



Food Safety Knowledge and Practice in Low-income Families in the United States: An Exploratory Study

ABSTRACT

A survey was carried out to evaluate the food safety knowledge and practices among consumers in low-income families in the U.S. Data was collected from 234 consumers who had received food or food stamps from local food banks/pantries in the past year. Participants had poor knowledge about how often they should sanitize their kitchen sink (26.9%), which practices cause food poisoning (33.8%), and which foods are most likely associated with *Listeria* bacteria (12.8%). Participants who had experienced foodborne illnesses had better food safety knowledge (10.64 ± 2.78 ; $P < 0.05$), attitudes (3.70 ± 0.43 ; $P < 0.05$), and practices (3.25 ± 0.54 ; $P < 0.1$) than those who had not. Information from health professionals (54.3%), friends or family (44.9%), and written material from the USDA or FDA (44.9%) as well as university scientists (32.9%) were seen as the most trustworthy sources by participants. Food safety educators should increase awareness of the food safety risks associated with home cooking (e.g.,

common sources of foodborne disease pathogens and cooking times and temperatures) and develop educational strategies tailored to consumers from low-income families in the U.S.

INTRODUCTION

The U.S. Centers for Disease Control and Prevention (13) reported 14,259 cases of foodborne illnesses in 2016, with 875 hospitalizations, 17 deaths, and 18 food product recalls. The link between socioeconomic factors and food safety has been demonstrated repeatedly (14, 33). Specifically, people living in high-poverty areas are more likely to suffer from particular foodborne illnesses (4, 11). For example, the incidence of shigellosis was higher in communities where many residents were below the poverty level (14). Another study examining risk factors for *Salmonella* and *Campylobacter* infections indicated that individuals with an annual household income of less than \$55,000 were more likely than more affluent individuals to be exposed to foodborne infections (33).

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Food safety, which has been a concern since the time of early humans (around 50,000 BCE) as a method of self-preservation (22), refers to the handling, preparation, and storage of food to prevent foodborne illnesses. With the relatively recent increase in consumption of raw foods, new contributors to foodborne illnesses have been discovered (25, 35). However, many mild cases go unreported, as illness may cause only discomfort. According to the U.S. Department of Agriculture (46), foodborne illnesses cost more than \$15.6 billion annually in the U.S. alone (39). People at risk for severe cases include pre-school children, older adults in health care facilities, and immunocompromised patients, such as those with cancer (37). According to the Food and Drug Administration (45) Food Code, five major risk factors are related to behaviors and preparation practices that contribute to foodborne illnesses: improper holding temperatures, inadequate cooking, contaminated equipment, food from unsafe sources, and poor personal hygiene.

Several articles on trends influencing food safety in retail foodservice have identified eight trends that can affect food safety and thus increase the need for education by nutrition professionals (26, 29, 30, 43, 47). Some are directly associated with characteristics of consumers, such as increased number of meals eaten away from home, employees being held more accountable for food safety practices, and increased number of people at high risk for foodborne illnesses, while the risk factors associated with inappropriate handwashing practices, cross-contamination, and time and temperature control continue to remain as major concerns. These trends show the need for increased food safety knowledge and improved practices among food handlers and consumers.

Food safety in home cooking is very important, as there are many areas in the home where food can become contaminated and cause foodborne illnesses. However, there are currently no studies investigating food safety knowledge, attitudes, and practices among low-income households cooking food at home. With foodborne diseases causing approximately 3,000 deaths each year in the U.S., it is important to recognize the need for safe food-handling behaviors at home.

Food safety issues with home cooking

The home is a multifunctional setting in which various activities that can influence food safety occur (41). According to Carlson, Kinsey, and Nadav (12), 72% of the food that Americans consume comes from the grocery store and is prepared at home; therefore, it is not surprising that the home is the last line of defense against foodborne diseases (41). However, many experts agree that the home is the primary location where foodborne illness outbreaks occur (9). Based on the 2018 Surveillance for Foodborne Disease Outbreaks (13), of 839 reported cases of foodborne disease outbreaks in 2016, 76 (almost 10%) were associated with home cooking. Among the food safety factors related

to home cooking, bacterial (e.g., *Salmonella*, *Clostridium perfringens*, and *Campylobacter*) and chemical (e.g., scombroid toxin and ciguatoxin) etiologies were mainly responsible for the outbreaks (13, 40). In addition, because most foodborne illness incidents are believed to be sporadic, mild, and unreported (2), it can be surmised that the actual number of cases associated with food safety problems in home cooking is much higher than reported (38).

Numerous factors can contribute to the food safety problems that occur at home, such as contamination of the raw food supply, insufficient awareness or knowledge of food safety, mistakes in food handling or preparation, and deliberate consumption of raw and undercooked foods of animal origin (24). Both *Campylobacter* and *Salmonella* can be transferred from raw chicken products to kitchen surfaces (16, 23). Also, the human and animal occupants of the home can serve as sources of foodborne pathogens (41). *Salmonella* and other enteropathogens have been linked with domestic pets such as dogs and cats (6).

Food safety issues and practices among low-income populations

Numerous factors contribute to food safety incidents among low-income populations, such as a lack of access to grocery stores and supermarkets, inadequate resources, and poor food safety practices (15, 31). Among these factors, food safety practices may be the most important. A study conducted by Signs et al. (42) found that egg samples from low-income census tracts were more often unrefrigerated than eggs from high-income census tracts. In another study, it was found that for each additional 10% of individuals below the poverty line in Detroit, there was an increase of 0.6 critical violations in the food store (36). In addition, studies that focused on the food safety practices of low-income Puerto Rican families in the U.S. showed that these consumers did not often utilize thermometers when cooking meat (3, 17). Furthermore, low-income households' kitchens are often crowded with items unrelated to food preparation but lack the paper towels and soap necessary for appropriate hand washing practices (17). Thus, the purpose of this study was to evaluate the level of food safety knowledge and practices among consumers in low-income families in an area of the U.S. The results of this study are aimed at raising awareness among the public regarding the food safety risks associated with home cooking.

METHODOLOGY

Subject selection

Approval to use human subjects in this study was obtained from the University of Missouri Institutional Review Board prior to initiating the research. The population consisted of adults over 18 years of age who had received food or food stamps from local food banks/pantries in the past year. Participants were recruited through Qualtrics.com, an online

platform that distributes tasks such as online surveys to qualified registered participants, who receive compensation.

Instrument development

The online survey instrument was designed on the basis of previous literature on food safety and consisted of five sections. Section 1 asked participants about their food safety knowledge, including knowledge of cross-contamination prevention, safe times/temperatures for cooking/storing, and common sources of foodborne disease pathogens (10). The number of correct answers was aggregated to obtain a measure of participants' food safety knowledge. In Section 2, participants were asked to indicate their attitudes toward food safety. A 5-point Likert scale (1 = strongly disagree and 5 = strongly agree) was adopted to measure participants' responses to each statement (9). Participants' food safety practices were measured in Section 3 with a 5-point Likert scale (1 = almost never and 5 = always). Questions for Section 3 were adopted from a study conducted by Bruhn and Schutz (5). In Section 4, statements about the reliability of sources of food safety information were presented to participants, and responses were measured using a 5-point Likert scale (1 = highly reliable and 5 = highly unreliable) (5). Section 5 contained questions about participants' demographic characteristics, such as gender, race, educational background, frequency of receiving food donations/stamps, household income, and previous experience in food safety training.

Data collection

The survey was uploaded to the Qualtrics survey system for data collection. A pilot test ($n = 30$) was conducted prior to the final data collection to test the inter-item reliability of measurement items and the clarity of the survey questions and instructions. Cronbach's alpha values were calculated to examine the internal consistency within constructs (32, 45). Results of the pilot test revealed that the Cronbach's alpha values of all constructs were greater than 0.9, indicating that no further revision of the survey instrument was needed. The survey instrument was then distributed to potential participants in the Qualtrics system for final data collection.

Two filtering questions were asked at the beginning of the survey to ensure that participants were adults from low-income families. Only those who identified themselves as "adults receiving foods/food stamps from local food banks/pantries" were invited to continue answering the questions in the survey. To ensure that participants read the questions and provided reliable answers, two attention-check questions were included. An example of this type of question was, "Please select 'Neutral' for this statement." Participants who failed to follow the instructions on these attention-check questions were removed from the final data analyses.

Data analyses

The Statistical Package for Social Sciences Version 25.0 software was used for data analyses. Descriptive statistics (means and standard deviations) were used to summarize the data. Multiple linear regression analyses were conducted to identify the predictors of the dependent variables (e.g., knowledge of practices). Statistical significance was set at $P < 0.05$.

RESULTS

Profile of the participants

Demographic information on the participants is provided in *Tables 1 and 2*. Most participants had an annual household income of \$30,000 or less ($n = 227$; 97%). The majority ($n = 167$; 82.7%) had received food assistance for less than one year. More than half of the respondents ($n = 132$; 56.4%) had some experience working in foodservice operations. In addition, 107 participants (45.7%) had attended training in food safety, and 92 (39.2%) had heard about or experienced foodborne illness outbreaks. In terms of participants' suggestions to food banks, 33 (14.1%) wanted the food banks to stop providing foods past their expiration date, and 25 (10.7%) requested more food options. Additionally, 9 (3.8%) suggested offering more healthful options, 8 (3.4%) wanted other types of help, 7 (3.0%) requested improvements in the service of the food banks, and 6 (2.6%) stated that the food banks should ensure the quality of the food provided (18, 19, 48). Providing more fresh food, and more food to more people, were each suggested by 12 participants (5.1%). Some other suggestions were also provided, such as only providing food stamps instead of requiring participants to visit the food banks ($n = 3$; 1.3%), better hygiene among employees ($n = 4$; 1.7%), and shorter waiting lines at the food banks ($n = 2$; 0.9%).

Food safety knowledge

Participants' food safety knowledge was assessed with 21 questions divided into three categories: cross-contamination prevention, safe times/temperatures for cooking/storing food, and common sources of foodborne disease pathogens. Almost two-thirds of the participants were aware that they should wash their hands after touching their face ($n = 151$; 64.5%) and knew the correct way to store raw food in the refrigerator ($n = 147$; 62.8%) and to wash food ($n = 146$; 62.4%) (*Table 3*). In addition, almost half of the participants ($n = 115$; 49.1%) knew the most hygienic handwashing method. However, participants seemed to have poor knowledge about how often they should sanitize their kitchen sink drain, as only 63 (26.9%) knew that they should clean the kitchen sink every day.

With regard to questions on safe cooking times and temperatures (*Table 4*), most of the participants ($n = 191$; 81.6%) showed a good understanding of the methods of preventing food poisoning, and the majority ($n = 164$; 70.1%) also knew the correct temperature to which food

TABLE 1. Respondents' demographic information

Characteristics	<i>n</i>	%
Age		
Do not wish to disclose	1	0.4
21–30 years	31	13.2
31–40 years	46	19.7
41–50 years	44	18.8
> 50 years	112	47.9
Gender		
Male	79	33.8
Female	155	66.2
Ethnicity		
Do not wish to disclose	4	1.7
Non-Hispanic Caucasian	162	69.2
Non-Hispanic Black/African American	36	15.4
Asian/Pacific Islander	1	0.4
Native American (American Indian)	4	1.7
Hispanic/Latino	12	5.1
Other	15	6.4
Education level		
Less than high school	21	9.0
High school or GED	100	42.7
Some college	75	32.1
Bachelor's degree	15	6.4
Some graduate/professional work beyond bachelor's degree	6	2.6
Graduate/professional degree	14	6.0
Total household income (\$)		
≤ 10,000	74	31.6
10,001–20,000	110	47.0
20,001–30,000	43	18.4
30,001–40,000	4	1.7
40,001–50,000	1	0.4
> 50,000	2	0.9
Other	3	1.3

Note: *N* = 234.

should be cooked and the most accurate way of determining whether hamburgers were cooked thoroughly enough to prevent food poisoning (*n* = 133; 56.8%). However, less than half of the participants (*n* = 102; 43.6%) knew the maximum refrigerator temperature that will keep foods safe. In addition,

participants had little understanding of practices that lead to food poisoning, with only 79 (33.8%) having some knowledge of such practices.

Overall, questions on common sources of foodborne disease pathogens received the lowest scores (*Table 5*). Only

TABLE 2. Respondents' specific household demographics and food experience

Characteristics	<i>n</i>	%
Number of adults living with you (including participants themselves; <i>n</i> = 234)		
Do not wish to disclose	9	3.8
1	101	43.2
2	86	36.8
3	20	8.5
4	11	4.7
5	4	1.7
≥ 5	3	1.3
Number of children living with you (<i>n</i> = 234)		
0	141	60.3
1	38	16.2
2	25	10.7
3	19	8.1
4	7	3.0
≥ 5	4	1.7
Number of months food donations were received (<i>n</i> = 202)		
1–12	167	82.7
13–24	25	12.4
25–36	8	4.0
≥ 37	2	0.9
Frequency of receiving food donations (<i>n</i> = 234)		
Every week	4	1.7
Every 2 weeks	3	1.3
Every month	227	97.0
Experience working in foodservice operations (<i>n</i> = 234)		
Yes	132	56.4
No	102	43.6
Months of experience working in foodservice (<i>n</i> = 112)		
1–12	97	86.6
13–24	12	10.7
25–36	2	1.8
37–48	1	0.9
Attended food safety training (<i>n</i> = 234)		
Yes	107	45.7
No	127	54.3

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TABLE 2. Respondents' specific household demographics and food experience (cont.)

Characteristics	<i>n</i>	%
Food safety training provider (<i>n</i> = 107)		
Local health department	36	33.6
The company	50	46.7
National Restaurant Association	4	3.7
Local community	8	7.4
Other	9	8.6
Heard about or experienced foodborne illnesses outbreak after eating food prepared at home (<i>n</i> = 234)		
Yes	92	39.2
No	142	60.7
Suggestions for the food bank (<i>n</i> = 234)		
No suggestions	102	43.6
Not offering expired food	33	14.1
Giving more options for food	25	10.7
Offering more healthy food	9	3.8
Ensuring the quality of the food provided	6	2.6
Improving the manners of employees at the food bank	7	3.0
Only providing food stamps	3	1.3
Storage of the food	6	2.6
Location of the food bank	5	2.1
Providing more food to more people	12	5.1
Better hygiene	4	1.7
Other types of help (such as providing nutrition info)	8	3.4
Shorter waiting lines	2	0.9

30 participants (12.8%) knew that *Listeria monocytogenes* was the pathogen most often associated with deli meats, and 32 (13.7%) knew that *Campylobacter* was related to raw or undercooked poultry. In addition, around one-fifth of the participants (*n* = 47; 20.1%) knew that food poisoning caused by *Staphylococcus aureus* was most likely due to the food being prepared by cooks with their bare hands and then left at room temperature.

Food safety attitudes

Participants' attitudes toward food safety were assessed from several perspectives, including interest in learning about avoiding food poisoning, the importance of cleanliness/sanitation, susceptibility to food poisoning, and understanding the threat of food poisoning in the U.S. as a whole and as a personal threat (Table 6). More than half of the participants

(*n* = 122; 52.1%) thought it was worth their time to learn about how to avoid food poisoning. A total of 115 participants (49.1%) stated that knowledge about food safety was useful, and 113 (48.3%) liked learning about how to keep food safe. However, only 8 participants (3.4%) showed interest in learning about methods of avoiding food poisoning.

Participants' perceived importance of cleanliness/sanitation was investigated as well. Over two-thirds of the participants (*n* = 161; 68.8%) agreed that the cleanliness of restaurants was very important, while 154 participants (65.8%) thought that it was important for food to be prepared in a sanitary manner. In addition, more than half the participants (*n* = 135; 57.7%) indicated that it was important that the restaurant looked clean. However, only 91 participants (38.9%) strongly agreed that they would be concerned if a food store looked dirty.

TABLE 3. Results from the cross-contamination prevention/disinfection procedures scale

Rank	Questions	Correct		Incorrect	
		<i>n</i>	%	<i>n</i>	%
1	To prevent food poisoning, how often should the kitchen sink drain in your home be sanitized? Answer: daily	63	26.9	171	73.1
2	Which procedure for cleaning kitchen counters is most likely to prevent food poisoning? Answer: wash with a detergent, rinse, then wipe with a sanitizing solution	65	27.8	169	72.7
3	When should kitchen counters be washed, rinsed, and sanitized? Answer: all of the above (after each use, when you begin working with another type of food, at 4-hour intervals if the counter is in constant use)	93	39.7	141	60.3
4	Which is the most hygienic way to wash your hands? Answer: run water, moisten hands, apply soap, rub hands together for 20 seconds, rinse hands, dry hands	115	49.1	119	50.9
5	The best way to keep from getting food poisoning from fresh fruits and vegetables is to wash them with what? Answer: cool running water	146	62.4	88	37.6
6	Which should not be done when storing raw meat, fish, or poultry in the refrigerator? Answer: all should be done when storing raw meat, fish, or poultry	147	62.8	87	37.2
7	When preparing food, you should wash your hands after touching which of these? Answer: your face	151	64.5	83	35.5

TABLE 4. Results from the safe times/temperatures for cooking/storing food scale

Rank	Questions	Correct		Incorrect	
		<i>n</i>	%	<i>n</i>	%
1	Which practice is most likely to cause food poisoning? Answer: leaving stuffing in a cooked turkey until it cools to room temperature	79	33.8	155	66.2
2	What is the maximum temperature refrigerators should be to preserve the safety of foods? Answer: 41°F (4°C)	102	43.6	132	56.4
3	When is it safest to place refrigerated foods in your cart when grocery shopping? Answer: at the very end of the shopping trip, just before checking out	130	55.6	104	44.4
4	Imagine that your electricity went off and the meat, chicken, and/or seafood in your freezer thawed and felt warm. To prevent food poisoning, what should you do? Answer: throw them away	131	56.0	103	44.0
5	Which method is the most accurate way of determining whether hamburgers are cooked enough to prevent food poisoning? Answer: measure the temperature with a food thermometer	133	56.8	101	43.2
6	All foods are considered safe when cooked to an internal temperature of what? Answer: 165°F (74°C)	164	70.1	70	29.9
7	Which of the following is considered the most important way to prevent food poisoning? Answer: keep foods refrigerated until it's time to cook or serve them	191	81.6	43	18.4

TABLE 5. Results from the common sources of foodborne disease pathogens scale

Rank	Questions	Correct		Incorrect	
		<i>n</i>	%	<i>n</i>	%
1	<i>Listeria</i> bacteria are most likely associated with which food? Answer: deli meats	30	12.8	204	87.2
2	<i>Campylobacter</i> bacteria are most likely associated with which food? Answer: raw or undercooked poultry	32	13.7	202	86.3
3	Staph (<i>Staphylococcus</i>) bacteria that cause food poisoning are most likely associated with which food? Answer: food prepared by cooks with their bare hands and then left at room temperature	47	20.1	187	79.9
4	Botulism is a disease that is most likely associated with which food? Answer: canned foods	75	32.1	159	67.9
5	<i>Salmonella</i> bacteria can cause food poisoning. How can a food be made safe if it has <i>Salmonella</i> in it? Answer: cook it thoroughly	80	34.2	154	65.8
6	Harmful <i>E. coli</i> bacteria are most likely associated with which food? Answer: raw or undercooked beef	98	41.9	136	58.1
7	You may contaminate the next food you touch with <i>Salmonella</i> bacteria if you don't wash your hands after touching what? Answer: raw chicken	161	68.8	73	31.2

Regarding participants' perceived susceptibility to food poisoning, only 80 (34.2%) participants strongly believed, while almost half ($n = 106$; 45.3%) did not believe, that they would get food poisoning in the current year. More than half of the participants (58.5%) strongly believed that the U.S. did not suffer from food poisoning each year. Moreover, only 18.8% of the participants strongly believed that food poisoning was a problem in the U.S.

For attitudes regarding food poisoning as a personal threat, the majority of the participants did not view food poisoning as a serious personal threat. Specifically, only 12 participants (5.1%) stated that they strongly worried about getting food poisoning, and 53 (22.6%) showed that they did not worry at all about getting food poisoning.

In general, the results showed that the majority of them always used safe practices (Table 7). For example, 173 participants (73.9%) always examined food packages to check the integrity of the food. Over half of the participants checked frozen food when purchasing it ($n = 144$; 61.5%) and cleaned food preparation areas with soap and water after preparing foods ($n = 147$; 62.8%). In addition, almost half of the participants ($n = 111$; 47.4%) stated that they would never use a luncheon meat, pasta, or sauce item after the expiration date. However, some participants showed relatively poor food safety practices. For example, 17 participants (7.3%) indicated that they always used raw eggs in salads, desserts, or drinks. Also, 11 participants (4.7%) indicated that they always left cooked meat on the counter for more than 4 hours.

Previous foodborne illnesses

Table 8 compares participants' food safety knowledge, attitudes, and practices between participants with and without foodborne illness experiences. The results indicate that participants who had experienced foodborne illnesses had better food safety knowledge (10.64 ± 2.78 ; $P < 0.05$), attitudes (3.70 ± 0.43 ; $P < 0.05$), and practices (3.25 ± 0.54 ; $P < 0.1$) than those who had not.

Reliability of food safety information sources

The perceived reliability of sources of food safety information was assessed using various categories: people, print media, electronic media, and written materials (Table 9). Over half of the participants ($n = 127$; 54.3%) strongly trusted the food safety information from health professionals, while 77 participants (32.9%) indicated that the information from university scientists was highly reliable. Most participants showed some degree of trust in the print media. For example, almost half of the participants thought that food safety information from *Consumer Reports* ($n = 105$; 44.9%), science magazines ($n = 102$, 43.6%), and food magazines ($n = 101$; 43.2%) were relatively reliable. Regarding electronic media, about half of the participants thought that the food safety information provided by radio programs ($n = 114$; 48.7%), television talk shows ($n = 106$; 45.3%), and social media ($n = 100$; 42.7%) were neither reliable nor unreliable. In addition, 94 (40.2%) and 92 (39.3%) participants believed in the reliability of the food

TABLE 6. Results from the food safety attitude scale

Questions		Response n (%)				
		Strongly Disagree			Strongly Agree	
		1	2	3	4	5
Interest in learning about avoiding food poisoning						
1	I am interested in finding out how to avoid food poisoning.	121 (51.7%)	60 (25.6%)	35 (15.0%)	10 (4.3%)	8 (3.4%)
2	It is worth my time to learn about preventing food poisoning.	5 (2.1%)	6 (2.6%)	28 (12.0%)	73 (31.2%)	122 (52.1%)
3	I like learning about how to keep my foods safe to eat.	5 (2.1%)	5 (2.1%)	38 (16.2%)	73 (31.2%)	113 (48.3%)
4	It is very useful to me to learn about how to prevent food poisoning.	4 (1.7%)	9 (3.8%)	28 (12.0%)	78 (33.3%)	115 (49.1%)
5	I would like to learn about how to prevent food poisoning.	5 (2.1%)	3 (1.3%)	39 (16.7%)	83 (35.5%)	104 (44.4%)
The importance of cleanliness/sanitation						
1	It is important to me that the foods I eat are prepared in a sanitary way.	3 (1.3%)	0 (0.0%)	19 (8.1%)	75 (32.1%)	137 (58.5%)
2	It is important that the restaurants I eat in look clean.	2 (0.9%)	4 (1.7%)	22 (9.4%)	71 (30.3%)	135 (57.7%)
3	It is important that the restaurants I eat in are clean.	1 (0.4%)	0 (0.0%)	18 (7.7%)	54 (23.1%)	161 (68.8%)
4	It does matter to me if a food store seems dirty.	59 (25.2%)	17 (7.3%)	21 (9.0%)	46 (19.7%)	91 (38.9%)
5	It is important to me whether or not a food has been prepared in a sanitary manner.	9 (3.8%)	1 (0.4%)	16 (6.8%)	54 (23.1%)	154 (65.8%)
Food poisoning susceptibility						
1	I believe that I could get food poisoning.	6 (2.6%)	12 (5.1%)	54 (23.1%)	82 (35.0%)	80 (34.2%)
2	I have a chance of getting food poisoning.	10 (4.3%)	15 (6.4%)	67 (28.6%)	76 (32.5%)	66 (28.2%)
3	It is possible that I could get food poisoning this year.	106 (45.3%)	58 (24.8%)	54 (23.1%)	8 (3.4%)	8 (3.4%)
Food poisoning as a threat in the U.S.						
1	Many people in this country suffer from food poisoning every year.	1 (0.4%)	4 (1.7%)	40 (17.1%)	92 (39.3%)	97 (41.5%)
2	Food poisoning is usual in the U.S.	16 (6.8%)	15 (6.4%)	82 (35.0%)	76 (32.5%)	45 (19.2%)
3	A lot of Americans never get food poisoning.	6 (2.6%)	18 (7.7%)	83 (35.5%)	77 (32.9%)	50 (21.4%)
4	Food poisoning is a problem in the U.S.	5 (2.1%)	18 (7.7%)	85 (36.3%)	82 (35.0%)	44 (18.8%)

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TABLE 6. Results from the food safety attitude scale (cont.)

Questions		Response n (%)				
		Strongly Disagree			Strongly Agree	
		1	2	3	4	5
Food poisoning as a threat in the U.S.						
5	Food poisoning is a concern in this country.	3 (1.3%)	16 (6.8%)	69 (29.5%)	88 (37.6%)	58 (24.8%)
6	Contamination of food by harmful microbes (germs) is a problem in this country.	6 (2.6%)	11 (4.7%)	78 (33.3%)	88 (37.6%)	51 (21.8%)
Food poisoning as a personal threat						
1	Food poisoning is currently a big threat to my health.	20 (8.5%)	56 (23.9%)	79 (33.8%)	43 (18.4%)	36 (15.4%)
2	I worry about getting food poisoning from the food I eat.	24 (10.3%)	54 (23.1%)	80 (34.2%)	46 (19.7%)	30 (12.8%)
3	I am afraid about getting food poisoning.	19 (8.1%)	40 (17.1%)	81 (34.6%)	54 (23.1%)	40 (17.1%)
4	Getting food poisoning is a problem I worry about.	26 (11.1%)	58 (24.8%)	71 (30.3%)	46 (19.7%)	33 (14.1%)
5	I am concerned about getting food poisoning.	20 (8.5%)	48 (20.5%)	72 (30.8%)	57 (24.4%)	37 (15.8%)
6	I worry about getting food poisoning.	53 (22.6%)	43 (18.4%)	68 (29.1%)	58 (24.8%)	12 (5.1%)

safety information from television programs and news, respectively.

Food safety information in written materials provided by institutions was believed to have relatively high reliability. For example, 97 participants (41.5%) strongly trusted the food safety information from government sources such as the USDA or FDA. Also, 105 participants (44.9%) thought that the food safety information provided by health food stores was of relatively high reliability. However, 94 participants (40.2%) thought that the food safety information provided by supermarkets was neither reliable nor unreliable.

DISCUSSION

In general, participants showed little knowledge of food safety. The rate of answering questions correctly ranged from 12.8% to 81.6%. More specifically, participants in this study had the highest rate of correct answers regarding questions about the safe times and temperatures for cooking and storing food but had very little knowledge about common sources of foodborne disease pathogens. For the question on *Listeria monocytogenes* and its association with deli meats,

only 30 of the 234 participants chose the correct answer. The results of this study differed from those of a previous study conducted by Patil, Cates, and Morales (33). In that study, individuals with high incomes showed less knowledge about good hygiene practices, compared with low-income consumers. However, results related to food safety knowledge were similar to those of this study in a report by Tionni, Katherine, Nan and Cathey (44), who found that food safety knowledge, especially regarding safe storage temperatures, was scanty among low-income adults.

Various explanations are possible for the results of this study. First, most members of the public lack knowledge of basic microbiology in general and food microbiology in particular (21). Second, people tend to learn about common foodborne illnesses from newscasts of highly publicized foodborne disease outbreaks, which do not provide detailed information about the responsible pathogens. Last, studies have shown a relationship between other demographic factors, such as educational level, and food safety knowledge, with participants of higher educational attainment having better food safety knowledge (14, 19, 34). Thus, food

TABLE 7. Results from the food safety practices scale

Questions		Response <i>n</i> (%)				
		Almost Never		Always		
		1	2	3	4	5
1	When purchasing, I examine food packages to see if they have been opened or damaged.	1 (0.4%)	6 (2.6%)	16 (6.8%)	38 (16.2%)	173 (73.9%)
2	When purchasing frozen foods, I check to be sure they are frozen solid.	9 (3.8%)	15 (6.4%)	20 (8.5%)	46 (19.7%)	144 (61.5%)
3	After preparing foods, I clean the food preparation area with soap and water.	11 (4.7%)	10 (4.3%)	21 (9.0%)	45 (19.2%)	147 (62.8%)
4	I leave cooked meat on the counter at room temperature for over 4 hours.	124 (53.0%)	43 (18.4%)	31 (13.2%)	25 (10.7%)	11 (4.7%)
5	I use the same plate for raw and cooked meat, and I do not wash the plate before using it for cooked meat.	187 (8.5%)	12 (20.5%)	22 (30.8%)	3 (24.4%)	10 (15.8%)
6	I taste leftovers to check if they are still safe.	65 (27.8%)	34 (14.5%)	58 (24.8%)	37 (15.8%)	40 (17.1%)
7	I use raw eggs in salads, desserts, and drinks like eggnog.	160 (68.4%)	21 (9.0%)	20 (8.5%)	16 (6.8%)	17 (7.3%)
8	When I cook a large portion of food, I refrigerate the leftovers in several small containers.	11 (4.7%)	27 (11.5%)	52 (22.2%)	62 (26.5%)	82 (35.0%)
9	When I need to defrost a frozen food, I take it out of the freezer and put it on the countertop.	55 (23.5%)	36 (15.4%)	40 (17.1%)	70 (29.9%)	33 (14.1%)
10	If a luncheon meat, pasta, or sauce item is past its package date, I do not use it after the date.	22 (9.4%)	23 (9.8%)	42 (17.9%)	36 (15.4%)	111 (47.4%)

TABLE 8. Comparison of food safety knowledge, attitudes, and practices based on previous foodborne illnesses experiences

Experienced Foodborne illnesses	Yes (<i>n</i> = 92)		No (<i>n</i> = 142)		<i>t</i> (232)
	Mean	SD	Mean	SD	
Knowledge ^a	10.64	2.78	9.45	2.79	3.17**
Attitudes ^b	3.70	0.43	3.56	0.48	2.13**
Practices ^c	3.25	0.54	3.12	0.57	1.76*

P* < 0.1; *P* < .05.

^aKnowledge score ranging from 0 to 14.

^bAttitudes measured using 5-point Likert scale (1 = strongly disagree and 5 = strongly agree).

^cPractices measured using 5-point Likert scale (1 = almost never and 5 = always).

TABLE 9. Reliability of sources of food safety information

Source		Response n (%)					M
		Highly Unreliable			Highly Reliable		
		1	2	3	4	5	
People							
1	University scientists	3 (1.3%)	10 (4.3%)	56 (23.9%)	88 (37.6%)	77 (32.9%)	3.88
2	Health professionals	2 (0.9%)	4 (1.7%)	24 (10.3%)	77 (32.9%)	127 (54.3%)	
3	Friends or family	8 (3.4%)	30 (12.8%)	105 (44.9%)	69 (29.5%)	22 (9.4%)	
Print media							
1	Consumer reports	3 (1.3%)	13 (5.6%)	67 (28.6%)	105 (44.9%)	46 (19.7%)	3.60
2	Science magazines	3 (1.3%)	10 (4.3%)	73 (31.2%)	102 (43.6%)	46 (19.7%)	
3	Food magazines (e.g., <i>Gourmet</i>)	3 (1.3%)	13 (5.6%)	67 (28.6%)	101 (43.2%)	50 (21.4%)	
4	News magazines (e.g., <i>Time</i>)	6 (2.6%)	37 (11.5%)	99 (42.3%)	77 (32.9%)	25 (10.7%)	
5	Newspapers	9 (3.8%)	25 (10.7%)	102 (43.6%)	73 (31.2%)	25 (10.7%)	
Electronic media							
1	TV programs (e.g., <i>Chopped</i> , <i>Iron Chef America</i>)	1 (0.4%)	17 (7.3%)	81 (34.6%)	94 (40.2%)	41 (17.5%)	3.31
2	Radio	7 (3.0%)	38 (16.2%)	114 (17.9%)	52 (9.8%)	23 (9.4%)	
3	Television news	6 (2.6%)	20 (8.5%)	78 (33.3%)	92 (39.3%)	38 (16.2%)	
4	TV talk shows (e.g., <i>The Pioneer Woman</i>)	9 (3.8%)	28 (12.0%)	106 (45.3%)	62 (26.5%)	29 (12.4%)	
5	Social media (e.g., Facebook)	33 (14.1%)	49 (20.9%)	100 (42.7%)	35 (15.0%)	17 (7.3%)	
Written material							
1	Government (USDA/FDA)	9 (3.8%)	11 (4.7%)	40 (17.1%)	77 (32.9%)	97 (41.5%)	3.81
2	Health food stores	4 (1.7%)	13 (5.6%)	64 (27.4%)	105 (44.9%)	48 (20.5%)	
3	Supermarkets	3 (1.3%)	11 (4.7%)	94 (40.2%)	91 (38.9%)	35 (15.0%)	

safety educators need to pay more attention to various demographic factors and develop educational strategies to improve consumers' knowledge with regard to areas such as common sources of foodborne disease pathogens and cooking time and temperatures. Since the targeted population in this study is low-income families, educational materials for them would need to be provided at low or no cost.

Compared with participants' scanty food safety knowledge, their food safety practices were more encouraging. The majority of the participants indicated that they regularly used safe food practices, with very few of them stating that they engaged in risky practices. However, some of them indicated that they used raw eggs when preparing salads. The results of the study conducted by Tionni et al. (44) were consistent with the findings of this study; in that study, too, respondents stated that they would infrequently engage in some unsafe food practices, the most common one being the consumption of raw or undercooked eggs.

According to previous research, better knowledge can lead to better food safety behaviors (33). Therefore, to improve food safety practices of low-income individuals, strengthening their food safety knowledge appears to be needed. Since resources for low-income people are scarce, free workshops on food safety should be provided in low-income communities in collaboration with local health departments. In addition, visual materials such as flyers and posters containing food safety information should be distributed to improve the public's knowledge of food safety.

Even though low-income families are more susceptible to foodborne illnesses (4, 11), participants in this study did not show a strong interest either in learning more about this topic or in improving their awareness of the risks. Of all of the 234 participants, only 8 were very interested in finding out how to avoid food poisoning, and only 36 participants regarded food poisoning as a big threat to their health. It seemed that they were not aware of the severity of foodborne illnesses, and awareness is known to influence risk perception; according to Gordon (20), inappropriately low risk perceptions can lead to failure to take preventive actions. Therefore, helping low-income people to perceive risk appropriately is essential. An important factor that may influence risk perception is emphasizing the association between an illness and a particular food or poor food handling practices to provide the necessary motivation for behavioral change (49). Thus, educational workshops based on this motivation should be arranged in low-income communities. Furthermore, consistent with the study by Angelillo, Viggiani, Rizzo, and Bianco (1), the results indicated that participants who had experienced foodborne illnesses had better food safety knowledge, attitudes, and practices than those who did not have these experiences (Table 8).

Food safety information can come from various sources, ranging from scientific reports to friends and family (7). In terms of trustworthiness scores, the results showed that information from university scientists, health professionals, and friends or family, as well as written material from the USDA or FDA, were perceived as the most trustworthy sources. Participants may prefer food safety information from people they know because interpersonal sources have more salience for their personal needs or with regard to social support (43). This finding is consistent with findings of other previous studies as well. For example, a study conducted by Kornelis et al. (27) showed that most consumers preferred either institutional or social sources. In addition, Buzby and Ready (8) reported that most people completely trust the food safety information in government publications, a finding that can be applied to education interventions related to food safety practices. For example, food safety reports from government publications could be added to the intervention materials, which would enhance the perceived reliability of the information.

Another finding worthy of attention is that electronic media sources had the least reliability for the low-income participants in this study, a pattern that is supported by some previous studies. For instance, Buzby and Ready (8) found that television shows and news were the least trusted sources for food safety information; one explanation is that consumers may not trust these sources because they think that advertisers have incentives to make positive claims for their products. Based on this result, it might be desirable for government agencies to regulate advertisements and information in electronic media more strictly to ensure the accuracy of food safety information. In addition, food safety professionals and educators should be cautious in using electronic media to educate consumers.

CONCLUSIONS AND RECOMMENDATIONS

Overall, this study provides a better understanding of the current level of food safety knowledge and practices among consumers in low-income families in the U.S. Food safety educators could use its findings to increase awareness of the food safety risks associated with home cooking and develop educational strategies tailored to consumers from U.S. low-income families.

Further research is needed to identify effective ways to overcome barriers to safe food handling practices in homes, especially those of low-income families. To increase consumers' awareness of the need for food safety practices, both tangible and intangible risks associated with foodborne illness outbreaks at home may be addressed by various sources (e.g., university scientists, health professionals, or written material from the USDA or FDA) (28). Finally, because the findings of this study are limited to consumers from low-income families in the U.S., the results cannot be generalized to other geographic locations or other populations (e.g., UK, Asian or middle-class households).

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In Memory

Robert H. Deibel

We extend our deepest sympathy to the family of Robert Deibel who recently passed away. Dr. Deibel was a member of the Association since 1987. IAFP will always have sincere gratitude for his contribution to the Association and the profession.
