



The CHEF Project: Results of a Randomized Bilingual Dual Format Passive Restaurant Food Handler Educational Intervention in Chicago

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SUMMARY

Restaurants are frequently reported as sources of the food associated with foodborne disease outbreaks. Using educational materials produced in English and Spanish, in formats that consisted of a straight forward brochure and a booklet in an illustrated story-based style (comic book), this study determined the efficacy of this educational intervention when distributed in a passive manner. From a total of 125 participating restaurants, 508 food handlers who spoke either English or Spanish were interviewed during January through July 2009 to determine baseline knowledge and identify which knowledge questions were most frequently answered incorrectly. An educational brochure and a comic book were then created based on the knowledge gaps most frequently identified from the baseline knowledge study. Forty-two restaurants (128 food handlers) from the intervention group and 35 restaurants (101 food handlers) from the control group participated in the follow-up knowledge survey. The knowledge score increased by 1.7 points (6 percentage points knowledge score rise, from 67% to 73%) among the 35 food handlers that read either or both of the intervention materials ($P < 0.05$). Knowledge in the intervention group about bloody diarrhea being a possible manifestation of eating ground meat that is not completely cooked increased by 32% ($P = 0.005$). These data demonstrate that even with a passively delivered educational intervention, significant knowledge increases may be observed among restaurant food handlers.

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INTRODUCTION

Each year in the United States, foodborne diseases causes millions of illnesses resulting in thousands of deaths and substantial economic costs (11). On any given day, an estimated 40% of the U.S. population eats food in a restaurant (8). Restaurants and delicatessens are most frequently reported as the source of the food associated with foodborne outbreaks (3). However, few studies on food safety knowledge of U.S. restaurant food handlers have been published. To determine knowledge gaps that should be prioritized for development of a targeted educational intervention, 508 food handlers in a random sample of 125 Chicago restaurants were surveyed on information relevant to foodborne disease outbreak prevention. The overall restaurant food handler knowledge score was 71% (14). Even after re-analyzing the data, examining the largest subgroup of food handlers (meat and poultry food handlers) and determining their knowledge of only those questions relevant to their actual duties, the researchers found that knowledge score was still below 80% (6). Although food safety behavior, rather than knowledge, is the overriding concern, and some restaurants have systems in place to minimize the influence of poor food handler knowledge, food safety knowledge remains a fundamental priority and is often the first step in promoting desired behavior.

Important challenges to improving food safety behavior in restaurants include languages spoken and differences in preferred learning styles. For example, data from Chicago and Los Angeles indicated that the primary language spoken was a language other than English for 47% and 49% of restaurant food handlers, respectively (9, 14). Restaurant managers and health department sanitarians may benefit from educational materials provided in languages other than English, particularly in Spanish. For example, in Chicago, 40% of the food handlers interviewed spoke Spanish as their first language (14). Using educational materials produced in English and Spanish in formats that included a straightforward brochure and a book in an illustrated story-based style (comic book), this study (the CHEF [Chicago Educational Food Handler] Project) determined the efficacy of this educational intervention when materials were distributed in a passive manner (providing materials to restaurant managers and encouraging them to have their food handlers read them). An important

aim was to evaluate the efficacy of the intervention on increasing the overall knowledge score as well as the effect on critical knowledge items such as those concerning time-temperature issues and hygiene. Food handlers' preferences for the format of learning and intervention compliance were also of interest. In Illinois, state regulations require at least one certified responsible individual to be on-site at all times at restaurants when potentially hazardous food such as eggs, poultry, beef, and shellfish are being prepared or served (*personal communication, Chicago Department of Public Health*).

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, by the criteria of restaurant Standard Industrial Classification (SIC) codes. To limit the study to higher-risk restaurants, banquet halls, caterers, and those considered low risk, such as establishments serving food that may have been packaged in a commercially inspected facility or foods that are nonperishable, were excluded (4). An example of an excluded low-risk establishment would be a coffee house that serves pre-packaged sandwiches and pastries. A random sample of 650 restaurants was selected. Restaurant managers were approached for verbal approval to interview their food handlers. The managers were told that the researchers would assist in the creation of educational materials based on the survey information and would provide those materials to approximately half of the randomly selected participating restaurants. They were also told that a follow-up knowledge survey would be performed beginning within one month after the distribution of the educational materials at all of the restaurants, and non-intervention restaurants would receive the educational materials after the conclusion of the intervention. From a total of 125 participating restaurants, 508 food handlers were interviewed during January through July 2009 to determine baseline knowledge and identify which knowledge questions were most frequently answered incorrectly. The intervention materials were distributed during February and March 2010 and the follow-up interviews were performed during March through July 2010. 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 and were younger than 18 years of age were excluded from participation.

Data collection

A questionnaire that asked 41 knowledge questions was developed and pilot tested after review of United States Department of Agriculture (USDA) and Food and Drug Administration Internet sites, the National Restaurant Association's educational materials, expert opinion (in part derived from local and state health department input), and published literature on restaurant-associated foodborne outbreaks. The survey included true-false, multiple-choice, and fill-in-the-blank formats. 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. 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. The participating food handlers were offered compensation of \$20.00. Approval from the University of Illinois at Chicago Institutional Review Board for the Protection of Human Subjects was received before the initiation of the study. The follow-up survey consisted of the same knowledge questions and was administered to the food handlers at intervention and non-intervention restaurants after creation of the educational materials.


Development of the educational intervention materials

An educational brochure and a comic book were created based on the most frequently identified knowledge gaps from the baseline knowledge study (14). The same twenty-six knowledge points were presented in both the brochure and the comic book. Any knowledge question that was answered incorrectly by at least 20% of the food handlers, either overall or by either of the two subgroups (Eng-

FIGURE 1. Side 2 of the English language brochure used in a food safety educational intervention for Chicago restaurant food handler

DON'T WORK WHEN YOU ARE SICK


In an outbreak of food poisoning, a bartender came to work when he had an illness with vomiting and diarrhea. Then that restaurant's line cook became sick with vomiting near his workstation. Eventually, there were 364 restaurant customers and 17 restaurant employees that became sick too.



FOOD POISONING IS WORTH PREVENTING

In an outbreak of food poisoning, a fast food restaurant chain served hamburgers that were not cooked long enough to kill the germs that had contaminated the meat. The germ (called *E. coli*) caused **bloody diarrhea** and in some persons it caused kidney failure. More than 500 people were sickened. Three children died including a 2 year old boy.

The USDA recommends you cook hamburgers and ground meat mixtures like meatloaf to an internal temperature of 160°F (71°C) (use a meat thermometer).




Here Is A Selection of Important Food Safety Recommendations

TIME AND TEMPERATURE

Many germs that cause food poisoning grow well between 41°F and 135°F (5°C and 57°C). Allowing food to sit for prolonged times in this temperature range is often called temperature abuse.

Frozen animal products like meat and poultry may be thawed in the refrigerator, submerged under running tap water (if the water is no warmer than 70°F (21°C), or in a microwave if it will be cooked immediately afterward. Avoid microwave thawing of large meat portions like a turkey.


When cooking poultry, heat until the internal temperature has reached 165°F (74°C) for at least 15 seconds. Use a metal stem thermometer and insert it into the thickest part of the meat.



Foil-lined shelves can decrease the circulation of cold air in a refrigerator.

Cooling hot food in the refrigerator is not a safe practice. Putting warm food in the refrigerator may make the refrigerator temperature go above 41°F (5°C) and help germs to grow. Remember, refrigerators are designed to keep cold food cold; not to cool food down.

Some fish like tuna, mackerel, and mahi mahi can have germs that can make a chemical called histamine when the fish is not kept cold. When you cook the fish, the germs die but the histamine survives and makes people who eat the fish get sick.



PERSONAL CLEANLINESS

Use warm water to wash hands. Apply soap and rub hands for 10 to 20 seconds. Rinse thoroughly. Don't dry hands on an apron. Dry them with a clean paper towel and use that paper towel to turn off the water.

CROSS CONTAMINATION

It is risky to place raw meat above cooked and ready-to-eat food in the refrigerator even if the shelf between them was foil-lined and even if the meat was wrapped in plastic. Even raw eggs still in their shells should not be placed over ready to eat foods. Accidents happen with spilling or dripping and these accidents can may cause serious disease in persons who eat the contaminated food. Food contamination may be so small, no one sees it.

OTHER IMPORTANT INFORMATION

In the refrigerator, keep similar foods that expire the earliest in front and have later expiring foods in the back. That way, you are helping to prevent reaching in the refrigerator and pulling out expired food. But this does not guarantee that food can't expire in the refrigerator so do check expiration dates as a routine.

Food can smell or taste normal but still be able to make someone sick. You cannot rely on smell and taste to be certain.

Raw eggs can have germs that make people sick.

Do not store raw animal products like meat or poultry above ready to serve foods like vegetables or salad.

Do not thaw meat or poultry on the counter.

Do not turn off water with bare hands after hand washing.

lish speakers or Spanish speakers) was included for presentation in both materials. In addition, two other food safety facts were included in the educational materials, because of their importance in the prevention of foodborne disease (where meat thermometers should be inserted [the thickest part of the meat] and the requirement that raw meat not be stored above ready-to-serve food). In the baseline knowledge survey, these two questions were answered correctly by ≥ 84 percent of food handlers, either overall or among the English- or the Spanish-speaking group.

The tri-fold brochure included food safety facts that demonstrated the public health importance of the problem, statements of the targeted educational information, and several "test yourself" questions, with their answers. The comic book was the result of collaboration between one of the authors (MD) and an artist. It presented the same food safety facts and "test yourself" questions as the brochure; however, many of the food safety facts were presented in a story of a

restaurant food handler preparing a meal for a food critic. In this story, a tiny chef recognizes and instructs the many errors in food handling identified in order to protect the critic from food poisoning and the restaurant from a bad review. In addition, two published outbreaks were summarized and illustrated one of norovirus that emphasized the importance of not working while ill (2) and the other of the multi-state *E. coli* outbreak from hamburgers that emphasized the potential severity of illness as well as how meat may become contaminated, and how to prevent transmission (1). Some concepts were repeated on different pages to increase the likelihood that a reader might recall the fact (such as the dangerous temperature range in which germs grow best). The materials were translated and back-translated into Spanish and reviewed by English- and Spanish-speaking food handlers in focus groups. The focus group participants (n = 8) were selected on the basis of convenience, from restaurants located near University of Illinois at Chicago School of Public Health, that

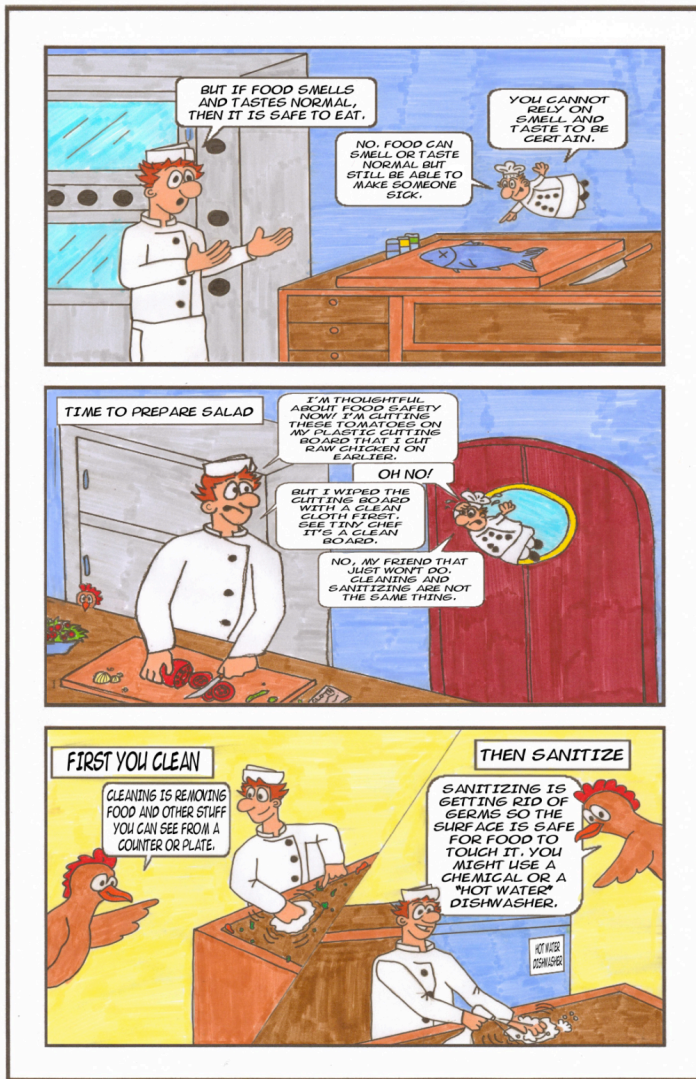
were not part of the study. The authors visited these restaurants and asked for the food handlers' opinions regarding clarity, receptivity, and recommendations for improvement of the materials. Afterwards, the materials were further edited and then approved by the University of Illinois at Chicago Institutional Review Board for the Protection of Human Subjects.

Sixty-two restaurants (276 food handlers) were randomly assigned to the intervention group and 63 (232 food handlers) to the control group. The intervention materials were hand delivered to intervention restaurants with a reminder that they were part of the educational survey project, and restaurant managers were told that the restaurant food handlers should read them. Portions of the interventions are presented in figures 1, 2a, and 2b.

Measurements

A knowledge score was created, equal to the number of questions an-

FIGURE 2a. Example of a story of a restaurant food handler making mistakes



answered correctly out of 26 knowledge questions that were specifically addressed in the educational materials; each correct answer yielded one point toward the knowledge score. The primary subject areas included optimal temperatures for bacterial growth, appropriate temperatures for heating and cooling foods, cross contamination, and relevant behavior such as hand hygiene. Factors that were potentially associated with knowledge included food handler characteristics (e.g., ethnicity, history of food safety training, and years of food handling experience) and restaurant characteristics such as type of service (fast food versus formal), average entrée price, food courts (yes/no), chain (yes/no), restaurant size (small, medium, or large) and whether the restaurant was located in a low socioeconomic area. More details regarding the sample and measurements of this study have been previously reported (14).

Statistical analysis

For analysis of the effect of the intervention, we compared food handlers who read the materials to those, at the nonintervention restaurants, who did not. If food handlers stated that they had only looked at, rather than read, the materials, this was considered insufficient to include them in the intervention group and they were therefore excluded from this portion of the analysis. Also excluded were any food handlers who, although employed at intervention restaurants, had neither read nor looked at the materials. Paired T-tests were performed to assess whether the post-intervention survey yielded a higher score than the pre-intervention survey in either group. A two-sample T-test was employed to evaluate whether the knowledge increase was statistically higher in the intervention group than that in the control group. Chi-square tests were performed to compare the number of intervention food handlers who read the

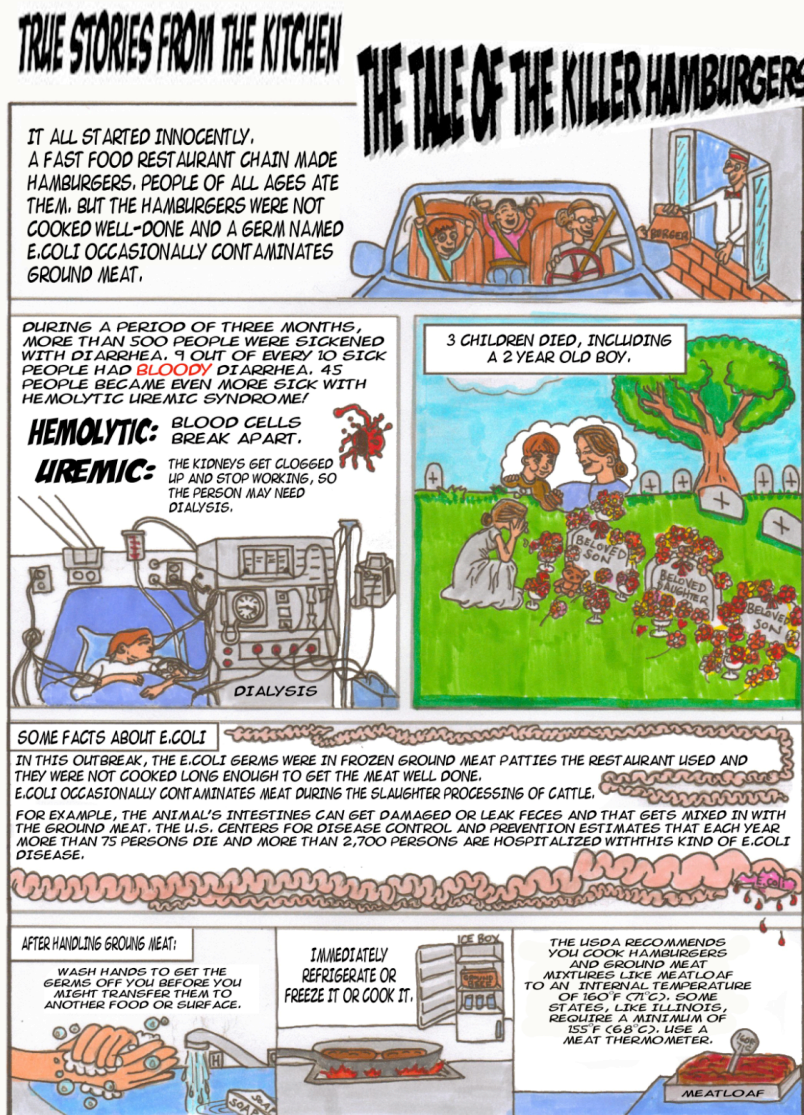
material versus those who did not across demographic categories such as ethnicity groups, education levels, and whether the food handler was a manager. To evaluate the intervention effect on an individual knowledge question, McNemar's test of paired dichotomous data (correct/incorrect answer) was employed. All statistical analyses were performed using SAS 9.2 for Windows (SAS, Chicago, IL).

RESULTS

Among 125 restaurants (508 participating food handlers) for whom baseline knowledge data had been collected, 77 restaurants (229 food handlers) participated in the intervention phase of the study, with 42 restaurants (128 food handlers) randomized into the intervention group and the remaining 35 in the control group (101 food handlers). Loss of restaurants occurred because of 14 closures (11%), 13 refusals by the person in charge (10%), 17 restaurants that no longer had any of the originally participating food handlers (14%), and four that never confirmed that the restaurant would or would not participate despite having been approached at least three times (3%). Loss of food handlers occurred because 165 no longer worked at the restaurant (32%), 52 worked at a restaurant that had closed (10%), 46 refused (9%), and 15 (3%) worked at a restaurant that never confirmed that they would or would not participate in the intervention phase. One interview was incomplete and not included in the analysis because a manager interrupted the interview and refused to allow the food handler to continue further.

The knowledge score increased 1.7 points (6 percentage points rise, from 67% to 73%) among the 35 food handlers that read either or both of the intervention materials, compared to their baseline score ($P < 0.05$). For comparison, 101 control food handlers (who were not provided with the intervention materials but did have a follow-up interview) had a non-significant rise in their knowledge score (0.5 point, or 1 percentage point rise, from 62% to 63%) ($P = 0.065$). The difference in the knowledge increase from pre-intervention to post-intervention among the food handlers who read the intervention compared with those who did not was statistically significant ($P = 0.0445$). Among the readers, 4 (11%) read the brochure only, 12 (34%) read the comic book only, and 19 (54%) read both. The change in knowledge score was from 16.8 to 17.5 points (65% to 67% knowledge score) for those

FIGURE 2B. Summary of a true story of an outbreak of *E. coli* caused by hamburgers



who read only the brochure, 16.6 to 18.0 points (64% to 69% knowledge score) for those who read only the comic book, and 18.0 to 20.1 points (69% to 77% knowledge score) for those who read both. The difference in the knowledge score by the type of materials read was not statistically significant ($P = 0.2241$).

Within the 42 intervention restaurants, those food handlers who read either of the materials ($n = 35$) more frequently were White and Asian race/ethnicity (31% White and 11% Asian among readers versus 14% White and 6% Asian among nonreaders), were English-speaking (49% among readers versus 40% among nonreaders), had at least some college education (60% among readers versus 46% among nonreaders), and worked as the certified manager (54% among readers versus 40% among nonreaders). These results were not statistically significant.

Within the 42 intervention restaurants, 21 restaurants had at least one food handler who read the materials as instructed before the follow-up survey was eventually administered, 10 restaurants had at least one food handler who looked at the materials but did not read them, and 11 restaurants had no food handler that had read or looked at the materials. Reasons for not reading the materials were not collected systematically, because it was not anticipated that food handlers or their managers who had agreed to have their restaurants participate in this intervention would not actually perform what was agreed to. Anecdotally, managers of at least three restaurants failed to distribute the materials to their food handlers.

Significant rises were observed for several knowledge questions. Knowledge in the intervention group about bloody diarrhea being a possible manifestation

of eating ground meat that is not completely cooked increased by 32% ($P = 0.005$). Other knowledge items to which correct answers increased significantly included knowing that raw meat cannot be stored anywhere in a refrigerator just because it is wrapped in plastic (increase of 29%, $P = 0.002$) and knowing which type of thermometer is best to check the temperature of a chicken breast (metal stem) (increase of 14%, $P = 0.025$). The knowledge that drying hands after hand washing should not be done with a kitchen towel or apron had a marginally significant increase of 14% ($P = 0.059$). Several knowledge items increased by a fair amount but were not statistically significant, because of the small post-intervention sample size. Such items included the knowledge that hand washing should include wetting hands with warm running water (increase of 11%), that water should not be turned off using bare hands (increase of 9%), and that it is not safe to place frozen chicken on the counter to thaw (increase of 9%).

When the 35 food handlers who had read either or both of the materials were asked which method of learning would they prefer (a brochure or a comic book) during the pre-intervention interview, 26 (74%) stated they would prefer a brochure and 9 (26%) said they preferred a comic book. These results were similar to those of the overall pre-intervention food handler baseline survey of 508 food handlers, when 374 (74%) stated they would prefer a brochure and 117 (23%) a comic book, 2 both (0.4%), and 14 had no preference (3%) (one response was missing). However, when the 35 (reading) food handlers were provided the brochure and educational comic book and instructed to read whichever they preferred, 4 (11%) read the brochure only, 12 (34%) read the comic book only, and 19 (54%) read both the brochure and the comic book.

DISCUSSION

This is the first randomized trial of an educational intervention to increase restaurant food handler knowledge. These data demonstrate that an intervention that allows for food handler choice of style (brochure versus comic book) and language (English versus Spanish) can raise food handler knowledge. The rise in overall knowledge of 6 percentage points was statistically significant, and several important areas of knowledge increased substantially. These were areas that dealt with severity of illness, cross contamination, checking for meat temperature, and hand hygiene, although not all of the differences in these areas were statistically significant.

TABLE 1. Pre- and post-intervention knowledge of food safety information among Chicago restaurant food handlers who read an educational brochure and/or comic book (n = 35 food handlers)

| Knowledge question | Correct response | Pre-intervention knowledge, number correct (%) | Post-intervention knowledge, number correct (%) | Knowledge change | P-value |
|--|-------------------------------|--|---|------------------|---------|
| Time and Temperature | | | | | |
| Hamburger and other ground beef mixtures such as meatloaf should be cooked to at least what temperature on a meat thermometer? | 155°F | 5 (14%) | 5 (14%) | (0%) | 1.0 |
| Germs that make people sick grow well between which temperatures?* | | | | | |
| Minimum. | 40°F or 41°F | 9 (26%) | 10 (29%) | (3%) | 0.7389 |
| Maximum. | 135°F (or 140°F) | 7 (20%) | 9 (26%) | (6%) | 0.4795 |
| What is the proper minimum internal temperature to cook chicken for at least 15 seconds? | 165°F | 10 (29%) | 9 (26%) | (-3%) | 0.6547 |
| Cold food must be kept at 55°F (13°C) or lower. | False | 23 (66%) | 24 (69%) | (3%) | 0.7389 |
| Which type of thermometer is best to check the temperature of a chicken breast? | A metal stem thermometer | 27 (77%) | 32 (91%) | (14%) | 0.0253 |
| Where should meat thermometer be inserted to accurately check the meat's temperature? | The thickest part of the meat | 33 (94%) | 34 (97%) | (3%) | 0.5637 |
| Hygiene | | | | | |
| Wet your hands with warm running water. | Okay | 22 (63%) | 26 (74%) | 4 (11%) | 0.1573 |
| Lather with soap and scrub between fingers, on the backs of your hands, and under nails for at least 20 seconds. | Okay | 35 (100%) | 34 (97%) | (-3%) | -- |
| Dry hands using a kitchen towel or your apron. | Not okay | 29 (83%) | 34 (97%) | (14%) | 0.0588 |

TABLE 1. Pre- and post-intervention knowledge of food safety information among Chicago restaurant food handlers who read an educational brochure and/or comic book (n = 35 food handlers) (continued)

| Knowledge question | Correct response | Pre-intervention knowledge, number correct (%) | Post-intervention knowledge, number correct (%) | Knowledge change | P-value |
|--|---|--|---|------------------|---------|
| Turn off the water using your bare hands. | Not okay | 25 (71%) | 28 (80%) | (9%) | 0.2568 |
| Cleaning and Sanitizing | | | | | |
| The difference between cleaning and sanitizing is: | 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. | 26 (74%) | 29 (83%) | (9%) | 0.1797 |
| Other | | | | | |
| Raw meat can be stored on foil-lined shelves to prevent dripping onto other foods. | False | 15 (43%) | 17 (49%) | (6%) | 0.5637 |
| Beef may be placed in the microwave to defrost. | True | 17 (49%) | 19 (54%) | (5%) | 0.5637 |
| Cooked rice can have germs that can make people sick. | True | 18 (51%) | 16 (46%) | (-5%) | 0.5930 |
| Raw meat can be stored anywhere in a refrigerator as long as it is wrapped in plastic. | False | 19 (54%) | 29 (83%) | (29%) | 0.0016 |
| Storing products with the earliest expiration dates in front of products with later dates is a safe food storage practice. | True | 22 (63%) | 25 (71%) | (8%) | 0.3173 |
| Beef may be placed in cold water to defrost. | True | 22 (63%) | 24 (69%) | (6%) | 0.5637 |
| You can be sure food is safe to eat when it smells and tastes normal. | False | 26 (74%) | 28 (80%) | (6%) | 0.4795 |

TABLE 1. Pre- and post-intervention knowledge of food safety information among Chicago restaurant food handlers who read an educational brochure and/or comic book (n = 35 food handlers) (continued)

| Knowledge question | Correct response | Pre-intervention knowledge, number correct (%) | Post-intervention knowledge, number correct (%) | Knowledge change | P-value |
|--|------------------|--|---|------------------|---------|
| Raw eggs in shells may be stored above a prepared salad in the refrigerator. | False | 29 (83%) | 29 (83%) | (0%) | 1.000 |
| It is safe to put frozen chicken breast on the counter to thaw. | False | 28 (80%) | 31 (89%) | (9%) | 0.1797 |
| Eating ground meat that is not completely cooked can cause bloody diarrhea. | True | 20 (57%) | 31 (89%) | (32%) | 0.0045 |
| Beef may be placed in the refrigerator to defrost. | True | 32 (91%) | 31 (89%) | (-3%) | 0.6547 |
| Beef may be placed on the counter to defrost. | False | 26 (74%) | 30 (86%) | (12%) | 0.1573 |
| If fish (such as raw tuna) has been stored at a temperature that is too warm, but then is properly cooked to the correct internal temperature, it becomes safe to eat. | False | 28 (80%) | 32 (91%) | (11%) | 0.1573 |
| Raw eggs can have germs that can make people sick. | True | 34 (97%) | 31 (89%) | (-8%) | 0.1797 |
| Raw meat can be stored above ready to serve food. | False | 34 (97%) | 35 (100%) | (3%) | — |

Note: — is placed where a P-value is not applicable.

*The two extremes of the temperature range were treated as a single knowledge point when calculating the knowledge score.

One knowledge area that increased substantially after the intervention dealt with recognition that food poisoning (specifically following consumption of undercooked ground meat) could cause bloody diarrhea. In the baseline knowledge survey of 508 food handlers, 41% were not knowledgeable about this fact (14). Among those who participated in the intervention, their knowledge increased from 57% to 89%. It is human nature to avoid behavior that may lead to disturbing consequences. Food handlers who do not know that improperly cooked ground meat could lead to something as alarming as bloody diar-

rhea might not take related food safety practices as seriously as they should, and therefore increasing their knowledge may help stimulate behavior change.

Another knowledge area in which scores increased substantially concerned recognizing that just because raw meat is wrapped in plastic does not indicate that it may be placed anywhere in the refrigerator. Malpractice of this behavior can predispose to risk for cross-contamination, such as when raw meat is placed above ready-to-serve food, since plastic wrap is not a reliable method of preventing contamination. In the baseline knowledge survey of 508 food handlers,

53% were not knowledgeable about this fact (14). Among those who participated in the intervention, their knowledge increased from 54% to 83%. In contradistinction, most of these food handlers reported that they knew not to store raw meat above ready-to-serve food. The results of the combination of these questions is revealing, as it may indicate that food handlers do not have a complete understanding of the principles of this cross-contamination issue, and they may consider placement of meat wrapped in plastic not to be the same thing as placement of raw unwrapped meat, thus not a hazard when stored above ready-to-serve food.

Many of the food handlers were knowledgeable about where a meat thermometer should be placed to accurately determine the internal temperature of chicken, although approximately one-fourth were not familiar with the type of thermometer that should be used. The fact that many knew where to place the thermometer but not that it is called a “metal stem” thermometer may indicate a lack of knowledge of terminology. Or it may be that the answer to the question on where to place a meat thermometer might have been easy to guess (although food handlers were instructed not to guess). Food handlers without knowledge might have chosen “the thickest part of the meat” because the other responses (“the thinnest part of the meat” and “any place is fine”) intuitively sounded wrong. It is not possible from the data to determine this, and fortunately the intervention led to a statistically significant rise, from 77% to 91% correct, regarding recognition of the correct type of thermometer to use, while recognition of where to place the thermometer remained high (94% rising to 97% correct).

Poor practice of hygiene is a notorious problem that has been implicated in many restaurant foodborne outbreaks (7, 12, 13, 15, 16). During 1998 through 2008, hygiene was listed as a contributing factor for 25% of the 1,592 foodborne outbreaks involving a restaurant or delicatessen that had a confirmed etiology and reported at least one contributing factor (10). The knowledge of several important hygiene practices (the preferred temperature of the water to wash hands with, not to re-touch the faucet with washed bare hands, and with what is it appropriate to dry washed hands) improved as the result of the intervention. The largest of these increases was from 83% to 97% for knowing not to dry hands using one’s apron or a kitchen towel, since these often become dirty during routine kitchen work. This finding was of borderline statistical significance and is notable because it indicated increased knowledge in nearly all of the readers who had answered the question wrong at baseline. Increases for the other two hygiene knowledge points were more modest (11 and 9%, respectively) but do represent some improvement.

Freezing of poultry is a common way to preserve the meat until it is ready

to be cooked. However, the prevalence of pathogens in poultry is relatively high, especially for *Campylobacter* and *Salmonella*. For example, 70% of retail chicken sampled in the Washington, D.C. area was positive for *Campylobacter* species (18). Since freezing does not sterilize the meat, proper thawing is essential, including not thawing meat on the counter, since some areas of the meat may experience ambient temperatures favorable to their growth while the center of the meat is still thawing and because meat may be perceived as having thawed while the center remains frozen. The educational intervention raised knowledge 9 percentage points (from 80% to 89%) on this critical knowledge point for chicken and a similar amount, 12 percentage points (from 74% to 86%) on the question regarding thawing of beef. Although these were not statistically significant findings, they do represent an important step in the right direction.

Reading both the brochure and the comic book led to a statistically significant rise in knowledge of 8%, compared with a 2% or 5% rise observed for reading only the brochure or only the comic book, respectively. This might indicate that a combination of the materials is more effective, but it may also signify that food handlers who read both were more motivated and receptive to the information. Most (89%) of the food handlers who read at least one of the interventions read the comic book (with or without the brochure). This was discordant with the baseline information that 76% preferred a brochure and only 26% a comic book. Possibly, the visual attractiveness of the comic book attracted many of the readers to it. Also, when imagining a comic book, many readers might have thought it would be too juvenile. Regardless, these data demonstrate that stated preferences might not reflect actual practices.

A critical issue to understand is why nearly one-fourth of the intervention restaurants did not have any food handlers who read the intervention materials. After all, these were restaurants where the manager had consented to the restaurant’s participation and had already allowed food handler baseline knowledge interviews. Therefore, when the free educational materials tailored to the knowledge needs of Chicago food handlers were delivered, one would hope that enthusiasm for them would be high. In fact, there were restaurants where food handlers greeted the research staff drop off of the materials with excitement and curiosity. However, reasons why some

restaurants failed to follow through with their food handlers reading the materials yet then participated in the follow-up survey is a matter of conjecture. One reason may be manager turnover. Another could be the presence of multiple managers in a restaurant, with one being more enthusiastic than another about the project. The less enthusiastic manager might have been present when materials arrived (leading in at least one instance to the materials being put in a cabinet in the back room and forgotten). This latter possibility also speaks to the issue of food safety leadership versus food safety management (an important concept promoted by Frank Yiannis in the book *Food Safety Culture: Creating a Behavior-based Food Safety Management System*) (17). Each restaurant has its own food safety culture. It is likely that managers who actively promote food safety education and adherence to best practices are more likely to have employees who practice what is preached. It is also possible that the managers forgot about the educational materials. While this latter explanation is plausible, if it occurred it is a matter of concern, since it suggests that food safety is not a very high priority in those establishments. While the limited penetration of the materials to the food handlers is disappointing, it is also revealing about what might be expected of paper-based educational materials that are available without supervision of their use. It also demonstrates the importance of educational methods or policies that ensure that food handlers engage with the interventions, so that these data represent real world conditions more than an experimental model and provide evidence of the minimum impact of these materials. Future research should focus on the most feasible methods of ensuring engagement by food handlers with these targeted educational materials.

Among the limitations of this research project is generalizability. The data may not be generalizable to all Chicago food handlers or to food handlers throughout the U.S. This study did employ randomization of restaurants, yet participation rates and loss of restaurants during the study as well as lack of engagement by many intervention restaurant food handlers are issues to consider when interpreting the results. The study was also limited by the loss of food handlers in the intervention phase, since it decreased the statistical power to demonstrate significant rises in knowledge such as those observed related to hand

hygiene. A historic economic downturn that closed restaurants, as well as the food handler turnover that occurred while the intervention material was being created, IRB-approved, and disseminated, contributed toward this loss. The number of food handler readers was also too low to examine the difference in efficacy by language or ethnicity. Finally, a limitation of any educational intervention is that a change in knowledge does not guarantee that the associated desired behavior will change. Future research of this kind would benefit from observation of food safety practices at participating restaurants, although enthusiasm by restaurants to have outside observers recording their noncompliance with food safety practices may limit the participation rate in such a study.

CONCLUSION

The data from this study demonstrate that even with a passively delivered educational intervention, measurable significant knowledge increases may be observed among restaurant food handlers. Currently, revision of the educational materials used in this intervention is under way based on feedback from food handlers and review of these data. Future research is needed to demonstrate feasibility and determine if there is heightened effectiveness when these educational materials are provided by sanitarians during restaurant inspections.

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REFERENCES

- Bell, P. B., M. Goldoft, P. M. Griffin, M. A. Davis, D. C. Gordon, P. I. Tarr, C. A. Bartleson, J. H. Lewis, T. J. Barrett, J. G. Wells, R. Baron, and J. Kobayashi. 1994. A multistate outbreak of *Escherichia coli* O157:H7-associated bloody diarrhea and hemolytic uremic syndrome from hamburgers. The Washington experience. *JAMA* 272:1349–1353.
- Bohm, S. R., B. M. Brennan, R. Schirmer, and G. Cabose. 2007. Norovirus outbreak associated with ill food-service workers – Michigan, January – February 2006. *Morb. Mortal Wkly. Rep.* 56:1212–1216. Available at: <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5646a2.htm>. Accessed 1 December 2011.
- Centers for Disease Control and Prevention. 2007. Surveillance for Foodborne Disease Outbreaks – United States. Available at: http://www.cdc.gov/outbreaknet/surveillance_data.html. Accessed 2 September 2010.
- Chicago Department of Public Health. 2010. Food Protection Division – Food Inspection Reporting System: General Information. Available at: http://webapps.cityofchicago.org/healthinspection/General_Info.jsp. Accessed 16 October 2010.
- DeBess, E. E., E. Pippert, F. J. Angulo, and P. R. Cieslak. 2009. Food handler assessment in Oregon. *Foodborne Path. Dis.* 6:329–335.
- Dworkin, M. S., P. Udompat, P. Panchal, and L. Liu. 2011. A comparison of overall versus duty-specific food poisoning prevention knowledge among restaurant food handlers. *Food Prot. Trends* 31:664–671.
- Friedman, D. S., D. Heisey-Grove, F. Argyros, E. Berl, J. Nsubuga, T. Stiles, J. Fontana, R. S. Beard, S. Monroe, M. E. McGrath, H. Sutherby, R. C. Dicker, A. DeMaria Jr., and B. T. Matyas. 2005. An outbreak of norovirus gastroenteritis associated with wedding cakes. *Epidemiol Infect.* 133:1057–1063.
- Garman, R., T. F. Jones, and M. H. Kennedy. 2002. Restaurant-associated behavior from the FoodNet population survey 1998–1999 (abstract 89). In program and abstracts of the International Conference on Emerging Infectious Diseases (Atlanta). Atlanta: Centers for Disease Control and Prevention. 97.
- Guevara, R. E. 2003. Predictors for restaurant inspection score: results from a study on food safety knowledge, attitudes, and behaviors among restaurant workers in Los Angeles County, 2003. Available at: http://lapublichealth.org/acd/reports/annual/Special_Report_2003.pdf. Accessed 28 November, 2011.
- Heiman, K. CDC. 30 November, 2011. Personal communication. Foodborne Outbreak Reporting System. Atlanta, GA: U.S. Department of Health and Human Services, [email: uwj0@cdc.gov].
- Lynch, M., J. Painter, R. Woodruff, and C. Braden. 2006. Surveillance for foodborne-disease outbreaks – United States, 1998–2002. *MMWR Surveill. Summ.* 55(SS10):1–34.
- Mank, L., M. Mandour, T. Rabastsky-Her, Q. Phan, J. Krasnitski, J. Brockmeyer, L. Bushnell, C. Applewhite, M. Cartter, and J. Kattan. 2010. Multiple-serotype *Salmonella* gastroenteritis outbreak after a reception – Connecticut, 2009. *MMWR Surveill. Summ.* 59:1093–1097.
- Mazurek, J., L. Holbert, M. K. Parrish, and E. Salehi. 2005. Raw eggs – Lessons learned from an outbreak of *Salmonella* serotype Enteritidis infection associated with meringue pie. *J. Public Health Manag. Pract.* 11:201–207.
- Panchal, P., L. Liu, and M. S. Dworkin. 2012. Food safety knowledge differs among Spanish and English-speakers. *Food Prot. Trends* 32:16–25.
- Quick, R., K. Paugh, D. Addis, J. Kobayashi, and R. Baron. 1992. Restaurant-associated outbreak of giardiasis. *J. Infect Dis.* 166:673–676.
- Todd, E. C., B. S. Michaels, J. D. Greig, D. Smith, and C. A. Bartleson. 2010. Outbreaks where food workers have been implicated in the spread of foodborne disease. Part 8. Gloves as barriers to prevent contamination of food by workers. *J. Food Prot.* 73:1762–1773.
- Yiannis, F. 2010. Food safety culture: Creating a behavior-based food safety management system. P. Springer Science and Business Media, LLC, Bentonville, Arkansas.
- Zhao, C., B. Ge, J. D. Villena, R. Sudler, E. Yeh, S. Zhao, D. G. White, D. Wagner, and J. Meng. 2001. Prevalence of *Campylobacter* spp., *Escherichia coli*, and *Salmonella* serovars in retail chicken, turkey, pork, and beef from the Greater Washington, D.C., area. *Appl. Environ. Microbiol.* 67:5431–5436.