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Title

Food allergy management among restaurant workers in a large U.S. city

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Abstract

We assessed restaurant workers' knowledge and practices regarding food allergy management and adverse events, which result in 90,000 emergency department visits annually in the United States. We surveyed all eligible restaurants within a defined catchment in Philadelphia and 80.3% (n=187) participated. No restaurant employee was able to name all seven "best practices" to reduce the risk of food allergy adverse events in restaurants. The majority of participants could name only zero or one preventive measure. Few participants knew to respond to anaphylaxis by administering epinephrine and calling 9-1-1. Public health professionals should work with the restaurant industry, and with food service workers, to evaluate and revise food allergy-relevant policies and trainings. This is critical to protect the 15 million American consumers, and far more globally, who suffer from food allergies.

Keywords

Food allergy; anaphylaxis; prevention; restaurant

1. Introduction

An estimated 15 million Americans and 17 million Europeans suffer from food allergies (Food Allergy Research & Education, 2014), which vary in severity and can be serious enough to be life threatening (Turnbull, Adams, & Gorard, 2014). There are approximately 90,000 emergency department visits in the United States (U.S.) annually because of anaphylactic reactions to food (Clark, Espinola, Rudders, Banerji, & Camargo, 2011).

To prevent adverse events, people with food allergies must diligently avoid allergenic foods, which depends upon food safety controls throughout the food production chain. Food allergen safety begins with producers and growers, and continues to include manufacturers, distributors, and transporters, as well as retailers, restaurants, and consumers themselves. Food allergen guidance is provided in the Codex Alimentarius and is embedded in the principles of Hazard Control and Critical Control Point (HACCP) management systems, which offer a prevention framework for the food industry globally (Codex Alimentarius, 2015; Wehr, 1997). In the United States, the Food Allergen Labeling and Consumer Protection Act (FALCPA), passed in 2004, specifies that packaged foods must include labeling for eight of the common allergens identified by the Codex Alimentarius Committee on Food Labeling: wheat, crustacean shellfish, egg, fish, peanuts, soy, milk, and tree nuts (Gendel & Zhu, 2013; Hey & Luedemann, 2001; Kjelkevik, Edberg, & Yman, 1997; Roses, 2011). For consumers with food allergies, trust in food processing, labeling, and handling is essential to management of their potentially life-threatening chronic condition.

Food consumed in restaurants or other food service settings accounted for one in four food-induced anaphylaxis deaths between 1994 and 2006 (Bock, Munoz-Furlong, & Sampson, 2001, 2007). The role of restaurants in allergy management is particularly important since food allergy prevalence is on the rise (Branum & Lukacs, 2008) and American families are eating more meals at restaurants and preparing fewer meals at home. In the U.S. in 2013, 49.6% of all food dollars were spent away from home (United States Department of Agriculture Economic Research Service, 2014a). Moreover, 20.8% of the food purchased away from home was procured at “limited-service eating places” (United States Department of Agriculture Economic Research Service, 2014b), where a customer orders food at a counter and does not receive table service (United States Department of Agriculture Economic Research Service, 2015).

Restaurant employees have critical roles to play in reducing the risk of food allergy adverse events. Their work requires specialized knowledge based on HACCP principles, as well as motivation to meet patrons’ needs, self-efficacy to employ best practices, and resources to execute safe food allergy management protocols (Choi & Rajagopal, 2013; Muraro, Hoffmann-Sommergruber, et al., 2014). The preparation of a food allergy safe meal begins even before a customer enters the restaurant, with steps that include careful review, segregation, and storage of ingredients (National Restaurant Association Educational Foundation, 2015b). Once a customer with food allergies enters a restaurant, a food service worker can employ a number of precautionary steps to mitigate risks, including having a conversation with the customer to clarify food allergies, reading food labels, using uncontaminated ingredients, and delivering an allergen-free meal using properly sanitized service ware. Diversion at any point from best practices could have serious consequences for a highly allergic customer. While all states require

some form of food safety training for restaurant workers, only five states and two cities—Massachusetts, Rhode Island, Michigan, New Jersey, Virginia, New York City, and St. Paul Minnesota—require additional food allergy training and/or food allergy materials to be displayed in restaurants (Abbot, Byrd-Bredbenner, & Grasso, 2007; Food Allergy Research & Education, 2015b; Massachusetts Department of Public Health Bureau of Environmental Health/Food Protection Program, 2010). Established training programs, like the National Restaurant Association’s ServSafe Allergens online course (National Restaurant Association Educational Foundation, 2015b), describe the range of distinct steps necessary to reduce the risk of food allergy adverse events in restaurants. In addition, food service workers should be prepared to recognize and respond to food allergy adverse events when they do occur. In the event of anaphylaxis, prompt administration of epinephrine is the preferred and lifesaving emergency response (Kemp, Lockey, & Simons, 2008), which should be followed by calling 9-1-1 and transporting the ill person to an emergency room (Muraro, Agache, et al., 2014; Sampson, 2003).

Across a broad range of food service environments (e.g., restaurants, institutions) and geographical areas (e.g., United Kingdom, U.S., Malaysia, Brazil), several studies have evaluated workers’ food allergy knowledge, identifying potential hazards to food allergic consumers (Ahuja & Sicherer, 2007; Ajala et al., 2010; Bailey, Albardiaz, Frew, & Smith, 2011; Choi & Rajagopal, 2013; Common et al., 2013; Shafie & Azman, 2015). These studies, which were conducted in selected populations and convenience samples, and have suggested a need for improved training and better adherence to HACCP practices and allergen management among food service workers. A study conducted in a small town in the United Kingdom reported that food service workers needed additional training regarding food allergy management and that proprietors and environmental health officers lacked motivation, time, and money to invest in this issue (Pratten & Towers, 2003, 2004). Low levels of motivation and concern also were reported by Ajala and colleagues (2010), who studied workers at 12 restaurants in Brazil. A study conducted at a university cafeteria in the U.S. revealed specific gaps in food allergy knowledge among food service workers, including challenges in identifying common food allergens among listed ingredients and a lack of knowledge regarding appropriate emergency response in the event of a severe food allergy reaction (Choi & Rajagopal, 2013). In Penang, Malaysia, food handlers were found to have moderate knowledge of safe food allergy management practices. For example, in that study, only about half of respondents knew that eating even a small amount of an allergen could cause a reaction (Shafie & Azman, 2015). These studies provided important early documentation of potentially serious shortcomings in allergy management in food service establishments, pointing to the need for additional research that is generalizable to other settings.

In a defined central city catchment area in a large northeastern U.S. city (Philadelphia), we conducted a survey to assess food allergy knowledge and adherence to best practices among food service workers in all eligible limited-service restaurants. Drawing from a well-defined denominator, we conducted in-person surveys, including a self-administered component, with restaurant staff, with the goal of understanding restaurant workers’ knowledge and practices regarding food allergy management and response to food allergy adverse events. Our long-term objective was to identify opportunities to reduce the risks faced by consumers with food allergies—for example, through improvements in education and training and through application of behavioral economic principles to reduce food allergy adverse events. Accordingly, this study

also used an embedded randomized behavioral economic experiment to test the influence of a consumer tool—a printed “consumer food allergy alert card” describing a hypothetical customer’s food allergies. The experimental food allergy alert card included a photograph of a patron with food allergies. The image was intended to increase food service workers’ engagement and motivation by amplifying the salience of food allergy and invoking concern for a specific customer (Blumenthal-Barby & Burroughs, 2012), just as patient photographs embedded in medical charts have been shown to increase radiologists’ engagement in their work and to improve the accuracy and detail of their reports (Turner & Hadas-Halpern, 2008). Additionally, research on philanthropic giving has documented that people feel more empathy and give more to a cause when they see an associated photograph of an adversely affected individual—for example, a single hungry child (Small & Verrochi, 2009).

Below we report results from this study, which identifies knowledge gaps in the food service industry in a large northeastern U.S. city. In the discussion section, we identify links to prior research, specify gaps in the literature, note education and training needs for restaurant workers, and suggest opportunities for public health departments and food allergy advocacy organizations to further engage food service workers as allies in protecting the health of people with food allergies.

2. Material and Methods

2.1 Sampling and recruitment

This study was approved by the Institutional Review Board at the University of Pennsylvania. We recruited food service workers from all eligible limited-service restaurant establishments within a designated area of Center City Philadelphia. Eligible restaurants were identified through “ground-truthing” (Sharkey & Horel, 2008), a method that relies on direct observation of existing establishments through walking surveys of the catchment area. In food environment research, ground-truthing is upheld as a superior method to the more routine strategy of identifying retail establishments through published lists of food outlets. Reliance on published lists showed a sensitivity of less than 40% in identifying operating food outlets in a recent urban food environment study (Lucan et al., 2013). Limited-service restaurants were defined as restaurants where the patrons could order at a counter and subsequently pay at a cash register. Outlets identifiable as having both limited-service and full table-service options were included. We excluded table-service only establishments. The protocol excluded food service workers who were under age 18 ($n=0$) or who were unable to give verbal consent or to complete the survey due to language barriers ($n=10$). There were 233 eligible restaurants approached in the catchment area, and 80.3% ($n=187$) participated. We sought one completed survey from each limited-service establishment meeting these criteria and located on numbered North-South streets between the Delaware River and 40th Street (i.e., 2nd Street to 40th Street, inclusive) and on all major East-West-oriented thoroughfares between and including South Street and Market Street.

Surveys were conducted between 9 am and 6 pm, although efforts were focused primarily between the hours of 2 pm and 5 pm, when restaurants tended to have the lowest customer volume. At each eligible restaurant, a research assistant approached the counter, used a script to invite one employee to participate, and obtained verbal consent before proceeding with the

survey. Participation was voluntary, and restaurant workers were free to decline to participate, with no adverse consequences.

2.2 Survey and data collection

The tablet-based survey included items informed by previous studies among food service workers at restaurants and cafeterias (Bailey et al., 2011; Choi & Rajagopal, 2013). The survey was administered using REDCap data collection and database management software, which includes a straightforward user interface (the “front-end”) for data collection as well as secure data storage and tools for analysis (the “back end”) (Harris et al., 2009). The survey included four major sections, as described below and included in Appendix A.

Section one included open-ended questions that assessed participants’ views regarding food allergies and food allergy management practices. After brief “icebreaker” questions, the research assistant asked the participant to describe every step he or she would take in order to assure the safety of the hypothetical customer with food allergies described in the printed “food allergy alert” card (Appendix B) shown at the start of the interview. The card explained that this customer’s food allergies were potentially life-threatening. Using a similar open-ended method, the research assistant then asked, “What steps would you take if this customer had an allergic reaction here?” During this portion of the survey, the research assistant transcribed participants’ verbal responses into REDCap.

For the second section of the survey, the research assistant handed the tablet to the participant and asked him or her to respond to a series of 13 statements, designed to measure attitudes and self-efficacy for meeting the needs of customers with food allergies. Participants were asked to respond to each statement along a continuum (e.g., from “not at all sure” to “completely sure” or from “strongly disagree” to “strongly agree”). Participants manually entered their responses using a REDCap “sliding scale” feature, by dragging a pointer on the tablet screen to the desired location along the response continuum. For each question, REDCap translated the pointer location to a score between 0-100.

The third section of the survey focused on participant characteristics, including gender, age, education level, role in the restaurant, and whether the respondent (or someone close to them) had food allergies. Finally, section four included five true or false questions to assess the participants’ knowledge regarding safe food allergy management practices. Upon survey completion, each participant was remunerated with a \$5 gift card (i.e., an amount sufficient to purchase a sandwich) from a local chain deli and food store (Wawa). This participant remuneration was approved by the university’s Institutional Review Board, which prohibits remuneration that presents an “undue influence” on research participants.

On average, the survey was completed in just under 14 minutes by the participating restaurant workers. A small proportion of respondents answered some but not all questions, as reflected in the denominators for each question in Tables 1-4. For example, in Table 4, 13 people did not complete the True/False question “If a customer is having an allergic reaction they should be served cold water to dilute the allergen.” This question was asked near the end of the survey. As noted in the tables, almost all participants completed the survey in its entirety. Very few people omitted questions or failed to complete the survey.

2.3 Embedded experiment

To focus participants on the issue of food allergies at the start of the survey, we began with the experiment in which participants were randomized to view one of two “food allergy alert” cards, both of which explicitly described a hypothetical customer—a 10-year-old boy with potentially life-threatening tree nut allergies. Participants were assigned at random (using NumeroRama (Tanuki Productions, 2011), a random number generator) to view either the version of the food allergy alert card that included a photograph of the boy or a version of the card that included the same text description but no photograph (Appendix B). Based on prior experiments using photographs, the food allergy customer card with the photo was intended to engage the food service worker, evoke empathy, and influence the worker’s level of motivation to provide help. Participants were given a moment to review the assigned food allergy alert card before proceeding.

2.4 Data analysis

To analyze the open-ended data regarding steps the participant would take to protect the customer with food allergies, we operationally defined a set of “best practices” in food allergy management for food service workers, in order to measure adherence to those best practices among survey participants. To establish the operational definition of best practices for food allergy management, we reviewed a standardized video issued by the ServSafe Allergens online course (National Restaurant Association Educational Foundation, 2015b), a training program that is endorsed by the national advocacy organization Food Allergy Research & Education (FARE) (Food Allergy Research & Education, 2015c). We also reviewed additional printed materials provided by FARE (Food Allergy Research & Education, n.d.). We conducted line-by-line coding of printed material and minute-by-minute coding of video content in order to identify all topics and themes covered in the trainings. From our coding, we reduced the recommended guidelines to seven recommended “best practices”—distinct, essential steps in food allergy management for restaurant workers. These steps included: (1) communicating with the patron to clarify the allergy and alert the customer to potentially risky (allergenic) menu items/make recommendations; (2) recording the allergy and/or communicating the customer’s needs to other staff; (3) checking all ingredient labels for the presence of allergens; (4) using fresh (uncontaminated) ingredients and/or preparing food away from allergens to avoid cross-contact; (5) sanitizing equipment and surfaces and/or using new or designated allergen-free equipment; (6) cleaning hands and/or changing gloves (or clothing) before preparing food for a customer with allergies; and (7) verifying orders and/or delivering them separately. We then used this definition to code all participants’ responses regarding the steps they would take to keep a food allergic customer safe. For each step, we noted whether or not the participant had named that step as a precaution they would take in preparing food for a customer with food allergies. Participants were given one point for each of the seven steps mentioned in their responses. We report the proportion of participants who mentioned each individual step, as well as the proportion who correctly identified 0,1,2,3 (etc.) steps in safe food allergy management.

We also operationally defined “best practices” for out-of-hospital management of anaphylaxis. Consensus medical opinion is that prompt administration of epinephrine should be the first step in emergency response in the event of an anaphylactic reaction (Kemp et al., 2008; Muraro, Agache, et al., 2014). Immediately following administration of epinephrine, the responder (in

this case the food service worker) should call for emergency medical assistance (9-1-1) so that the ill person can be transported to the emergency department (Sampson, 2003). We conducted line-by-line coding of participants' responses to an open-ended question regarding steps they would take to assist a customer who was having an allergic reaction, and we classified responses according to whether or not the participant mentioned either or both of the key emergency response steps: giving epinephrine and/or calling 9-1-1 for assistance. We report the proportion of respondents who identified each of these steps in effective emergency response to anaphylaxis. We coded additional open-ended responses that would not be considered best practices, such as seeking out a parent or referring to restaurant procedures (e.g., notifying a manager or completing restaurant paperwork).

Analyses were conducted using SPSS version 22 (IBM, 2013) and Microsoft Excel 2010 (Microsoft, 2010). For all parts of the survey, descriptive statistics are reported. The denominator for each question was the number of participants who responded to that specific question. For part two of the survey, participants' sliding scale scores on self-efficacy and attitude measures were coded from 0-100. The optimal goal would be for all workers to attain perfect scores of 100. We considered scores of 85 or above (akin to test scores of B+ or A) be strong endorsements of the self-efficacy or attitude statements. To assess the effect of the experimental exposure to the food allergy alert card with or without a customer photo, we used the chi-square test to compare the proportions of intervention vs. control group participants who strongly endorsed the attitudes and self-efficacy statements in part two of the survey. We also used the independent samples t-test to compare the difference in mean scores of intervention vs. control group participants.

3. Results

To frame our results regarding restaurant workers' food allergy knowledge and practices, we will briefly describe the context for food safety in our study setting. Policies regarding food safety and food control establish the context for training and education—as well as the resultant knowledge and practices—of restaurant workers. In the U.S., food safety training requirements for restaurants vary by state, with jurisdictions sometimes establishing standards that exceed the State Food Code. In Pennsylvania, each food retail establishment is required to have one certified supervisor who has completed food safety training, but that person does not have to be on-site at the restaurant during all working hours. In Philadelphia, the code requires that an employee certified in food safety (i.e., having completed an approved food safety course) be present at all times (City of Philadelphia Department of Public Health, 2013). Philadelphia's code specifies three courses that can be completed to satisfy the requirement, one of which is the ServSafe course for food managers. This basic ServSafe course is to be distinguished from the ServSafe Allergens course that we used to define "best practices" for food allergy management in restaurants. The basic ServSafe manager course mentions allergens as an important hazard, but detailed information about the control and prevention of food allergy adverse events is not covered. Specialized allergy training is not required by the city of Philadelphia or the state of Pennsylvania. Additionally, the City of Philadelphia Department of Public Health Regulations Governing Food Establishments (City of Philadelphia Department of Public Health, 2009) cite the need for HACCP plans to manage certain (mostly microbial) hazards, but the City Regulations do not specifically mention the control of food allergens using an HACCP plan.

In this context, between October 2013 and September 2014, we investigated the food allergy knowledge and practices of restaurant workers in Center City Philadelphia. Out of 233 eligible restaurants, staff at 187 restaurants completed the survey, for an overall response rate of 80.3%. Of the 187 survey participants, half were women and half were men (Table 1). The most common age group was 18-25 years old (48.1%), followed by 30-39 years old (18.9%) and 26-30 years old (18.4%). One out of four participants spoke a first language other than English, indicating that the sample was culturally diverse. Cashiers (38.6%), managers (34.8%), and food preparers/chefs/cooks (28.8%) most commonly responded to the survey. Participants sometimes fulfilled multiple roles within the establishment. One in five participants reported that s/he had a food allergy, and more than half reported that someone close to them had a food allergy.

Overall, participants performed poorly when they were asked to respond to a hypothetical customer with food allergies by identifying all of the steps they would take to prepare and serve an allergy-safe meal for that patron (Table 2). Based on the seven “best practices” for reducing the risk of food allergy adverse events, which we identified from the ServSafe Allergens and FARE restaurant training programs, participants were unable to name critical steps in safe food allergy management. No participant was able to name all seven steps that are considered necessary to protect a customer with food allergies (Figure 1). The majority (53.7%) of participants named one step or fewer that they would take to manage food allergies safely in their establishment—far short of the goal of taking all seven precautionary steps. The most commonly noted action step was to sanitize equipment, work surfaces, and instruments, and only 37.1% of participants noted that they would take this step. A minority of participants noted that they would communicate with the patron to clarify the allergy/alert them about risk (28.0%), use fresh (uncontaminated) ingredients/avoid cross-contact (23.1%), check ingredients (21.5%), or clean their hands or change gloves (19.9%). It was even less common for participants to note that they would document the allergy on the order form to communicate the allergy to other restaurant staff (11.3%) or verify the order as allergy-safe at the time of serving it to the customer (4.8%). In some limited-service restaurants, the participant may have been the only staff member present, obviating the need for communication with other staff. All other steps can be viewed as essential elements in the process chain of providing safe food for a patron with severe allergies. Any missed step—from checking of ingredients to washing of hands or changing of gloves—could conceivably introduce an opportunity for exposure to the allergen, with potentially serious health consequences for a patron susceptible to anaphylaxis.

Despite these clear gaps in restaurant workers’ knowledge of safe food allergy management, participants generally were aware of the seriousness of food allergies (Table 3). Most participants (88.6%) strongly endorsed the statement “I want to go the extra mile to help keep this child [a hypothetical patron with food allergies] safe.” A similarly high proportion (90.1%) strongly endorsed the idea that “In this business, food allergies should be taken very seriously,” and 88.5% strongly believed that “I always take it seriously when a customer like this says he or she has a food allergy.” Participants’ endorsement of these statements indicated both an awareness of food allergens as a hazard and a commitment to reducing the risk of adverse events among food allergic patrons.

A lower proportion, but still the majority of participants (64.5%), strongly endorsed the statement “I am sure that a safe meal can be prepared for the child at this restaurant.” The majority of participants reported high self-efficacy for food allergy management practices, with 69.2% of participants strongly endorsing the statement that “I am confident that I know how to provide a safe meal for this child.” Participants revealed a lower level of certainty about their food allergy management skills when asked about their confidence in performing specific tasks necessary for safe food allergy management. Only 55.8% of participants strongly endorsed the idea that “I am confident that I can accurately identify the ingredients in all of the food served here.” In a general sense, participants’ confidence and self-efficacy appeared high, which contrasted with the low knowledge of safe food allergy management practices demonstrated in the “hypothetical patron” exercise described above.

Participants’ responses revealed concerns about their managers and co-workers with regard to safe food allergy management. Only half of participants strongly endorsed the idea that “My employer has provided good training about food allergies,” and approximately one out of three participants “would be concerned that my coworkers may not know how to keep this child safe.” Sixty percent of participants expressed strong interest in learning more about safe food allergy management. A small proportion of participants (3.4%) strongly believed that “This child should not eat out at restaurants,” while 12.4% “would feel better having this child eat someplace else.”

When asked a series of basic true/false questions (Table 4) about food allergy management, a small proportion of participants offered incorrect responses—indicative of misinformation that could be dangerous to patrons with food allergies. For example, 10.7% of respondents incorrectly believed that “Removing an allergen from a finished meal, e.g. removing the nuts, may be all that is necessary to provide a safe meal for a food allergic customer.” A similar proportion (11.7%) incorrectly reported that “Customers with food allergies can safely consume a small amount of that food,” while 6.7% reported incorrectly that “Cooking, for example frying, can stop food from causing allergies.” Almost one in four participants reported incorrectly that a patron should be given cold water in the event of an allergic reaction, in order to dilute the allergen.

Given these knowledge gaps, as well as participants’ incomplete identification of necessary steps for safe food allergy management, it is especially concerning that few participants knew how to respond effectively to a food allergy adverse event in their establishment (Figure 2). One in six respondents (16.6%) correctly named both of the two most important steps for responding to an anaphylactic event: administration of epinephrine and calling 9-1-1 for emergency transport to the hospital. Even among the participants who mentioned epinephrine, very few explicitly mentioned a willingness to administer the medication to a patron in need of assistance, and a few also noted explicitly that they would not administer the medication. In several comments, participants noted that instead of leading an emergency response, they would defer to the hypothetical patron’s parent, emergency personnel, hospital staff, another patron, or a doctor at a nearby hospital. Notably, food service workers often mentioned non-medical (i.e., procedural or bureaucratic) responses to a patron’s severe allergic reaction—such as filling out an incident report, reporting to a manager, or offering the patron a coupon for use on a return visit—rather than describing effective emergency response actions that they would take to assist a patron having a severe allergic reaction.

Based on chi-square tests of differences in proportion and independent samples t-tests of differences in mean, the responses to survey questions were similar, regardless of whether the participant was in the intervention or control group (Supplemental Tables 1-4). No differences were observed between the intervention and control group in demographic characteristics, except that there were more cashiers in the control group (45% versus 31%, $p=0.05$). Participants' responses to attitude and self-efficacy questions did not vary measurably according to whether they viewed the experimental food allergy alert card with or without a patron's photo, with one exception for the statement "I always take it seriously when a customer like this says he or she has a food allergy." Given that we conducted multiple comparisons, it is possible that this difference was attributable to chance alone. We had hypothesized that the presence of the photo would increase the salience of the allergy and the respondent's empathy and desire to help, but this was not borne out in the experiment that was embedded in the survey. Participants in both the intervention and control groups reported a high degree of concern regarding the seriousness of food allergies, as well as a commitment to reducing the risks of adverse events for patrons with food allergies.

While completing the survey, 49 participants were highly engaged and/or provided spontaneous, positive feedback (not specifically solicited through questions from the staff) regarding the survey topic and study design. They expressed a range of comments from: finding the topic interesting and a good learning opportunity to being happy to help, demonstrating an interest in the topic of food allergies and their management.

Discussion

This study reports several key findings regarding food allergy management in restaurants, based on a high-participation survey of all eligible limited-service restaurants in Philadelphia's central downtown business district. The most important findings from this study relate to the inadequate readiness of food service workers in a large U.S. city to manage food allergies safely. This raises concerns for the 15 million consumers in the U.S., and far more globally, who suffer from food allergies. Throughout the study, participants revealed fundamental knowledge gaps regarding how to reduce the risk of and respond to food allergy adverse events. Critically important is the finding that no single respondent could identify all seven steps necessary for safe food preparation, and that the overwhelming majority of participating food service workers could identify only zero or one of those seven necessary steps. Despite these shortfalls in their own knowledge, participants indicated a high level of willingness to assist food allergic customers and to learn more about food allergies, coupled with an inflated sense of their own self-efficacy for safe food allergy management—a finding echoed in reports from other countries (Ajala et al., 2010; Bailey et al., 2011; Common et al., 2013; Pratten & Towers, 2003, 2004; Shafie & Azman, 2015; Sogut et al., 2015; Wham & Sharma, 2014). Table 5 summarizes results from studies relevant to the current report. Though the studies have used different sampling and data collection methods and have investigated food service workers in a range of roles, the collective findings suggest the need for widespread appraisal and rigorous evaluation of policies and practices for food allergy training and education among food service workers.

In this study, conducted in the only representative sample using ground-truthing to identify eligible restaurants in the U.S. to date, the high participation rate suggests a high level of engagement on the part of food service workers. We had anticipated that busy and potentially poorly compensated (Allegretto et al., 2013) food service workers might be reluctant to participate, but we encountered quite the opposite. Participants eagerly answered and asked questions and offered additional commentary at the close of the survey, with 49 participants expressing unsolicited positive evaluations of the study, an interest in the topic of food allergies, and appreciation of the opportunity to learn more about food allergies. It is also notable that employees were critical of the training offered by their establishments despite social desirability bias, especially when employees were responding to the survey at their work site. In addition, just over half of participants strongly endorsed the desire for more training on food allergies. In restaurant work, low wages, limited autonomy, and high turnover (Allegretto et al., 2013; National Restaurant Association, 2015) might limit worker engagement on issues like this, but many of the workers we studied demonstrated a willingness to learn more about this common health problem.

A second, related finding is that there is ample room for improvement in food service workers' basic knowledge of how to reduce the risk of accidental exposure to known allergens. Even with the international efforts of the FAO/WHO Codex Alimentarius, and the HACCP guidelines for food safety, our findings, along with the findings of studies from the UK (Bailey et al., 2011; Common et al., 2013), New Zealand (Wham & Sharma, 2014), and Malaysia (Shafie & Azman, 2015) confirm the need for redoubled efforts to communicate, encourage, and even enforce best practices in food allergy management in restaurant settings (Center for Food Safety and Applied Nutrition, 2006). The Codex Alimentarius recommends standards for voluntary adoption by members, and it also serves in many cases as the basis for national legislation regarding food control. The findings of this and other studies suggest the importance of 1) testing how restaurants translate, interpret, and implement the HACCP principles with regard to food allergen management; and 2) evaluating the effectiveness of regulations that emanate from HACCP guidance, and 3) evaluating the effectiveness of existing and new food allergen trainings. To our knowledge, only one small pilot study of 11 restaurant employees tested the effectiveness of a food allergen training program. Though very small, that study suggested that participating workers' improved knowledge was sustained four weeks after the training (Bailey, Billmeier Kindratt, Smith, & Reading, 2014). Otherwise, no other studies have subjected food allergy training programs to rigorous empirical evaluation. There are some data to suggest that employee training in HACCP is associated with improved microbial quality in meals served, which may be one good measure of training effectiveness (Soriano, Rico, Molto, & Manes, 2002).

A third critical finding is that few participants knew how to respond safely to a food allergy emergency. A minority of participants correctly identified the need for epinephrine followed by calling 9-1-1 in the event of anaphylaxis. A few participants who mentioned epinephrine specifically noted that they would not be comfortable administering this medication, which is potentially life-saving and carries few risks in most people, and is especially safe for children (Kemp et al., 2008). Clearly, this is a major opportunity for public health education, and for increased access to emergency epinephrine, which could be made broadly available in restaurants, just as Automated External Defibrillators (AEDs) have become more widely available in public venues (Caffrey, Willoughby, Pepe, & Becker, 2002). However, just as is the

case with AEDs, education and protections for Good Samaritans will be necessary to overcome barriers to use of epinephrine—which are well-documented among even Emergency Medical Service responders, people with food allergies themselves, and caregivers of people with food allergies (Chung et al., 2014; Gold & Sainsbury, 2000; Kastner, Harada, & Wasserman, 2010; Kim, Sinacore, & Pongracic, 2005; Lammers, Willoughby-Byrwa, & Fales, 2014; Money, Barnett, Kuljis, & Lucas, 2013; Sicherer, Forman, & Noone, 2000; Umasunthar et al., 2015). One city in Canada is experimenting with universally accessible epinephrine in food courts and chain restaurants and evaluation is expected later in the fall of 2015 (Anaphylaxis Canada, n.d.; Bennett, 2015).

Taken together, the findings from this and other studies suggest the need for renewed appraisal of food allergen training policies and evaluation of training and education programs. The city of Philadelphia, the state of Pennsylvania, and many other states and jurisdictions share similar approved training courses for basic food safety. For example, the ServSafe Food Safety Manager course is accepted for certification or demonstration of knowledge in 39 states (including Pennsylvania). In the other 11 states the same ServSafe course is accepted by many jurisdictions (including Philadelphia) (National Restaurant Association Educational Foundation, 2015a). This course touches on food allergens as a hazard to be controlled. Far more specific guidelines and best practices are presented in the ServSafe Allergen course, which is not required in Pennsylvania or in Philadelphia. A minority of states, including Massachusetts, Rhode Island, Virginia, and Michigan, have developed higher standard food allergy training requirements for restaurant employees. Since 2011, the Massachusetts Department of Public Health has required all food service establishments to have a food protection manager trained and certified in safe food allergy management practices (Massachusetts Department of Public Health Bureau of Environmental Health/Food Protection Program, 2010), much as they have long been required to undergo general food safety training in many states (National Restaurant Association Educational Foundation, 2015a). These enhanced policies and related programs should be empirically tested for their effectiveness in imparting food allergy knowledge, changing restaurant worker behavior, and reducing the risk to allergic consumers, since up to 42% of food allergy adverse events and anaphylaxis occur because of accidental exposure in restaurants (Furlong, Maloney, & Sicherer, 2006). Training food service staff is also essential in institutional settings, such as hospitals and colleges, where patients and students have more constrained options and consume most or all of their meals at the institution. Colleges, for example, are required by Americans with Disabilities Act to provide safe food alternatives for students with food allergies (Food Allergy Research & Education, 2015d). It is not clear that colleges and universities are in compliance, though advocacy groups like FARE are working to improve food allergy management on college campuses (Food Allergy Research & Education, 2015a). One study, conducted at a large Midwestern university, showed serious gaps in cafeteria workers' knowledge of safe food allergy management (Choi & Rajagopal, 2013).

A common regulatory challenge is that most states and jurisdictions do not require that all restaurant employees receive food safety training of any type (with or without specific reference to food allergies). In Philadelphia, an owner or manager must complete food safety training, but most employees are exempt. This policy virtually assures that the full restaurant staff will not be formally trained, introducing opportunities for “weak links” and behavioral errors in the food production chain if the one person who received formal training does not disseminate that

knowledge throughout the restaurant staff. Another study highlighted that cooks tended to have more thorough food allergy knowledge than servers, for example. But if servers are not knowledgeable and actively involved in seeking information about consumers' allergies, and if they fail to communicate accurate information to the cook, then the cook's knowledge is undermined and the consumer could be at risk (Kwon & Lee, 2012). An additional pragmatic challenge is the rapid turnover of restaurant employees (National Restaurant Association, 2015), such that owners/employers may be reticent to invest in the training of their employees. New, inexperienced, or untrained employees may pose a hazard to consumers with food allergies. In addition to educating a broader array of restaurant staff, training strategies should incorporate behavioral rehearsals and simulated work tasks, since these training modalities have proven highly effective in shaping other health and safety behaviors, including microbial reduction in food service settings (Soares, Garcia-Diez, Esteves, Oliveira, & Saraiva, 2013). With increased training in general food safety come additional benefits, including reductions in occupational stress and increases in self-efficacy among food handlers (da Cunha, Taddeo Cipullo, Stedefeldt, & de Rosso, 2015). The same may hold true for training in food allergies. Behavioral economic approaches, such as the provision of financial incentives, have also encouraged behavioral compliance with food safety practices among restaurant workers (York et al., 2009).

In this study, we did not seek restaurant-specific information about training programs completed by the managers or employees of establishments visited, or by the specific participants who responded to the survey. This is important information to seek in future research, in order to guide interventions and improve workers' knowledge and adherence to food allergen precautions.

A limitation of this study is that we included only English-speaking restaurant workers, in an industry that employs many new immigrants with primary languages other than English. Notably, only 10 potential participants were excluded on this basis, and one quarter of survey participants spoke a first language other than English, reflecting a high degree of cultural diversity in this study sample. Educating new immigrants and devising strategies to assist in communication are essential to making restaurants safer for people with food allergies. In the Philadelphia, the restaurant community has partnered with the Free Library and the Garces and Vetri Foundations to provide English as a Second Language classes for restaurant employees, to benefit both the food service workers themselves and the patrons they serve. Language barriers, and different cultural beliefs and experiences, may be important determinants of food allergy awareness, knowledge, beliefs, and practices (Brown et al., 2014; Harrington, Dean, Wilson, & Qamar, 2015; Leftwich et al., 2011; Lu, Elliott, & Clarke, 2014).

In this paper, we see restaurant workers as one important group in the food production chain. Restaurant workers have power to mitigate but not totally eliminate the risk of food allergy adverse events. Like consumers with food allergies, restaurant employees are dependent upon accurate labels that reflect the presence of all allergens, for example. Labeling errors, and other errors earlier in the food production chain, are fully outside the control of the restaurant worker and can lead to adverse events in restaurants, even if a restaurant worker adheres faithfully to all of the best practices suggested in the ServSafe Allergen and FARE restaurant trainings. Similarly, restaurant employees often rely on consumers to communicate their allergies clearly

when dining away from home. Indeed, several studies have noted that consumer error—particularly failure to notify the restaurant employee of an allergy—often plays a role in adverse events (Furlong, DeSimone, & Sicherer, 2001; Leftwich et al., 2011). Therefore, both proactive efforts by restaurant staff to elicit food allergy information from all consumers and improved consumer training may also be in order to reduce the risk of food allergy adverse events.

The use of a consumer allergy alert card with a visual cue (vs. the consumer allergy alert card without the visual cue) did not work to improve food service workers' engagement or desire to help a hypothetical patron with food allergies. This may have been because workers' engagement was high at baseline, with or without additional prompts or encouragement. Alternatively, perhaps a better test or intervention to increase workers' engagement would have been the use of the consumer allergy alert card itself vs. no printed consumer allergy alert card. Participants commented that the food allergy alert cards—of both types, with and without the customer photos—provided useful, clear guidance regarding the hypothetical participant's allergies. In addition, comments indicated that being handed a printed card underscored and reinforced the severity of the allergy. In addition, further research should test the effects of a tool using only visual symbols to describe a patron's food allergies. Perhaps pictorial representations of allergenic foods could serve as a universal language for patrons to communicate with food service workers effectively regarding food allergies, thus attending to the diversity of first languages represented among restaurant workers in this study and elsewhere (Choi & Rajagopal, 2013).

4. Conclusions

This study is one of the largest to date to report on the food allergy management beliefs, knowledge, and practices of food service workers. Taken together with evidence from other studies and settings, this report offers evidence of a need for public health professionals to work closely with the restaurant industry, and with food service workers, to develop evidence-based trainings and protocols to protect the large and growing population of people who suffer from food allergies. In the U.S. and abroad, eating away from home is extremely common. We need to find evidence-based, effective strategies for training and education of food service workers, in order to make restaurants safer for consumers with food allergies.

Table 1: Study participants' demographic characteristics

Characteristics	n		%
Gender	185	Male	50.3
		Female	49.7
Age	185	18-25	48.1
		26-30	18.4
		30-39	18.9
		40-49	6.5
		50-65	6.5
		66+	1.6
Education	183	< high school	1.1
		High school degree	21.3
		Some college or more	77.6
First language	181	Other than English	23.8
Position	184	Wait staff	16.3
		Cashier	38.6
		Owner	13.0
		Manager	34.8
		Preparer/chef/cook	28.8
		Other	8.7
Food allergies	175	Worker has a food allergy	21.7
	183	Someone close to them has a food allergy	55.2

Table 2: Proportion of workers who reported that they would take each of the essential steps required to reduce the risk of food allergy adverse events

Steps & workers who reported that they would take these steps			n	%
Steps	(1)	Communicate with patron to clarify allergy and make recommendations	186	28.0
	(2)	Record allergy/communicate with staff		11.3
	(3)	Check ingredients		21.5
	(4)	Use fresh (uncontaminated) ingredients/avoid cross-contact		23.1
	(5)	Sanitize equipment/surfaces and use new instruments		37.1
	(6)	Clean hands or change gloves		19.9
	(7)	Verify order and/or deliver separately		4.8

Table 3: Proportion of workers who strongly endorsed attitude and self-efficacy statements for meeting the needs of customers with food allergies

Item	n	%
In this business, food allergies should be taken very seriously.	182	90.1
I want to go the extra mile to help keep this child safe.	184	88.6
I always take it seriously when a customer like this says he or she has a food allergy.	183	88.5
It is my job to keep customers with food allergies safe.	184	72.8
I am confident that I know how to provide a safe meal for this child.	182	69.2
I am sure that a safe meal can be prepared for the child at this restaurant.	183	64.5
I want to learn more about how to provide safe foods for a customer like this with food allergies.	177	59.9
I am confident that I can accurately identify the ingredients in all of the food served here.	156	55.8
I feel confident that I know what to do if this customer has an allergic reaction.	179	54.2
My employer has provided good training about food allergies.	178	52.2
I would be concerned that my coworkers may not know how to keep this child safe.	179	31.3
I would feel better having this child eat someplace else.	177	12.4
This child should not eat out at restaurants.	177	3.4

Table 4: Restaurant workers' food allergy knowledge

Questions (Bailey et al., 2011)	n	% incorrect
If a customer is having an allergic reaction they should be served cold water to dilute the allergen.	174	24.1
Customers with food allergies can safely consume a small amount of that food.	180	11.7
Removing an allergen from a finished meal, e.g. removing the nuts, may be all that is necessary to provide a safe meal for a food allergic customer.	177	10.7
Cooking, for example frying, can stop food from causing allergies.	179	6.7
A food allergy reaction can cause death.	176	2.8

Table 5: Previous studies assessing the food allergy knowledge, attitudes, and practices of restaurant workers

Reference	Location	Sample	Methods	Findings
Ahuja, R., & Sicherer, S. H. (2007). Food-allergy management from the perspective of restaurant and food establishment personnel. <i>Annals of Allergy, Asthma & Immunology</i> , 98(4), 344-348.	New York City, US	Convenience sample of personnel (managers, servers, chefs, or other) from a broad range of restaurant types identified through the yellow pages and New York Magazine restaurant guide (n=100, 70% response rate)	Structured questionnaire administered via phone	22% of respondents were able to correctly answer 5 true/false knowledge questions, yet over 50% were “very comfortable” providing a safe meal
Ajala, A. R., Cruz, A. G., Faria, J. A. F., Walter, E. H. M., Granato, D., & Sant'Ana, A. S. (2010). Food allergens: Knowledge and practices of food handlers in restaurants. <i>Food Control</i> , 21, 1318-1321.	Metropolitan region of Sao Paulo, Brazil	Staff (managers, cooks, kitchen assistants, service assistants) from 12 restaurants from 2 large hypermarket chains (n=74, 100% response rate)	Paper-based questionnaire (sent via mail)	Restaurants did not provide food allergy specific training to food handlers 67% of managers and 63% of food handlers mentioned they read labels
Bailey, S., Albardiaz, R., Frew, A. J., & Smith, H. (2011). Restaurant staff's knowledge of anaphylaxis and dietary care of people with allergies. <i>Clinical and Experimental Allergy</i> , 41(5), 713-717.	Brighton, UK	Staff members (chefs, managers, owners, waiters) at table-service restaurants identified through 2 online databases (n=90, 56% response rate)	Structured questionnaire administered via phone	33% of respondents received food allergy training although this did not necessarily translate to greater knowledge 59% of respondents were able to correctly answer 5

				true/false knowledge questions, yet 94% were comfortable serving a meal to a food-allergic customer
Choi, J. H., & Rajagopal, L. (2013). Food allergy knowledge, attitudes, practices, and training of foodservice workers at a university foodservice operation in the Midwestern United States. <i>Food Control</i> , 31(2), 474-481.	Midwestern suburban setting, US	Convenience sample of foodservice employees working in university dining (n=193)	Paper-based questionnaire (distributed to managers)	58% of respondents correctly identified epinephrine as the treatment for a severe allergic reaction and 91.2% answered “get medical help immediately” as the first step in emergency response 46.4% of respondents were able to identify common allergens from a list
Common, L., Corrigan, C., Smith, H., Bailey, S., Harris, S., & Holloway, J. (2013). How safe is your curry? Food allergy awareness of restaurant staff. <i>Allergy & Therapy</i> , 4(4), 1000140.	Leicester, UK	Staff (managers, waiters, owners, chefs, supervisors) at restaurants serving Asian-Indian food identified through an online database (n=40, 50% response rate)	Questionnaire administered via phone	15% of respondents received food allergy training (incorporated within a food hygiene or catering course) 32.5% of respondents were able to correctly answer 5 true/false knowledge questions, yet 65% were “very comfortable”

				providing a safe meal for a customer with food allergies
Pratten, J. D., & Towers, N. (2003). Food allergies: a problem for the catering industry. <i>British Food Journal</i> , 105(4/5), 279-287.	Small market town within south Cheshire, UK	Convenience sample (through personal contacts) of restaurants and pubs (and environmental health officers)	Face-to-face surveys	Preliminary findings: Proprietors had limited food allergy knowledge Environmental health officers did not feel like food allergies were their responsibility
Pratten, J., & Towers, N. (2004). Food allergies and the UK catering industry: A study of the training needs for the industry to serve those with food allergies. <i>Journal of European Industrial Training</i> , 28(6), 490-498.	Small market town in the North West of England	Convenience sample (through personal contacts) of restaurants, pubs, and hotels (n=44)	Structured interviews and more limited surveys	Respondents had limited food allergy knowledge The majority of respondents believed environmental health officers should be responsible for providing information about food allergies, although officers did not think this was their responsibility
Shafie, A. A., & Azman, A. W. (2015). Assessment of knowledge, attitude and practice of food allergies among food handlers in the state of Penang, Malaysia. <i>Public Health</i> , 129(9), 1278-1284.	Penang, Malaysia	Convenience sample of food handlers (managers, kitchen crew, waiters, other) at independent and chain restaurants (n=121, 81.76% response rate)	Structured questionnaire administered face-to-face (with the option of self-administering)	1.7% of respondents had excellent food allergy knowledge 21.4% of respondents had low risk practice 4.3% of respondents has a positive attitude

				to reduce risks
Sogut, A., Kavut, A. B., Kartal, I., Beyhun, E. N., Cayir, A., Mutlu, M., & Ozkan, B. (2015). Food allergy knowledge and attitude of restaurant personnel in Turkey. <i>Int Forum Allergy Rhinol</i> , 5(2), 157-161.	City in Erzurum Province, Turkey	Random sample of 207 table-service restaurants identified from Erzurum Chamber of Tradesmen and Craftsmen lists of restaurants, with all staff (chefs, managers, owners, waiters) (n=351, 82.9% restaurant response rate)	Structured questionnaire administered face-to-face	17.1% of respondents received food allergy training 54.3% of respondents could identify at least 3 allergens 12.1% of respondents were able to correctly answer 4 true/false knowledge questions, yet 88% were comfortable serving a meal to a food-allergic customer
Wham, C. A., & Sharma, K. M. (2014). Knowledge of cafe and restaurant managers to provide a safe meal to food allergic consumers. <i>Nutrition & Dietetics</i> , 71(4), 265-269.	Wellington, New Zealand	Random sample of managers and owners from registered eating houses by the Wellington City Council seating 10+ patrons (n=124, 76% response rate)	Self-administered questionnaire (while interviewer was present)	13% of respondents were able to correctly answer 11 true/false knowledge questions, yet 93% were confident they could provide a meal to a food-allergic customer and 64% were confident they could handle an emergency 42.9% of respondents with past food allergy training had a training program for staff compared

to 8.8% of
respondents
without past
training

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ACCEPTED MANUSCRIPT

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ACCEPTED MANUSCRIPT

Figure 1. Number of preventive steps taken by workers (n=186)

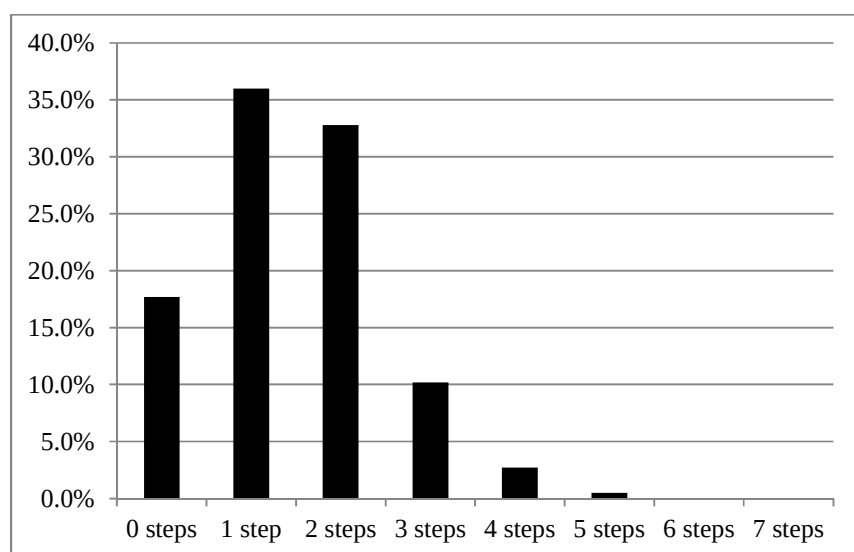
Note: The goal is for each worker to take all 7 preventive steps.

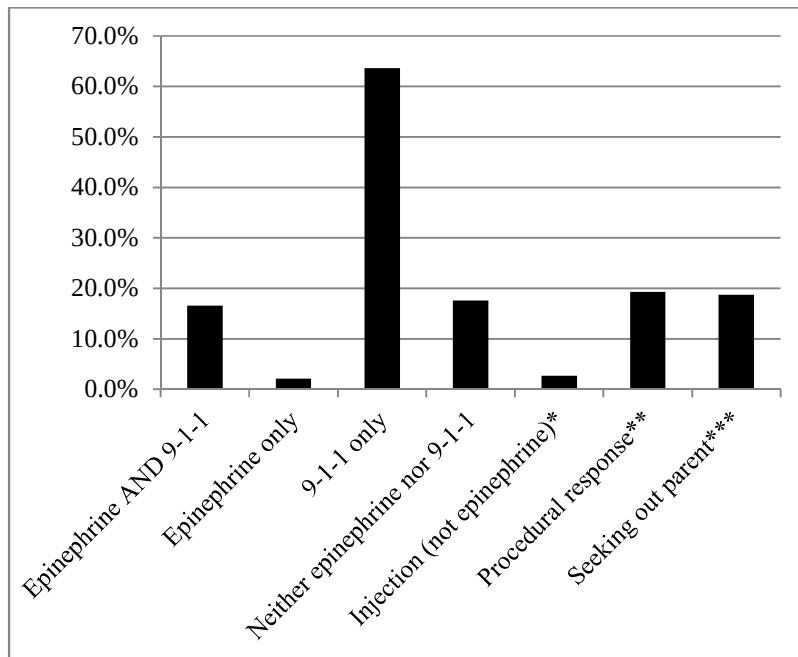
Figure 2. Steps participants reported taking in the event of an emergency due to food allergy (n=187)

Notes: *Participants mentioned giving the participant a shot or another type on injectable medication but could not correctly name the medication; several participants incorrectly mentioned injecting the patron with insulin

**Participants mentioned restaurant procedures they had to follow in the case of an emergency, including calling the manager, filing a report, and compensating the patron

***Participants mentioned looking to the parent for help in the emergency, or seeing if the parent had the appropriate medication





Highlights

1. We surveyed quick-service urban restaurants, with an 80% response (n=233).
2. We measured adherence to 7 best practices to reduce food allergy adverse events.
3. Despite high motivation, *no restaurant employee* used all 7 best practices.
4. Few respondents knew how to assist a customer experiencing anaphylaxis.
5. Improved food allergen training is warranted, as is review of existing policies.

Fast Food Allergy Survey

Image?

☐ Yes
☐ No

What do you think of when you think about food allergies?

What comes to mind if you try to describe a person with food allergies?

What comes to mind when you think about the challenges of serving a person with food allergies?

Name any menu selections you think the child should avoid.

What is one nut-free menu item you believe the child can safely eat?

Name any steps you would take when serving this child in order to keep him safe.

What steps would you take if this customer had an allergic reaction here?

I am sure that a safe meal can be prepared for the child at this restaurant.

Not at all sure Completely sure

=====

(Place a mark on the scale above)

I am confident that I know how to provide a safe meal for this child.

Not at all confident Extremely confident

=====

(Place a mark on the scale above)

I am confident that I can accurately identify the ingredients in all of the food served here.

Not at all confident Extremely confident

=====

(Place a mark on the scale above)

I want to go the extra mile to help keep this child safe.

Strongly disagree Strongly agree

=====

(Place a mark on the scale above)

My employer has provided good training about food allergies.

Strongly Disagree Strongly Agree

=====

(Place a mark on the scale above)

In this business, food allergies should be taken very seriously.

Strongly disagree Strongly agree

=====

(Place a mark on the scale above)

I feel confident that I know what to do if this customer has an allergic reaction.

Not at all confident Extremely confident

=====

(Place a mark on the scale above)

I always take it seriously when a customer like this says he or she has a food allergy.

Strongly disagree Strongly agree

=====

(Place a mark on the scale above)

I want to learn more about how to provide safe foods for a customer like this with food allergies.

Strongly disagree Strongly agree

=====

(Place a mark on the scale above)

I would be concerned that my coworkers may not know how to keep this child safe.

Not at all concerned Very concerned

=====

(Place a mark on the scale above)

I would feel better having this child eat someplace else.

Strongly disagree Strongly agree

=====

(Place a mark on the scale above)

It is my job to keep customers with food allergies safe.

Strongly disagree Strongly agree

=====

(Place a mark on the scale above)

This child should not eat out at restaurants.

Strongly disagree Strongly agree

=====

(Place a mark on the scale above)

What, if anything, are you allergic to?

- ☐ Nothing
- ☐ Peanuts
- ☐ Tree nuts
- ☐ Milk
- ☐ Wheat
- ☐ Eggs
- ☐ Soy
- ☐ Fish
- ☐ Shellfish
- ☐ Other

What are you allergic to?

Does someone close to you have food allergies?

- ☐ Yes
- ☐ No

If so, what is his or her relationship to you?

What is your role in this restaurant?

- ☐ Wait staff
- ☐ Cashier
- ☐ Owner
- ☐ Manager
- ☐ Food preparer/chef/cook
- ☐ Other

What is your gender?

- ☐ Male
- ☐ Female
- ☐ Other

What is your age?

- ☐ younger than 18
- ☐ 18-25
- ☐ 26-30
- ☐ 30-39
- ☐ 40-49
- ☐ 50-65
- ☐ 66 or older

What is the highest level of schooling you have completed?

- ☐ Elementary School/Junior High
- ☐ High School/GED
- ☐ Some college
- ☐ Associate's degree
- ☐ Bachelor's degree
- ☐ Advanced degree (Masters, PhD, etc.)

What is your first language?

Customers with food allergies can safely consume a small amount of that food.

- ☐ True
☐ False

Cooking, for example frying, can stop food from causing allergies.

- ☐ True
☐ False

A food allergy reaction can cause death.

- ☐ True
☐ False

If a customer is having an allergic reaction they should be served cold water to dilute the allergen.

- ☐ True
☐ False

Removing an allergen from a finished meal, e.g. removing the nuts, may be all that is necessary to provide a safe meal for a food allergic customer.

- ☐ True
☐ False

ALLERGY ALERT

My name is Caleb, and I am 9 years old.

I have a severe, life-threatening allergy to all TREE NUTS.

Even small amounts of the following nuts can make me extremely sick: walnuts, pecans, hazelnuts, almonds, pistachios, cashews, pine nuts, brazil nuts, chestnuts, macadamia nuts, filberts, hickory nuts, and any other nut.

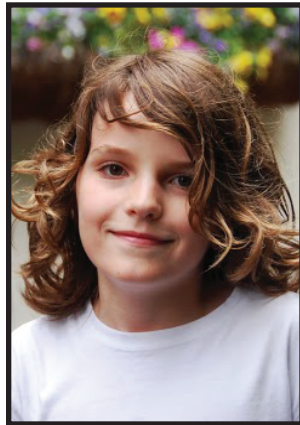
My food cannot contain OR come into contact with any of these ingredients. This includes sauces, marinades and oils made from these nuts.

ALLERGY ALERT

My name is Caleb, and I am 9 years old.

I have a severe, life-threatening allergy to all TREE NUTS. Even small amounts of the following nuts can make me extremely sick: walnuts, pecans, hazelnuts, almonds, pistachios, cashews, pine nuts, brazil nuts, chestnuts, macadamia nuts, filberts, hickory nuts, and any other nut.

My food cannot contain OR come into contact with any of these ingredients. This includes sauces, marinades and oils made from these nuts.



Supplemental Table 1: Study participants' demographic characteristics, by group

Characteristics		Intervention (%)	Control (%)	p-value ^A
Gender	Male	52.9	48.0	0.503
	Female	47.1	52.0	
Age	18-25	47.1	49.0	0.203
	26-30	17.6	19.0	
	30-39	21.2	17.0	
	40-49	2.4	10.0	
	50-65	9.4	4.0	
	66+	2.4	1.0	
Education	< high schools	1.2	1.0	0.915
	High school degree	22.6	20.2	
	Some college or more	76.2	78.8	
First language	English	73.5	78.6	0.434
Position	Wait staff	15.5	17.0	0.780
	Cashier	31.0	45.0	0.051
	Owner	17.9	9.0	0.076
	Manager	32.1	37.0	0.491
	Preparer/chef/cook	28.6	29.0	0.949
	Other	8.3	9.0	0.873
Food allergies	Worker has a food allergy	19.8	23.4	0.559
	Someone close to them has a food allergy	55.4	55.0	0.954

A: Two-sided

Supplemental Table 2: Restaurant workers attitudes and self-efficacy for meeting the needs of customers with food allergies, by group

Item	Measure ^A	Intervention	Control	p-value ^B
I am sure that a safe meal can be prepared for the child at this restaurant.	Mean	81.8	80.5	0.725
	Proportion	65.9%	63.4%	0.727
I am confident that I know how to provide a safe meal for this child.	Mean	83.3	82.8	0.871
	Proportion	72.0%	67.0%	0.471
I am confident that I can accurately identify the ingredients in all of the food served here.	Mean	79.2	79.6	0.917
	Proportion	58.1%	53.7%	0.576
I want to go the extra mile to help keep this child safe.	Mean	91.6	92.5	0.460
	Proportion	86.9%	90.0%	0.511
My employer has provided good training about food allergies.	Mean	74.6	75.9	0.741
	Proportion	50.6%	53.6%	0.691
In this business, food allergies should be taken very seriously.	Mean	92.8	93.3	0.645
	Proportion	92.8%	87.9%	0.271
I feel confident that I know what to do if this customer has an allergic reaction.	Mean	78.3	78.5	0.960
	Proportion	57.3%	51.5%	0.440
I always take it seriously when a customer like this says he or she has a food allergy.	Mean	91.4	94.2	0.031
	Proportion	83.1%	93.0%	0.037
I want to learn more about how to provide safe foods for a customer like this with food allergies.	Mean	82.9	85.0	0.402
	Proportion	53.0%	66.0%	0.080
I would be concerned that my coworkers may not know how to keep this child safe.	Mean	59.7	52.4	0.155
	Proportion	37.8%	25.8%	0.084
I would feel better having this child eat someplace else.	Mean	32.9	36.4	0.470
	Proportion	11.3%	13.4%	0.666
It is my job to keep customers with food allergies safe.	Mean	87.6	88.5	0.676
	Proportion	69.0%	76.0%	0.291
This child should not eat out at restaurants.	Mean	24.1	25.1	0.781
	Proportion	3.7%	3.2%	0.854

A: Mean: higher scores indicate a stronger endorsement of the statement; Proportion of participants who strongly endorsed the statement (score of 85+)

B: Two-sided

Supplemental Table 3: Restaurant workers' food allergy knowledge, by group

Item	Intervention (% incorrect)	Control	p-value ^A
Customers with food allergies can safely consume a small amount of that food.	13.1%	10.4%	0.577
Cooking, for example frying, can stop food from causing allergies.	9.6%	4.2%	0.144
A food allergy reaction can cause death.	1.2%	4.3%	0.227
If a customer is having an allergic reaction they should be served cold water to dilute the allergen.	22.5%	25.5%	0.641
Removing an allergen from a finished meal, e.g. removing the nuts, may be all that is necessary to provide a safe meal for a food allergic customer.	13.4%	8.4%	0.285

A: Two-sided

Supplemental Table 4: Prevention of and response to food allergy adverse events, by group

Item	Intervention	Control	p-value ^A
Mean number of preventive steps	1.49	1.43	0.650
Proportion of participants who correctly named both emergency response steps (epinephrine and 9-1-1)	16.5%	16.7%	0.971

A: Two-sided