, ventilation, flooring, and food- and non food-contact surfaces. Although minor violations are less likely than critical or serious violations to contribute to food contamination or illness, schools must not ignore these violations because they can cause more serious problems if neglected. Thomas et al. (34) highlighted the importance of cleaning procedures in school foodservice for ensuring the health and safety of the students.

Trends in violation patterns were also identified for the least common violations during the 10-year period. The five least common critical violations were associated with proper personal hygiene habits, proper water sources and temperatures, a manager on duty, and the presence of contamination controls. However, these violations may be underrepresented; due to the timing of inspections some potential violations may not be observed. For example, inspectors may not have the opportunity to observe employees eating or drinking during the inspection. The majority of least common serious and minor violations were associated with food storage (disposal, labeling, and use of original packaging), inspection reports on display, and availability of thermometers. Thus, the majority of the least common critical, serious, and minor violations were not those associated with employee behavior. School foodservice employees often are the cause of food safety violations. Thus, updated and targeted training interventions are needed to mitigate these improper employee food handling behaviors.

This study had limitations. The analysis targeted only school foodservice, and generalization to other areas of the foodservice industry may not be accurate. Because the data were from a large urban school system, rural schools were not represented. However, the school system targeted is the second largest in the country and represents the varied demographics of students and employees. Although the data for only the last 10 years were analyzed, this allowed a longitudinal trend analysis.

## CONCLUSIONS

This study of school foodservice food safety inspections over a 10-year period was conducted to identify trends in critical, serious, and minor violations. Although a slight downward trend was found in the average number of violations per inspection, the same critical violations persisted throughout the 10-year period. These findings underscore the need to reevaluate current food safety educational interventions and food safety handling practices. Key critical and serious violations were lack of food safety knowledge, lack of temperature controls throughout the food preparation process, and lack of appropriate supplies. The presence of a certified food safety manager appeared to be critical for ensuring proper food safety practices by employees. Recurring minor violations were associated with cleanliness of the facility (ventilation, flooring, walls,

ceiling, and food- and non food-contact surfaces). In light of these recurring trends, food safety training programs should ensure that employees understand and follow proper temperature controls and cleaning and sanitizing procedures. School foodservice directors should also ensure appropriate oversight for confirming that these procedures are being implemented properly.

Over the 10-year period, the most common critical violation was lack of food safety knowledge by managers and employees. The increase in the prevalence of this violation could be due to increased scrutiny from health inspectors; therefore, future study is needed on the behaviors of school foodservice health inspectors over time. Future research should target the most commonly recurring violations to improve knowledge and food safety specific practices. For example, future educational interventions could utilize advanced technology such as augmented reality to educate school foodservice employees in real time on the job. Future research could also focus on current training practices and topics for school foodservice directors to identify gaps in educational interventions.

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