



A Comparison of Overall Versus Duty-specific Food Poisoning Prevention Knowledge among Restaurant Food Handlers

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ABSTRACT

Data collected in a baseline knowledge survey of Chicago restaurant food handlers were analyzed to determine knowledge scores related to questions relevant to the food handler's job duties. It was hypothesized that food handler knowledge scores would be higher when only the score based on the questions more relevant to their duties was determined, rather than the overall score that included all knowledge questions in the score denominator. The mean knowledge score for the meat and poultry food handlers ($n = 372$) was 71% on the overall survey and 75% when the score based on only the questions specifically relevant to their duties was calculated. Among the findings in a multivariable model, meat or poultry handlers whose primary language was Spanish (with or without the ability to speak English) or other language (with the ability to speak English) scored significantly lower than persons for whom English was their primary language, after controlling for confounding variables. Despite the fact that a knowledge survey of meat and poultry restaurant food handlers was limited to meat and poultry relevant questions, the mean knowledge score was not substantially higher than their mean score on a more general food safety knowledge survey.

A peer-reviewed article

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INTRODUCTION

In the United States, foodborne disease causes millions of illnesses each year, resulting in thousands of deaths and substantial economic costs (5). On any given day, it is estimated that 40% of the U.S. population eats food in a restaurant (4). Restaurants or delicatessens are the most frequently reported sources of the food reported to have been eaten in foodborne outbreaks (1). However, few data have been published on food safety knowledge of U.S. restaurant food handlers. DeBess and colleagues surveyed 407 food handlers working at 67 restaurants in two Oregon counties in 2000 (3). This study reported a relatively low overall knowledge score (68%), similar to that found in studies we have performed in Chicago (71%) and the Chicago suburbs (72%) (6). Although food safety behavior is an overriding concern and some restaurants have systems in place to minimize the influence of poor food handler food safety knowledge on risk to consumers, food safety knowledge remains a fundamental priority because knowledge influences behavior.

When food safety knowledge surveys are performed, a spectrum of questions may be asked and the overall knowledge score summarized. A critic of such studies may believe the surveys are biased toward showing poor results because each food handler's score is calculated from responses that include questions that are not relevant to that individual's routine duties as part of a general overview of food safety knowledge. For example, if a food handler who works in a restaurant where no seafood is served does not know the correct response to a seafood knowledge question, although this does reflect a lack of overall food safety knowledge, it may not reflect a potential risk to the consumer. An examination of food safety knowledge survey data that excludes survey questions not relevant to the food handler's duties might be more useful in understanding how to target educational interventions to reduce the risk of restaurant-related food poisoning. No study has examined food handler knowledge that was based only on

questions relevant to the food handler's job duties. We analyzed data collected in a baseline knowledge survey of Chicago restaurant food handlers to determine knowledge scores related to questions relevant to the food handler's job duties. We hypothesized that food handler knowledge scores would be higher when the score based only on the questions more relevant to their duties was determined, rather than the overall score that included all knowledge questions in the score denominator.

MATERIALS AND METHODS

Sample

A list of 5,935 food establishments was provided by the Chicago Department of Public Health through a Freedom of Information Act (FOIA) request. Of these, 5,584 (94%) were commercial restaurants based on restaurant Standard Industrial Classification (SIC) codes. To limit the study to restaurants, banquet halls, caterers, and establishments that serve non-perishable packaged foods and those considered low risk by the health department were excluded (2). A random sample of 650 restaurants was then selected to be approached. Restaurant managers were approached for verbal approval to consent food handlers at each restaurant. From a total of 125 participating restaurants, 508 food handlers were interviewed during January through July 2009. A signed consent form was obtained from each participant and confidentiality of food handler and restaurant name was assured. Food handlers who did not speak either English or Spanish or were less than 18 years of age were excluded from participation.

Data collection

A survey that asked 41 knowledge questions was developed and tested in a pilot study after review of USDA and FDA Internet sites, the National Restaurant Association's educational materials, expert opinion (in part derived from local and state health department input), and published literature of restaurant-associated foodborne out-

breaks. The survey included true-false and multiple-choice questions. The primary knowledge subject areas were optimal temperatures for bacterial growth, appropriate temperatures for heating and cooling foods, cross contamination, and relevant behavior such as practices related to working while ill and hand hygiene. The food handlers could choose to have the survey administered in English or Spanish, based on their personal preference. Participants were asked for information on ethnicity, history of food safety training, and years of food handling experience. Data on restaurant characteristics such as type of service style (for example, fast food or formal) and average entrée price were also collected. All surveys were completed discreetly at the food handlers' place of employment. Each participating food handler was offered compensation of \$20.00. Approval from the University of Illinois at Chicago Institutional Review Board for the Protection of Human Subjects was obtained before initiation of the study. For this study, task-relevant knowledge scores for the 372 meat or poultry handlers were calculated and analyzed.

Outcome measurement

Among 41 knowledge questions on the food handler questionnaire, 13 questions were specific to meat or poultry handling or cooking and 18 questions were general knowledge questions relevant to any food handler. All 31 questions were considered relevant to a meat or poultry handler's duties, and therefore the task-relevant knowledge score was the number of correctly answered questions out of these 31 questions. The other 10 questions, specific to seafood, egg, vegetable, rice and fruit handling, were excluded. A question was considered incorrect and assigned a 0 value if the food handler answered with a wrong response or responded that he or she did not know the correct answer; I was assigned to a correctly answered question.

Statistical analysis

Bivariate analysis was performed to explore the association between

TABLE 1. Frequency of incorrect responses to meat or poultry food handling knowledge questions among 372 Chicago restaurant meat or poultry food handlers

Questions (Answers)	Incorrect Responses	
	Question types	N (%)
Uncooked chicken is potentially contaminated with germs that can cause people to become very ill. (True)	True/False	11 (3)
Raw meat can be stored above ready-to-serve food. (False)	True/False	28 (7.5)
Uncooked beef is potentially contaminated with germs that can cause people to be hospitalized or die. (True)	True/False	34 (9.1)
Beef may be placed in the refrigerator to defrost. (True)	True/False	60 (16.1)
Vegetables for a salad splashed with a few drops of raw chicken juice should not be served but must be thrown away. (True)	True/False	61 (16.4)
Beef may be placed on the counter to defrost. (False)	True/False	63 (16.9)
It is safe to put frozen chicken breast on the counter to thaw. (False)	True/False	91 (24.5)
Beef may be placed in cold water to defrost. (True)	True/False	112 (30.1)
Raw meat can be stored below ready-to-serve food. (True)	True/False	116 (31.2)
Eating ground meat that is not completely cooked can cause bloody diarrhea. (True)	True/False	137 (36.8)
Raw meat can be stored anywhere in a refrigerator when it is wrapped in plastic. (False)	True/False	169 (45.4)
Raw meat can be stored on foil-lined shelves to prevent dripping onto other foods. (False)	True/False	209 (56.2)
Beef may be placed in the microwave to defrost. (True)	True/False	243 (65.3)

mean task-relevant knowledge score and food handler or restaurant variables. *t*-tests were conducted to compare the mean knowledge scores between levels of binary variables. Analysis of variance models and Tukey's pairwise comparisons were employed to compare the mean knowledge scores for categorical variables with more than two categories. Pearson correlation coefficients were calculated to describe the relationship between the knowledge score and a continuous variable, such as age and number of food handling years. Variables of primary research interest, such as primary language, and those that had a statistically significant association ($P < 0.1$) with the knowledge score were included in the multivariate analysis. In the multivariate analysis, first, a mixed-effects regression model predicting the knowledge score with a random restaurant effect was employed. The use of a random restaurant effect allowed us to test and account for potential correlation between food handlers from the same restaurant. A

significant within-restaurant correlation (β [SE] = 1.04 [0.59], $P = 0.04$) led to the choice of the mixed linear regression model using all food handler and restaurant characteristics predicting the knowledge score. Backward variable selections were performed for the regression model, using a Type I Error of $\alpha = 0.10$ to ensure the inclusion of any useful information. Statistical (bivariate and multivariate) analyses were performed using SAS software on data from 368 meat or poultry food handlers who had no missing data, while frequency data on knowledge scores were derived from all 372 of these food handlers.

RESULTS

Among 508 food handlers interviewed, 372 were meat or poultry handlers (73%), including 287 who both handled and cooked meat or poultry and 85 who only handled meat or poultry. Of the participating food handlers, 150 were certified managers (40.3%). The sum of the 31 task-relevant ques-

tions yielded a total knowledge score, ranging from 12 to 31, with a mean score of 75% (23.3/31) and a median of 77% (24.0/31). The mean score for only the meat and poultry specific questions was 72% (9.4/13) and for the general knowledge questions was 77% (13.9/18). As expected, the mean score of task-relevant questions was higher, but not substantially higher, than that of the original 41 knowledge questions (75% vs. 71%). Meat and poultry handlers who reported a history of any food safety training course ($n = 245$) had a mean total knowledge score of 24.5 (79%) compared to a score of 21.0 (68%) for those who did not ($n = 127$) ($P < 0.0001$).

Examination of the data by primary language of the food handler revealed several findings relevant to planning prevention education. In a sub-analysis of only those restaurants that had at least one non-manager meat or poultry food handler participating in the survey, we examined the data to determine how often there might be a

TABLE 2. Frequency of incorrect responses to general food safety knowledge questions among 372 Chicago restaurant meat or poultry food handlers

Questions (Answers)	Incorrect Responses	
	Question types	N (%)
Is it OK to put ice in a glass by picking up ice with your bare hand? (No)	Yes/No	6 (1.6)
Gloves used to handle ready-to-eat food should be thrown in the trash when interruptions occur in operations. (True)	True/False	10 (2.7)
At work if you only urinated, and did not have a bowel movement, you do not need to wash your hands? (False)	True/False	19 (5.1)
Do you need to have thoroughly washed hands if you use deli tissue to handle food? (Yes)	Yes/No	29 (7.8)
It is OK to put ice in a glass by using an ice-scoop? (Yes)	Yes/No	37 (10)
It is OK to put ice in a glass by scooping the glass into the ice? (No)	Yes/No	44 (11.8)
Do you need to have thoroughly washed hands if you use a spatula or tongs to handle food? (Yes)	Yes/No	44 (11.8)
A food handler with a small infected cut on his/her finger prepares a sandwich that is kept warm but not hot. The person who eats that sandwich could become ill with vomiting or diarrhea. (True)	True/False	52 (14.0)
Do you need to have thoroughly washed hands if you use single-use gloves to handle food? (Yes)	Yes/No	55 (14.8)
Is it OK to dry your hands by using a kitchen towel or your apron after washing your hands? (No)	Yes/No	62 (16.7)
Is it OK to wet your hands with warm running water before washing your hands? (Yes)	Yes/No	95 (25.5)
Is it OK to turn off the water by using your bare hand after washing your hands? (No)	Yes/No	97 (26.1)
Is it okay to put ice in a glass by using tongs? (Yes)	Yes/No	100 (26.9)
What is the difference between cleaning and sanitizing? (Cleaning is to remove food or other types of soil from a surface but sanitizing is to reduce the number of germs on a clean surface to safe levels)	Multiple choice	107 (28.8)
We store products with the earliest expiration dates in front of products with later dates. (True)	True/False	124 (33.3)
You can be sure food is safe to eat when it smells and tastes normal. (False)	True/False	134 (36.0)
Cold food must be kept at 55°F or lower. (False)	True/False	171 (46.0)
Germs that make people sick grow well between which temperatures? (Between 40° or 41° to 135° or 140°F)	Fill-in-the-blank	324 (87.1)

language disconnect between the manager and the staff. Fifty-one percent of the Spanish-speaking meat or poultry handlers who worked under a manager, versus only 34% of the certified managers, spoke Spanish as their primary language. In other words, approximately one out of six of these manager-staff food handler pairs included a manager who did not speak the primary language of his or her staff. Restaurants that had an English and Spanish speak-

ing (bilingual) manager (n = 8) and restaurants with English-speaking managers (n = 30) scored higher than those with Spanish speaking managers (n = 21) (overall 75%, 74%, and 68%, respectively, $P < 0.05$).

The responses to knowledge questions that were specific to meat or poultry handling demonstrated several important substantial knowledge gaps (Table 1). Knowledge of proper storage of raw meat was poor, as evidenced by 56% of the meat and poultry

handlers being unaware of the need to avoid storing raw meat on foil-lined shelves and nearly 46% not knowing that just because raw meat is wrapped in plastic does not mean that it can be stored anywhere in a refrigerator. Also, almost 8% answered that raw meat can be stored above ready-to-serve food. Although this latter percentage is reassuringly below 10%, it still indicates that one out of approximately 12 of these restaurant meat or poultry han-

TABLE 3. Comparison of the mean scores for meat or poultry handling questions by demographics and other characteristics (N = 372)

Independent variables	N (%)	Mean ^a (SD)/ Range
Primary language (F test: $P < 0.0001$)		
Others	26 (7)	21.8* (3.6)/13–28
Spanish	163 (44)	21.7* (3.5)/12–30
English (Reference group)	183 (49)	25.0 (3.2)/14–31
Gender (F test: $P = 0.628$)		
Male	271 (73)	23.4 (3.8)/12–30
Female (Reference group)	101 (27)	23.2 (3.6)/12–31
Race (F test: $P < 0.0001$)		
Non Hispanic Black	50 (13)	24.3* (3.0)/17–29
Other	33 (9)	23.1*(3.2)/17–29
Hispanic	205 (55)	22.0* (3.7)/12–31
Non Hispanic White (Reference group)	83 (23)	26.0 (2.7)/19–30
Education (F test: $P < 0.0001$)		
Below high school	78 (21)	21.9* (3.1)/14–28
High school	106 (28)	21.8* (3.7)/12–30
Above high school (Reference group)	188 (51)	24.9 (3.3)/14–31
Certified manager (F test: $P < 0.0001$)		
No and not certified	127 (34)	21.0* (3.3)/12–28
No but certified	95 (26)	23.6* (3.6)/15–31
Yes and a manager (Reference group)	150 (40)	25.2 (3.0)/14–30

^aVariables with mean scores that are statistically different from mean scores of the reference group are denoted

dlers might unhesitatingly place ready-to-serve food at such a risk. Such a number may still be unacceptably high, given the large volume of both meat and poultry handlers and customers that they serve.

Other revealing findings about food safety knowledge among these meat and poultry handlers included their lack of knowledge of the severity of illness that can result from incompletely cooked ground meat and of important unacceptable practices related to thawing and cross-contamination. More than one-third did not know that something as alarming as bloody diarrhea could result from incomplete cooking of ground meat. This

raises the concern that they may not appreciate the rationale for (or even know about) the recommendations for checking temperatures in a menu item such as meatloaf. Similarly, lack of knowledge of appropriate thawing of beef and poultry (16.9% and 24.5% of these meat and poultry handlers, respectively) could lead to amplification of pathogen burden in contaminated meat products. Failure to discard ready-to-eat food (such as vegetables for a salad) that have recognizably been contaminated with raw poultry places consumers at clear risk of food poisoning caused by germs such as *Salmonella* and *Campylobacter* (16.4% of meat and poultry handlers answered the question on this topic incorrectly).

Several important and substantial knowledge gaps were also revealed by the responses to questions that were of general importance but not specific to meat and poultry handling alone (Table 2). Knowledge of the temperature “danger zone” in which foodborne pathogens may grow well (nearly 88% did not know one or both of these temperatures) and of best hygiene practices such as knowing not to use bare hands to turn off the water after washing hands (26% did not answer correctly) was unacceptably low. There was also poor understanding of the difference between cleaning and sanitizing and the unreliability of smell and taste to ensure that food is safe to eat (nearly 29% and 36% answered incorrectly, respectively).

TABLE 4. Comparison of the mean scores for meat or poultry handling by restaurant characteristics (N = 372)

Independent variables	N	Mean total score ^a (SD), range
Restaurant variables		
Size of restaurant (F test: $P = 0.01$)		
Small	135 (36)	22.6* (3.5)/12–30
Medium	97 (26)	23.6 (3.9)/13–31
Large (Reference group)	140 (38)	24.0 (3.7)/12–30
Food service (F test: $P < 0.0001$)		
Fast food	111 (30)	22.3* (3.9)/12–30
Informal	161 (43)	23.5* (3.6)/14–30
Formal (Reference group)	100 (27)	24.7 (3.3)/17–31
Type of food served (F test: $P = 0.014$)		
Other cuisine	47 (13)	22.8 (3.7)/14–30
Mexican	52 (14)	22.3* (3.7)/12–30
Italian	53 (14)	23.9 (3.6)/15–29
American (Reference group)	220 (59)	23.8 (3.7)/12–31
Restaurant specialty (F test: $P = 0.002$)		
Seafood	15 (4)	24.7* (2.9)/20–29
Non specific	289 (78)	23.6* (3.6)/12–31
Meat or Poultry (Reference group)	68 (18)	22.0 (4.3)/12–30
Restaurant chain (F test: $P = 0.0005$)		
Yes	155 (42)	22.6 (3.7)/12–29
No (Reference group)	217 (58)	23.9 (3.6)/12–31
Entrée price (F test: $P < 0.0001$)		
< \$10	215 (58)	22.6* (3.8)/12–30
\$10–\$20	100 (27)	23.6* (3.4)/15–31
> \$20 (Reference group)	57 (15)	25.8 (2.9)/18–30

^aVariables with mean scores that are statistically different from mean scores of the reference group are denoted by an asterisk ($P < 0.05$).

The meat and poultry handler variables that were significantly associated ($P < 0.05$) with the mean knowledge score were age, primary language, race/ethnicity, education, number of years experience as a food handler, and history of a food safety training course, stratified by whether the food handler was or was not a manager (Table 3). The restaurant variables that were

significantly associated with the mean knowledge score were restaurant size (small, medium or large), type of food service (formal, informal or fast food), type of food served (e.g., Italian cuisine or Mexican cuisine), specialization of food (seafood, meat or poultry, or not specialized), membership in a restaurant chain (yes or no), and entrée price (< \$10, \$10 – \$20, or > \$20) (Table 4).

In the final multivariable model, a significant correlation between knowledge scores of food handlers from the same restaurants was detected by use of a random restaurant effect (β [SE = 1.12 [0.57], $P = 0.02$]. Meat or poultry handlers whose primary language was Spanish (with or without the ability to speak English) or other language (with the ability to speak English) scored

TABLE 5. Multivariable model demonstrating food handler and restaurant characteristics associated with lower knowledge scores among 368 meat and poultry restaurant food handlers in Chicago

Predicting variables	Description	N (%)	Coefficient (SD) ^a	P-value
Race/ Ethnicity	Non Hispanic Black	50 (14)	-1.28 (0.54)	0.018
	Other	33 (9)	-0.75 (0.62)	0.23
	Hispanic	204 (55)	-1.74 (0.55)	0.0016
	Non Hispanic White	81 (22)	Ref	Ref
Primary language	Other	24 (7)	-2.25 (0.72)	0.002
	Spanish	163 (44)	-1.59 (0.48)	0.0010
	English	181 (49)	Ref	Ref
Certified manager	No but certified	127 (35)	-1.54 (0.39)	<0.0001
	No and not certified	93 (25)	-3.20 (0.36)	<0.0001
	Yes	148 (40)	Ref	Ref
Entrée price	< \$10	212 (58)	-1.74 (0.63)	0.0061
	> \$10 but < \$20	99 (27)	-0.99 (0.68)	0.142
	> \$20	57 (15)	Ref	Ref

^aCoefficient results demonstrate how many knowledge questions greater or fewer than the reference group were answered correctly.

significantly lower than persons for whom English was their primary language, after controlling for confounding variables (Table 5). Other variables associated with lower scores were race/ethnicity (i.e., Black or Hispanic compared to White), and working as a certified meat or poultry handler, (certified managers scoring better than non-managers and noncertified non-managers). Among restaurant characteristics, meat or poultry handlers in low-priced restaurants significantly underperformed compared to those in higher priced restaurants.

DISCUSSION

Despite the fact that a knowledge survey of meat and poultry restaurant food handlers was limited to meat and poultry relevant questions, the mean knowledge score was not substantially higher than their mean score on a more general food safety knowledge survey. Food safety policy makers should consider these findings and determine if current training and certification re-

quirements are adequate, given that some of the knowledge gaps identified were substantial. These and other published results of food safety knowledge may in part explain why restaurant foodborne disease outbreaks associated with food handler error continue to occur throughout the country despite food safety certification programs and health department inspections and requirements.

One policy change to consider is that food safety certification should require a higher score on the certification exam. Possibly, a near perfect score should be required on the questions that are associated with recognized risk factors for foodborne illness (such as those dealing with time and temperature, hand hygiene, cross contamination, and cleaning and sanitizing). When considering such a change, it may be worth asking oneself, “to which questions on the exam is it acceptable for a food handler to not know the correct responses and yet still be allowed to handle food for the public (including vulnerable populations?)” Another

change to consider is whether restaurant inspectors from local health departments should focus more of their limited inspection time on questioning and educating food handlers, especially those without a history of training. It is not clear that food safety certified food handlers or other sources of on-the-job training are adequately teaching these food handlers, given that food handlers without a history of training were demonstrated in our study to have lower food safety knowledge relevant to their duties. Health department inspectors should also consider engaging restaurant managers in discussions of the need to ensure that food handler knowledge regarding their duties is no less than that of the managers and to identify language barriers to such education. If managers cannot communicate adequately with their food handler employees because of language barriers, health departments should explore whether resources are available to provide language-specific educational materials to these non-English food handlers in an attempt to minimize these knowledge gaps.

These data are derived from Chicago restaurant food handlers whose voluntary consent to participate was obtained only if their managers allowed it. For 28 of the restaurants, only certified managers who handled food performed the survey and no additional non-manager foodhandlers were available. Therefore, our data might overrepresent the knowledge of food handlers, because participation bias may have occurred, in which food handlers with certification and/or other training were more likely to participate. Also, we suspect that some foreign-born food handlers may have been illegal immigrants who were unwilling to participate because they would have been required to sign a consent form. The proportion of food handlers who speak Spanish as their primary language may have also been underestimated for this same reason. Therefore, additional studies of this kind would be helpful to validate these findings.

The United States has many strong systems in place to prevent food poisoning, including public health surveillance systems designed to detect outbreaks and promote prevention practices in response to reported cases of foodborne disease; local, state and federal health department staff trained in outbreak investigation; government

and nongovernment training programs to certify food handlers in food safety; and regular inspections to monitor compliance with important food safety practices. Despite these systems, typically more than 1,000 foodborne outbreaks are reported each year (1) and it is likely that many more go unrecognized. The data in this study demonstrate that while many food handlers are either certified or work with a certified manager, despite the fact that the survey questions were limited to the ones most relevant to the duties of these food handlers, their level of food safety knowledge is, on average, not very high. Novel educational methods to reach more food workers, including the uncertified ones, are needed.

ACKNOWLEDGMENTS

This study was supported by the National Institute of Food and Agriculture of the United States Department of Agriculture (Award Number 2008-51110-04343). The authors thank the City of Chicago Health Department, Cook County Health Department, Lake County Health Department, Kane County Health Department, DuPage County Health Department, and the Illinois Department of Public Health for advice related to survey development and project feedback.

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