Food Control 50 (2015) 259–264

Contents lists available at ScienceDirect

Food Control

journal homepage: www.elsevier.com/locate/foodcont

Food safety knowledge of foodservice workers at a university campus by education level, experience, and food safety training

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ARTICLE INFO

Article history:
Received 11 April 2014
Received in revised form
26 August 2014
Accepted 2 September 2014
Available online 9 September 2014

Keywords:
Food safety
Food contamination
Nutrition knowledge
Foodborne

ABSTRACT

Food safety knowledge of university foodservice workers was evaluated and the relationship between food safety knowledge and education level, length of employment, and food safety training was assessed using a 40-item food safety questionnaire. Each knowledge question was scored as "1" for a correct answer and as "0" for an incorrect answer. The relationships between the level of education and food safety knowledge scores and length of employment in the foodservice industry and food safety knowledge scores were determined using bivariate correlation analysis. A total of 63.5% of the respondents had limited knowledge, 79% were well-informed about hygiene practices, while 33.9% of persons knew of correct time-temperature control measures. Kendall's tau = 0.067; $p = 0.294$ revealed a lack of strength of the relationship between education level and food safety knowledge. The relationship between length of employment and food safety knowledge was Kendall's tau = −0.133; $p = 0.121$. No mean differences ($p = 0.426$) were observed for mean knowledge scores between groups of food safety trained and untrained persons. Neither education level, nor the length of employment in the foodservice industry had a significant impact on food safety knowledge. The authors recommend that in order to improve food safety knowledge, attention should be given to the planning, implementation, monitoring, and evaluating food safety education programs.

1. Introduction

Food safety is a constant public health concern supported by the fact that in both industrialized and developing countries, the rates of foodborne diseases are increasing and encompass a wide spectrum of illnesses. Numerous devastating foodborne outbreaks of salmonellosis, *Escherichia coli* infections, listeriosis, and other diseases have occurred in these countries. They are the result of ingesting contaminated food items and range from diseases caused by a multitude of microorganisms to those caused by chemical hazards. The World Health Organization (WHO, 2009) highlighted that worldwide, every year, millions of people fall ill and die as a consequence of consuming unsafe food. According to WHO (2011), the global incidence of foodborne disease is difficult to estimate. However, reports have indicated that approximately 15.3% of deaths are caused by infections or parasitic diseases globally, and of these, 4.3% is accounted to diarrheal diseases. The Latin American and Caribbean region is not immune to this phenomenon. In low- and middle-income countries in this region, 33,000 deaths were attributed to diarrheal diseases, which represent 1% of all deaths and 5.9 deaths per 100,000 population (WHO, 2011). The Caribbean Epidemiological Centre (CAREC, 2011) revealed that human foodborne disease (FBD) pathogens in the Caribbean increased by 26.7%, from 1064 cases in 2005 to 1310 in 2011, with a peak in *Salmonella* in 2010. Human salmonellosis which was the most commonly reported cause of foodborne disease illness and outbreaks in the Caribbean since 1985 continued in 2011, when salmonellosis accounted for 60% of the overall reported FBD pathogens (CAREC, 2011).

Recent global developments are increasingly challenging international health security. Globally, WHO estimates that between 15 and 79% of all cases of diarrhea is due to food contamination. However, for the Latin American and Caribbean region that percentage is approximately 70% (WHO, 2011). Foodborne outbreaks occur frequently when sufficient care is not paid as foods move along the food chain. The challenge is that the food chain is complex and involves production, processing, distribution, and

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http://dx.doi.org/10.1016/j.foodcont.2014.09.002
0956-7135/

preparation to get food to the table. Therefore, contamination can occur at any point along the chain leading to foodborne illnesses. Although many countries have legislation to protect citizens from food related illnesses, frequent outbreaks continue to occur. Food manufacturers have recalled food products from the market due to an outbreak of foodborne illness where consumers became ill or died after consuming contaminated foods (Ingelfinger, 2008). Epidemiological studies (Jones et al., 2004; Olsen, Mackinon, Goulding, Bean, & Slutsker, 2000) have reported that the majority of foodborne illness outbreaks originate in foodservice entities. Some case control studies (Friedman et al., 2004; Kassenborg et al., 2004; Kimura et al., 2004; Sobel et al., 2000) indicated that "dining-out" is a risk factor for contracting a foodborne illness.

Several factors contribute to the spread of foodborne outbreaks by foodservice workers. Among these factors are improper practices and low level of knowledge (Sharif, Obaidat, & Al-Dalalah, 2013). Mederios, Hillers, Kendall, and Mason (2001) revealed that common food handling mistakes include, serving contaminated raw food, inadequate cooking, or reheating of foods consumption of food from unsafe sources, cooling food inappropriately, and allowing too much of a time lapse. Other contributors to the spread of foodborne outbreaks involve human foodborne pathogens, such as hepatitis A, noroviruses, *Staphylococcus aureus*, *Shigella* sp, and typhoidal *Salmonella* that can be carried by foodservice workers in cuts, sores, mouth, and skin (Sharif et al., 2013). In order to minimize foodborne outbreaks, education must be an integral component of all interventions. Therefore, to plan a successful food safety intervention, obtaining information pertaining to food safety knowledge is of utmost importance. Additionally, making prudent decisions to uproot the problems as early as possible lessens the risk of major foodborne outbreaks. Several studies have reported strong emphasis for educational programs as a way to improve knowledge and control foodborne diseases (Angelillo, Viggiani, Rizzo, & Bianco, 2000; Baş, Ersun, & Kivanç, 2006; Martins, Hogg, & Otero, 2012; Osaili et al., 2013). Baş et al. (2006) and Nel, Lues, Buys, and Venter (2004) pointed out that food handlers need training and education as a result of their low level of knowledge on microbiological food hazards, temperature control of refrigerators, cross contamination, and personal hygiene. Mortlock, Peters, and Griffith (1999) reported that there is a consensus among authors that knowledge towards food safety as it relates to food handlers and the effective practices of such knowledge in food handling were important in ensuring the safe production of food in any catering operation.

Roberts et al. (2008) postulated that restaurant employees who underwent training were better able to respond to questions on food safety knowledge and behavior than untrained employees. Brannon, York, Roberts, Shanklin, and Howells (2009) suggested that it may be beneficial if employees underwent training as it heightens awareness and serves as a stimulus for behavior modification. Johnson, Shin, Feinstein, and Mayer (2003) cited a direct causal relationship between education level and experience on food safety knowledge in a comparison between "fine-dining" and "quick service" restaurant. In contrast, other studies (Chukwuocha et al., 2009; Hertzman & Barrash, 2007) took the position that food safety practices were substandard although employees received food safety training and were experienced. Foote (2004) reported that due to the high turnover among employees in foodservice establishments, many companies consider them less valuable and therefore not worth the investment in training. As a result, many employees handling food at foodservice entities lack food safety knowledge and skills.

Limited research has been conducted in Trinidad and Tobago to evaluate food safety knowledge of foodservice workers. In this study, food safety knowledge of foodservice workers was carried out to examine the distribution and relationship of food safety knowledge and education level (i.e., primary, secondary, tertiary), as well as length of employment.

2. Methods

This study was conducted using a cross-sectional descriptive survey. The inclusion criteria were full-time and part-time employees who were actively involved in the preparation of food at 14 food establishments located on a university campus in Trinidad and Tobago. The food establishments prepared and served both hot and cold items. The number of businesses was reduced from the initial 15 because one of the fast food chain outlets declined to allow employees to participate in the study. A total of 84 questionnaires were distributed; however, only 57 were returned completed, 14 were returned incomplete, and 13 were never returned, giving a response rate of 68%. The questionnaire consisted of a modified version of a validated food safety diagnostic test, developed and established in 2010 by the National Restaurant Association Educational Foundation, USA (2002). The modified version consisted of 33 questions, which examined hygiene, contamination, time-temperature control, and cleaning and sanitizing practices suitable to the study location and population. The questionnaire also collected general/demographic information. The questionnaire was pre-tested to identify the wording and sequencing of the questions, administration, and time to complete. A senior Public Health Officer of the Public Health Inspectorate of Trinidad and Tobago examined the questionnaire to ensure that questions assessed knowledge based on information presented at the 1-h food safety seminars, which is one of the requirements for a "food badge". A food badge is a certificate that indicated that the food handler is registered with the Ministry of Health to handle food.

Data were analyzed using SPSS® version 19 (SPSS, Inc., Chicago, IL, USA, 2011). Descriptive statistics were used to compile the data. The knowledge questions were worth a total of 33 points, each question was scored as "1" for a correct answer and as "0" for an incorrect answer. Cross tabulation was carried out to examine the distribution and relationship of the variables. Bivariate correlation analyses were conducted to determine the relationships between level of education and food safety knowledge scores and length of employment in the foodservice industry and food safety knowledge scores. The effect of basic food safety training on knowledge was measured by conducting an independent sample *t*-test which compared the mean scores of persons who received basic food safety training with those who did not. The level of significance was set at <0.05.

3. Results

3.1. Socio-demographic data

Table 1 presents a summary profile of participants in the study. Of the 57 participants, 19 (33.3%) were from fast food chain outlets and 38 (66.7%) were employed at independently owned food establishments. Among the participants, there were 13 (22.8%) males and 42 (73.7%) females. The majority of respondents were full-time employees 46 (80.7%) of which were females. The greatest number of employees (61.3%) had $\leq$3 years experience working in the foodservice industry and 6 participants acquired >10 years service. Approximately, 91.3% of the participants received secondary (i.e., persons between 11 and 18 years that were exposed to standard school curriculum) or higher level education. Two-thirds of the participants self-reported that they have received basic training in food safety.

Table 1
Summary chararcteristics of the participants ($n = 57$).

Variables	*n*	%
Gender		
Females	42	73.7
Males	13	22.8
No response	2	3.5
Age (years)		
<20	2	3.5
20–30	25	43.9
31–40	14	24.5
41+	15	26.3
No response	1	1.8
Level of education		
Primary	5	8.8
Secondary	38	66.7
Tertiary	14	24.6
Length of employment (years)		
≤3	35	61.3
4–10	15	26.3
>10	6	10.5
No response	1	1.8
Employment status		
Full-time	46	80.7
Part-time	9	15.8
No response	2	3.5
Food safety training		
Yes	38	66.7
No	17	29.8
No response	2	3.5

3.2. Food safety knowledge

Food safety knowledge percentage scores for each question ranged from a minimum of 3.5% to a maximum of 97.7%. The foodservice employees' knowledge was low with a mean percentage score of 46.6 ± 27.24. Overall, they demonstrated poor knowledge in hygiene, time-temperature control, contamination, and cleaning and sanitizing practices. There were 24 (72.7%) of the total (33) questions where the participants failed to obtained a score greater that 60.0% (Table 2). For three of the five hygiene questions, participants received a score less than 55.0%. Only 3.5% of the employees responded correctly to the question, "A food handler must be excluded from the operation for which symptom?" and 36.8% of the participants knew the correct answer related to the correct procedure for washing hands. Participant also scored low on the question, "to work with food, a food handler with a hand wound must …" with 51.0% providing the correct response. The majority (93%) of participants were fully aware that it was improper to handle food with long and painted fingernails and that it was best to use single-use paper towels to dry hands after washing them (Table 2).

Participants scored poorly for the majority of questions related to time-temperature control except for one question where 61.4% responded correctly to "What method should be used when thawing frozen meat, poultry, fish and fish products?" Only 14.0% correctly answered the question pertaining to food stored in a dry-storage area and 78.9% did not know the purpose of a time-temperature indicator or the temperature range of the temperature danger zone.

In terms of contamination, only 3.5% of the participants responded correctly to the question related to the risk reduction of physical contamination. A low percentage of participants (21.1%) received a point for the question on the only type of jewelry that should be worn on the hands or arms while handling food. Only 15.8% participants knew the correct answer on the first step in developing a HACCP plan and 87.7% did not know the sign of a possible rodent infestation. The majority (70.2%) did not know the reason why food should not be stored in a galvanized container.

Regarding cleaning and sanitizing, participants score below 45.0% in three of the five questions. Only 43.9% were able to identify what is sanitizing and the purpose of material safety data sheets. Participants were also deficient in how a prep table should be cleaned and sanitized, with only 28.1% answering correctly.

3.3. Level of education, length of employment and food safety basic training

Table 3 shows that 60% of the persons who were educated at the primary level reported that they received basic training in food safety. This percentage increased at the secondary level, with a recorded percentage of 68.4%, but slightly decreased to 64.3% at the tertiary level. Analysis showed statistically significant differences between levels of education (primary, secondary, tertiary) ($p < 0.01$) with respect to food safety basic training. Participants that were employed for a period of 3 years or less (60.0%) represented those that received basic training in food safety, approximately 89%, 83%, and 50% of those employed 4–6 years, 7–10 years, and more than 10 years, respectively, received basic food safety training (Table 3). There were statistically significant differences between the means for each category within the variables length of employment, i.e., <3, 4–6, 7–10, and >10 years ($p < 0.01$) and food safety basic training. There were no statistically significant associations when the means for education level and length of employment were compared with respect to food safety basic training (not shown). Furthermore, there were no significant relationships between food safety training and age, education level or length of employment.

4. Discussion

Food safety is extremely important to health since it protects against foodborne illnesses due to low level of knowledge in the area. In this study, food safety knowledge of foodservice workers was carried out to examine the distribution and relationship of food safety knowledge and education level (i.e., primary, secondary, tertiary) as well as length of employment. The study demonstrated that food handlers in often have lack of knowledge regarding hygiene, time-temperature control, contamination, and cleaning and sanitizing practices. Results showed that regardless of education level, the employees' performance in the survey was less than satisfactory and is a cause for concern. This study revealed that although 66.7% foodservice employees received basic training in food safety, there was no significant difference of the mean knowledge scores between employees who received basic food safety training and those who did not. A comparison between fine dining and quick service restaurant employees also led to the discovery of a direct causal relationship between education level and experience on food safety knowledge (Johnson et al., 2003).

In our study, the mean percentage score was 46.6 ± 27.24. These findings were similar to that of a study conducted in Ankara, Turkey which reported the mean food safety knowledge score of food handlers ($n = 764$) was 43.4 ± 16.3 (Nee & Norrakiah, 2011). Cohen, Reichel, and Schwartz (2001) reported that in order to ensure food safety, only knowledgeable, motivated, and skilled employees, who are trained to follow proper procedures together with management, can effectively monitor employees' performance. In our study, employees were most knowledgeable about hygiene

Table 2
Percentage of participants with correct answer for each knowledge question.

Question	% Correct	Category
A food handler must be excluded from the operation for which symptom?	3.5	Hygiene
The risk of physical contamination can be reduced by ____.	3.5	Contamination
What is the temperature range of the temperature danger zone?	21.1	Time-temperature control
Using one set of cutting boards for raw potentially hazardous (time/temperature control of safety) food and another set of cutting boards for ready-to-eat food reduces the risk of ____.	80.7	Contamination
What should be used to dry hands after washing them?	93.0	Hygiene
At what internal temperature should raw meat, poultry, and seafood be stored?	52.6	Time-temperature control
What is the only jewelry that may be worn on the hands or arms while handling food?	21.1	Contamination
A backup of raw sewage has occurred in the kitchen. What should happen next?	87.7	Cleaning and sanitizing
Several people became ill with Bacillus cereus gastroenteritis after eating time-temperature abused rice. This result is an example of what?	38.6	Contamination
Food stored in a dry-storage area should NOT be ____.	14.0	Time–temperature control
What is sanitizing?	43.9	Cleaning and sanitizing
The three potential hazards to food are biological, physical and ____.	56.1	Contamination
To work with food, a food handle with a hand wound must ____.	50.9	Hygiene
What do time-temperature indicators do?	21.1	Time–temperature control
What is one way that food should NEVER be thawed?	35.1	Time–temperature control
What is the minimum internal cooking temperature for poultry?	28.1	Time–temperature control
What is the first step in developing an HACCP plan?	15.8	Contamination
Which is a sign of a possible rodent infestation?	12.3	Contamination
Hot potentially hazardous (time/temperature control of safety) food that has been held below 135 °F (57 °C) for over 4 h should be ____.	45.6	Time–temperature control
What is the purpose of Material Safety Data Sheets?	43.9	Cleaning and sanitizing
When receiving a delivery of food for an operation, it is important to ____.	97.7	Contamination
Labels on containers of ready-to-eat potentially hazardous (time/temperature control of safety) food that was prepped on-site must include the ____.	45.6	Time–temperature control
How should a prep table be cleaned and sanitized?	28.1	Cleaning and sanitizing
What is one factor that affects the growth of microorganisms in food?	54.4	Contamination
What is the correct procedure for washing hands?	36.8	Hygiene
How should food handlers keep their fingernails?	93.0	Hygiene
What is the key to limiting bacterial growth?	80.7	Contamination
Why should food NOT be stored in a galvanized container?	29.8	Contamination
Food should be cooled from 135 F to 70 F (57–21 °C) within ____ h, and then 70–41 F (21–5 °C) or lower within ____ h.	35.1	Time–temperature control
The majority of foodborne illnesses is a result of ____.	70.2	Contamination
What method should be used when thawing frozen meat, poultry, fish and fish products?	61.4	Time–temperature control
If the counter and other surfaces came into contact with food, it should be cleaned with ____.	86.0	Cleaning and sanitizing
Which of the following is the most common foodborne bacterium?	50.9	Contamination

Table 3
Variation between level of education, years of employment and food safety basic training.

Variables	Food safety basic training					
	Yes	No	No response	Total	*F*-value	*p*-Value
Education level						
Primary	3	2	0	5	5.715	0.005[a]
Secondary	26	10	2	38	14.132	0.000[a]
Tertiary	9	5	0	14	10.212	0.000[a]
Employment (Yr)						
≤3	21	12	2	35	13.287	0.000[a]
4–6	8	1	0	9	10.000	0.000[a]
7–10	5	1	0	6	7.000	0.001[a]
>10	3	3	0	6	6.708	0.001[a]

[a] Significant at the 0.01 level.

practices, but not on cleaning and sanitation procedures. They were least acquainted with time and temperature control measures and forms of contamination. Many knew that time and temperature control was the key to managing microbial growth, but they were unable to identify other factors which contributed to microbial proliferation. Employees were deficient in knowledge on the temperature danger zone, proper thawing, and the time limit for which foods are deemed safe when kept below 135 °F (57 °C). Anon. (2003) reported that most cases of foodborne disease were due to improper handling of food, including time–temperature control. In our study, participants score low on all the temperature control questions. This finding is supported by Baş et al. (2006) who also found that knowledge of critical temperatures were low amongst their study participants. Further support of this finding was demonstrated in studies conducted in different countries, which reported that food handlers lack the knowledge regarding temperature control (Buccheri et al., 2007; Marais, Conradie, & Labadarios, 2007; Walker, Pritchard, & Forsythe, 2003).

Although a number of employees were not knowledgeable about what sanitizing was, how to clean and sanitize a prep table or the purpose of material safety data sheets, over 80% of them knew what they should do if there was a backup of raw sewage and what should be used to clean surfaces that come into contact with food. Further, despite the fact that a significant number of respondents failed to identify the symptoms for which a food handler should be excluded and the correct steps in hand washing, participants were fully aware that it was best to use single-use paper towels to dry hands after washing them and it was improper to handle food with long and painted fingernails. In contrast, Manning and Snider (1993) in their study reported that 81% of respondents were aware of the importance of hand washing, but only 2% actually observe washing their hands thoroughly. These areas of strength and weakness in knowledge are most likely due to the fact that many employees are very familiar with what constitutes proper hygiene as a result of repeated exposure and practice, but seldom perform more technical procedures, such as time and temperature monitoring, and proper sanitization measures. Similar to finding of Brannon et al. (2009), many employees in this study were unable or unwilling to carry out these procedures as advised due to time constraints and unavailability of resources, such as thermometers.

The correlation analysis revealed there was a weak and indirect association between the length of employment in the foodservice industry and food safety knowledge. This meant that persons with longstanding years of service had lower levels of food safety knowledge than employees with shorter experience. These findings contradict those of Brannon et al. (2009) and Johnson et al. (2003), who stated that employees tend to have higher levels of food safety knowledge as they became experienced in the operations.

Improvement of food safety practices in the foodservice industry is imperative but it can only be realized when food handlers have acquired food safety knowledge by education, training, and the appreciation its continuous application. This view is supported by Roberts et al. (2008), who observed that restaurant employees that underwent training were better able to respond to questions on food safety knowledge and behavior than untrained employees. The investigation proposed the need for training as an additional factor in influencing positive food safety behavior. Brannon et al. (2009) also suggested that this route may be beneficial as it heighten awareness and serve as a stimulus for behavior modification.

Chukwuocha et al. (2009) put forth the need to evaluate the effectiveness of food safety training programs because research indicated that a greater number of the food handlers were less educated. The study's findings suggest that although a program may be well arranged, its content and materials may not be properly interpreted, reviewed or retained by the target audience. In addition to improving food safety education, Dundes and Swann (2008) elaborated further and revealed that management also has a key role to play in the advancement of food safety compliance. The idea of management providing incentives as a means of positive reinforcement towards developing more favorable food safety behavior was suggested. Azanza, Gatchalian, and Ortega (2000) also stated that management would be better able to bridge the gap between food safety knowledge and practices by providing regular food safety education sessions and better water and waste management utilities.

A number of limitations were identified in this study. The number of completed questionnaires was lower that desirable with a return rate of 68%. Supervisors stated that time constraints, staff shortage, and rotation of colleagues to locations off-campus were the reasons for having incomplete and retained questionnaires. It is important to note that the study was conducted among the foodservice workers on a university campus and therefore, the results may not be generalized to overall foodservice workers.

Despite these limitations, this study provided some evidence-based data regarding food safety knowledge of foodservice workers at a major university. The data presented suggest that there is need for urgent intervention in order to increase food safety knowledge among foodservice employees on the campus. Many participants were unaware of the critical areas of food safety and sanitation and this is highly indicative of the tendency to be less cautious when handling food. It is implied that there was an increased risk of contracting foodborne illness, since many are less informed about time and temperature controls, contaminants and cleaning and sanitization procedures. This observation was the same regardless of education level, length of employment in the foodservice, and most surprisingly food safety training.

5. Conclusions

The results of the present study highlight the urgent need to remodel the food safety education training system to include regular workshops and training sessions. In this setting, participants will receive hands-on experience in measures to reduce contamination, they would be trained to correctly read and interpret measurements (e.g., thermometers), and they will be guided on proper cleaning and sanitation measures. Additionally, continuous practical and theoretical assessments with incentives would be effective because it will help to encourage employees to be abreast and informed of proper food safety practices. Public health professionals can work together with managers, owners or supervisors to maintain food safety awareness and practices at food establishments. Further, managers need to set the right example by

practicing correct measures during operations. They should also educate employees on food safety policies and food safety management systems, such as HACCP as this would encourage employees to practice safe food handling from a conscious rather than instructive stand point.

Finally, this study revealed moderate level of knowledge and practice among the foodservice employees. This suggests the need for stronger regulations in relation to training, legislation, and certification, as well as continuous assessment for retaining food badges. Moreover, there is an urgent need for awareness programs for foodservice employees to improve their food safety knowledge. Additionally, the findings can be used by public health officials and foodservice professionals to plan, evaluate, and modify food safety education programs in order to increase food safety knowledge and improve food handling practices.

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