

# Food Allergy Knowledge and Attitudes of Restaurant Managers and Staff: An EHS-Net Study

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## ABSTRACT

Dining outside of the home can be difficult for persons with food allergies who must rely on restaurant staff to properly prepare allergen-free meals. The purpose of this study was to understand and identify factors associated with food allergy knowledge and attitudes among restaurant managers, food workers, and servers. This study was conducted by the Environmental Health Specialists Network (EHS-Net), a collaborative forum of federal, state, and local environmental health specialists working to understand the environmental factors associated with food safety issues. EHS-Net personnel collected data from 278 randomly selected restaurants through interviews with restaurant managers, food workers, and servers. Results indicated that managers, food workers, and servers were generally knowledgeable and had positive attitudes about accommodating customers' food allergies. However, we identified important gaps, such as more than 10% of managers and staff believed that a person with a food allergy can safely consume a small amount of that allergen. Managers and staff also had lower confidence in their restaurant's ability to properly respond to a food allergy emergency. The knowledge and attitudes of all groups were higher at restaurants that had a specific person to answer food allergy questions and requests or a plan for answering questions from food allergic customers. However, food allergy training was not associated with knowledge in any of the groups but was associated with manager and server attitudes. Based on these findings, we encourage restaurants to be proactive by training staff about food allergies and creating plans and procedures to reduce the risk of a customer having a food allergic reaction.

Key words: Food allergies; Food allergy attitudes; Food allergy knowledge; Food safety; Restaurants

Food allergies are a growing public health and food safety concern affecting an estimated 15 million U.S. residents, including 1 in every 13 children (8). A food allergic reaction occurs when the immune system overreacts to the proteins in food (2). Currently, the only way to prevent a food allergic reaction is strict avoidance of the allergen (15). Eight foods are responsible for approximately 90% of all food allergic reactions in the United States: milk, eggs, fish, shellfish, wheat, tree nuts, peanuts, and soybeans (8). Symptoms of an allergic reaction range from mild skin rashes to severe, potentially life-threatening anaphylactic reactions (10). In the case of anaphylactic reactions, administration of epinephrine within minutes is crucial to survival (15). Food-related anaphylaxis is responsible for approximately 30,000 emergency room visits, 2,000 hospitalizations, and 150 deaths each year in the United States (13).

A significant number of food allergic reactions occur in restaurants. A survey at the 2007 Food Allergy &

Anaphylaxis Network conference (14) found that 34% of the 294 respondents had experienced at least one food allergic reaction in a restaurant, and of those, 36% had experienced at least three reactions. Another study revealed that nearly half of fatal food allergic reactions over a 13-year period were caused by food from a restaurant or other food service establishment (15). An investigation of peanut and tree nut allergic reactions in restaurants or other food service establishments found that in 45% of these cases, the food allergic customers had alerted the restaurant to their allergy in advance (9). The same investigation revealed that in 78% of the episodes, someone in the establishment knew that the food contained the allergen as an ingredient.

Managers, food workers, and servers all play unique and crucial roles in preventing food allergic reactions in their restaurants. Managers can provide food allergy training for staff and develop plans for serving food allergic customers. Food workers can become educated about allergens and methods to ensure allergen-free food preparation. Servers can accurately describe menu items to the customer and alert the manager and kitchen staff to requests for allergen-free meals. Miscommunication between any of these groups can

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result in an unsafe meal being served (3). Benefits to restaurants that consistently provide safe meals to food allergic customers include preventing harm to their clientele, avoiding lawsuits, and gaining the loyal patronage of the food allergic community.

A key to preventing food allergic reactions in restaurants is understanding manager, food worker, and server food allergy knowledge, attitudes, and practices. Several studies have been conducted to examine these topics collectively (1, 3, 5, 6, 11, 12). However, the measures used in these studies have been limited with regard to food allergy attitudes and practices. All studies either included a regional or convenience sample (1, 6, 11) or were conducted outside of the United States (3, 5, 11, 12); thus, the generalizability of their results must be considered.

In 2014, the Centers for Disease Control and Prevention's (CDC) Environmental Health Specialists Network (EHS-Net) conducted a study on restaurant manager and staff (food workers and servers) food allergy knowledge, attitudes, and practices. Our measures of knowledge, attitudes, and practices were comprehensive and were primarily based on the Food Allergy Research and Education guidance document "Welcoming Guests with Food Allergies" (7). EHS-Net also collected data in six demographically diverse sites, providing good geographic coverage of the United States (Northeast, South, Midwest, West). The goals of this study were threefold: (i) describe restaurant manager and staff food allergy knowledge, attitudes, and practices; (ii) compare knowledge, attitudes, and practices among managers and staff; and (iii) identify factors associated with food allergy knowledge, attitudes, and practices. This article primarily focuses on knowledge and attitudes. Complete practice data will be published at a later date.

## MATERIALS AND METHODS

EHS-Net is a network of environmental health specialists and epidemiologists who conduct research designed to identify and understand environmental factors associated with foodborne illness outbreaks and other food safety issues. EHS-Net is a collaborative project of the CDC, the U.S. Food and Drug Administration, the U.S. Department of Agriculture, and state and local health departments. At the time this study was conducted, six state and local health departments were funded by CDC to participate in EHS-Net. The state and local health departments (EHS-Net sites) were in California, Minnesota, New York, New York City, Rhode Island, and Tennessee.

**Sample.** For this study, we used a random sample from a nonrandomly selected cluster (i.e., site). In each site, EHS-Net personnel chose an area, based on convenience (reasonable travel distance), in their jurisdiction to recruit restaurants for study participation through telephone calls. SAS version 9.3 (SAS Institute, Cary, NC) was used to select a random sample of restaurants from population lists of restaurants in those areas. Data collectors (EHS-Net personnel) collected data in approximately 50 randomly selected restaurants per site. For this study, restaurants were defined as facilities that prepare and serve food or beverages to customers and are not institutions, food carts, mobile food units, temporary food stands, supermarkets, restaurants in supermarkets,

or caterers. Only restaurants with English-speaking managers were included in the study.

**Data collection.** Data were collected from January 2014 through February 2015. The institutional review boards of the participating EHS-Net site health departments approved the study protocol. We did not collect any data that could identify individual restaurants, managers, food workers, or servers. All data collectors participated in training designed to increase data collection accuracy and consistency. Data collectors solicited restaurant participation by contacting randomly selected restaurants within a specified geographic location via telephone using a standardized recruiting script.

After obtaining permission from the restaurant manager, data collectors conducted an on-site interview with a manager (worker with authority over the kitchen), food worker (worker who primarily prepares or cooks food), and server (worker who primarily takes orders or serves food to customers). To increase participation and cooperation, data collectors asked the manager to choose the food worker and server to be interviewed. Manager interviews lasted approximately 20 min and were focused on characteristics of the restaurant (e.g., chain versus independent ownership and number of meals served in a typical day) and the manager (e.g., years of experience in current restaurant and whether they had been food safety certified). Food worker and server interviews lasted approximately 12 min each and were focused on food worker and server characteristics (e.g., highest level of education and whether they had received food allergy training in their current restaurant).

Interviewers asked 19 questions to assess manager, food worker, and server food allergy knowledge (e.g., identifying major food allergens and knowing what to do when a customer has a bad food allergic reaction). Five questions (e.g., should servers be knowledgeable about food allergies and should restaurants try to meet food allergic customers' special requests) were scored on a Likert scale to assess staff food allergy attitudes. Another 13 to 22 questions (e.g., whether the restaurant has a plan for answering questions from food allergic customers and whether the restaurant has a specific person on duty to handle food allergy questions and requests) were used to assess food allergy practices. Data collectors also observed the restaurant and examined its menu to assess additional restaurant characteristics (e.g., highest priced food item and number of critical violations on the restaurant's last inspection) and food allergy documentation (e.g., whether the menu mentioned anything about allergens and whether documentation about allergens was available in the kitchen area).

**Data analysis.** We initially created knowledge and attitude scores for each participant group (i.e., manager, food worker, and server). For the knowledge score, we summed the number of correct answers (out of 19) and used each group's median score to dichotomize the participants as having more or less knowledge.

For the attitude score, we assigned point values to each response as follows: strongly disagree = 1, disagree = 2, unsure = 3, agree = 4, and strongly agree = 5. We then averaged each participant's response to the five attitude questions. We used each group's median score to divide participants into those having relatively positive or less positive attitudes.

We used one-way analyses of variance (ANOVAs) to test whether groups were significantly different ( $P \leq 0.05$ ) in knowledge and attitude scores. We then conducted univariate descriptive analyses of restaurant, manager, food worker, and server characteristics; food allergy knowledge, attitudes, and practices; and food allergy documentation. Some continuous

variables were recoded to provide approximately even groups to facilitate interpretation. For example, managers' experience was split into <4 years (52.0%) and  $\geq 4$  years (48.0%). We next conducted a series of simple logistic regressions to examine associations between potential explanatory variables (restaurant, manager, food worker, and server characteristics; food preparation and service practices; and allergen documentation) and each outcome variable (knowledge and attitude scores) for managers, food workers, and servers (data not shown). We then created multiple logistic regression models for each group and outcome using a forward selection criterion (entrance criterion of  $P \leq 0.10$ ) to further explore the relationship between 20 potential explanatory variables and the outcomes. We choose  $P \leq 0.10$  to allow for more inclusiveness, given the relative exploratory nature of these analyses. We used SAS version 9.3 for all analyses.

## RESULTS

**Restaurant characteristics.** Of the 1,307 restaurants contacted for participation in the study, 852 fit the study definition, and 278 (32.6%) of those agreed to participate (Table 1). Manager interview data indicated that 60.1% of the participating restaurants were independently owned. Data collectors classified 56.9% of the restaurants as either quick service (e.g., fast food), fast casual service, or takeout only. Manager interview data indicated that 54.3% of the restaurants had complex food preparation processes (i.e., preparation that includes holding food beyond same day service or some combination of holding, cooling, reheating, and freezing). Additionally, 64.1% had American (nonethnic) menus, 29.7% served more than 300 meals in a typical day, 50.5% had three or more managers, 50.7% employed more than 10 workers, 25.5% had a food item priced more than \$20, and 23.0% were cited for more than one critical violation on the last inspection.

**Manager, food worker, and server characteristics.** Interview data from the 277 managers indicated that 66.4% were male, 81.2% spoke English as their primary language, 61.0% had some college education or more, 48.0% had been working at the restaurant for at least 4 years, and 80.8% had been food safety certified (Table 1). Less than half (44.7%) of managers had received training on food allergies while working at their current restaurant, and 27.8% did not recall serving any meals to food allergic customers in the past month.

Interview data from the 211 food workers indicated that 67.3% were male, 77.7% spoke English as their primary language, 37.0% had some college education or more, and 50.7% had been working at the restaurant for at least 2 years (Table 1). Less than half (44.1%) had received food allergy training while working at their current restaurant, and 21.0% did not recall preparing any meals for food allergic customers in the past month.

Interview data from the 156 servers indicated that 72.9% were female, 85.9% spoke English as their primary language, 50.0% had some college education or more, and 52.6% had been working at the restaurant for at least 2 years (Table 1). Only 33.5% had received training on food allergies while working at their current restaurant, and

12.6% did not recall serving any meals to food allergic customers in the past month.

**Practices and observations.** According to manager interview data, 70.8% percent of the restaurants had a plan for answering questions from food allergic customers (Table 2). Approximately half (53.3%) of the restaurants typically had a specific person on duty to handle food allergy questions and requests. Data collectors found that 22.0% of menus mentioned allergens. In 55% of these menus, the allergen information was a note for the customer to inform the restaurant whether they or someone with them had a food allergy. Food allergen documentation was available in the front of the restaurant (areas accessible to customers or the dining area) and the kitchen area in 23.1 and 36.3% of restaurants, respectively.

**Manager, food worker, and server knowledge.** Overall, managers correctly identified peanuts (95.0%), milk and dairy (91.0%), shellfish (92.4%), and eggs (81.6%) as major allergens (Table 3). Managers also recognized that trouble breathing (97.1%), hives or rash (98.2%), and swelling of tongue and throat (97.5%) are symptoms of an allergic reaction to food. Nearly all managers knew to call 911 (99.3%) when a customer has a bad food allergic reaction, such as trouble breathing. Managers (95.0%) knew that a person who eats food they are allergic to can die, and 92.8% of managers correctly said that taking a food allergen out of a meal after the meal had been prepared is not a way to make it safe for a food allergic customer. However, more than 1 in 10 managers (11.9%) incorrectly believed that a person allergic to a specific food ingredient can safely eat small amounts of that food.

Food workers also correctly identified peanuts (95.3%), milk and dairy (88.2%), shellfish (90.5%), and eggs (77.7%) as major allergens (Table 3). Food workers recognized trouble breathing (96.7%), hives or rash (97.2%), and swelling of tongue and throat (95.7%) as symptoms of an allergic reaction to food. Nearly all workers knew to call 911 (98.1%) when a customer has a bad food allergic reaction, such as trouble breathing. Food workers (94.8%) knew that a person who eats food they are allergic to can die, and 91.5% of food workers correctly said that taking a food allergen out of a meal after the meal has been prepared is not a way to make it safe for a food allergic customer. However, more than 1 in 10 food workers (11.8%) incorrectly believed that a person allergic to a specific food ingredient can safely eat small amounts of that food.

Servers correctly identified peanuts (95.5%), milk and dairy (93.0%), shellfish (94.2%), and eggs (72.4%) as major allergens (Table 3). Servers also recognized trouble breathing (99.4%), hives or rash (100%), and swelling of tongue and throat (100%) as symptoms of an allergic reaction to food. All servers knew to call 911 (100%) when a customer has a bad food allergic reaction, such as trouble breathing. Servers (97.4%) knew that a person who eats food they are allergic to can die, and 93.0% of servers correctly said that taking a food allergen out of a meal after the meal has been prepared is not a way to make it safe for a food

TABLE 1. Descriptive data on restaurant, manager, and staff characteristics

Parameter	n	%
<b>Restaurant characteristics<sup>a</sup></b>		
Restaurant type (N = 276)		
Chain	110	39.9
Independent	166	60.1
Service type (N = 276) <sup>b</sup>		
Full service casual or fine dining	119	43.1
Quick service, fast casual service, or takeout only	157	56.9
Establishment type (N = 278) <sup>b</sup>		
Prep serve or cook serve	127	45.7
Complex	151	54.3
Menu type (N = 276)		
American	177	64.1
Non-American	99	35.9
No. of meals served in a typical day (N = 266)		
1–100	95	35.7
101–300	92	34.6
>300	79	29.7
No. of managers or persons in charge that work in this restaurant (N = 277)		
<3	137	49.5
≥3	140	50.5
No. of workers other than managers that work in this restaurant (N = 272)		
≤10	134	49.3
>10	138	50.7
Highest priced food item on the menu (N = 267) <sup>b</sup>		
<\$10	95	35.6
\$10–\$20	104	38.9
>\$20	68	25.5
No. of critical violations received after the last inspection (N = 278) <sup>b</sup>		
0	134	48.2
1	80	28.8
>1	64	23.0
<b>Manager characteristics<sup>a</sup></b>		
Sex (N = 277)		
Male	184	66.4
Female	93	33.6
Primary language spoken (N = 277)		
English	225	81.2
Other	52	18.8
Highest level of education (N = 277)		
High school diploma or less	108	39.0
Some college or more	169	61.0
Experience as a manager in this restaurant (N = 277)		
<4 yr	144	52.0
≥4 yr	133	48.0
Ever been food safety certified (N = 276)		
Yes	223	80.8
No	53	19.2
Received training on food allergies while working at this restaurant (N = 275)		
Yes	123	44.7
No	152	55.3

TABLE 1. Continued

Parameter	n	%
<b>No. of meals served to food allergic customers in the past month (N = 263)</b>		
0	73	27.8
1–10	115	43.7
>10	75	28.5
<b>Food worker characteristics<sup>c</sup></b>		
Sex (N = 211)		
Male	142	67.3
Female	69	32.7
Primary language spoken (N = 211)		
English	164	77.7
Other	47	22.3
Highest level of education (N = 211)		
High school diploma or less	133	63.0
Some college or more	78	37.0
Experience in this restaurant (N = 207)		
<2 yr	102	49.3
≥2 yr	105	50.7
Received training on food allergies while working at this restaurant (N = 209)		
Yes	86	41.1
No	123	58.9
No. of meals prepared for food allergic customers per month (N = 495)		
0	41	21.0
1–10	105	53.9
>10	49	25.1
<b>Server characteristics<sup>d</sup></b>		
Sex (N = 455)		
Male	42	27.1
Female	113	72.9
Primary language spoken (N = 456)		
English	134	85.9
Other	22	14.1
Highest level of education (N = 456)		
High school diploma or less	78	50.0
Some college or more	78	50.0
Experience in this restaurant (N = 456)		
<2 yr	74	47.4
≥2 yr	82	52.6
Received training on food allergies while working at this restaurant (N = 455)		
Yes	52	33.5
No	103	66.5
No. of meals served to food allergic customers per month (N = 451)		
0	19	12.6
1–10	97	64.2
>10	35	23.2

<sup>a</sup> Data were obtained from manager interviews, unless otherwise noted.

<sup>b</sup> Data were obtained from data collector observations.

<sup>c</sup> Data were obtained from food worker interviews.

<sup>d</sup> Data were obtained from server interviews.

allergic customer. However, more than 1 in 10 servers (11.5%) incorrectly believed that someone allergic to a specific food ingredient can safely eat small amounts of that food.

TABLE 2. Descriptive data on food allergy practices and restaurant environment observations

Parameter	n	%
Practices <sup>a</sup>		
Restaurant has plan for answering questions from food allergic customers (N = 267)		
Yes	189	70.8
No	78	29.2
Specific person typically on duty to handle food allergy questions and requests (N = 276)		
Yes	147	53.3
No	129	46.7
Observations <sup>b</sup>		
Menu shows anything about allergens (N = 273)		
Yes	60	22.0
No	213	78.0
Documentation in the front of the house (areas accessible to customers) or dining area about allergens (N = 277)		
Yes	64	23.1
No	213	76.9
Documentation about allergens in the kitchen area (N = 278)		
Yes	101	36.3
No	177	63.7

<sup>a</sup> Data were obtained from manager interviews.

<sup>b</sup> Data were obtained from data collector observations.

**Comparisons of manager, food worker, and server knowledge scores.** All three groups had similar knowledge scores (Table 4). Median knowledge scores were 13 for managers (mean = 13.7, SD = 2.0, n = 277), 12 for food workers (mean = 13.0, SD = 2.5, n = 211), and 13 for servers (mean = 13.5, SD = 2.2, n = 156).

The overall ANOVA model suggested significant differences between groups ( $F_{2,641} = 7.45, P < 0.001$ ). Post hoc tests revealed that managers (mean = 13.75, SD = 2.01, n = 277) had significantly higher knowledge scores than did food workers (mean = 12.96, SD = 2.50, n = 211). Servers had a mean score of 13.46 (SD = 2.21, n = 156), and their scores were not significantly different from those of managers or workers.

**Multiple logistic regression of manager, food worker, and server knowledge.** A multiple logistic regression analysis identified two characteristics that were significantly associated with manager food allergy knowledge (Table 5). Managers in restaurants that served more than 10 meals to allergic customers in the past month had greater odds of having a higher food allergy knowledge score than did managers in restaurants that served 10 or fewer such meals. Managers in restaurants that had a specific person to answer food allergy questions and requests had greater odds of having a higher food allergy knowledge score than did those managers in restaurants without such a person.

A multiple logistic regression analysis identified four characteristics that were significantly associated with food worker food allergy knowledge (Table 5). Food workers in restaurants with a plan for answering questions from food allergic customers had greater odds of having a higher food allergy knowledge score than did workers in restaurants with no such plan. Female food workers had greater odds of having a higher food allergy knowledge score than did male food workers. Food workers with at least 2 years of experience in the restaurant had greater odds of having a higher food allergy knowledge score than did food workers with less experience. Food workers in restaurants in which the highest priced food item was between \$10 and \$20 had greater odds of having a higher food allergy knowledge score than did those workers in restaurants in which the highest priced food item was less than \$10.

A multiple logistic regression analysis identified three characteristics that were significantly associated with server food allergy knowledge (Table 5). Servers in restaurants with a specific person to answer food allergy questions and requests had greater odds of having a higher food allergy knowledge score. Servers in full service restaurants had greater odds of having a higher food allergy knowledge score than did servers in quick service restaurants. Servers in restaurants that served more than 300 meals in a typical day had greater odds of having a higher food allergy knowledge score than did servers in restaurants that served 300 meals or less.

**Manager, food worker, and server attitudes.** Managers (97.5%) agreed or strongly agreed that servers should be knowledgeable about food allergies (Table 6). Nearly all managers (99.6%) agreed or strongly agreed that kitchen staff should be knowledgeable about food allergies. Managers (91.3%) agreed or strongly agreed that restaurants should try to meet food allergic customers' special requests. Most managers (87.4%) also agreed or strongly agreed that their restaurant could easily meet food allergic customers' special requests. However, fewer managers (70.7%) agreed or strongly agreed that the staff in their restaurant would know what to do if a customer had a bad food allergic reaction.

All food workers (100%) agreed or strongly agreed that servers should be knowledgeable about food allergies (Table 6). Food workers (99.5%) agreed or strongly agreed that kitchen staff should be knowledgeable about food allergies. Food workers (97.1%) also agreed or strongly agreed that restaurants should try to meet food allergic customers' special requests. Most food workers (92.9%) agreed or strongly agreed that their restaurant could easily meet food allergic customers' special requests. However, only 74.4% of food workers agreed or strongly agreed that the staff in this restaurant would know what to do if a customer had a bad food allergic reaction.

All servers (100%) agreed or strongly agreed that servers should be knowledgeable about food allergies (Table 6). Servers (100%) also unanimously agreed or strongly agreed that kitchen staff should be knowledgeable about food allergies. Nearly all servers (98.1%) agreed or strongly

TABLE 3. Descriptive data on restaurant manager and staff food allergy knowledge<sup>a</sup>

Question	Manager (N = 277)		Food worker (N = 211)		Server (N = 156)	
	n	%	n	%	n	%
Of the following foods, which do you think are major allergens?						
Peanuts ( <i>correct</i> )	263	95.0	201	95.3	149	95.5
Tomatoes	53	19.1	47	22.3	37	23.7
Milk or dairy ( <i>correct</i> )	252	91.0	186	88.2	145	93.0
Strawberries	88	31.8	68	32.2	47	30.1
Shellfish ( <i>correct</i> )	256	92.4	191	90.5	147	94.2
Eggs ( <i>correct</i> )	226	81.6	164	77.7	113	72.4
Chocolate	64	23.1	59	28.0	27	17.3
Which of the following are symptoms of an allergic reaction to food?						
Trouble breathing ( <i>correct</i> )	269	97.1	204	96.7	155	99.4
Hives or rash ( <i>correct</i> )	272	98.2	205	97.2	156	100
Headache	154	55.6	109	51.7	72	46.2
Swelling of tongue and throat ( <i>correct</i> )	270	97.5	202	95.7	156	100
Fever	166	59.9	122	57.8	102	65.4
Which of the following should you do if a customer is having a bad food allergic reaction, such as trouble breathing?						
Suggest that the customer drink water	67	24.2	59	28.0	41	26.3
Call 911 ( <i>correct</i> )	275	99.3	207	98.1	156	100
Ask the customer if they have medicine they could take	250	90.3	193	91.5	145	93.0
Suggest that the customer throw up	42	15.2	28	13.3	9	5.8
Someone with a food allergy can safely eat small amounts of the food they are allergic to.						
Yes	33	11.9	25	11.8	18	11.5
No ( <i>correct</i> )	225	81.2	159	75.4	122	78.2
Unsure or skipped	19	6.9	27	12.8	16	10.3
Someone with a food allergy can die from eating the food they are allergic to.						
Yes ( <i>correct</i> )	263	95.0	200	94.8	152	97.4
No	7	2.5	6	2.8	2	1.3
Unsure or skipped	7	2.5	5	2.4	2	1.3
Taking a food allergen out of a meal after it has been made is one way to make it safe for a food allergic customer.						
Yes	17	6.1	12	5.7	6	3.8
No ( <i>correct</i> )	257	92.8	193	91.5	145	93.0
Unsure or skipped	3	1.1	6	2.8	5	3.2

<sup>a</sup> Responses are shown in the order they were asked. n, the number of managers and workers that affirmatively answered the question.

agreed that restaurants should try to meet food allergic customers' special requests. Most servers (93.0%) agreed or strongly agreed that their restaurant could easily meet food allergic customers' special requests. However, only three-quarters of servers (75.7%) agreed or strongly agreed that the staff in their restaurant would know what to do if a customer had a bad food allergic reaction.

**Comparisons of manager, food worker, and server attitude scores.** The three participant groups had approximately equivalent median attitude scores: 4.2 for managers (mean = 4.3, SD = 0.5, n = 277), 4.2 for food workers (mean = 4.4, SD = 0.4, n = 207), and 4.4 for servers (mean = 4.5, SD = 0.4, n = 155) (Table 4). Knowledge and attitude scores were not significantly correlated in any of the respondent

groups: managers,  $r = 0.06$ ,  $P = 0.317$ ,  $n = 277$ ; food workers,  $r = -0.03$ ,  $P = 0.684$ ,  $n = 207$ ; and servers,  $r = -0.04$ ,  $P = 0.653$ ,  $n = 155$ .

The overall ANOVA model suggested significant differences between groups ( $F_{2,636} = 6.31$ ,  $P = 0.002$ ). Post hoc tests revealed that servers (mean = 4.46, SD = 0.41,  $n = 155$ ) had significantly higher attitude scores than did managers (mean = 4.30, SD = 0.50,  $n = 277$ ). Food workers had a mean score of 4.39 (SD = 0.44,  $n = 211$ ), and their scores were not significantly different from those of managers or servers.

**Multiple logistic regression of manager, worker, and server attitudes.** A multiple logistic regression analysis identified six characteristics that were significantly associ-

TABLE 4. Comparisons of food allergy knowledge and attitude scores by group

Group	Mean difference	95% confidence interval
Knowledge scores <sup>a</sup>		
Manager vs food worker	0.785	(0.28, 1.29) <sup>b</sup>
Manager vs server	0.292	(-0.26, 0.84)
Server vs food worker	0.493	(-0.08, 1.07)
Attitude scores <sup>c</sup>		
Manager vs food worker	-0.087	(-0.19, 0.02)
Manager vs server	-0.157	(-0.27, -0.04) <sup>b</sup>
Server vs food worker	0.069	(-0.05, 0.19)

<sup>a</sup> Fisher's one-way ANOVA ( $F_{2,641} = 7.45, P < 0.001$ ).

<sup>b</sup>  $P \leq 0.05$ .

<sup>c</sup> Equal variance not assumed. Welch's one-way ANOVA ( $F_{2,636} = 6.31, P = 0.002$ ).

ated with manager food allergy attitudes (Table 7). Managers in restaurants that served more than 10 meals to food allergic customers in the past month had greater odds of having a higher food allergy attitude score than did managers in restaurants that served 10 meals or fewer. Managers in restaurants with plans for answering questions from food allergic customers had greater odds of having a higher food allergy attitude score. Managers in restaurants with a specific person to answer food allergy questions and requests had greater odds of having a higher food allergy attitude score than did managers in restaurants without such a person. Managers in restaurants that had allergen information on the menu were less likely to have a higher food allergy attitude score than did managers in restaurants without this information. Managers with at least 4 years of experience in the restaurant were also less likely to have a higher food allergy attitude score than were managers with less experience. Managers who had received food allergy training at their restaurant had greater odds of having a higher food allergy attitude score than did managers with no food allergy training.

TABLE 5. Multiple logistic regression analysis of characteristics associated with restaurant managers, food workers, and servers scoring in the top 50% of food allergy knowledge scores<sup>a</sup>

Characteristic	OR (90% CI)	P
Manager scored in top 50% <sup>b</sup>		
No. of meals served to allergic customers in the past month		0.003
1-10 vs 0	1.48 (0.89, 2.48)	0.208
>10 vs 1-10	2.33 (1.35, 4.04)	0.011
>10 vs 0	3.45 (1.87, 6.36)	0.001
Specific person to answer food allergy questions and requests		
Yes vs no	1.71 (1.09, 2.70)	0.052
Food worker scored in top 50% <sup>c</sup>		
Restaurant plan for answering questions from food allergic customers		
Yes vs no	4.23 (2.20, 8.12)	<0.001
Sex		
Female vs male	3.63 (1.81, 7.26)	0.002
Experience in this restaurant		
$\geq 2$ vs <2 yr	2.60 (1.43, 4.72)	0.009
Highest priced food item on the menu		0.071
\$10-\$20 vs <\$10	2.72 (1.33, 5.56)	0.022
>\$20 vs \$10-\$20	0.68 (0.32, 1.42)	0.389
>\$20 vs <\$10	1.84 (0.80, 4.24)	0.228
Server scored in top 50% <sup>d</sup>		
Specific person to answer food allergy questions and requests		
Yes vs no	2.49 (1.33, 4.66)	0.017
Service type		
Full service vs quick service	2.71 (1.40, 5.24)	0.013
No. of meals served in a typical day		0.077
101-300 vs 1-100	1.03 (0.51, 2.05)	0.953
>300 vs 101-300	2.54 (1.20, 5.38)	0.042
>300 vs 1-100	2.60 (1.19, 5.69)	0.045

<sup>a</sup> Overall models were created using a forward selection criterion of  $P < 0.10$ . Variables are presented in order of steps at which they entered the model. OR, odds ratio; CI, confidence interval. OR > 1 indicates that the odds of the outcome (knowledge score in top 50%) were greater for the first mentioned category (e.g., 1 to 10) than for the second mentioned category (e.g., 0).

<sup>b</sup>  $\chi^2 = 17.18, df = 3, P < 0.001, N = 262$ .

<sup>c</sup>  $\chi^2 = 30.50, df = 5, P < 0.001, N = 192$ .

<sup>d</sup>  $\chi^2 = 16.97, df = 4, P = 0.002, N = 149$ .

TABLE 6. Descriptive data on restaurant manager and staff food allergy attitudes<sup>a</sup>

Statement	Manager (N =277)		Food worker (N =211)		Server (N =156)	
	n	%	n	%	n	%
Servers should be knowledgeable about food allergies						
Strongly agree	173	62.5	137	64.9	113	72.4
Agree	97	35.0	74	35.1	43	27.6
Unsure	0	0	0	0	0	0
Disagree	7	2.5	0	0	0	0
Strongly disagree	0	0	0	0	0	0
Kitchen staff should be knowledgeable about food allergies						
Strongly agree	194	70.0	147	69.7	125	80.1
Agree	82	29.6	63	29.8	31	19.9
Unsure	0	0	1	0.5	0	0
Disagree	1	0.4	0	0	0	0
Strongly disagree	0	0	0	0	0	0
Restaurants should try to meet food allergic customers' special requests						
Strongly agree	133	48.0	106	50.2	88	56.4
Agree	120	43.3	99	46.9	65	41.7
Unsure	7	2.6	0	0	2	1.3
Disagree	15	5.4	4	1.9	1	0.6
Strongly disagree	2	0.7	2	1.0	0	0
This restaurant can easily meet food allergic customers' special requests						
Strongly agree	113	40.8	82	38.9	74	47.5
Agree	129	46.6	114	54.0	71	45.5
Unsure	9	3.2	4	1.9	1	0.6
Disagree	26	9.4	10	4.7	10	6.4
Strongly disagree	0	0	1	0.5	0	0
The staff in this restaurant know what to do if a customer has a bad food allergic reaction						
Strongly agree	66	23.8	51	24.2	36	23.1
Agree	130	46.9	106	50.2	82	52.6
Unsure	27	9.8	29	13.7	22	14.1
Disagree	49	17.7	25	11.9	16	10.2
Strongly disagree	5	1.8	0	0	0	0

<sup>a</sup> Strongly disagree = 1; disagree = 2; unsure = 3; agree = 4; strongly agree = 5.

A multiple logistic regression analysis identified four characteristics that were significantly associated with food worker food allergy attitudes (Table 7). Food workers in restaurants with a plan for answering questions from food allergic customers were more likely to have a higher food allergy attitude score than were workers in restaurants without such a plan. Food workers with at least some college education had greater odds of having a higher food allergy attitude score than did workers with less education. Food workers in restaurants that employed fewer than five workers for every manager were more likely to have a higher food allergy attitude score than were those workers in restaurants with five workers or more for every manager.

Food workers in chain restaurants had greater odds of having a higher food allergy attitude score than did workers in independent restaurants.

A multiple logistic regression analysis identified four characteristics that were significantly associated with server food allergy attitudes (Table 7). Servers with at least some college education were more likely to have a higher food allergy attitude score than were servers with less education. Servers who had received food allergy training at the restaurant had greater odds of having a higher food allergy attitude score than did servers with no food allergy training. Servers in restaurants with a plan for answering questions from food allergic customers were more likely to have a

TABLE 7. Multiple logistic regression analysis of characteristics associated with restaurant managers, food workers, and servers scoring in the top 50% of food allergy attitude scores<sup>a</sup>

Characteristic	OR (90% CI)	P
Manager scored in top 50% <sup>b</sup>		
No. of meals served to allergic customers in past month		<0.001
1–10 vs 0	1.29 (0.73, 2.28)	0.467
>10 vs 1–10	3.72 (2.00, 6.92)	0.001
>10 vs 0	4.80 (2.35, 9.77)	<0.001
Restaurant plan for answering questions from food allergic customers		
Yes vs no	2.77 (1.59, 4.81)	0.003
Specific person to answer food allergy questions and requests		
Yes vs no	1.71 (1.02, 2.85)	0.085
Allergen information on menu		
Yes vs no	0.42 (0.22, 0.79)	0.023
Experience in this restaurant		
≥4 vs <4 yr	0.57 (0.35, 0.94)	0.061
Received food allergy training at this restaurant		
Yes vs no	1.71 (1.00, 2.92)	0.099
Food worker scored in top 50% <sup>c</sup>		
Restaurant plan for answering questions from food allergic customers		
Yes vs no	2.43 (1.33, 4.43)	0.015
Highest level of education		
Some college or more vs high school diploma or less	3.35 (1.83, 6.14)	0.001
Worker:manager ratio		
<5:1 vs ≥5:1	2.44 (1.37, 4.35)	0.011
Restaurant type		
Chain vs independent	2.04 (1.13, 3.70)	0.048
Server scored in top 50% <sup>d</sup>		
Highest level of education		
Some college or more vs high school diploma or less	3.33 (1.80, 6.17)	0.001
Received food allergy training at this restaurant		
Yes vs no	2.60 (1.32, 5.08)	0.020
Restaurant plan for answering questions from food allergic customers		
Yes vs no	2.43 (1.16, 5.12)	0.050
Experience in this restaurant		
≥2 vs <2 yr	1.89 (1.01, 3.52)	0.093

<sup>a</sup> Overall models were created using a forward selection criterion of  $P < 0.10$ . Variables are presented in order of steps at which they entered the model. OR, odds ratio; CI, confidence interval. OR > 1 indicates that the odds of the outcome (attitude score in top 50%) were greater for the first mentioned category (e.g., 1 to 10) than for the second mentioned category (e.g., 0).

<sup>b</sup>  $\chi^2 = 52.00$ ,  $df = 7$ ,  $P < 0.001$ ,  $N = 248$ .

<sup>c</sup>  $\chi^2 = 27.86$ ,  $df = 4$ ,  $P < 0.001$ ,  $N = 196$ .

<sup>d</sup>  $\chi^2 = 24.43$ ,  $df = 4$ ,  $P < 0.001$ ,  $N = 149$ .

higher food allergy attitude score than were servers in restaurants with no such plan. Servers with at least 2 years of experience in the restaurant had greater odds of having a higher food allergy attitude score than did servers with less experience.

## DISCUSSION

The overarching goal of this study was to describe food allergy knowledge, attitudes, and practices in restaurants. This multisite study revealed that restaurant managers and staff are knowledgeable and have positive attitudes concerning accommodations for food allergic customers. One positive finding was that nearly all restaurant staff could correctly identify symptoms of an allergic reaction and knew to call emergency medical services (i.e., 911) in these situations. Most managers and staff thought it was important

for food workers and servers to be knowledgeable about food allergies and that their restaurant could easily meet food allergic customers' special requests. However, we identified important gaps in knowledge and attitudes. For example, restaurant staff members were less likely to recognize eggs as a major allergen, and conversely, some foods such as strawberries were incorrectly believed to be major allergens. Another troubling finding was that more than 10% of managers and staff believe that someone with a food allergy can safely consume a small amount of that allergen. These findings for food workers are particularly troubling, because their main job responsibilities include food preparation. Accurate knowledge is critical to preventing an allergic reaction. Managers and staff also had lower confidence in their restaurants' ability to properly respond to a food allergy emergency. This finding suggests that

restaurant plans and trainings may not adequately prepare staff for these emergencies. Because the incidence of food allergies continues to increase, it is important for restaurants to be prepared for potential anaphylaxis emergencies.

Identifying areas of concern is only the first step in preventing food allergic reactions in restaurants. Our additional analyses quantified the associations between restaurant, manager, and staff characteristics, practices, and observations and their food allergy knowledge and attitudes. Understanding these relationships is critical to creating effective interventions.

We found that several individual characteristics were significantly associated with food allergy knowledge and attitudes, e.g., education, work experience, and sex. Food worker knowledge level was higher among female workers and those with more experience working in their current restaurant. These findings suggest that it is important for restaurants to engage less experienced workers in food allergy trainings. Work experience and education were also significantly related to attitudes for managers, food workers, and servers. Managers with less experience had positive attitudes. In this case, experience might be a proxy for age. Anecdotal information from our data collectors suggests that younger managers were more receptive to accommodating food allergens than were older managers. In contrast, servers with more experience had positive attitudes. The contradiction between these findings is not readily explainable. Both food workers and servers with higher levels of education had positive attitudes.

Our findings also revealed a number of restaurant characteristics associated with food allergy knowledge and attitudes. Food workers in restaurants with higher priced food and servers in full service restaurants were more knowledgeable about food allergies. These characteristics might be indicative of restaurants with more resources to hire and retain staff who are more knowledgeable in general. Servers who served more meals per day also were more knowledgeable, perhaps because they recited the ingredients in meals to customers more frequently. Food workers in chain restaurants and those in restaurants with a lower worker-to-manager ratio also had positive food allergy attitudes.

Several allergy-specific practices were consistently related to knowledge and attitudes for managers, food workers, and servers. Serving more meals to food allergic customers was positively related to manager knowledge and attitudes but not to food worker and server knowledge and attitudes. Although staff are all involved in the process of serving food allergic customers, managers have more of the burden to ensure a meal is allergen free, especially if they are designated as the specific person in the restaurant to handle food allergy questions and requests. Having a plan for answering questions from food allergic customers or having a specific person to answer food allergy questions and requests was positively related to food allergen knowledge and attitudes for all staff groups. Both of these practices are recommended by the Food Allergy Research and Education group (8) as part of a restaurant's food allergy management plan. Research concerning the direction of the relationship between restaurant practices and food allergy knowledge and attitudes should be explored.

Food allergy training was associated with positive manager and server attitudes but not with knowledge in any staff group. These findings suggest that food allergy trainings influence attitudes but either do not impart enough food allergy knowledge or do not result in retention of that knowledge. Relevant material for these trainings can include information on major food allergens, menu items containing food allergens, symptoms of an allergic reaction, interacting with food allergic customers, preparing for a food allergic reaction, and preventing cross-contact with allergens. Food allergy training can also be provided to new employees, and existing staff can be retrained periodically. Further research could explore which training techniques are most effective and result in long-term retention of important food allergy information.

Counterintuitively, the presence of allergen information on the menu was associated with less positive attitudes for managers. In 55% of these menus, the allergen information was a note for the customer to inform the restaurant if they or someone with them had a food allergy. In at least one of the data collection sites, legislation requires restaurants to state in the menu that customers should notify the server of any food allergies. Such legislation may produce situations in which even managers with less positive food allergy attitudes still include such notices on their menus. As more states and cities adopt food allergy laws, the extent to which these laws affect restaurants' food allergy practices can be evaluated. In any case, alerting customers to menu items containing allergens or encouraging these customers to notify staff regarding their allergies might help prevent allergic reactions. Only 22% of restaurant menus mentioned anything about allergens; we encourage more restaurants to include information about allergens on their menus.

This study had several limitations. Because we included only English-speaking managers, food workers, and servers in the study, the findings might not generalize to non-English speakers. Similarly, because the interviewed food workers and servers were chosen by managers rather than randomly, the food worker and server data might not be representative of these groups as a whole. This study also had a low participation rate (32.6%). The low response rate might have resulted in an overrepresentation of better and safer restaurants in the sample. In reporting results of a food allergen survey that also had a low response rate (4), the authors suggested that a lack of participation might reflect "a general discomfort in responding to an inquiry regarding food allergies." In comparison to other food safety topics, food allergies have emerged more recently, and managers might not feel as comfortable participating in research. Almost all participants in the present study had very favorable food allergy attitudes. This range restriction limited our ability to investigate the relationship between explanatory variables and attitudes. We also were not able to make causal inferences about the relationships between explanatory and outcome variables. For example, knowledgeable managers may attract and retain more customers with food allergies, or an increase in customers with food allergies may compel staff to acquire additional knowledge about allergens. We cannot determine whether serving more

customers with food allergies leads to higher knowledge levels. Thus, although our data suggest significant relationships between several restaurant, manager, and staff characteristics and food allergy knowledge and attitudes, more research is needed to determine the causal nature of those relationships.

Overall, these findings suggest that managers, food workers, and servers are knowledgeable and have positive attitudes about accommodating customers with food allergies. We encourage restaurants to develop plans and designate a specific person to handle food allergy requests. Such practices were consistently associated with better knowledge and more positive attitudes. Food allergy training is also recommended for new and existing managers and staff.

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