



Food Safety Training Needs Assessment for Independent Ethnic Restaurants: Review of Health Inspection Data in Kansas

JUNEHEE KWON,^{1*} KEVIN R. ROBERTS,¹ CAROL W. SHANKLIN,² PEI LIU¹ and WEN S. F. YEN¹

¹Dept. of Hospitality Management and Dietetics, ² Graduate School, Kansas State University, Manhattan, KS 66506-1404, USA

ABSTRACT

Each year, commercial foodservice operations in the United States serve over 70 billion meals/snacks. The majority of foodborne disease outbreaks have been attributed to commercial foodservice establishments, and independent ethnic restaurants received poorer inspection scores than the non-ethnic or chain restaurants. These findings imply additional need for food safety training for ethnic restaurant employees. To identify specific food safety training needs, online health inspection reports of 500 randomly-selected independent restaurants in 14 Kansas counties were reviewed. Food code violations were recorded and categorized for further analysis. Numbers of critical and non-critical violations, inspections within 12 months, and violations within each category for ethnic and non-ethnic restaurants were compared, using independent t-tests. Ethnic restaurants had more critical (4.52 ± 2.97) and non-critical violations (2.84 ± 2.85) and more frequent inspections (2.29 ± 1.63) than non-ethnic restaurants (2.90 ± 2.83 , 1.71 ± 1.94 , and 1.76 ± 1.11 , respectively, $P < 0.001$). Significantly more ($P < 0.05$) violations were reported in ethnic restaurants for several categories: time and temperature control of PHFs, physical facility maintenance, protection from contamination, hand hygiene, proper use of utensils, demonstrated knowledge, and food temperature control for non-PHF. The data suggested that ethnic restaurant personnel need increased food safety training, especially for critical behaviors such as time and temperature control and hand washing.

A peer-reviewed article

*Author for correspondence: 785.532.5369; Fax: 785.532.5522
E-mail: jkwon@ksu.edu

INTRODUCTION

Dining in restaurants is an important part of the American lifestyle, as evidenced by the more than 70 billion meals or snacks served by restaurants annually, generating \$566 billion in sales (20). A major trend in the restaurant industry is the growing number of ethnic restaurants. This growth is a result of changing demographics and increased interest in ethnic cuisine. According to the U.S. Census Bureau, 34.4% of the U.S. population in 2008 was expected to be in a racial/ethnic minority group (32). As the minority population increases, so does demand for ethnic foods.

Of the racial/ethnic minorities in the U.S., the Hispanic and Asian populations are the two largest groups likely to be involved in the restaurant business. Economic census data of 2002 show that minority-owned businesses account for 10.2% of accommodation and foodservice businesses, representing 11.0% of total sales in this sector (29). Specifically, Asian and Hispanic business owners, the two largest minority ethnic groups, comprise 85.3% of total minority business owners and create 88.0% of total sales generated by minority businesses in this sector (30, 31).

The Centers for Disease Control and Prevention (CDC) estimated that foodborne illnesses cause approximately 76 million illnesses, 325,000 hospitalizations, and approximately 5,000 deaths each year in the U.S. (19). The actual number of foodborne illnesses may be even higher, as many foodborne illnesses are not reported. Food safety in restaurants is especially important because the results of poor food handling behaviors can affect more than one individual.

Of the reported cases of foodborne outbreaks, 60% were traced to a restaurant (10). By definition, foodborne outbreaks affect two or more people, but when outbreaks are linked to restaurants, many more people may be affected. For example, the Jack in the Box *E. coli* outbreak in 1993 resulted in approximately 700 illnesses and four deaths from a single cause — infected meat (9). Over 600 people were infected with Hepatitis A in one restaurant in 2003 after eating mild salsa that contained contaminated green onions grown in Mexico (35). In addition to these examples, restaurants

were responsible for numerous cases of outbreaks in the U.S. (10, 22).

Ethnic restaurants are not exempt from foodborne illness cases associated with operations. Consumers are often aware of poor food handling techniques and environmental cleanliness at ethnic restaurants and rate ethnic restaurants lower on these attributes than on other attributes (14). In addition, researchers have found increased concerns about food handling at ethnic restaurants (1, 2, 17, 26, 27). Foodborne illness data from CDC showed that total outbreaks associated with ethnic foods rose from 3% to 11% of total cases between 1990 to 2000 (26). *Bacillus cereus* outbreaks were frequently associated with unsafe cooling practices for fried rice (4, 18), which is commonly served in ethnic restaurants. According to the CDC database, 1,662 individuals were affected by *Bacillus cereus* in 73 outbreaks in the U.S. from 1990 to 2006. Of those, 25 outbreaks were traced back to the restaurant setting, with rice or fried rice dishes being the most common source (13 of 25 restaurant outbreaks and 31 of 73 total outbreaks) (4). A review of 29.5 million laboratory-diagnosed foodborne illnesses confirmed unique associations between frequency of certain foodborne illnesses and racial/ethnic groups (13). Researchers speculated that there might be different high-risk consumption behaviors for different racial/ethnic groups and recommended targeting different groups with pertinent food safety education information (13). These racially/ethnically specific high-risk consumption behaviors may be because the family is a major source of information on how to handle food (12).

The restaurant industry, especially the ethnic restaurant segment, provides a familiar working environment for many first-generation immigrants who may have language barriers (15, 34). The associations between racial/ethnic groups, common foodborne illnesses (13), and certain food handling behaviors (12) indicate a necessity for additional food safety training for members of ethnic minority populations, who typically own and operate ethnic restaurants.

The most recent (2008) data published by the CDC indicated that foodborne illness incidences have not changed

from the 2005–2007 data (5). The CDC recommends continued education of restaurant employees and consumers about foodborne illness risks and prevention measures (5). Along with this recommendation, the associations among racial/ethnic groups, undesirable food handling practices (12, 13), and the increased prevalence of outbreaks in ethnic restaurants (26) may justify emphasis in food safety training for personnel working in ethnic restaurants. Furthermore, Simonne et al. contended that current general food safety training may not be adequate to reduce the number of foodborne outbreaks associated with ethnic foods because of the lack of specificity of this training to ethnic food handling practices (26).

Researchers have demonstrated that food safety training improves food handling practices in restaurants. The inspection scores of pre- and post-sanitation class interventions were significantly different, showing that improvement had occurred following the food sanitation classes (6). Managers who were mandated to take the class because of either a documented foodborne illness from their operation or a serious sanitation breach on their most recent inspection improved their facility's inspection score by an average of 14.7 points. Even those who voluntarily attended the class without problematic inspection scores improved by an average of 7.5 points, compared to no improvement for control group participants (6).

Despite consumer perceptions about food safety in ethnic restaurants (14) and reports by food safety researchers of increased needs for food safety training for ethnic restaurants (1–3, 6, 17, 26, 27), little research has been conducted to describe and analyze food handling behaviors in independent ethnic restaurants. One of the barriers to identifying food handling practices in ethnic restaurants is the unwillingness of ethnic restaurant personnel to participate in research (24, 25). Nonetheless, research and extension activities specifically targeting food handling behaviors at these restaurants may be needed to ensure food safety.

In Kansas, there are 4,671 licensed eating-and-drinking places, employing nearly 130,000 workers and generating over \$3 billion in sales (21). At the time

of this study, health inspection reports from the Kansas Department of Health and Environment (KDHE) were posted on the Internet in the public domain for anyone to review. KDHE reports include detailed information on violations of Kansas food codes, which help researchers identify and target food code violations. The Web site provides information about the different types of health inspections conducted for a one-year period. The types include routine, licensure, customer complaint-driven, and follow-up re-inspection completed after the restaurant has received poor performance ratings on a routine or complaint inspection. The KDHE is mandated to inspect all establishments once annually, but more inspections are required to ensure that an establishment has become compliant with the food code. In September 2008, the Kansas Department of Agriculture assumed the role of restaurant inspectors in the state, and they too make inspection results available on the Internet. As a proxy measure for food handling behaviors in independent ethnic restaurants, restaurant inspection reports were analyzed from a readily available, government internet site.

The purpose of this research project was to identify the food safety training needs of independent ethnic restaurants. Specific objectives were to identify the frequencies and types of food code violations and to compare and contrast food safety inspection reports of ethnic and non-ethnic independent restaurants.

MATERIALS AND METHODS

Study sample

Five hundred randomly selected independent restaurant inspection reports (for 250 ethnic and 250 non-ethnic restaurants) in 14 Kansas counties with the highest numbers of Hispanic and Asian populations were selected as the study sample. The sample was drawn from the list of foodservice establishments, including both commercial and non-commercial establishments, that were subject to KDHE health inspections.

From the list of foodservice establishments in the 14 counties, all chain restaurants, non-commercial foodservices (i.e., schools, churches, and community centers), and convenience stores

were eliminated. Of the 2,097 remaining, 541 were identified as ethnic and 1,556 as non-ethnic restaurants. Although there were about three times as many non-ethnic restaurants as ethnic restaurants, equal numbers as restaurants (250 ethnic and 250 non-ethnic) were randomly selected as the study sample to assure a balanced sample for statistical analysis. Because publicly available data were used without contacting human subjects, no approval from the institutional review board was necessary.

Variables and data collection

For the 500 restaurants selected, health inspection results were reviewed online (<http://kansas.kdhe.state.ks.us/pls/certop/fssearch>). Using the KDHE inspection guide, a data collection form was created so that research assistants could easily record necessary information from the online report. Code numbers of 275 Kansas food codes were listed on the data collection form so that the number of violations of each code could be entered. Spaces were provided for recording the numbers of critical and non-critical violations, the date of the health inspection with the greatest number of critical violations between September 1, 2007 and August 31, 2008, the total number of inspections during the 12-month period, and the inspection type (e.g., routine inspection, complaint-driven inspection, re-inspection after poor performance on previous inspections, etc.). For each randomly-selected facility, the one inspection report that indicated the most violations was selected from the multiple inspection reports during the specified period. This decision was made because reviewing the most recent inspection may result in selecting re-inspection reports, which are usually better than the preceding report. During October and November 2008, two research assistants reviewed the KDHE Web site and completed the data collection form. After the data had been recorded, the information was cross-checked by a different research assistant to ensure accuracy of data entry. Data were then entered into a Microsoft Access database, cross-checked to verify correct data entry, and converted to SPSS Version 15.0 for statistical analyses (28).

Statistical analyses

Descriptive statistics, consisting of frequencies, cross-tabulations, means,

and standard deviations of continuous variables (i.e., number of violations and inspections), were calculated. Pearson χ^2 analyses were conducted to evaluate differences between numbers of independent ethnic and non-ethnic restaurant establishments where individual food code violations were cited. Independent sample t-tests were conducted to compare differences in mean numbers of critical, non-critical, and within-category violations.

Individual food codes were grouped based on KDHE categories. KDHE categories were further combined to reduce the number of variables. For example, KDHE had separate categories for toilet facilities, hot and cold water availability, sewage and waste water disposal, and garbage and refuse disposal. Because these were all related to maintenance of physical facilities, we created the category "*Physical Facility Maintenance*" by combining them. The number of violations within each category was calculated using the "compute" function of SPSS for further analyses. Independent t-tests and ANOVA with Scheffé's post hoc analyses were conducted to evaluate differences in number of violations in different categories between ethnic and non-ethnic independent restaurants and among different categories of ethnic restaurants. Statistical significance was established at $P < 0.05$.

RESULTS

Of all inspection reports included ($n = 500$), 360 (72.0%) were reports of routine inspections, and 79 (15.8%) were triggered by customer complaints. There was no statistical difference in types of inspections between ethnic and non-ethnic independent restaurants.

Numbers of critical and non-critical violations and inspections

Independent restaurants were cited for an average of 3.71 ± 2.90 critical and 2.28 ± 2.40 non-critical food code violations on average per inspection. Independent t-tests revealed significant differences in the number of critical and non-critical inspections between ethnic and non-ethnic restaurants. Ethnic restaurants had more critical (4.52 ± 2.97) and non-critical violations (2.84

TABLE 1. Mean number of critical and non-critical violations and inspections by types of ethnic restaurants

Dependent Variable	Asian (n = 123)	Mexican or Latin American (n = 106)	Italian & Other (n = 21)	Non-Ethnic Other (n = 250)	F	P ^a
	Mean Number ^b ± SD					
Critical Violations ^b	4.73 ± 2.93 ^x	4.29 ± 3.06 ^x	4.38 ± 2.78 ^{zy}	2.90 ± 2.83 ^y	13.38	< 0.001
Non-critical Violations ^b	3.26 ± 3.06 ^x	2.32 ± 2.42 ^{yz}	2.95 ± 3.28 ^{xyz}	1.71 ± 1.94 ^z	11.83	< 0.001
Inspections ^c	2.43 ± 1.68 ^x	2.22 ± 1.59 ^{xy}	1.86 ± 1.46 ^{xyz}	1.76 ± 1.11 ^z	7.21	< 0.001

Note: Means with different superscripts (x, y, z series) differed significantly by Scheffe's post hoc test, $P < 0.05$

^aResults from Analysis of Variance (ANOVA)

^bNumber of violations found in one health inspection report with the most violations between September 1, 2007 and August 31, 2008

^cFrequencies of health inspection visits between September 1, 2007 and August 31, 2008

± 2.85) than non-ethnic restaurants (2.90 ± 2.83, 1.71 ± 1.94, respectively, $P < 0.001$). The average number of inspections during the 12-month study period for the entire sample was 2.03 ± 1.37, with ethnic restaurants inspected more frequently (2.29 ± 1.63) than non-ethnic restaurants (1.76 ± 1.11, $P < 0.001$).

When the number of critical and non-critical violations and the number of inspections were further compared among different types of ethnic restaurants, by use of ANOVA with Scheffe's post hoc analyses, significant ($P < 0.001$) differences were found. As shown in Table 1, non-ethnic restaurants had significantly fewer critical violations and inspections than Asian and Mexican or Latin American ethnic restaurants. In addition, Asian ethnic restaurants had the greatest number of non-critical violations, compared Mexican or Latin American ethnic restaurants and non-ethnic restaurants.

Prevalence of individual food code violations

Regardless of the type of ethnic restaurant, the food code category with the greatest number of violations was

“Time and Temperature Control of Potentially Hazardous Foods (PHF, also known as TCS [time/temperature control for safety] foods).” Of the individual codes in this category, 39.2% (n = 196) of the establishments in the sample violated the code stating that *PHF must be maintained at appropriate temperature of 5°C or less*. Other food codes such as *Equipment and utensils must be clean to sight and touch* (n = 144, 28.8%), *Employees wash hands at appropriate times* (n = 113, 22.6%), *Food should be clearly marked to indicate the date food should be consumed by, sold, or discarded* (n = 94, 18.8%), and *Person in charge is able to demonstrate knowledge of foodborne disease prevention and application of HACCP* (n = 88, 17.6%) were also violated in many independent restaurants. All of these food codes are considered critical food safety requirements.

Table 2 shows all individual food codes violated by 10% or more of establishments. Food code violations that differed significantly in number between ethnic and non-ethnic independent restaurants are indicated. When prevalence of violations were compared by use of Pearson χ^2 analyses, significant differences between ethnic and non-ethnic independent restaurants were found in 21 individual food codes. Except for the one

food code related to discarding food based on time and temperature control or time as the only control measure, all 20 of the other food codes were violated more often by ethnic restaurants than by non-ethnic restaurants. According to the Kansas food code (11), the majority (25 of 33) of the food codes listed in Table 2 are considered critical food safety requirements.

Number of food code violations per category

The number of food code violations per category was computed by taking all violations within each category and computing an average across the entire sample. As illustrated in Table 3, the mean number of violations within each code ranged from 0.01 to 0.99. The five most prevalent violation categories regardless of restaurant type, were *“Time and Temperature Control of PHF”* (0.99 ± 0.98), *“Physical Facility Maintenance”* (0.83 ± 1.11), *“Protection from Contamination”* (0.78 ± 0.95), *“Control of Hands as a Vehicle of Contamination”* (0.73 ± 1.09), and *“Food & Non-food Contact Surface Maintenance and Ware Washing Facilities”* (0.60 ± 0.96).

TABLE 2. Number of independent ethnic and non-ethnic restaurants where selected individual food code violations were reported^a

Food Code Violation Categories <i>Individual Food Code Descriptions (Critical or Non-Critical)</i>	Ethnic Restaurants (n = 250)	Non-Ethnic Restaurants (n = 250)	χ^2	P^b
	No. of Establishments (%)			
<i>Time and Temperature Control of Potentially Hazardous Food</i>				
§ Potentially hazardous foods must be maintained at appropriate temperature of 5°C or less	111 (44.4)	85 (34.0)	11.16	0.004
§ Food should be clearly marked to indicate the date food should be consumed by, sold, or discarded	55 (22.0)	39 (15.6)	4.90	NS
§ Cooked foods need to be cooled from 57°C to 21°C within 2 hours. Within a total of 6 hours from 57°C to 5°C	32 (12.8)	14 (5.6)	8.14	0.017
§ Ready-to-eat or PHF must be discarded based on time and temperature control or after a maximum of 4 hours if time is the only control; written procedures about removing food from service must be established and maintained	13 (5.2)	34 (13.6)	12.50	0.002
<i>Physical Facility Maintenance (e.g., hot & cold water availability, toilet, sewage & waste water, garbage & refuse disposal)</i>				
§ Physical facilities maintained in good repair & cleaned as often as necessary to keep them clean	51 (20.4)	22 (8.8)	15.11	0.001
§ Water reservoir of fogging devices maintained & cleaned Plumbing system maintained in good repair	45 (18.0)	15 (6.0)	17.05	< 0.001
§ Water capacity & pressure adequate to meet facility demands	8 (3.2)	0 (0.0)	8.13	0.004
Designated dressing rooms/lockers used by employees	5 (2.0)	0 (0.0)	5.05	0.025
<i>Protection from Contamination</i>				
§ Equipment and utensils must be clean to sight and touch	77 (30.8)	67 (26.8)	0.98	NS
§ Separation of food items to prevent cross-contamination	55 (22.0)	26 (10.4)	14.62	0.001
§ Chemical sanitizers used in sanitizing must meet criteria in accordance with manufacturer's label use instructions	27 (10.8)	22 (8.8)	0.57	NS
<i>Food & Non-Food Contact Surface Maintenance & Ware Washing Facilities</i>				
Ware washing equipment maintained free of encrusted grease/soil deposits	41 (16.4)	25 (10.0)	4.47	0.035
Nonfood-contact surfaces cleaned at frequency to prevent buildup of residue	41 (16.4)	16 (6.4)	12.38	< 0.001
§ Utensils/food-contact surfaces made of safe, durable, smooth materials	41 (16.4)	5 (2.0)	31.03	< 0.001
§ Contact surfaces and equipment must be sanitized before use and after cleaning	38 (15.2)	17 (6.8)	9.01	0.003
Thermometer for testing sanitizing water temperature &/or test kit for measuring sanitizer concentration provided	37 (14.8)	28 (11.2)	1.43	NS
<i>Control of Hands as a Vehicle of Contamination</i>				
§ Employees wash hands at appropriate times	65 (26.0)	48 (19.2)	3.42	NS
§ Preventing contamination from hands, including minimizing bare hand contact with ready-to-eat food	39 (15.6)	19 (7.6)	9.64	0.008
§ Appropriate hand drying provisions available	32 (12.8)	28 (11.2)	0.30	NS
§ Employees use the correct hand washing procedure	23 (9.2)	1 (0.4)	21.18	< 0.001

TABLE 2. Number of independent ethnic and non-ethnic restaurants where selected individual food code violations were reported^a (continued)

Food Code Violation Categories Individual Food Code Descriptions (Critical or Non-Critical)	Ethnic	Non-Ethnic	χ^2	P^b
	Restaurants (n = 250)	Restaurants (n = 250)		
	No. of Establishments (%)			
<i>Contamination Prevention through Pest Control, Storage, and Personal Cleanliness</i>				
§ Eating, drinking, and using tobacco only happens in designated areas	46 (18.4)	26 (10.4)	6.49	0.011
§ Effective pest control measures in place; dead or trapped pest removed from traps at adequate frequency	32 (12.8)	27 (10.8)	2.75	NS
§ Openings to outside protected against entry of pest; Protective barriers provided for exterior walls/roofs	29 (11.6)	18 (7.2)	3.44	NS
Food stored 6" off the floor in clean, dry location & not stored in prohibited areas	26 (10.4)	9 (3.6)	9.75	0.008
§ Stored frozen foods shall be maintained frozen. Cooling shall be accomplished in accordance with the time and temperature criteria	20 (8.0)	8 (3.2)	5.45	0.020
<i>Safe Cooling, Thawing, Hot Holding Methods & Working Thermometer</i>				
§ Thawing hazardous foods can be done under refrigeration, submerged under running water, or as part of a cooking process	34 (13.6)	8 (3.2)	17.57	< 0.001
§ Cooling and heating foods and holding cold and hot foods, shall be sufficient in number and capacity to provide food temperature requirements	33 (13.2)	22 (8.8)	2.47	NS
§ Cooked foods need to be cooled from 57°C to 21°C within 2 hours. Within a total of 6 hours from 57°C to 5°C	32 (12.8)	14 (5.6)	8.14	0.017
<i>Chemical Handling</i>				
§ Working containers containing toxic or poisonous chemicals clearly labeled with the common name	40 (16.0)	28 (11.2)	2.45	NS
§ Poisonous or toxic materials shall be stored so they cannot contaminate food, equipment, utensils, linens, and single service and single-use articles	27 (10.8)	21 (8.4)	0.83	NS
<i>Proper Utensil Use & Storage</i>				
In-use utensils properly stored between uses	48 (19.2)	24 (9.6)	9.35	0.002
<i>Approved Sources</i>				
§ Food shall be safe, unadulterated, and honestly presented	46 (18.4)	33 (13.2)	2.54	NS
<i>Demonstration of Knowledge</i>				
§ Person in charge is able to demonstrate knowledge of foodborne disease prevention and application of HACCP	63 (25.2%)	25 (10.0%)	19.91	< 0.001

HACCP: Hazard Analysis Critical Control Point

NS: No statistical significance

§ This symbol at the beginning of each food code indicates it is a critical violation

^aOnly statistically significant results ($P < 0.05$) based on Pearson χ^2 analyses and Food Codes violated by > 10% of establishments are reported

^bResults from Pearson χ^2 analyses

TABLE 3. Mean number of violations in selected food code categories observed in ethnic and non-ethnic independent restaurants

Food Code Violation Categories	No. Codes ^a (max)	Ethnic Restaurants (n = 250)		Non-Ethnic Restaurants (n = 250)	
		Mean ± SD ^b	T	P ^c	
Time and Temperature Control of Potentially Hazardous Food	7	1.12 ± 0.96	0.85 ± 0.98	3.09	0.002
Physical Facility Maintenance (e.g., hot & cold water availability, toilet, sewage & waste water, garbage & refuse disposal)	78	1.04 ± 1.22	0.63 ± 0.95	4.20	< 0.001
Protection from Contamination	14	0.93 ± 1.01	0.64 ± 0.86	3.42	0.001
Control of Hands as a Vehicle of Contamination	14	0.91 ± 1.16	0.55 ± 0.98	3.76	< 0.001
Food & Non-Food Contact Surface Maintenance & Ware Washing Facilities	48	0.80 ± 1.09	0.40 ± 0.77	4.70	< 0.001
Contamination Prevention through Pest Control, Storage, & Personal Cleanliness	23	0.56 ± 0.93	0.36 ± 0.68	2.82	0.005
Safe Cooling, Thawing, Hot Holding Methods & Working Thermometer	7	0.43 ± 0.64	0.21 ± 0.48	4.32	< 0.001
Chemical Handling	21	0.44 ± 0.62	0.32 ± 0.60	2.13	0.033
Proper Utensil Use & Storage	13	0.33 ± 0.55	0.21 ± 0.48	2.59	0.010
Approved Sources	18	0.29 ± 0.51	0.20 ± 0.44	2.17	0.030
Demonstration of Knowledge	3	0.26 ± 0.46	0.10 ± 0.30	4.62	< 0.001
Good Hygienic Practices	3	0.18 ± 0.39	0.10 ± 0.31	2.56	0.011
Food Labeling	6	0.02 ± 0.14	0.00 ± 0.00	2.25	0.025
Conformance with Approved Practices	4	0.02 ± 0.13	0.02 ± 0.15	0.00	NS
Employee Health	5	0.02 ± 0.13	0.00 ± 0.06	1.35	NS

SD: standard deviation

NS: No statistical significance

^aNumber of Food Codes within each category

^bNumber of violations found in one health inspection report with the most violations between September 1, 2007 and August 31, 2008

^cResults from independent sample t-tests

When the mean numbers of food code violations within individual categories were compared, results were significantly different between ethnic and non-ethnic independent restaurants in most categories. A greater number of food code violations were reported for ethnic restaurants in most of the categories (Table 3).

When mean scores were further analyzed among the different types of ethnic restaurants, by use of ANOVA and Scheffe's post hoc analyses, significant differences were found in the mean number of food code violations within

each category (See Table 4). In most cases, however, these differences were found between Asian and non-ethnic restaurants. Violations in Italian and other restaurants were not significantly different from those in non-ethnic, Asian, and Mexican or Latin American restaurants. Asian and Mexican or Latin American restaurants had more food code violations in the "Safe Cooling, Thawing, Hot Holding Methods and Working Thermometer" category ($P < 0.01$), and Mexican or Latin American restaurants had food code violations than non-ethnic restaurants in the "Demonstration of Knowledge" category ($P < 0.01$).

DISCUSSION

Results from this study, which utilized publicly-available health inspection reports to identify specific food safety training needs associated with independent ethnic restaurants, provide evidence of the need for food safety training in independent restaurants and more specifically in independent ethnic restaurants.

Our results show that ethnic restaurants had a greater frequency of health inspections than non-ethnic restaurants. In Kansas, each foodservice establishment receives one unannounced inspection per year. Multiple health inspection

TABLE 4. Comparison of numbers of violations in different categories based on ethnicity of independent restaurants

Food Code Violation Categories	No. Codes ^a (max)	Asian (n = 123)	Mexican or Latin American (n = 106)	Italian & Other (n = 21)	Non-Ethnic (n = 250)	Mean ± SD ^b		F	P ^c
Time and Temperature Control of Potentially Hazardous Food	7	1.14 ± 0.91	1.08 ± 0.99	1.24 ± 1.14	0.85 ± 0.98	3.35	0.019		
Physical Facility Maintenance (e.g., hot & cold water availability, toilet, sewage & waste water, garbage & refuse disposal)	78	1.11 ± 1.23 ^x	0.96 ± 1.20 ^{xy}	1.05 ± 1.32 ^{xy}	0.63 ± 0.95 ^y	6.20	< 0.001		
Protection from Contamination	14	1.08 ± 1.08 ^x	0.78 ± 0.94 ^{xy}	0.76 ± 0.83 ^{xy}	0.64 ± 0.86 ^y	6.11	< 0.001		
Food & Non-Food Contact Surfaces Maintenance & Ware Washing Facilities	48	0.94 ± 1.20 ^x	0.64 ± 0.90 ^{xy}	0.76 ± 1.22 ^{xy}	0.40 ± 0.77 ^y	9.39	< 0.001		
Control of Hands as a Vehicle of Contamination	14	0.94 ± 1.34 ^x	0.85 ± 0.90 ^{xy}	1.05 ± 1.16 ^{xy}	0.55 ± 0.98 ^y	4.96	0.002		
Contamination Prevention through Pest Control, Storage, & Personal Cleanliness	23	0.66 ± 1.06 ^x	0.44 ± 0.73 ^{xy}	0.57 ± 0.93 ^{xy}	0.36 ± 0.67 ^y	4.00	0.008		
Proper Utensil Use & Storage	13	0.40 ± 0.58 ^x	0.26 ± 0.52 ^{xy}	0.29 ± 0.46 ^{xy}	0.21 ± 0.48 ^y	3.60	0.014		
Safe Cooling, Thawing, Hot Holding Methods & Working Thermometer	7	0.40 ± 0.61 ^x	0.46 ± 0.66 ^{xy}	0.48 ± 0.75 ^{xy}	0.21 ± 0.48 ^z	6.50	< 0.001		
Chemical Handling	21	0.39 ± 0.61	0.47 ± 0.64	0.52 ± 0.60	0.32 ± 0.60	2.02	NS		
Approved Sources	18	0.38 ± 0.58 ^x	0.21 ± 0.41 ^{xy}	0.19 ± 0.40 ^{xy}	0.20 ± 0.44 ^y	4.57	0.004		
Demonstration of Knowledge	3	0.27 ± 0.46 ^x	0.26 ± 0.46 ^x	0.19 ± 0.40 ^{xy}	0.10 ± 0.30 ^y	7.35	< 0.001		
Good Hygienic Practices	3	0.18 ± 0.38	0.18 ± 0.39	0.24 ± 0.44	0.10 ± 0.31	2.36	NS		
Food Labeling	6	0.04 ± 0.20 ^x	0.00 ± 0.00 ^{yz}	0.00 ± 0.00 ^{yz}	0.00 ± 0.00 ^z	5.28	0.001		
Conformance with Approved Practices	4	0.03 ± 0.18	0.00 ± 0.00	0.00 ± 0.00	0.02 ± 0.15	1.11	NS		
Employee Health	5	0.02 ± 0.15	0.01 ± 0.10	0.00 ± 0.00	0.00 ± 0.06	1.23	NS		

Note: Means with different superscripts (x, y, z series) differed significantly by Scheffe's post hoc test, P < 0.05

SD: Standard Deviations

NS: No statistical significance

^aNumber of Food Codes within each category

^bNumber of violations found in one health inspection report with the most violations between September 1, 2007 and August 31, 2008

^cResults from Analysis of Variance (ANOVA)

tions occur if the results of the routine inspection show poor performance that warrants a re-inspection. Customer complaints can trigger additional inspections. Therefore, the number of inspections in the 12-month period indirectly measures potential problems in safe food handling in foodservice facilities.

Results also indicate a significantly higher number of food safety violations in ethnic restaurants than in non-ethnic restaurants. Detailed information posted by KDHE enabled researchers to identify not only the number of violations, but also the specific code violations that occurred in each restaurant. Because re-

viewing the most recent inspection may not provide a consistent description of food handling across facilities, researchers selected the one health inspection report with the greatest number of critical violations. Researchers observed that re-inspections usually detected significantly fewer food code violations than the proceeding inspection reports. Thus, by selecting the one inspection with the largest number of critical violations, potential bias was eliminated.

The types of food code violations found in this study may be related to the causes of foodborne illnesses in restaurants. Time and temperature abuse, poor

personal hygiene, and cross-contamination problems are the most significant contributors to foodborne illnesses, according to a Food and Drug Administration (FDA) report (7). In this study, "Time and Temperature Control of PHF" was identified as the most frequently violated food code category; with 39.2% of the sample restaurants violating this code. This percentage is similar to the finding reported by Walczak (33) that 43% of restaurants violated time and temperature, control codes during food preparation and storage. The FDA also reported that only 60% of full-service restaurants were adhering to FDA Food

Code requirements with regard to controlling risk factors, such as personal hygiene and temperature control (8). Despite the emphasis that has been placed on the importance of time and temperature control for PHF, significant number of establishments did not comply with the regulation.

Food codes in “Control of Hands as a Vehicle of Contamination,” “Protection from Contamination,” and “Food and Non-food Contact Surface Maintenance” categories were also violated by many independent restaurants, both ethnic and non-ethnic. These code violations are related to personal hygiene and cross-contamination, the major causes of foodborne illnesses originating in restaurants (7). Although the researchers did not observe food handling behaviors firsthand in the field, the consistency in the findings from our review of health inspection reports with previously published data supports the validity of our data. Data from this study could be used to identify food safety training needs for independent restaurants.

It is not clear why ethnic restaurants had more food code violations in general and within selected categories than non-ethnic restaurants. However, cultural traditions of food preparation handed down through generations may be a contributing factor (12). Poor food handling behaviors, as revealed in this study, could be the source of the greater numbers of foodborne outbreaks associated with ethnic foods (26).

Results of this study provide empirical evidence that help justify concerns about the safety of food served in ethnic restaurants. Owners and managers of independent ethnic restaurants need to be more diligent in training their employees about safe food handling. The majority of violations in ethnic and non-ethnic restaurants were considered critical violations, including time and temperature control of PHF, storage temperatures for PHF, and employee hand washing practices. The impact of poor food handling in restaurants is much more serious than in a home setting because of the number of individuals who can be infected with foodborne illnesses.

The findings from this study identified areas where food safety training should be focused: time and temperature control; physical facility and food & non-food contact surface maintenance; and control of hands, including hand

washing. The types of frequent violations were not necessarily different from those reported in previously published studies (8, 16, 33). However, differences observed between and among different types of independent ethnic restaurants and non-ethnic restaurants reflected the need for increased food safety training for employees of ethnic restaurants, especially Asian and Mexican or Latin American restaurants. Researchers have addressed the inadequacy of current generalized food safety training with regard to specific food handling of ethnic foods (26). Other researchers have identified barriers to food safety training in restaurants and pointed out that increasing knowledge alone may not improve food handling practices (23). However, no ethnic restaurants were included in the study samples of these researchers (24, 25). Future research should address attitudes toward food safety training, behavioral controls, and barriers to food safety training in ethnic restaurants.

Future studies should investigate ways to overcome barriers to food safety training and identify the most cost effective method to train independent ethnic restaurant employees. High employee turnover and lack of resources may be reasons why independent restaurant managers are not enthusiastic about training their employees. However, the cost of having a foodborne illness outbreak attributed to a restaurant is far greater than the cost of training. Food safety educators may need to address tangible and intangible risks associated with foodborne illnesses in order to increase managers' awareness of the need for training.

Another factor to be explored is the role of language barriers in understanding and following proper food safety practices. There were no significant differences in performance between European ethnic restaurants and non-ethnic restaurants, especially for the “Demonstration of Knowledge” category (e.g., identifying person in charge or explaining foodborne disease prevention and application of HACCP). While researchers postulate that language barriers may be a factor in code violations for some ethnic restaurants, there is no evidence to support language barriers being the cause of poor performance in this category.

Findings of this study are limited to 14 county regions in Kansas and cannot be generalized to restaurants in other geographic locations. Several other states also

publish health inspection reports online, but the lack of specificity of these reports makes it difficult to compare them with our results. The results are also limited to independent restaurants and therefore cannot be generalized to restaurants operated with franchise agreements or by large corporations, which often exercise internal controls to ensure food safety, with resources available from the parent companies, and which may thus be more likely to perform better than independent restaurants during health inspections.

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