Food Protection Trends, Vol. 32, No. 2, Pages 73–80

6200 Aurora Ave., Suite 200W, Des Moines, IA 50322-2864

Characteristics of Restaurants Associated with Critical Food Safety Violations

N. MENACHEMI,[1] V.A. YEAGER,[1]* D. M. TAYLOR,[2] B. BRADEN,[2] L. A. MCCLURE[3] and C. OUIMET[2]
[1]University of Alabama at Birmingham, School of Public Health, Dept. of Health Care Organization & Policy, 1530 3rd Ave. South, RPHB 320, Birmingham, AL 35294-0022, USA; [2]Jefferson County Dept. of Health, 1400 6th Ave. South, Birmingham, AL 35233, USA; [3]University of Alabama at Birmingham, School of Public Health, Dept. of Biostatistics, 1530 3rd Ave. South, RPHB 327, Birmingham, AL 35294-0022, USA

ABSTRACT

This study examined whether restaurant characteristics are associated with critical violations identified during restaurant inspections. Using multiple years of data, we also examined changes in critical violation patterns over time. Data from all restaurant inspections in Jefferson County, Alabama between the years 2008–2010 were analyzed. The results of a total of 5,488 inspections were examined, with an average of 1,829 restaurants in operation each year of the study. Key findings suggested that certain restaurant characteristics, including cuisine-type, are associated with certain critical violations. The five most common critical violations were related to cold holding temperatures, sanitization of equipment, personnel training/certification, hygienic practices/hand-washing, and storage/labeling of toxic/poisonous items, including smoke from people smoking. The frequency of critical violations changed over time; some increased or worsened, whereas others decreased or improved, commonly in response to policy and enforcement changes. Overall, we find that certain food establishments are prone to specific critical violations, information which should be considered in the development of targeted educational programs and interventions for food service settings.

A peer-reviewed article

*Author for correspondence: Phone: +1 205.975.8961; Fax: +1 205.934.3347
E-mail: vyeager@uab.edu

INTRODUCTION

Despite numerous efforts to reduce its occurrence, foodborne illness remains a significant problem in the U.S., with estimates of its societal costs reaching $357 billion annually *(11)*. It is believed that foodborne illness results in some 48 million illnesses, 128,000 hospitalizations, and 3,000 deaths annually *(12)*. According to recent reports, half of foodborne illness in the U.S. results from eating in restaurants *(3, 5)*. As a component of our national food safety program, local public health departments devote considerable resources to inspecting restaurants and training food workers.

Although the occurrence of foodborne illness is the ideal indicator of how well food safety programs perform, foodborne illness is severely underreported and as such it is not a reliable performance measure. In an effort to identify alternative measures, the U.S. Food and Drug Administration (FDA) identified five risk factors that contribute to foodborne illness *(14)*: (1) food from unsafe sources, (2) inadequate cooking, (3) improper holding temperatures, (4) contaminated equipment, and (5) poor personal hygiene. These five risk factors are included in public health inspections

TABLE 1. Food establishment and inspection characteristics

Variable	N (%)
Year	
2008	1,788 (32.6%)
2009	1,859 (33.9%)
2010	1,841 (33.5%)
Average number of inspections/restaurant	
2008	2.51
2009	2.71
2010	2.62
Number of businesses registered to same owner	
1	3,380 (61.6%)
2–3	831 (15.1%)
4–9	697 (12.7%)
10 or more	524 (9.6%)
Food service setting	
Quick Service (e.g., fast food)	931 (17.0%)
Casual Dining (e.g., steakhouse, bar and grill, and family-style restaurant)	779 (14.2%)
Sandwiches (e.g., café/deli)	643 (11.7%)
Cafeteria/Diner	397 (7.2%)
Asian/Indian	335 (6.1%)
Grocery Store Kitchen (e.g., deli/bakery)	287 (5.2%)
Pizzeria	270 (4.9%)
Mexican/Latin	262 (4.8%)
Barbeque	190 (4.8%)
Hotel/Country Club	256 (4.7%)
Stand-alone Bakery/Coffee Shop	216 (3.9%)
Catering	208 (3.8%)
Gas Station Mart	130 (2.4%)
Italian (not pizzeria)	81 (1.5%)
Seafood	81 (1.5%)
Mediterranean/Greek	76 (1.4%)
Fine dining	65 (1.2%)
Breakfast	18 (0.3%)
All Other	263 (4.8%)

Notes: Cafeterias and diners were grouped together for the purpose of this study's analyses because in the South, diners are much like cafeterias in that foods are commonly served in a cafeteria-style manner. Also for the purposes of this study, grocery store kitchens (e.g., delis/bakeries) were grouped separately from stand-alone bakeries/coffee shops.

of restaurants, and as such, restaurant inspections are often the focus of food safety studies *(2, 7–10)*.

Researchers interested in food safety have examined the types of critical violations that are most common *(9)*, perceptions regarding which inspection items should have the greatest point values *(8)*, what effect various interventions (e.g., certified kitchen managers) have on inspection score, *(2, 7)*, and whether announcing inspections ahead of time has an impact on specific violations *(10)*. A study of restaurants in Oklahoma examined the type and frequency of critical violations in relation to restaurant characteristics, including the inspector's perceived level of risk (medium versus high) for each restaurant and whether establishments were local, part of regional chains, or part of national chains *(9)*. Findings indicated that regional-chain restaurants had more critical violations overall and more recurrent violations than did the other two types of restaurants. To our knowledge, no other restaurant characteristics have been examined in other studies.

The purpose of this study was to examine a wider range of restaurant characteristics, including the type of food setting and number of locations, in relation to the types of critical violations identified during restaurant inspections. This study used three consecutive years of inspection data collected on all food establishments in the largest county in Alabama. Having multiple years of data, we were also able to examine changes in violations over time and whether repeat inspections lessoned the likelihood of critical violations. Findings from this study will provide public health

TABLE 2. Frequency of critical violations among food establishments

Critical Item	Description	Average Across All 3 Years	2008 Violation Rate (N = 1,788)	2009 Violation Rate (N = 1,859)	2010 Violation Rate (N = 1,841)	*P*-value
#1	Assignment of person in charge; commissary used, personnel with infections restricted, excluded. No discharge from eyes, nose, mouth.	1.2%	1.6%	0.9%	1.0%	0.08
#2	Hands clean; properly washed. No bare hand contact; approved alternative. No eating drinking, tobacco use.	16.9%	19.6%	17.0%	14.3%	**<0.001**
#3	Demonstration of knowledge; approved course, other requirements met.	19.0%	16.2%	12.9%	27.8%	**<0.001**
#5	Safe source of food, not adulterated; shellstock tags; compliance with plan/ROP, other.	3.6%	3.9%	3.2%	3.6%	0.54
#6	Potentially hazardous food meets temperature requirements during receiving, cooking, hot holding, cooling. Pasteurized eggs used if required.	14.2%	16.6%	14.0%	12.1%	**0.001**
#7	Potentially hazardous food meets temperature requirements during cold holding. Time as a public health control. Consumer advisory used if required.	21.8%	18.6%	17.8%	29.0%	**<0.001**
#8	Food separated, protected from contamination. Tasting. Returned, reservice of food.	2.1%	2.6%	2.0%	1.6%	0.14
#15	Equipment; food contact surfaces (non-cooking) clean; sanitized. Sanitization temperature, concentration, time.	21.8%	22.6%	22.7%	20.2%	0.12
#16	Food contact service characteristics. Single service/use when required.	5.6%	4.4%	4.5%	7.9%	**<0.001**
#24	Water: source, quality, capacity. System: approved.	1.5%	1.8%	1.3%	1.3%	0.41
#25	Sewage, grease disposal: system approved; Flushed (mobile).	1.7%	2.3%	1.6%	1.2%	**0.05**
#26	Cross connection; back siphonage; backflow.	2.2%	2.6%	2.2%	1.8%	0.27
#27	Hand-washing facilities/toilets: number and location	1.6%	1.9%	1.5%	1.4%	0.37
#32	Food contamination from cleaning equipment prevented.	1.0%	1.2%	0.9%	0.9%	0.55
#33	Presence of insects, rodents, other pests; animals prohibited.	7.3%	7.9%	7.4%	6.5%	0.22
#40	Toxic or poisonous items (including smoking), medicine, first aid materials: stored, labeled, used.	15.3%	16.8%	14.2%	14.9%	**0.09**

Notes: ROP is reduced oxygen packaging. *P*-value indicates the significance of change over time.

decision-makers with insight that may guide future approaches to improve the safety of foods served in restaurants by developing strategies that allow officials to develop training programs that target specific types of restaurants.

MATERIALS AND METHODS

Study Population

This study examined restaurant inspection records for all restaurants located in Jefferson County, Alabama between 2008 and 2010. Jefferson County is home to approximately 665,000 individuals and, as the largest county in the State of Alabama, includes numerous cities and towns, including Birmingham.

TABLE 3. Factors associated with critical item performance (only significant odds ratios shown)

	Violation of critical item															
	#1	#2	#3	#5	#6	#7	#8	#15	#16	#24	#25	#26	#27	#32	#33	#40
Businesses owned:																
1								0.57***								2.21***
2-3								0.62**								1.93**
4-9				0.33**	0.70*			0.72*								1.87**
10 or more	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Year:																
2008	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
2009	0.52*	0.82*	0.78**		0.81*											
2010		0.68***	2.16***		0.7***	1.84***			1.9***		0.54*					
Avg. # of annual inspections		1.5***	1.37***	1.6***	1.4***	1.54***	1.4*	1.6***	1.5***		1.4*	1.5**	1.5**		1.6***	2.3***
Smoke-free Establishment			0.69**					0.76*							0.57**	0.68***
Food Service Setting																
∞ Quick Service (e.g., fast food)	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
∞ Casual Dining (e.g., bar & grill and family-style restaurant)			0.64***			1.71***			1.56**							2.61***
∞ Sandwiches (e.g., café/deli)			0.73*		1.4*	2.17***					0.31*	0.39*				
∞ Cafeteria/Diner		0.54**	0.5***		2.29***	1.76***										
∞ Asian/Indian			0.44***	4.8***		2.01***	3.6***		1.96**							
∞ Grocery Store Kitchen (e.g., deli/bakery)		0.44***	0.57**		3.14***											
∞ Pizzeria		0.52**			0.42**						0.11*				0.47*	
∞ Mexican/Latin			0.6**	2.3*	2.23***	1.67**										1.66*
∞ Barbeque			0.69*		2.36***	1.76**									2.44**	
∞ Hotel/Country Club		0.67*	0.23***													
∞ Stand-Alone Bakery/Coffee Shop		0.56*	0.49**		0.24**	0.53*		0.51**							0.31*	
∞ Catering		0.52**	0.27***					0.55*	0.2*						0.36*	
∞ Gas Station Mart					1.89*			1.67*								
∞ Italian (Not Pizza)								1.75*								
∞ Seafood												3.8**				
∞ Mediterranean/ Greek			0.33**		2.21*	2.67***										
∞ Fine dinning			0.14**													
∞ Breakfast																
∞ All other			0.53**													1.97**

Notes: Cafeterias and diners were grouped together for the purpose of this study's analyses because in the South, diners are much like cafeterias in that foods are commonly served in a cafeteria-style manner. Also for the purposes of this study, grocery store kitchens (e.g. delis/bakeries) were grouped separately from stand-alone bakeries/coffee shops. Ref refers to the reference category to which other categories were compared. *$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

Critical Item 1: Assignment of Person in Charge; Commissary used, Personnel with infections restricted, excluded. No discharge from eyes, nose, mouth.

Critical Item 2: Hands clean; properly washed. No bare hand contact; approved alternative. No eating, drinking, tobacco use.

Critical Item 3: Demonstration of knowledge; Approved course, other requirements met.

Critical Item 5: Safe source of food, not adulterated; Shellstock tags; Compliance with plan/ROP, other.

Critical Item 6: Potentially hazardous food meets temperature requirements during receiving, cooking, hot holding, cooling. Pasteurized eggs used if required.

Critical Item 7: Potentially hazardous food meets temperature requirements during cold holding. Time as a public health control. Consumer advisory used if required.

Critical Item 8: Food separated, protected from contamination. Tasting. Returned, reservice of food.

Critical Item 15: Equipment; food contact surfaces (non-cooking) clean; sanitized. Sanitization temperature, concentration, time.

Critical Item 16: Food contact service characteristics. Single service/use when required.

Critical Item 24: Water: source, quality, capacity. System: approved.

Critical Item 25: Sewage, grease disposal: system approved; Flushed (mobile).

Critical Item 26: Cross connection; back siphonage; backflow.

Critical Item 27: Hand-washing facilities/toilets: number and location.

Critical Item 32: Food contamination from cleaning equipment prevented.

Critical Item 33: Presence of insects, rodents, other pests, animals prohibited.

Critical Item 40: Toxic or poisonous items (including smoking), medicine, first aid materials: stored, labeled, used.

Variables

The Jefferson County Department of Health utilizes the standard Alabama Department of Public Health's Food Establishment/Retail Food Store Inspection Report form, which contains 42 inspection items. Sixteen of these items are considered "critical items" by the U.S. Food and Drug Administration *(13)*, requiring immediate action when an establishment is in violation. These sixteen critical items (to be described later) were considered in relation to restaurant characteristics, including the number of businesses registered to the same owner, the year of inspection, the average number of annual inspections, whether the establishment is smoke free, and the type of food establishment (e.g., quick service, casual dining, cafeteria, etc.).

Analysis

Descriptive statistical analyses were conducted to examine variable distributions. Chi Square tests were used to detect differences among the three years with respect to the sixteen critical items. Multivariable logistic regressions were fitted to examine the relationship between each individual critical violation and restaurant characteristics.

TABLE 4. Factors associated with an increasing number of violations

	Unstandardized Beta Coefficient (standard error)
Number of Businesses Owned:	0.03 (0.02)
Year:	
2008	Ref.
2009	-0.15 (0.06)**
2010	0.12 (0.06)*
Avg. # of Annual Inspections	0.45 (0.03)***
Smoke-free Establishment	-0.53 (0.08)***
Food Service Setting	
• Quick Service (e.g., fast food)	Ref.
• Casual Dining (e.g., bars & grills, family-style)	0.24 (0.09)**
• Sandwiches/Cafés/Delis	0.02 (0.10)
• Cafeteria/Diners	0.005 (0.11)
• Asian/Indian	0.35 (0.12)**
• Grocery Store Kitchen (Deli/Bakery)	-0.099 (0.12)
• Pizzeria	-0.022 (0.12)
• Mexican/Latin	0.13 (0.13)
• Barbeque	0.29 (0.14)*
• Hotel/Country Club	-0.20 (0.13)
• Stand Alone Bakery/Coffee Shop	-0.64 (0.13)***
• Catering	-0.63 (0.14)***
• Gas Station Mart	0.11 (0.17)
• Italian (not pizza)	-0.02 (0.21)
• Seafood	0.37 (0.21)
• Mediterranean/Greek	0.07 (0.21)
• Fine dinning	-0.64 (0.23)**
• Breakfast	0.55 (0.43)
• All other	0.05 (0.13)

Notes: Cafeterias and diners were grouped together for the purpose of this study's analyses because in the South, diners are much like cafeterias, in that foods are commonly served in a cafeteria-style manner. Also for the purposes of this study, grocery store kitchens (e.g., delis/bakeries) were grouped separately from stand-alone bakeries/coffee shops. Beta coefficients are regression coefficients that measure the standard deviation change in the dependent variable given one standard deviation increase in an independent variable. *$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

In addition, we were interested in the restaurant characteristics associated with an increased number of overall violations. To model this, we utilized linear regression analysis, in which the dependent variable was the total number of critical violations in any given year. All analyses were performed in SPSS version 16 and statistical significance was considered to be present at the $P < 0.05$ level.

RESULTS

A total of 5,488 inspections of food establishments (including initial and follow-up inspections) were conducted on an average of 1,829 food establishments in operation per year during the years 2008–2010 in Jefferson County, Alabama. Table 1 presents characteristics of food establishments in the sample. The average number of inspections per restaurant was 2.51 in 2008, 2.71 in 2009, and 2.62 in 2010. The majority of restaurants (n = 3,380, 61.6%) were owned by entities that owned no other restaurant in the county. Fifteen percent (n = 831) of inspections were conducted in food establishments registered to owners that have 2–3 establishments, and almost 10% of all inspections took place in establishments registered to an owner with more than 10 food establishments. The three most common types of food establishments inspected were "quick service" restaurants (e.g., fast food; n = 931, 17.0%); "casual dining" (n = 779, 14.2%), which included steakhouses, bars and grills, and family-style restaurants; and "sandwiches (e.g. café/deli)" (n = 643, 11.7%).

Table 2 presents the frequency of critical violations among all food establishments for 2008–2010.The most common critical violations (average across all years) were items #7 (cold holding temperature, 21.8%), #15 (sanitization of equipment, 21.8%), #3 (personnel training/ certification, 19.0%), #2 (hygienic practices/ handwaing, 17.0%), and #40 (storage/ label of toxic/ poisonous items — including smoking, 15.3%). Seven out of 16 critical violations changed significantly over time. The frequency of three critical violations increased significantly over time (critical items #3, #7, and #16). Violations of critical item #3 (personnel training/ certification) rose from 12.9% in 2009 to 27.8% in 2010 ($P < 0.001$). Additionally, the number of violations of critical item #7 (cold holding temperatures) increased from 17.8% to 29.0% between 2009 and 2010 ($P < 0.001$). Four of the critical violations decreased over time, including items #2 (hygienic practices/ handwashing), #6 (hot holding temperatures), #25 (sewage/grease disposal), and #40 (storage/label of toxic/poisonous items — including smoking).

Results from logistic regression analyses indicated that with a couple of exceptions, the number of businesses owned by the same entity was unrelated to any individual violations (see Table 3). Results also indicate that in four instances smoke-free establishments were associated with lower odds of a critical violation. Moreover, all restaurants that differed significantly from quick service restaurants on critical items #2 (hygienic practices/handwashing) and #3 (personnel training/certification) were less likely to have these violations. Excluding these two particular critical items (#2 and #3), eight types of food establishments, Casual Dining, Cafeterias/Diners, Asian/ Indian, Mexican/Latin, Barbeque, Gas Station Marts, and Mediterranean/Greek restaurants) were more likely to have critical violations than quick service restaurants anytime a significant difference existed. Specifically, Asian/Indian restaurants were more likely to have a violation on items #5 (approved food sources, OR = 4.82, $P < 0.001$), #7 (cold holding temperatures, OR = 2.01, $P < 0.001$), #8 (food protected from contamination, OR = 3.59, $P < 0.001$), and #16 (single service use when required, OR = 1.96, $P < 0.01$). Mexican/Latin restaurants were more likely to have violations on #5 (approved food sources, OR = 2.3, $P < 0.05$), #6 (hot holding temperatures, OR = 2.23, $P < 0.001$), #7 (cold holding temperatures, OR = 1.67, $P < 0.01$), and #40 (storage/label of toxic/poisonous items — including smoking, OR = 1.66, $P < 0.05$). Compared with quick serve restaurants, Asian/Indian and Mexican/ Latin restaurants had more items for which they were more likely to have violations than any other restaurants.

Cafeteria/diners were significantly more likely than other establishments to have violations for items #6 (hot holding temperatures, OR = 2.29, $P < 0.001$) and #7 (cold holding temperatures, OR = 1.76, $P < 0.001$). Gas station marts and Italian restaurants (not including pizzerias) were more likely to have violations for item #15 (sanitization of equipment) than quick service restaurants (OR = 1.66, $P = 0.02$ and OR = 1.75, $P = 0.035$). Casual dining and Asian/ Indian restaurants were more likely to have violations for item #16 (single service use hygienic practices) than quick service restaurants (OR = 1.56, $P = 0.04$ and OR = 1.96, $P = 0.008$). Casual dining and Mexican/Latin restaurants were more likely to have violations for item #40 (storage/label of toxic/poisonous items — including smoking) than quick service restaurants (OR = 2.61, $P < 0.001$ and OR = 1.66, $P = 0.019$), respectively. Lastly, general time trends were similar to the findings presented in univariate analysis.

Results from the linear regression analysis that examined restaurant characteristics associated with an increased number of violations indicated that various restaurant types differed from quick service (see Table 4). Some food establishments were less likely than quick service, to have a higher number of critical violations in any given year; these were stand-alone bakery/coffee shops (ß = -0.64, $P < 0.001$), catering (ß = -0.63, $P < 0.001$), and fine dining (ß = -0.66, $P = 0.003$). Moreover, two food establishments were more likely than quick service to have a higher number of critical violations: barbeque (ß = 0.0.29, $P = 0.046$) and Asian/Indian (ß = 0.35, $P = 0.07$) food establishments.

DISCUSSION

Foodborne illness continues to affect millions of Americans each year, despite numerous prevention efforts. Studies that offer insight into ways to further reduce the incidence of foodborne illness are needed. Findings from this study provide empirical evidence regarding the types of violations occurring in restaurants over time and their relationships to restaurant characteristics.

Our main findings suggest that certain restaurant characteristics are statistically related to certain critical violations. For example, entities that owned 10 or more restaurants in the county were more likely to have inspection violations

on item #15 (sanitization of equipment) and less likely to have violations on item #40 (no toxic substances/smoking). A previous study of restaurant inspection scores found that the number of critical violations varied as a function of the number of outlets of the particular restaurant or chain; having many outlets was associated with fewer critical violations *(7)*. Although findings from the current study neither support nor negate these previous findings, the current study was unable to determine if food establishments were chains, indicating only whether a particular establishment was owned by an entity that owned other establishments in the county.

Food establishment setting was also associated with certain critical violations. For example, compared with quick service restaurants, six food service settings were significantly less likely to have a critical violation for item #2, violations commonly related to not using proper handwashing procedures or using bare hands to work directly with foods being served. Additionally, twelve different food service settings were less likely than quick service restaurants to have a violation for item #3. Item #3 violations are commonly due to workers not having completed the required food safety courses, and such failure to complete training may be related to the high turnover rates in the quick service industry. Asian/Indian restaurants and Mexican/Latin restaurants were more likely than quick service establishments to have violations for item #5, which is often related to being able to show that foods used come from safe/approved sources. Additionally, Asian/Indian restaurants were the only establishments in which there was a difference (i.e., greater likelihood than for quick service restaurants) of a critical violation on item #8, which is related to the separation and protection of food from contaminated sources. Research has found that food safety infosheets may decrease instances of cross-contamination and increase more hygienic practices, which may be beneficial as a targeted public health initiative for this setting *(4)*.

Although the current study found cafeteria/diners to be more likely than quick service establishments to have violations related to hot and cold holding temperatures, this finding is inconsistent with results of a study by Kassa and colleagues that examined differences between restaurants and institutional food establishments (cafeterias in hospitals, nursing homes, schools, daycares, etc.) *(7)*. Kassa et al. reported that institutional food establishments had significantly fewer critical violations than restaurants, although they grouped food establishments differently from the grouping used in the current study, which may account for the conflicting findings.

Overall, we found that compared with quick service establishments, fine dining food establishments, stand-alone bakery/coffee shops, and catering establishments were consistently less likely to have many specific critical violations and less likely to have an overall number of violations. Such findings suggest that these food settings may need less attention from a public health training standpoint than other food settings, with their higher rates of critical items and overall number of violations.

The five most common critical violations identified in this study were cold holding temperatures (item #7), the sanitization of equipment (item #15), personnel training/certification (item #3), hygienic practices/handwashing (item #2), and storage/label of toxic/poisonous items — including smoking (item #40). Comparisons, with some caveats, can be made to critical violation prevalence rates available in three previously published studies *(1, 9, 10)*. Although differences in county inspection practices make it difficult to make direct comparisons, these studies reported similar findings, with the most common critical violations consisting of those related to protection from contamination, *(1, 10)* food temperatures, *(1)* hand hygiene *(1, 6)*, storage of toxic/poisonous items, *(1, 6)* and persons in charge with appropriate food safety knowledge *(10)*. As a public health initiative, Jefferson County Department of Health required food establishments to limit smoking in their establishments by adding smoking as a toxic item to critical item #40 (storage/label of toxic/poisonous items). As a result, the frequency of this particular critical violation may be higher than in other locations.

Findings also show that the frequencies of critical violations have changed over time; some have increased (or worsened) and some have decreased (or improved). Two of the three critical items (#3-personnel training/certification, #7 — cold holding temperatures, and #16 — single service use hygienic practices) that have worsened may be explained by changes in restaurant inspection policies. For example, although certified kitchen managers have been required for all food establishments in Jefferson County since 2005, it was not until 2010 that noncompliant food establishments received critical violations (item #3), which would account for to the large increase in 2010. Similarly, although the Food and Drug Administration lowered the cold holding safe temperature limit from 45 to 41 degrees Fahrenheit in 2005, this requirement was not enforceable until 2010, at which point food establishments began to receive critical violations for item #7, again possibly factoring into the notable increase in 2010 (inspection forms reflected both of these changes as of 2010). Despite the fact that these changes were phased in over multiple years, significantly more food establishments were not in compliance as of the first year of enforcement. Although no policy changes were related to the 2010 increase in violations of critical item #16, one possible explanation is provided by considering 'availability bias' or giving more consideration to the possibility that public health inspectors may be more likely to identify certain critical violations following training or reminders about specific items. This in turn may impact the frequency of such violations during a specific period of time.

In conclusion, knowing that certain food services establishments are prone to specific critical violations is an important contribution of this study. This information should be considered in the development of targeted educational programs and interventions for food service settings. Future research should examine the effect of such targeted programs in relation to changes in critical violations.

Strengths and limitations

An important strength of this study is that it offers new insight into changes in critical violations during food establishment inspections over time. Although this is the most recent study of this kind, findings are representative of one county

in Alabama and therefore may not be generalizable to other locations. Additionally, data collected routinely by the Jefferson County Health Department does not include information on whether food establishments were locally owned or are part of regional/national chains. This information would be useful in comparing findings to those of similar studies that examined the relationships between ownership type and critical violations.

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