



International Food Information Council Foundation *Food and Health Survey*, 2006–2010, Food Safety: A Web-enabled Survey

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ABSTRACT

Consumer attitudes toward food safety and their food-handling practices help to determine their risk of foodborne illness. The food safety questions in the International Food Information Council (IFIC) Foundation *Food and Health Survey* have tracked these attitudes and self-reported practices using an annual, web-delivered survey each year since 2006, with more extensive food safety questions starting in 2008. Participants were members of an online panel compensated with a point system by a survey company, were recruited annually, and reflected the latest Census data for the United States population on key Census characteristics, including age, gender, race, and level of educational attainment. Each year's Survey included approximately 1000 participants. From 2008 to 2010, when the Survey included detailed food safety questions, participant confidence in the food supply increased ($P = .000$) and respondent reports of the following key food safety practices — hand washing ($P = .001$), washing cutting boards ($P = .000$), separating raw meat and poultry from ready-to-eat food products ($P = .000$), cooking to required temperature ($P = .001$), and properly storing leftovers ($P = .000$) — as well as following microwave cooking instructions declined ($P \leq .001$). White, more highly educated respondents, and respondents from households that included individuals who were particularly vulnerable to foodborne illness, were more likely to report following recommended food safety practices. Survey respondents reported using expiration dates (68%), ingredient listings (54%), allergen labeling (9%), organic labeling (16%), and country of origin labeling (16%) on package labels to make food purchase and consumption decisions. Consumers used a range of sources for food safety information. The most trusted sources were government agencies/officials (39%), health professionals (37%), health associations (31%) and television news programs (31%). Consumer responses show gaps in knowledge and implementation of food safety behaviors that can be addressed by food safety educators, and demographic differences documented by Survey responses can help educators put their information into contexts that will make it more compelling. Food safety information needs to have consistent, actionable messages distributed through multiple delivery systems to reach target audiences.

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INTRODUCTION

Scallan and colleagues estimate that contaminated food causes 48 million illnesses, 128,000 hospitalizations, and 3,000 deaths in the United States (U. S.) each year (16, 17). The U. S. documents approximately 1,000 foodborne disease outbreaks each year (4), but most foodborne illnesses occur sporadically and are not included in these recognized outbreaks (17). In the period 2006 – 2010, the U.S. Centers for Disease Control and Prevention (CDC) documented 31 multi-state food outbreaks, including high profile outbreaks involving fresh spinach, tomatoes, peanut butter, frozen pot pies, cantaloupes, rice/wheat cereals, pistachios, alfalfa sprouts, beef, shredded lettuce, cheese, and shell eggs (6). Media reports of these outbreaks, along with their resulting recalls and food safety messaging from government agencies (8) and other groups (13), help to inform consumer attitudes and practices.

Consumer attitudes and practices about food safety are important components of determining the risk of foodborne illness because consumers make food purchase and handling decisions based on their attitudes, and food handling practices can either increase or decrease risk of foodborne illness. Researchers have tracked consumer attitudes and practices for over 25 years (15), and the U.S. Food & Drug Administration (FDA)/U.S. Department of Agriculture, Food Safety & Inspection Service (FSIS), as well as several food industry trade associations, have monitored various consumer food safety attitudes and practices by survey approximately every five years since 1988 (11). Data from these studies have been used to establish baseline data for the *Healthy People* objectives (19) and to inform recommendations in the *Dietary Guidelines for Americans* (7). Notably, the *Dietary Guidelines for Americans* discussions for 2010 included an evidence analysis process for food safety practices, which acknowledged that, while self-reported practices have limitations based on verification of practices being performed correctly, if at all, these data are some of the best indicators that we currently have for consumer practices, since there are few observational studies available, and these have limitations as well.

According to the Health Belief Model, individuals take actions to improve health when they feel that a nega-

tive condition can be avoided when they take a recommended action (9). Consumer self-reports of their attitudes and practices can document attitudinal and practice trends and help to direct food safety messaging with the goal of reducing foodborne illness.

The International Food Information Council (IFIC) Foundation *Annual Food and Health Survey, Consumer's Attitudes toward Food Safety, Nutrition, and Health (Food & Health Survey)* has monitored consumer food and nutrition knowledge, attitudes, and self-reported practices annually since 2006 through a nationally representative Web-distributed survey. This report covers the period 2006 to 2010, although the majority of food safety questions were added in 2008, and includes the following food safety topics: (1) confidence in the safety of the U.S. food supply, (2) consumer attitudes toward responsibility for food safety by sector, (3) consumer food safety issues, (4) use of food safety related information on product labels, (5) sources of food safety information and trusted sources of food safety information, (6) reported food safety practices, and (7) reported microwave cooking practices. These data are reported both longitudinally and by comparison among demographic groups based on age, gender, race, educational level, and U.S. region, with some emphasis on responses by individuals from households that include individuals in vulnerable populations, defined as older adults, young children, individuals with food allergies, and individuals with diseases or conditions that reduce the immune response.

MATERIALS AND METHODS

Using a web distribution approach, Cogent Research (Cambridge, MA) developed and conducted the International Food Information Council (IFIC) Foundation *Annual Food and Health Survey, Consumer's Attitudes toward Food Safety, Nutrition, and Health (Food & Health Survey)* from 2006 to 2010.

Sample

Participants were members of an online panel compensated with a point system by a survey company and recruited through an email list constructed by Cogent Research to reflect the latest

Census data for the U.S. population on key Census characteristics. These characteristics included age (2006, 2008, 2009, 2010), gender (2006, 2007, 2009, 2010), race (2008, 2009, 2010), and level of educational attainment (2006, 2007, 2008, 2009, 2010). Numbers of survey responses from invited participants were accepted until quotas were full. Numbers of survey participants were 1000–1064 per year: 1060 participants (2006), 1000 participants (2007), 1000 participants (2008), 1064 participants (2009), and 1006 participants (2010). The sample size error was +/- 3.0-3.1 for individual years and +/- 4.4 among the Survey years. Participants were recruited each year without regard to whether they had participated in earlier versions of the Survey.

Questionnaire

Questionnaires collected information on a variety of nutrition, health, and food safety attitudes and self-reported practices. They were presented in English, were self-administered online, and contained between 90 and 134 questions related to food and nutrition knowledge, attitudes and behaviors: 134 questions (2006), 120 questions (2007), 129 questions (2008), 120 questions (2009) and 90 questions (2010). Reading levels for the questionnaires ranged from 6.8 to 7.5 Flesch-Kincaid grade level. Some questions were repeated in every *Food & Health Survey* wave, but others were varied to obtain additional detail to previous information or to address additional areas of interest. Potential responses were randomized within questions, where appropriate. Respondents answered questions in the order that they appeared to complete the questionnaire and were unable to revisit earlier responses. The strong focus on food safety began with the 2008 Survey wave, which had a section of questions on food and consumer food handling practices. Earlier surveys had only a few questions related to food safety. Only Survey components related to food safety are included in this report.

Analysis

The following characteristics were assessed for each respondent: age, gender, race, level of highest educational attainment, residence by U.S. region, whether

FIGURE 1. Confidence in the safety of the U.S. food supply by survey year

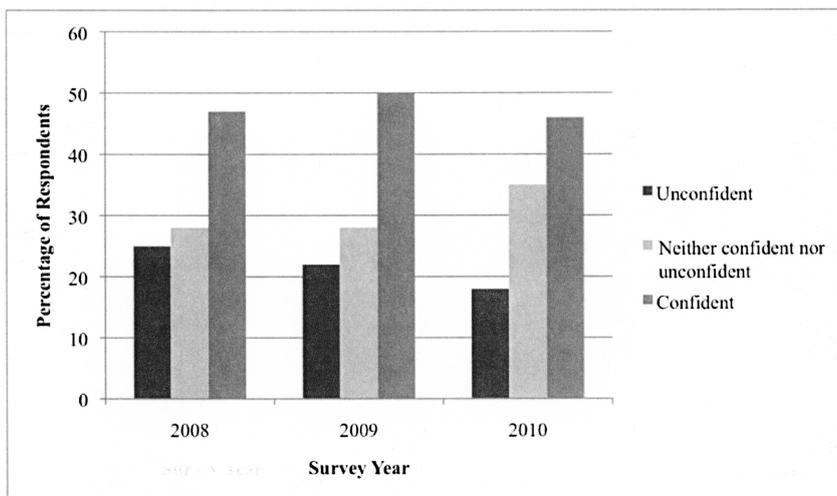
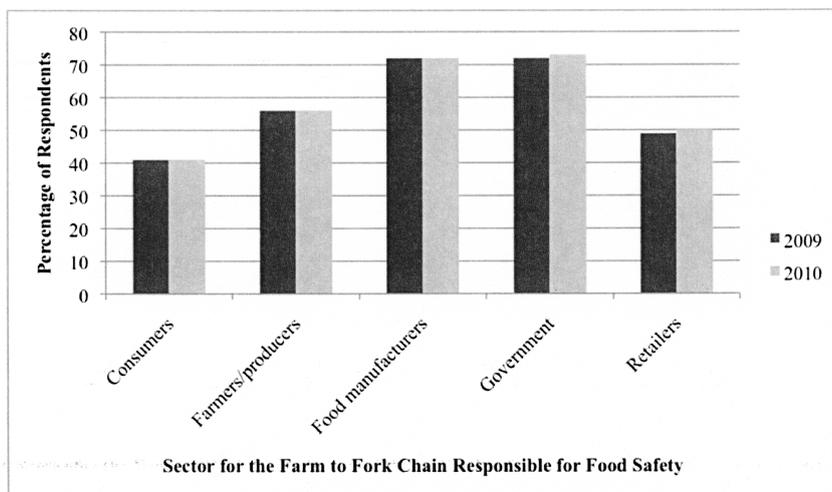


FIGURE 2. Assignment of responsibility for safety of the food supply by sector of the farm-to-fork chain for food safety



the household included children aged six or under, and presence or risk of various health conditions, including asthma, arthritis, cancer, diabetes, and food allergies. A variable for presence in a “vulnerable household” was defined to include households of participants reporting individuals who were 50 or over, and/or who resided in a household with children aged 6 or younger, and/or who reported living in a household that included individuals reporting food allergies or having conditions that would in themselves or through treatment reduce immune function (e.g., asthma, arthritis, cancer, diabetes). Frequencies were calculated for each question and were based on the number of respondents to a question. Categorical differences were analyzed by chi-square tests to determine relationships between

attitudes and self-reported practices for longitudinal comparisons and for comparisons among groups with different demographic characteristics. Responses of “don’t know” were excluded from the chi-square analyses. Data were analyzed using IBM SPSS Statistics 19 software (Somers, NY).

RESULTS

Table 1 describes the demographic characteristics of the respondents. Of the total 5130 respondents over the five waves of the *Food & Health Survey*, 53% were under the age of 44, 63% had some education beyond high school, 69% were white and non-Hispanic, and 55% were female. Ten percent of respondents reported having children age six or under

in their household, and 66% reported having persons in their household having, or at risk of having, one or more health conditions: asthma (19%), arthritis (32%), cancer (26%), diabetes (35%), and food allergies (11%). Eighty percent of respondents were from vulnerable households.

Confidence in the food supply

Almost half of respondents over the period 2008 – 2010 reported that they were confident in the safety of the food supply (Fig. 1), and confidence in the food supply increased over time ($P = .000$). The proportion of respondents who were confident in the safety of the food supply was stable ($P = .129$), while the proportion of respondents who were not confident in the safety of the food supply decreased ($P = .001$) and the proportion of respondents who were neither confident nor unconfident in the food supply increased ($P = .000$). Over the three-year period 2008–2010, there were differences in confidence in the food supply by age ($P = .017$), gender ($P = .002$), and level of educational attainment ($P = .000$), but not by race ($P = .315$) or U.S. region ($P = .268$) (Table 2). Although there was no clear pattern for confidence in the food supply by age, males were more confident than females, and the greater the level of education of the respondent, the greater the level of their confidence.

Responsibility for safety of the food supply

Respondents to the 2009–2010 *Food & Health Surveys* assigned responsibility for safety of the food supply to a broad range of stakeholders, with a greater percentage assigning responsibility to government and food manufacturers than to farmers, retailers, and consumers (Fig. 2). Overall, 57% of respondents assigned responsibility to three or more sectors, and 24% assigned responsibility to all five sectors listed. While this general pattern held across demographic groups, there were differences in responsibility assigned to specific sectors by demographic groups. Younger respondents were more likely than older respondents ($P = .046$), and white respondents were more likely than respondents of other racial groups ($P = .001$), to assign responsibility to retailers. More educated

TABLE 1. Demographic characteristics of participants in the International Food Information Council (IFIC) Foundation Food and Health Survey, 2006 – 2010

	Year					Total n = 5130 (%)
	2006 n = 1060 (%)	2007 n = 1000 (%)	2008 n = 1000 (%)	2009 n = 1064 (%)	2010 n = 1006 (%)	
Age						
18–24	9	12	10	13	14	11
25–34	20	19	24	27	19	22
35–44	21	21	23	18	19	20
45–54	21	20	18	16	18	19
55–64	13	14	12	10	16	13
65+	17	14	14	17	14	15
Gender						
Male	40	47	49	43	47	45
Female	60	53	52	56	53	55
Highest level of educational attainment						
< high school	7	9	9	9	12	9
High school diploma	18	28	22	35	28	26
Some college/ associate degree/ technical or vocational certification	38	31	34	26	35	33
Bachelor's degree	26	19	20	17	15	19
Graduate/ Professional School	10	12	15	12	9	11
Race						
White only, non- Hispanic	73	68	71	65	65	69
Black only, non- Hispanic	9	12	9	11	12	11
Hispanic	12	13	14	14	14	13
All others, non- Hispanic	6	6	6	10	9	7
U.S. Region						
Northeast	18	18	19	19	19	19
Midwest	24	23	23	23	24	23
South	33	36	36	33	35	35
West	26	23	23	25	22	24
Household includes children age 6 or under	14	13	6	5	14	10
Household includes individuals with health conditions: food allergies, asthma, arthritis, cancer, diabetes	73%	72%	70%	68%	49%	66%

TABLE 2. Confidence in the safety of the food supply by demographic characteristic

Characteristic	Level of Confidence						P value
	Unconfident		Neither unconfident nor confident		Confident		
	No.	%	No.	%	No.	%	
Age							.017
18–24, n = 368	67	18	119	32	182	49	
25–34, n = 710	139	20	236	33	335	47	
35–44, n = 610	135	22	203	33	272	45	
45–54, n = 531	136	26	142	27	253	48	
55–64, n = 389	94	24	97	25	198	51	
65+, n = 462	97	21	135	29	230	50	
Gender							.002
Male, n = 1424	284	20	411	29	729	51	
Female, n = 1646	384	23	521	32	741	45	
Education^a							.000
> high school, n = 302	72	24	113	37	117	39	
High school diploma, n = 872	189	22	301	35	382	44	
Some college/technical school, n = 966	217	22	280	29	469	49	
Bachelor's degree, n = 528	98	19	137	26	293	55	
Graduate/professional school, n = 357	79	22	79	22	199	56	
Race							.315
White, non-Hispanic, n = 2058	446	22	600	29	1012	49	
Black, non-Hispanic, n = 333	73	22	111	33	149	45	
Hispanic, n = 427	96	22	145	34	186	44	
Other, non-Hispanic, n = 252	53	21	76	30	123	49	
U.S. Region							.268
Northeast, n = 581	132	23	192	33	257	44	
Midwest, n = 709	142	20	227	32	340	48	
South, n = 1067	229	21	312	29	526	49	
West, n = 713	165	23	201	28	347	49	

Note: Data are from years 2008–2010 of the International Food Information Council (IFIC) Foundation *Food & Health Survey*, which has been given annually from 2006 to 2010. The total number of respondents to this Survey over the three-year period 2008–2010 was 3070.

^aForty-five respondents did not include their highest level of educational attainment.

respondents and white respondents were more likely to assign responsibility to farmers ($P = .000$ and $P = .013$, respectively), consumers ($P = .012$ and $P = .002$, respectively), and food manufacturers ($P = .001$ and $P = .000$, respectively) than were less educated groups and other racial groups. There were no differences in assignment of responsibility by gender or by U.S. region.

Most important food safety issues

Overall, the most important food safety issues reported in 2009–2010, in

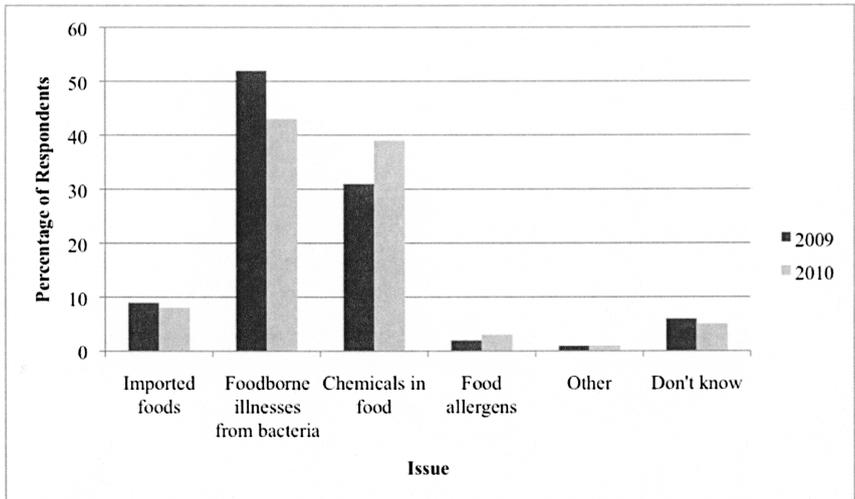
order of importance to the respondents, were foodborne illnesses from bacteria (48%), chemicals in food (35%), imported foods (9%), and food allergens (2%) ($P = .000$) (Fig. 3). There were differences in responses by age ($P = .000$) and by racial group ($P = .003$) but not by level of educational attainment, gender, or U.S. region. Older respondents were more likely to cite imported foods as the most important food safety issue, and younger respondents were more likely to cite chemicals in food as the most important issue. Respondents in the “other” racial category, the majority of whom

were Asian, were more likely than white, black, or Hispanic respondents to cite chemicals in food as the most important food safety issue and less likely to cite foodborne illnesses from bacteria as the most important food safety issue.

Use of information on product labels

Respondents reported looking for the following food label components when deciding whether to purchase or eat a food: allergen labeling (9%), ingredient listings (54%), expiration

FIGURE 3. Respondent selection of top food safety issue



Note 1: Examples of foodborne illness listed in the question were *E. coli* and *Salmonella*.

Note 2: Examples of chemicals in food listed in the question were acrylamide, melamine, mercury, and bisphenol-A (BPA).

FIGURE 4. Label components that respondents reported using to make purchase and consumption decisions

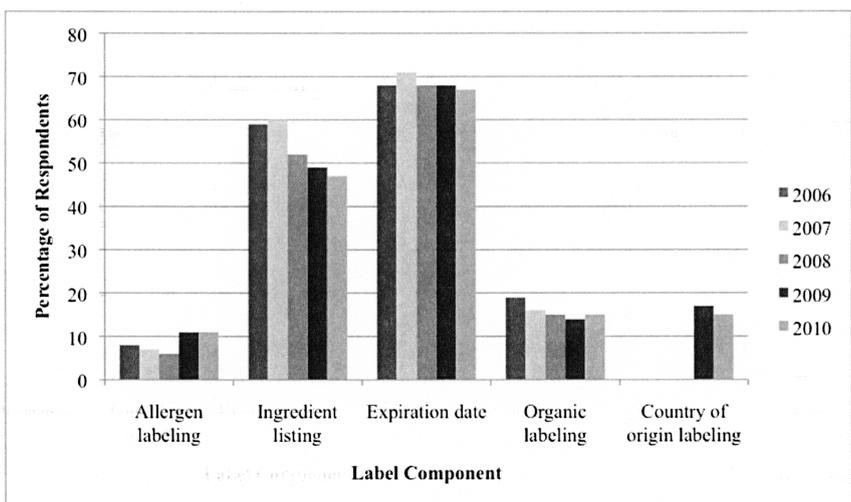
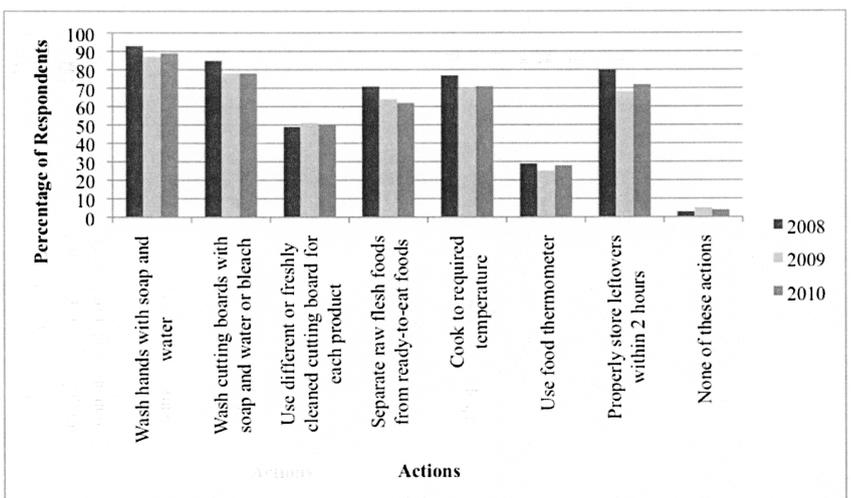


FIGURE 5. Actions reported to be performed regularly when cooking, preparing, and consuming food products



dates (68%), organic labeling (16%) and country of origin labeling (16%) (Fig. 4). Over the 2006–2010 Survey period, respondent reports of looking for allergen labeling increased ($P = .000$) and reports of looking at ingredient labeling ($P = .000$) and organic labeling information ($P = .008$) decreased.

There were differences in label use by age, gender, educational attainment, race, and U.S. region (Table 3). Females were more likely than males to report using allergen labeling ($P = .005$). Use of ingredient lists were different by age ($P = .000$), gender ($P = .000$), level of educational attainment ($P = .000$) and race ($P = .001$); older, female, more highly educated, white or “other” racial groups were more likely than other groups to report using ingredient listings to make food purchase or consumption decisions. Reported use of expiration dates was different by age ($P = .000$), gender ($P = .000$) and race ($P = .000$), with older, female, and white or “other” racial groups more likely than other groups to report its use. Organic labeling use was different by age ($P = .000$), gender ($P = .001$), level of educational attainment ($P = .000$), race ($P = .000$) and U.S. region ($P = .000$). Younger, female, more highly educated, Hispanic or “other” racial groups, and respondents living in the West were more likely than other groups to look for organic labeling.

Sources of food safety information and trust in food safety information sources

The most frequently cited sources of food safety information that respondents reported using in the six months prior to completing the survey were television news programs (42%), Internet articles (33%), newspapers (28%), and friends/family (28%), and the most trusted sources of food safety information were government agencies/officials (39%), health professionals (37%), health associations (31%), and television news programs (31%) (Table 4). Respondents were more likely to report being prompted to make changes in their food safety behaviors based on the advice of physicians and mainstream media than other sources. The least trusted sources of food safety information were blogs or social networking sites.

TABLE 3. Label components used in making purchase/consumption decision

Characteristic	Label Component for Making Purchase/Consumption Decision											
	Allergen labeling			Ingredients list			Expiration date			Organic labeling		
	No.	%	<i>P</i> value	No.	%	<i>P</i> value	No.	%	<i>P</i> value	No.	%	<i>P</i> value
Age			.212			.000			.000			.000
18–24	47	8		245	42		368	64		125	22	
25–34	88	8		506	45		715	64		206	18	
35–44	77	7		534	51		692	66		160	15	
45–54	82	9		545	57		657	69		148	16	
55–64	63	10		392	59		493	75		89	13	
65+	81	10		520	67		566	73		90	12	
Gender			.005			.000			.000			.001
Male	166	7		1149	50		1509	65		324	14	
Female	272	10		1593	57		1983	71		494	18	
Education			.137			.000			.229			.000
< high school	44	9		209	44		313	66		47	10	
High school diploma	129	10		649	48		900	67		146	11	
Some college/technical school	134	8		912	54		1156	69		269	16	
Bachelor's degree	72	7		580	58		678	68		208	21	
Graduate/professional school	58	10		369	63		415	71		141	24	
Race			.062			.001			.007			.000
White, non-Hispanic	284	8		1941	55		2435	69		539	15	
Black, non-Hispanic	44	8		275	50		353	65		66	12	
Hispanic	65	9		324	47		437	64		117	17	
Other, non-Hispanic	45	12		202	53		269	71		96	25	
U.S. region			.111			.515			.131			.000
Northeast	92	10		518	54		659	69		141	15	
Midwest	84	7		623	53		773	65		160	14	
South	166	9		928	52		1228	69		256	14	
West	96	8		669	55		828	68		260	21	

Note: Data are from years 2006–2010 of the International Food Information Council (IFIC) Foundation *Food & Health Survey*, given annually from 2006 to 2010.

Reported food safety practices

Most reported food safety practices declined over the *Food & Health Survey* period from 2008 to 2010 (Fig. 5). Hand washing ($P = .001$), washing cutting boards ($P = .000$), separating raw meat and poultry from ready-to-eat food products ($P = .000$), cooking to required temperature ($P = .001$), and properly storing leftovers ($P = .000$) all declined, while using different or freshly cleaned

cutting boards for each product ($P = .695$) and using a food thermometer to check the doneness of meat and poultry items remained stable ($P = .091$). The most commonly reported food safety practice across all groups was washing hands with soap and water, which was reported by over 90% of respondents through the three-year period that the question was asked in the Survey (Table 5). More respondents reported cleaning

cutting boards (80%) than reported using a different or freshly cleaned cutting board for each product (50%) (Table 5). While 70% or more respondents each year reported cooking to required temperatures, fewer than 30% reported using food thermometers to verify that the required temperature had been achieved (Table 6). Seventy-three percent of respondents reported storing leftovers properly within two hours of serving. Females

TABLE 4. Sources of food safety information

Source	Heard from Source in Past 6 Months	Trust Source to Deliver Food Safety Information	Would Prompt Me to Make Changes in Safe Food Handling Practices ^a
Government agency/official (%)	14	39	--
Health professional (e.g., doctor, nurse, physician assistant, pharmacist, etc.) (%)	10	37	58 ^b
Health association (%)	9	31	--
TV news program (%)	42	31	54 ^c
Food label (%)	24	25	
Newspaper (%)	28	24	54 ^c
Dietitian (%)	4	23	37
Consumer advocacy groups (%)	9	18	--
Friends/family (%)	28	18	36
Magazine article (%)	25	18	54 ^c
Cooking shows/hosts (%)	23	17	--
Internet article (%)	33	17	--
Grocery store, drug store, or specialty store (%)	15	16	--
Radio news program (%)	13	13	54 ^c
Product or manufacturer communications (i.e., Web sites, advertising, etc.) (%)	13	13	--
Talk shows (%)	22	11	--
At/from schools (%)	6	8	--
Cooperative extension (%)	1	7	--
Livestock veterinarians (%)	1	4	--
Blog or social networking (e.g., Facebook, MySpace, Yahoo groups, etc.) (%)	5	3	7
None of the above (%)	20	15	14

Note: Data are from year 2010 of the International Food Information Council (IFIC) Foundation *Food & Health Survey*, which has been given annually from 2006 to 2010. The total number of Survey respondents for 2010 was 1006.

^aCategories with “—” did not appear on the Survey for this question.

^bThe category for this question included only physicians.

^cThe category for this question included TV, radio, newspapers, magazines, and online news sources.

and whites trended toward having the best reported food safety behaviors.

Differences in many reported food safety practices by age, gender, educational attainment, race, and U.S. region were significant (Tables 5 and 6). Respondents reporting hand washing using soap and water were different by age ($P = .012$), gender ($P = .000$), race ($P = .029$) and U.S. region ($P = .039$); respon-

dents who were older, female, white, and from the South or Northeast were more likely than other groups to report hand washing using soap and water. Reported washing of cutting boards with soap and water or bleach was different by age ($P = .002$), gender ($P = .000$), and race ($P = .000$), and reported use of a different or freshly cleaned cutting board for each product was different by gender ($P =$

.000), level of educational attainment ($P = .007$), race ($P = .002$) and U.S. region (.049). Separating raw meat and poultry from ready-to-eat food products was different across gender ($P = .000$), education ($P = .010$), racial ($P = .022$) and regional groups ($P = .024$), with female, more highly educated, white and black respondents, and respondents from the South and West more likely than other

TABLE 5. Cleaning and separating actions performed regularly when cooking, preparing, and consuming food products

Characteristic	Cleaning and Separating Actions											
	Wash hands			Wash cutting board			Use different cutting board			Separate foods		
	No.	%	<i>P</i> value	No.	%	<i>P</i> value	No.	%	<i>P</i> value	No.	%	<i>P</i> value
Age			.012			.002			.293			.575
18–24	322	88		273	74		198	54		226	61	
25–34	618	87		556	78		367	52		470	66	
35–44	544	89		492	81		309	51		406	67	
45–54	488	92		426	80		264	50		344	65	
55–64	354	91		328	84		184	47		254	65	
65+	427	92		390	84		216	47		310	67	
Gender			.000			.000			.000			.000
Male	1220	86		1064	75		641	45		838	59	
Female	1533	93		1401	85		897	54		1172	71	
Education			.154			.304			.007			.010
> high school	266	88		236	78		136	45		182	60	
High school diploma	766	88		687	79		403	46		545	63	
Some college/technical school	881	91		795	82		520	54		661	68	
Bachelor's degree	482	91		433	82		281	53		361	68	
Graduate/professional school	322	90		282	79		177	50		239	67	
Race			.029			.000			.002			.022
White, non-Hispanic	1869	91		1694	82		1082	53		1375	67	
Black, non-Hispanic	293	88		245	74		149	45		220	66	
Hispanic	372	87		330	77		193	45		270	63	
Other, non-Hispanic	219	87		196	78		114	45		145	58	
U.S. region			.039			.339			.049			.024
Northeast	528	91		472	81		268	46		362	62	
Midwest	616	87		555	78		343	48		443	62	
South	969	91		854	80		548	51		718	67	
West	640	90		584	82		379	53		487	68	
Children aged 6 and under			.563			.065			.033			.098
Yes	384	89		361	84		237	55		298	69	
No	2369	90		2104	80		1301	49		1712	65	
Disease or condition			.000			.000			.001			.000
Yes	1757	92		1595	83		1004	53		1321	69	
No	996	86		870	75		534	46		689	59	
Vulnerable household			.000			.000			.049			.000
Yes	2215	91		2019	83		1239	51		1653	68	
No	538	84		446	70		299	47		357	56	

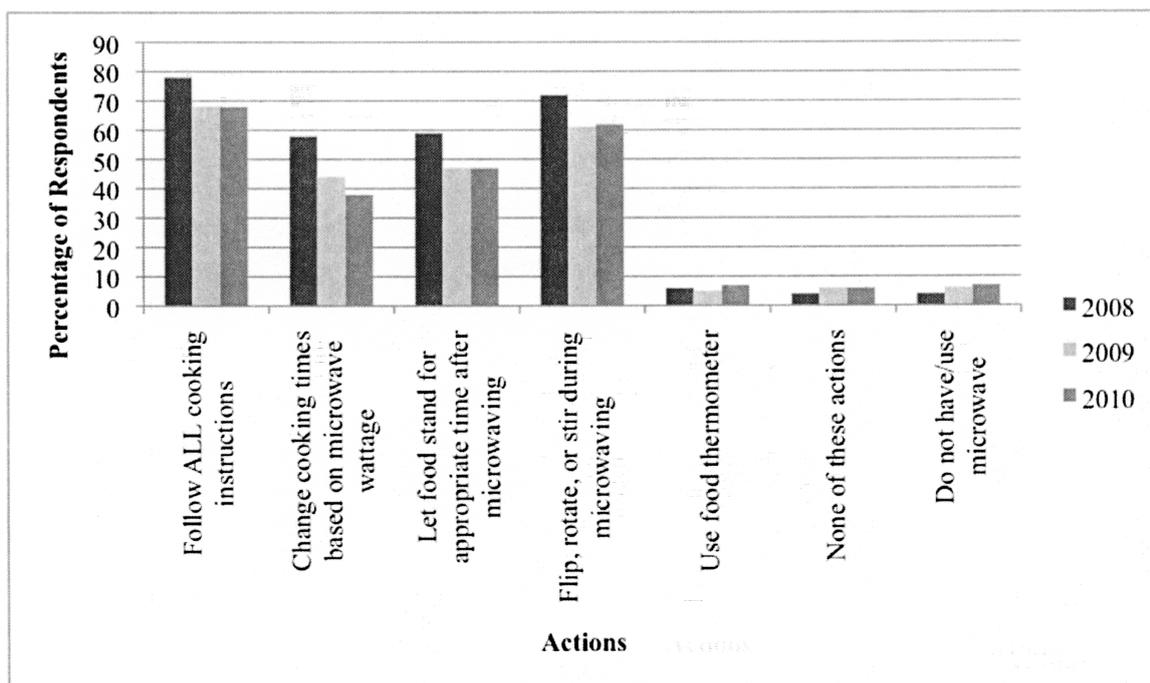
Note: Data are from years 2008–2010 of the International Food Information Council (IFIC) Foundation *Food & Health Survey*, which has been given annually 2006 to 2010. Questions on food safety behaviors were not on the Survey prior to 2008.

TABLE 6. Cooking and chilling actions performed regularly when cooking, preparing, and consuming food products

Characteristic	Cooking and Chilling Actions											
	Cook to required temperature			Use a food thermometer			Properly store leftovers			None of these actions (includes cleaning and separating actions)		
	No.	%	<i>P</i> value	No.	%	<i>P</i> value	No.	%	<i>P</i> value	No.	%	<i>P</i> value
Age			.000			.000			.000			.272
18–24	263	71		82	22		250	68		17	5	
25–34	475	67		151	21		472	66		34	5	
35–44	431	71		156	26		433	71		29	5	
45–54	391	74		147	28		394	74		16	3	
55–64	298	77		130	33		312	80		12	3	
65+	367	79		163	35		392	85		13	3	
Gender			.006			.111			.000			.000
Male	998	70		365	26		968	68		81	6	
Female	1227	75		464	28		1285	78		40	2	
Education			.841			.701			.001			.039
> high school	218	72		72	24		205	68		19	6	
High school diploma	631	72		244	28		614	70		42	5	
Some college/technical school	701	73		269	28		712	74		29	3	
Bachelor's degree	379	72		137	26		422	80		13	2	
Graduate/professional school	266	75		95	27		270	76		15	4	
Race			.000			.000			.000			.017
White, non-Hispanic	1585	77		650	32		1652	80		68	3	
Black, non-Hispanic	219	66		48	14		193	58		22	7	
Hispanic	260	61		79	19		253	59		17	4	
Other, non-Hispanic	161	64		52	21		155	62		14	6	
U.S. region			.095			.291			.261			.247
Northeast	410	71		166	29		434	75		19	3	
Midwest	531	75		172	24		531	75		37	5	
South	786	74		295	28		784	73		39	4	
West	498	70		196	27		504	71		26	4	
Children aged 6 and under			.554			.329			.045			.599
Yes	308	71		125	29		300	69		19	4	
No	1917	73		704	27		1953	74		102	4	
Disease or condition			.000			.007			.000			.000
Yes	1435	75		548	29		1456	76		55	3	
No	790	68		281	24		797	69		66	6	
Vulnerable household			.000			.000			.000			.001
Yes	1815	75		711	29		1844	76		81	3	
No	410	64		118	18		409	64		40	6	

Note: Data are from years 2008–2010 of the International Food Information Council (IFIC) Foundation *Food & Health Survey*, which has been given annually 2006 to 2010. Questions on food safety behaviors were not on the Survey prior to 2008.

FIGURE 6. Actions that respondents report taking when purchasing or preparing microwavable meals



Note 1: Data are from years 2008 – 2010 of the International Food Information Council (IFIC) Foundation *Food & Health Survey*, which has been given annually from 2006 – 2010. The total number of respondents to this Survey over the three-year period was 3070. There were 1000 Survey respondents in 2008, 1064 respondents in 2009, and 1006 respondents in 2010.

Note 2: Changes in reported actions over the three-year period were significant at the $P \leq .001$ level for following all cooking instructions, changing cooking times based on oven wattage, letting food stand for the appropriate time after microwaving, and flipping, rotating, or stirring during the microwave cooking process.

groups to report this practice. Responses for cooking to required temperature was different by age ($P = .000$), gender ($P = .006$) and race ($P = .000$); older, female, white respondents were more likely than other groups to report this practice. Reported use of food thermometers was different by age ($P = .000$) and race ($P = .000$), with older, white respondents more likely than other groups to report this practice. Reports of properly storing leftovers within two hours of serving were different by age ($P = .000$), gender ($P = .000$), level of educational attainment ($P = .001$), and race ($P = .000$); the greatest level of compliance to this practice was from older, female, white respondents who hold bachelor's degrees as their highest level of educational attainment. Reports of following none of the recommended food safety practices were different by gender ($P = .000$), level of educational attainment ($P = .039$) and race ($P = .017$); male respondents who have not attended

college or who have attended graduate/professional school and racial groups other than white were more likely to report following none of the recommended food safety practices.

As a group, respondents from vulnerable households, i.e., those that include individuals aged 50 and over and/or six and under, or individuals with food allergies or health conditions that reduce immune function, were more likely to report following each of the recommended food safety practices than were respondents who were not from vulnerable households (Tables 5 and 6). However, respondents from households with children aged 6 years and younger were different from other respondents in vulnerable households for some self-reported practices. These respondents were more likely than other Survey respondents from vulnerable households to report using different cutting boards ($P = .033$), but they were less likely to report properly storing leftovers ($P = .045$).

For all other food handling practices, responses from households with young children were not different from responses of individuals whose households did not include young children, regardless of whether they were vulnerable households. Respondents from households that included individuals who have, or are at risk of having, health conditions that would affect risk of foodborne illness by reducing immune function and/or who reported having household members with food allergies were more likely than other respondents to report following each of the recommended food safety practices ($P \leq .010$).

Reported microwave safety behaviors

Microwave cooking safety practices either remained stable or declined over the *Food & Health Survey* period from 2008 to 2010 (Fig. 6). Reports of following all cooking instructions, chang-

TABLE 7. Actions performed regularly when purchasing or preparing microwavable meals

Characteristic	Actions											
	Check suitability ^a			Follow ALL instructions			Change cooking time based on wattage			Let food stand for appropriate time		
	No.	%	<i>P</i> value	No.	%	<i>P</i> value	No.	%	<i>P</i> value	No.	%	<i>P</i> value
Age			.000			.000			.016			.002
18–24	142	51		255	69		185	50		175	48	
25–34	240	50		482	68		310	44		348	49	
35–44	188	49		420	69		255	42		300	49	
45–54	196	56		380	72		247	47		259	49	
55–64	150	56		295	76		192	49		206	53	
65+	220	68		369	80		233	50		276	60	
Gender			.062			.000			.487			.002
Male	491	53		964	68		650	46		682	48	
Female	645	57		1237	75		772	47		882	54	
Education			.798			.012			.043			.140
> high school	111	51		202	67		124	41		134	44	
High school diploma	357	55		659	76		394	45		456	52	
Some college/technical school	345	55		685	71		461	48		498	52	
Bachelor's degree	187	56		380	72		263	50		265	50	
Graduate/professional school	116	53		252	71		163	46		192	54	
Race			.055			.001			.000			.000
White, non-Hispanic	765	57		1514	74		1011	49		1119	54	
Black, non-Hispanic	134	56		239	72		148	44		155	47	
Hispanic	142	49		288	67		160	37		186	44	
Other, non-Hispanic	95	48		160	63		103	41		104	41	
U.S. region			.591			.104			.727			.420
Northeast	208	53		397	68		273	47		289	50	
Midwest	277	57		522	74		331	47		350	49	
South	390	55		780	73		501	47		565	53	
West	261	54		502	70		317	44		360	50	
Children aged 6 and under			.000			.793			.142			.598
Yes	253	41		312	72		186	43		215	50	
No	1817	57		1889	72		1236	47		1349	51	
Disease or condition			.000			.000			.000			.000
Yes	911	77		1444	76		987	52		1067	56	
No	1159	38		757	65		435	38		497	43	
Vulnerable household			.000			.000			.000			.000
Yes	1369	66		1811	75		1179	49		1307	54	
No	701	33		390	61		243	38		257	40	

ing cooking times based on microwave wattage, letting food stand for the appropriate time after microwaving, and flipping, rotating or stirring during the cooking process declined, while using a food thermometer to check that food

has reached the required temperature remained stable, at below 10% of respondents. Over the three-year period that questions about microwave cooking practices were asked, respondents reported following all cooking instruc-

tion on product labels (72%); increasing or decreasing cooking times based on oven wattage (46%); allowing food to stand for the appropriate time after microwaving (51%); flipping, rotating, or stirring during the microwave process

TABLE 7. Actions performed regularly when purchasing or preparing microwavable meals (continued)

Characteristic	Actions											
	Flip, rotate, or stir during microwaving			Use food thermometer to check temperature			Check food to see if it is fully heated before consuming ^b			None of these actions		
	No.	%	<i>P</i> value	No.	%	<i>P</i> value	No.	%	<i>P</i> value	No.	%	<i>P</i> value
Age			.255			.900			.016			.024
18–24	251	68		25	7		94	68		18	5	
25–34	467	66		46	6		105	55		39	5	
35–44	376	62		37	6		105	55		42	7	
45–54	337	63		30	6		105	58		30	6	
55–64	255	66		20	5		93	58		18	5	
65+	311	67		25	5		101	70		10	2	
Gender			.011			.122			.016			.066
Male	893	63		95	7		266	56		84	6	
Female	1104	67		88	5		337	63		73	4	
Education			.080			.876			.400			.275
> high school	190	63		21	7		82	67		19	6	
High school diploma	540	62		53	6		163	59		43	5	
Some college/technical school	647	67		53	5		215	62		51	5	
Bachelor's degree	363	69		32	6		86	57		19	4	
Graduate/professional school	231	65		21	6		47	54		24	7	
Race			.000			.552			.585			.042
White, non-Hispanic	1423	69		125	6		401	61		90	4	
Black, non-Hispanic	197	59		17	5		67	56		25	8	
Hispanic	234	55		22	5		82	57		28	7	
Other, non-Hispanic	143	57		19	8		53	60		14	6	
U.S. region			.513			.534			.922			.560
Northeast	365	63		34	6		113	58		31	5	
Midwest	474	67		35	5		147	62		30	4	
South	693	65		66	6		209	60		61	6	
West	465	65		48	7		134	60		35	5	
Children aged 6 and under			.914			.007			.611			.104
Yes	282	65		38	9		80	58		29	7	
No	1715	65		145	5		523	60		128	5	
Disease or condition			.000			.743			.161			.000
Yes	1322	69		116	6		304	62		73	4	
No	675	58		67	6		299	58		84	7	
Vulnerable household			.000			.679			.097			.002
Yes	1650	68		147	6		452	61		109	4	
No	347	54		36	6		151	56		48	7	

Note: Data are from years 2008–2010 of the International Food Information Council (IFIC) Foundation *Food & Health Survey*, which has been given annually 2006 to 2010. Questions on microwave cooking safety behaviors were not on the Survey prior to 2008.

^aThis question was asked only during years 2009 and 2010.

^bThis question was asked only during year 2010.

(65%); and using a food thermometer to make sure that the food reaches the required temperature (6%). The age group 35–44 years trended toward having the poorest microwave cooking practices, and females and whites trended toward having the best microwave cooking practices. Fewer than 10% of the respondents reported that they did not have or use a microwave oven, and there were no differences by age, gender, educational attainment or race in response to this question.

Differences by age, gender, educational attainment, and race, but not U.S. region, were significant for specific microwave cooking practices (Table 7). Over half of respondents reported checking the meal package label at point of purchase to determine whether the product is suitable for microwave cooking, and responses were different by age ($P = .000$). Responses for following all microwave cooking instructions on product packages was different by age ($P = .000$), gender ($P = .000$), level of educational attainment ($P = .012$) and race ($P = .001$). Older, female respondents were more likely than other groups to report following all cooking instructions, and white and black respondents, as well as respondents with high school diplomas as their highest educational attainment, were more likely than other groups to report following all instructions. Reports of increasing or decreasing cooking times based on the microwave oven's wattage were different by age ($P = .016$), educational attainment ($P = .043$), and race ($P = .000$). Age ($P = .002$), gender ($P = .002$), and racial group ($P = .000$) responses were different for letting food stand for the appropriate time after microwaving; older, more educated, female and white respondents were more likely to report following this recommendation than were other groups. Reports of flipping, rotating or stirring food during the microwave cooking process were different by gender ($P = .011$) and race ($P = .000$), with female and white respondents more likely to report these practices. Responses for checking food to see if it is fully heated before consuming it were different by age ($P = .016$) and gender ($P = .016$).

Respondents from vulnerable households were more likely than re-

spondents from other households to report following most microwave cooking actions (Table 7). These included checking the meal package label at point of purchase to determine whether the product is suitable for microwave cooking ($P = .000$); following all microwave cooking instructions ($P = .000$); increasing or decreasing cooking times based on the microwave oven's wattage ($P = .000$); letting food stand for the appropriate time after microwaving ($P = .000$); and flipping, rotating or stirring food during the microwave cooking process ($P = .000$). They were also less likely to report following none of these recommendations ($P = .002$). However, respondents from vulnerable households were no more likely than others to report using a thermometer to check temperatures ($P = .679$) or to check food to see if it was fully heated ($P = .097$). Similarly, respondents who reported having a household member with a health condition that would place the person at greater risk of foodborne illness were more likely than others to report following all microwave cooking instructions ($P = .000$); increasing or decreasing cooking times based on the microwave oven's wattage ($P = .000$); letting food stand for the appropriate time after microwaving ($P = .000$); and flipping, rotating or stirring food during the microwave cooking process ($P = .000$). These respondents were less likely to report following none of these recommendations ($P = .000$) and were no more likely than others to report using a thermometer to check temperatures ($P = .743$) or to check food to see if it is fully heated ($P = .161$). Respondents from households with children aged six and under were more likely than other respondents to report using thermometers to check temperatures of microwaved food ($P = .007$), but the percentage was very low (9%).

DISCUSSION

The strengths of the *Food & Health Survey* results presented in this report include the large national sample size reflecting the latest Census data for the U.S. population on key Census characteristics and the multiple years of data collection that allow for both longitudinal analysis of key areas of interest and comparison by demographic groups over time. There were several large, high pro-

file outbreaks during the five years of the Survey administration (5), but these were not clustered within a specific year so as to affect results greatly during a single administration of the Survey. Additionally, the web interface allows efficient transfer of respondent data into the database for analysis, reducing transfer error and time to analysis.

Study weaknesses include the self-reported data for practices and for descriptions of household members, which may not always reflect actual practices or composition (7, 15). Participants had to be English-speaking and have Internet access, since the survey was delivered by Internet in English only; this reduces the potential sample and reduces the generalizability of results. Data for descriptions of vulnerable households are incomplete, are not completely aligned with current definitions of vulnerability (12, 19), and may reflect a slightly smaller number of vulnerable households than were actually in the sample. For example, (1) respondents were not asked whether pregnant women were in the household; (2) some diseases or conditions that would reduce immune status, such as organ transplant or HIV/AIDS infections, were not included in the check-off list of diseases and conditions; and (3) the child ages in the check-off list were not in alignment with the definition of vulnerability for children under age five (12). However, we expect that the errors in the composition of the vulnerable household sample would be small, because the percentage of pregnant women in a sample that does not weigh for them would be very small, the number of individuals with additional health conditions would be expected to be small, and the age range for children was increased by only two years, from age 4 to age 6. The demographic characteristics of the respondents may not adequately reflect their food consumption patterns and their lifestyles in this mobile, multicultural society. The study results do not consider the meal patterns of the respondents, the frequency of their food preparation activities, or their food preparation and food safety education and training. The *Food & Health Survey* does not ask about exposure to food safety issues, such as knowledge of foodborne illness outbreaks or occurrence of a food safety problem they may have

experienced personally, in their household, or among their family and social networks. Also, there were no queries on occupation, and some respondents, such as health professionals or individuals employed in the food industry, may have had specialized training or knowledge of recommended food safety practices.

During the *Food & Health Survey* period, confidence in the food supply increased and respondent reports of following food safety practices and microwave cooking instructions declined, which is in alignment with the Health Belief Model (9). According to this model, individuals take actions to improve health when they feel that a negative condition can be avoided when they take a recommended action (9). This model is further supported by responses that advice from physicians would prompt respondents to make changes in safe food handling practices, since this advice would likely be provided in the context of making the advice more personal, i.e., describing an individual's susceptibility and the likely severity of consequences, as well as combining advice with medical interventions. Advice from media was also likely to prompt respondents to make changes in safe food handling practices, which would be predicted because this advice would likely come at a susceptible time, i.e., would be delivered during an outbreak, would describe the severity of the problem, and would describe appropriate actions to take to reduce risk. Further, respondents from vulnerable households, i.e., those whose susceptibility was greater and for whom consequences would be more severe, were more likely than others to report following food safety practices and microwave cooking practices. This was especially evident from responses of individuals in a household where members either had, or were at risk of having, a health condition that would increase risk of foodborne illness. Responses to this Survey do not show that respondents living in households with young children report following food safety practices or microwave cooking practices at levels greater than those of other groups, even though children under age 5 are at greater risk of foodborne illness. These respondents may not consider their households at greater risk unless they have been informed that their children have greater

susceptibility to foodborne illness and may face more severe consequences; this information could be provided at wellness check-ups, child daycare centers, and WIC clinics.

While respondents held all sectors of the food supply chain responsible for food safety, more respondents placed responsibility in the hands of government and food manufacturers and fewer placed responsibility in the hands of consumers. This is consistent with findings of other investigators that consumers believe that government and industry have greater responsibility for, and control over, food safety than consumers have (2, 3). The lower response for consumer responsibility may also reflect lower perceived susceptibility to foodborne illness and lower perceived benefits to following recommended actions to reduce foodborne illness, based on the Health Belief Model. Food safety educators have an opportunity to link personal food safety practices to good health outcomes for individuals and for the persons for whom they prepare and serve food.

Respondents' reported use of label information is consistent with their concerns about food safety and nutrition issues and also follows the Health Belief Model. Over two-thirds of respondents reported looking at expiration dates, which is consistent with earlier surveys (2). Use of this information would be one action that could reduce their perceived food safety risks. While fewer reported looking for allergen, organic or country-of-origin labeling, for those who do, using that information would help them reduce their perceived food safety risks.

Food safety information sources may provide consumers with many types of information. For example, they may describe populations that are at greater risk of foodborne illness, consequences of foodborne illness, and actions to take to reduce risk of foodborne illness. They may also promote awareness and provide reminders of positive actions. The range of food safety information sources reported in this Survey illustrate these roles. Except for television news programs, the sources that respondents reported as the most trusted sources were not sources that they had accessed during the six months prior to completing the Survey question-

naire. For the two sources that were most likely to compel action (physicians and media) the percentage of respondents reporting that they would make changes in response to source information was greater than the percentage of respondents who reported having trust in the source; we cannot explain that incongruent finding with the Survey data. The Survey data also cannot show how the intersection of sources affects levels of trust. For example, if a physician from a government agency presents information on a webpage, during a television news story and in a newspaper, is the level of trust higher for one access point than for others? Since no single source was trusted by more than 40% of the respondents, it is important that actionable, evidence-based messages be uniform in content and distributed through multiple sources to reach target audiences. The Partnership for Food Safety Education, a public-private partnership of trade associations, consumer advocates, scientific organizations, consumer science food safety extension educators, and NGOs, such as the International Food Information Council Foundation, as well as government liaisons from agencies having food safety responsibilities, develops, tests, and disseminates research-based, actionable consumer food safety messages to fulfill this need (13).

Reports of food safety behaviors from this study are consistent with behaviors reported by the Redmond and Griffith 26-year systematic review of reported food safety behaviors (15), the FDA/FSIS 2006 Food Safety Survey (11), and the Dietary Guidelines Advisory Committee Report (7). While self-reported behaviors are not documented for accuracy or for correct implementation, they represent what consumers are doing or think that they should be doing. Typically, self-reports of positive behaviors are higher than observed behaviors (7, 15).

Corresponding to the 90% of respondents in this Survey from 2008 to 2010 who reported washing hands with soap and water regularly when cooking, preparing, and consuming food products, respondents to the FDA/FSIS survey responded that they washed hands with soap and water before preparing food (94%), after handling raw chicken (81%), and after handling raw fish

(79%) (11). These numbers are high, are self-reported and may not represent actual behaviors, according to the evidence summary from the Dietary Guidelines Advisory Committee, which shows a high degree of over-reporting of desirable hand washing behaviors during food preparation (7). However, they are supported by the American Society for Microbiology/The Cleaning Institute observational study of individuals washing their hands at entertainment venue restrooms (85%) (10). While the kitchen is not the same venue as a stadium restroom, the high percentage of hand washing observation offers some support of hand washing practices being implemented at a high level.

Consistent responses from the FDA/FSIS survey and the IFIC Foundation *Food & Health Survey* show that consumers understand the importance of preventing cross-contamination. Two types of questions were included in examination of this prevention — using clean cutting boards and separating raw flesh foods from ready-to-eat products. Questions from the FDA/FSIS survey allowed answers for methods of cleaning cutting boards or for using different cutting boards in response to a single question on what consumers do after using a cutting board for preparing raw flesh products; allowable answers included washing with soap, washing with bleach, or using a different cutting board. The comparable questions in the *Food & Health Survey* included whether respondents washed cutting boards with soap and water or bleach and whether they used a different or freshly-cleaned cutting board for each product. Depending upon the scenario, 78% – 85% of FDA/FSIS survey respondents reported washing cutting boards with soap and 4% – 6% reported washing cutting boards with bleach, while 80% of respondents in the *Food & Health Survey* reported washing cutting boards with soap and water or bleach (11). Only 1% – 4% of FDA/USDA respondents reported using different cutting boards for different products (11), compared to 50% in this Survey; however, for this Survey, answers for using a different cutting board were not exclusive of cleaning a cutting board for reuse. Sixty-five percent of respondents to this Survey reported that they regularly separated raw meat, poultry and seafood from ready-to-eat food products; similarly, in a more restricted question, FDA/FSIS survey respondents

reported moving grilled meat to a different plate (78%), serving food directly from the grill to individual plates (15%) or washing the plate that held raw meat with soap or bleach before putting the cooked meat on it (2%) (11). Consistent evidence reports that preventing cross-contamination in home kitchens, including proper cleaning of cutting boards, can reduce foodborne illness (7), making this consumer behavior important. While reporting the behavior does not document its use, these responses show that consumers value this behavior.

Reports of consistently low thermometer use by surveys and observational studies (7, 11, 15) have been confirmed in this study, where throughout three waves of the annual *Food & Health Survey* only 27% of respondents reported using a food thermometer regularly to check doneness of meat and poultry items cooked using conventional methods. The FDA/FSIS 2006 food safety survey reported that respondents “always” or “usually” use a food thermometer to judge doneness of roasts, excluding poultry, (54%), chicken parts (26%) and hamburgers (13%) (11), and the Redmond and Griffith systematic review reported that 12% – 24% of consumers regularly use food thermometers (15). While 79% of respondents to the FDA/FSIS survey report that they think that using a food thermometer when cooking is important and 65% report having a food thermometer (11), 72% of the *Food & Health Survey's* respondents report cooking food to required temperatures, and many fewer report using a thermometer on a regular basis to verify that foods have reached appropriate internal temperatures to inactivate pathogens. This difference in reported value or knowledge and implementation may reflect consumer opinions that alternative methods of judging doneness, such as color and texture change or following cooking time recommendations, are sufficient without measuring internal temperatures of food. Since these characteristics would be more difficult to judge in large cuts of meat, they may find thermometer use with these products more important to reaching a successful outcome. Additionally, they may not find it as easy to use a thermometer on smaller cuts or portions of meat. Reducing the gap in knowledge of the benefits of using a thermometer and its regular application in the home setting represents an opportunity for food safety educators to help consumers reduce food safety risks.

Defining foods as “leftover” when they are held beyond a two-hour room temperature service time describes a wide range of foods, including foods cooked at home, take-out foods that are consumed at home, foods that are served for consumption at one site and remainders taken home for later consumption, and foods repurposed for consumption away from home, such as bag lunches. In the *Food & Health Survey*, 73% of respondents reported that they properly stored leftovers within two hours of service; this general question does not provide specific information on how the leftovers were treated, and it does not consider holding time before service that would count toward time at room temperature. In comparison to other studies, the FDA/FSIS respondents reported eating hot, take-out food in less than one hour (81%) or two hours (14%) (11). Of those who reported keeping hot take-out food in the refrigerator (65%), 1% reported the longest time that they held this food out of refrigeration in minutes, 11% reported their longest time in hours, and 79% reported their longest time in days (11). Similarly, Almanza and colleagues (1) reported that 63% of clients who received home-delivered meals consumed them upon delivery and, of clients who kept hot leftovers for later consumption, 38% reported storing them at room temperature. Proper storage of prepared foods represents another opportunity for food safety educators to help consumers reduce food safety risks.

A 2007 multistate outbreak of salmonellosis associated with microwaving not ready-to-eat frozen pot pies highlighted issues associated with microwave preparation of foods (4). Clarity of labeling instructions for preparing the pies was questioned after the outbreak, especially cooking times that required knowledge of microwave oven wattage. Additionally, consumers may not have recognized differences in recommended procedures for preparing foods in microwave ovens compared to conventional ovens, such as the need for standing times to allow for heat penetration required to reach proper endpoint temperatures throughout products. While 72% of respondents to the *Food & Health Survey* reported following all microwave cooking instructions on product labels, fewer respondents reported the actual behaviors that would be required to cook not-ready-to-eat foods safely in a microwave oven, and just over

half reported checking product labels for suitability of microwave cooking at point of purchase. Since over 90% of respondents report having or using microwave ovens and few respondents report following instructions that are basic to preparing food safely in this appliance, this is an area where food safety education is needed. The new U.S. Department of Agriculture's "Cook It Safe" campaign focuses on providing this information to consumers (18).

Food safety behaviors of vulnerable populations and their caregivers are especially important for reducing foodborne illness, and respondents in this study who were in vulnerable households generally reported better food safety behaviors than others for basic food safety and for microwave cooking. However, this does not mean that their reported behaviors were exemplary. Approximately three-quarters of respondents from vulnerable households reported following recommendations to prevent cross-contamination, cooking foods to required temperatures, and properly storing leftovers and following all cooking instructions for packaged microwave products. Whether for conventionally prepared products or microwave-prepared products, fewer than 30% reported using a food thermometer to verify internal endpoint temperatures for foods. Respondents from households that included children aged 6 and under were less likely than respondents from other vulnerable households to report following recommended food safety behaviors. Education of parents and caregivers of young children will likely require programming that personalizes risk to heighten awareness of children's susceptibility and potential severity of consequences of foodborne illness and makes clear the actions that will reduce risk. Given the responses to questions about sources of food safety information, this information would best be accessed from government agencies, health professionals, and media. In addition, since the food label was given as a visible and trusted source of information by a quarter of respondents, lessons based on use of the food label for finding product expiration dates and preparation instructions could be an effective tool.

While other current surveys and reviews have found that better educated individuals and racial minorities have more food safety knowledge but poorer practices (11, 14), we did not find this to be the case overall. Where there were significant differences in behavior, indi-

viduals with higher levels of education were more likely to report recommended behaviors related to separating raw foods from ready-to-eat foods and to storing leftovers properly. There were no differences in reported behaviors based on educational attainment for cleaning or cooking. Responses for microwave cooking were more mixed by level of educational attainment, with high school graduates more likely to report checking label information and following label cooking instructions. Similarly, white respondents were more likely to report following recommended behaviors for cleaning, separating raw foods from ready-to-eat foods, cooking, and properly storing leftovers. White respondents were also more likely to report following all microwave cooking instructions, adapting cooking time based on wattage, letting food stand for an appropriate time after microwaving, and flipping, rotating, or stirring food during microwaving. The *Food & Health Survey* confirms results from many other studies that women report better food safety behaviors than men report (7, 11, 14, 15); this may be related to purchasing, preparing and serving training and experience, which was not examined in this Survey. Consumer responses show gaps in knowledge and implementation of food safety behaviors that can be addressed by food safety educators, and demographic differences documented by Survey responses can help educators put their information into contexts that will make it more compelling. Food safety information needs to have consistent, actionable messages distributed through multiple delivery systems and touch points to reach target audiences. There is a strong need to prepare evidence-based, compelling food safety materials that target males and households that include young children.

Future research needs include more detailed survey information on the relationships of consumer cultural/ethnic backgrounds and food handling training and experience to food safety attitudes and practices, as well as validation of survey responses with observational studies. One example of this may include examining whether regional differences in food safety success trace to food safety programs on regional, state or local levels or to experience working in food retail establishments. Another may be querying where respondents get the information that they use to prepare foods, such as grandparents, parents, friends, cookbooks, television, etc. Including demographic questions that align with the

definition of vulnerable populations and over-sampling specific vulnerable groups, such as pregnant women and families with children under the age of five, could provide better information on the food safety attitudes and practices of populations that are at higher levels of risk from foodborne illness. This information could also help agencies and healthcare professionals that have direct contact with these individuals, such as physicians, WIC nutritionists, and teachers, as well as extension educators, to reach them with appropriate food safety information. Obtaining information on handling practices for food types or foods from special venues can help food safety educators target programs. Some of these include take-out or prepared foods, such as foods from restaurant meals that are taken away for later consumption, foods consumed desk-side at work or at youth sports events, and foods stored and prepared in dorm rooms or other minimally-equipped spaces. Because only safe food can be nutritious food, this research is an important part of the applied research needed to ensure a wholesome food supply for the U.S.

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