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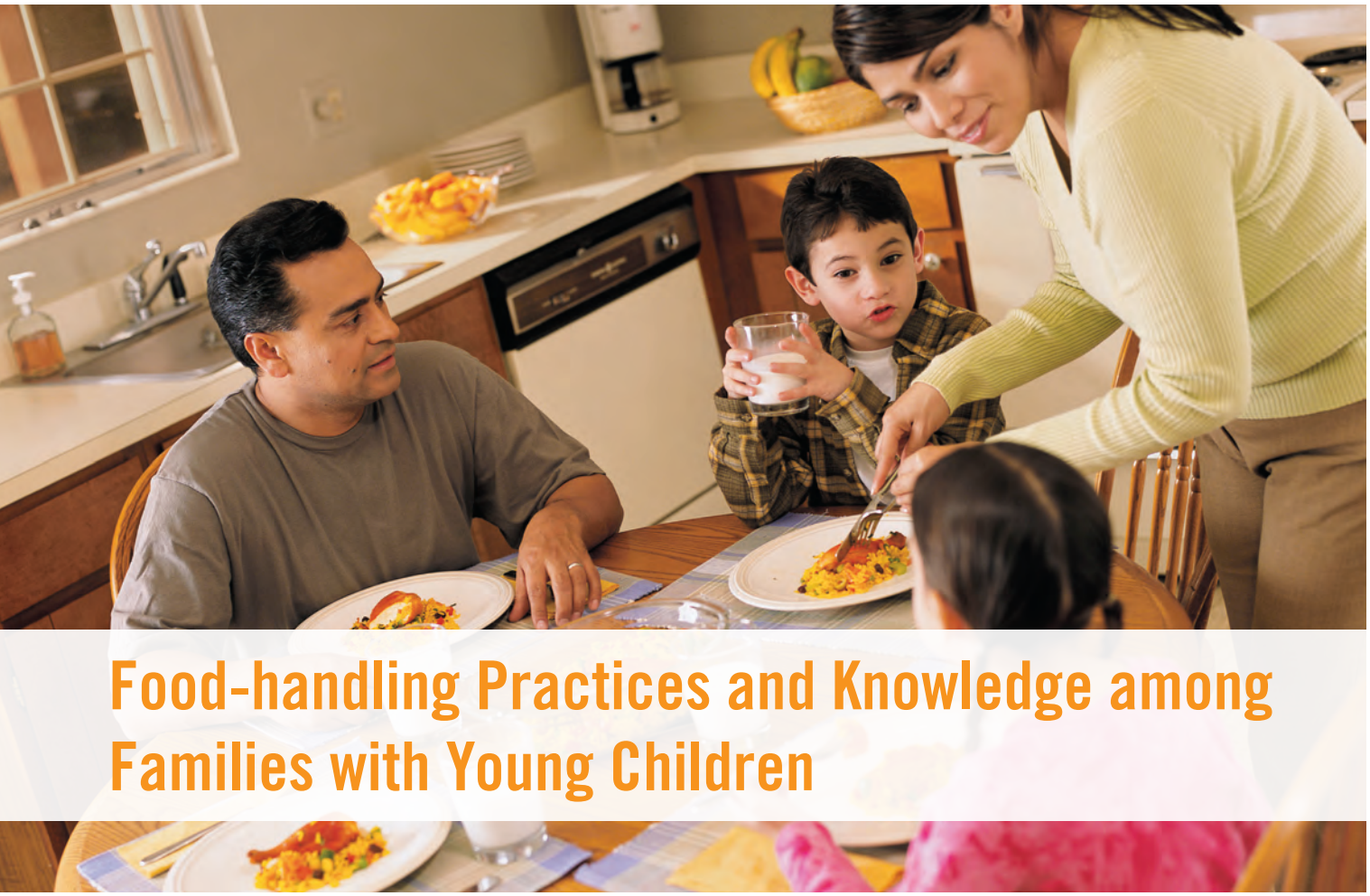

Food-handling Practices and Knowledge among Families with Young Children

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ABSTRACT

Children are at higher risk for foodborne illness than adults. Primary food handlers for young children have a direct impact on their child's food safety risk. The objective of this study was to determine food safety handling practices and knowledge of main food preparers in families with children <10 years of age. Four surveys based on the FightBAC!® concepts Clean, Separate, Cook, and Chill were developed and evenly distributed by mail to a nationwide random sample of 3,000 households with children < 10 years of age. Participants (n = 503) were female (67%), Caucasian (80%), 30–49 years of age (83%), college educated (79%) and had one to two children 10 years and younger (83%). Responses were compared to Healthy People 2020 objectives/goals for food safety. The number of safe food-handling practices always practiced that met the goals were categorized by concept: Clean; 2, Separate; 1, Cook; 3, Chill; 4. Average food safety knowledge scores exceeded the Healthy People 2020 goals for Clean, 85%, 5.1 ± 1.1 (6-point scale) and Cook, 80%, 8.0 ± 2.9 (10-point scale) but not for Separate, 69%, 8.3 ± 1.9 (12-point scale) or Chill, 78%, 10.9 ± 1.9 (14-point scale). The lower knowledge scores for the Separate and Chill concepts indicate that food safety educators should focus on these concepts when designing messages for this population.

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INTRODUCTION

Young children are at higher risk than adults for foodborne illness because of their underdeveloped immune system, lower body weight, lower stomach acid production, and lack of control over their own meal preparation *(12)*. In a recent Pew report *(44)*, children were identified as disproportionately affected by five foodborne pathogens: *E. coli* O157:H7, *Salmonella*, *Campylobacter*, *Listeria monocytogenes* and *Shigella*. Twenty percent of consumers who contracted *Salmonella* Typhimurium from eating contaminated peanut butter were children younger than five years of age *(13)*. Buzby *(12)* reported that the incidence of campylobacteriosis and salmonellosis were higher among infants than other age groups. Foodborne illness may result in serious health consequences or death in very young children. Approximately 15% of children who contracted *E. coli* O157:H7 suffered from Hemolytic Uremic Syndrome (HUS), which can cause anemia and permanent kidney failure *(44)*. *L. monocytogenes* cause premature death in fetuses or severe illnesses in newborns. The economic losses caused by foodborne illness are estimated at $2.9 billion each year, and one-third of this is attributed to illness in children under 10 years of age *(12)*.

Primary food handlers who prepare meals for young children at home may place their children at high risk for foodborne illnesses because of unsafe food-handling practices. Daniels et al. *(17)* noted that 74% of food handlers at home performed at least one unsafe food-handling practice. Anderson et al. *(5)* observed food handlers during food preparation and reported an average of four cross-contamination events between ready-to-eat foods and raw food, with seafood, raw meat or poultry, and eggs as the most common raw foods (84%) to cross-contaminate ready-to-eat foods. These food items, in addition to produce, accounted for 60% of foodborne illnesses *(18)*. Forty-three percent of beef-associated outbreaks were due to undercooked ground beef, hamburger, and roast beef, and poor personal hygiene and improper contact with sewage were responsible for 40% of foodborne illness outbreaks involving fresh produce *(18)*.

Daniels et al. *(17)* found that lack of education and awareness about food safety accounted for 80% of unsafe food handling practices. Knowledge is recognized as a prerequisite to safe food handling *(3, 4, 17, 32, 37)*. Food handlers who knew the food vehicle for *Salmonella* were more likely to wash their hands and prevent cross-contamination than those who did not *(3, 37)*. In other studies, over one-fourth of food handlers did not understand the concept of cross-contamination *(2, 19)*. Although 68% of food handlers could identify undercooked meat as a source of foodborne illness in response to specific questioning in a study by Cody and Hogue *(16)*, only 26% of food handlers gave this answer to an open-ended question. Abbot and colleagues found that although hand-washing knowledge was high (72%) among young adults, only 16% were observed to use proper handwashing technique during food preparation *(1)*. Of the 94% of women of childbearing age knowledgeable about the need to sanitize cutting boards, only 64% knew how to sanitize these items correctly *(35)*. Of the 35% of food handlers who reported knowing the internal end point cooking temperature for ground beef, only 9% gave the correct answer of 160°F *(16)*. Altekruse et al. *(3)* found that food handlers who were able to correctly identify a food vehicle for *Salmonella* were more likely to eat undercooked hamburgers than those without such knowledge, possibly because of taste preference, as purported by Lin et al. *(37)*. Consumers reported not applying their food safety knowledge during food preparation *(17)*. Sixty-three percent of food handlers in small food businesses reported not practicing safe food behaviors, despite the fact that 96% had received food hygiene training *(15)*. In a meta-analysis of numerous studies, consumers reported significantly more knowledge of good hygiene and methods to prevent cross-contamination than was indicated by what they practiced *(42)*. Plausible reasons suggested were a negligent attitude or an underestimation or acceptance of the risk.

The Partnership for Food Safety Education (PFSE) created FightBAC!® to educate consumers about safe food-handling practices. FightBAC!® consists of four concepts: Clean, Separate, Cook, Chill *(43)*. Healthy People (HP) 2010 was created by a coalition of government agencies to provide national objectives for improving the health of people in the United States *(55)*. Recently, HP2020 listed objectives/goals for the percent of consumers practicing safe food handling for the four FightBAC!® concepts: Clean, "Wash hands and surfaces often," 74%; Separate, "Separate: don't cross-contaminate," 92%, Cook, "Cook to proper temperature," 50%, Chill, "Refrigerate promptly," 91% *(56)*.

Numerous surveys have been conducted to determine consumer food safety attitudes, knowledge and practices *(2, 6, 7, 8, 22, 23, 32, 33, 45, 46, 48, 49)*. These studies report findings with little segmentation of the consumer population. Few surveys of food-handling practices among families with young children are available. In a meta-analysis *(42)* and a review article on food safety surveys *(47)*, families with young children were not studied as a separate population. The objective of this study was to examine the home food-handling practices and knowledge of primary food-handlers (parents/guardians) with children ≤10 years of age, using the FightBAC!® concepts Clean, Separate, Cook and Chill.

MATERIALS AND METHODS

Survey instrument development

Food-handling practice questions were collected from published sources *(2, 11, 30, 31, 35, 40, 41, 52, 57)*. Questions (n = 76) were tested for reliability and homogeneity among adults 19 to 30 years of age (n = 195). Cronbach's alpha with internal consistency of 0.72 was obtained *(51)* resulting in a survey containing 40 questions. Food safety knowledge questions (n = 29) were obtained from the literature *(21, 39, 40, 58, 59)*, and aligned to correspond to the food-handling practice questions.

A modified planned missing data design was used to reduce respondent burden *(26)*. Questions were divided into four surveys using the FightBAC!® concepts, Clean, Separate, Cook, and Chill. All surveys contained the same demographic questions and a question asking if a child is more likely than an adult to become sick from food poisoning. In addition, participants were asked to rank the top three preferred characteristics and delivery methods for receiving food safety education. IRB approval was obtained for the study.

Study sample and data collection

The four surveys were evenly distributed to a randomly selected nationwide sample obtained from InfoUSA® *(29)*, of households with children 10 years and under (n = 3,000; 750 per survey). Dillman's method *(20)* was used for survey delivery. An informed consent letter

was obtained from each respondent. To increase response rate, multiple mailings were used. Two weeks after the first mailing, reminder postcards with handwritten names of non-responders were sent. In a third mailing, three weeks later, Post-it® Notes with handwritten messages were attached to each survey *(25, 27)*.

Data analysis

Demographic data were analyzed by use of descriptive statistics. Frequencies of item responses on food-handling practices and food safety knowledge questions were obtained and compared to Healthy People 2020 (HP2020) Objectives for Food Safety *(56)*, which lists goals for the percent of consumers practicing safe food-handling for each FightBAC!® concept (Clean, 74%; Separate, 92%; Cook, 50%; Chill, 91%). HP2010 determined that consumers who "always" practice safe food handling for a particular concept are considered safe foodhandlers for that concept *(14)*. Responses of "always" on the Likert scale (always, most of the time, some of the time, rarely, and never) for each food-handling practice were coded as practicing safe food handling. Where appropriate, the "never" response was coded as meeting a safe food-handling practice. Food safety knowledge scores were derived by assigning one point to each correct response.

One-way analysis of variance (ANOVA) and Tukey HSD post-hoc tests were used to determine significant differences between food-handling practices and demographic variables. A paired *t*-test (CI = 0.95) compared income data of participants and those who did not participate because of low response rate (data provided by InfoUSA®). SPSS release 15.0 software package *(50)* was used for data analysis.

RESULTS

Sample characteristics

Demographic data are reported in ***Table 1***. After accounting for undeliverable (n = 46) and unusable questionnaires (n = 77), cumulative response rate was 17.5% (n = 503) (Clean 14%, Separate 19%, Cook 16%, Chill 21%). Participants resided in 50 states; most were female (67%), Caucasian (80%), between 30 and 49 years of age (83%), college-educated (79%), had one or two children 10 years old and under (83%), and prepared meals nearly all or all of the time (76%). No significant differences were found among income levels between participants and non-respondents ($P = 0.881$).

Food-handling practices and food safety knowledge

Food-handling practices and knowledge responses for questions for each FightBAC!® concept Survey are listed in ***Tables 2–5***. Food-handling practices that met the respective HP2020 goal in each Survey were: Clean, always washing hands immediately after handling raw meat (93%) and always washing hands with soap and running water after playing with a pet (76%); Separate, never placing cooked meat on the same place where raw meat has been (93%); Cook, always stirring or rotating foods in the microwave or having a microwave with automatic turntable (82%) and never allowing their child(ren) to eat hamburger that is pink in the middle (70%); and Chill, keeping leftover pizza (93%), hard-cooked eggs (97%) and raw hamburger (97%) in the refrigerator only for the recommended time. Average food safety knowledge scores exceeded the HP2020 goals for Clean, 85%, 5.1 ± 1.1 (6-point scale) and Cook, 80%, 8.0 ± 2.9 (10-point scale) but not for Separate, 69%, 8.3 ± 1.9 (12-point scale) or Chill, 78%, 10.9 ± 1.9 (14-point scale). Sixty-two percent knew that a child is more likely than an adult to become sick from food poisoning.

Women were significantly more likely than men to practice safe food handling for the Clean ($P = 0.050$) and Separate ($P = 0.025$) concepts. A significant difference in safe food handling practices ("always" response) was observed between participants who prepare meals all of the time compared to some of the time for Clean ($P = 0.043$) and between those who prepared meals all of the time compared to nearly all of the time for Separate ($P = 0.017$) concepts.

DISCUSSION

FightBAC!® clean survey

The Healthy People 2020 Objective for the Clean FightBAC!® concept is "Wash hands and surfaces often," with the goal of 74% of consumers meeting this objective. Two food-handling practices met the goal, and all food safety knowledge questions except one, were answered correctly by 74% or more of participants ***(Table 2)***.

Main food preparers reported always washing hands before food preparation less often than other consumers. The frequency of always washing hands with soap and running water before preparing food, even snacks (61%), was lower than that reported in a recent national survey (78%) *(22)* and in a study of low income consumers enrolled in Expanded Food and Nutrition Education classes (96%) *(31)*. Observational studies suggest that consumers over-report their hand washing practices. Abbot et al. *(1)* noted that of the 40% of young adults who reported the practice of hand washing, only 25% were observed to wash hands prior to food preparation. In a study of low-literacy Hispanic women who reported hand washing with soap and water (92%), only 37% were observed to use appropriate hand washing techniques *(19)*. The United States Department of Agriculture Food Safety and Inspection Service reported that when consumers were observed in their home during hand washing, only one-third of the episodes used the correct practice *(54)*. It is possible that the frequency of hand washing using correct technique during food preparation among main food preparers is lower than the self-reported frequency in this study.

The percent of participants who practiced always washing hands immediately after handling raw meat (93%) and always washing hands with soap and running water after playing with a pet (76%) met the HP2020 goal. The figure for the former practice is higher than that reported in another study (79–81%) *(41)*. Among main food preparers, washing hands with warm soapy water was practiced more often after handling raw meat (93%) than after cracking raw eggs (71%). Raw meat may be perceived as a higher food safety risk than raw eggs, or participants may have had exposure to more messages on safe handling of raw meat. Other consumers have reported similar hand washing practices when handling raw eggs *(22)*.

Children of main food preparers were reported to follow safe food-handling practices less often than the main food preparer. The

TABLE 1. Demographic characteristics of main food preparers (n = 503) in families with children ≤ 10 years of age who completed FightBAC!® concept surveys on food-handling practices and food safety knowledge

DEMOGRAPHICS	TOTAL	CLEAN	SEPARATE	COOK	CHILL
			N (%)		
GENDER					
Male	165 (33)	31 (32)	43 (32)	40 (35)	51 (33)
Female	338 (67)	67 (68)	93 (68)	75 (65)	103 (67)
ETHNIC BACKGROUND					
American Indian or Alaskan[a]	6 (1)	2 (2)	2 (2)	1 (1)	1 (1)
Asian[a]	7 (1)	1 (1)	3 (2)	0 (0)	3 (2)
Black or African American[a]	28 (6)	5 (5)	9 (7)	5 (4)	9 (6)
Caucasian or White[a]	391 (80)	70 (74)	106 (80)	94 (83)	121 (80)
Hispanic or Latino[a, b]	33 (7)	11 (12)	2 (2)	9 (8)	11 (7)
Native Hawaiian or other Pacific Islander [a, c]	1 (<1)	0 (0)	1 (1)	0 (0)	0 (0)
Other [d]	25 (5)	6 (7)	9 (7)	4 (3)	6 (5)
AGE (YEARS)					
19–29	31 (6)	6 (6)	8 (6)	5 (4)	12 (8)
30–39	220 (45)	46 (49)	57 (44)	48 (42)	69 (46)
40–49	185 (38)	34 (36)	45 (35)	50 (43)	56 (37)
> 50	56 (11)	11 (12)	19 (15)	12 (10)	14 (9)
LAST GRADE COMPLETED					
Less than high school	3 (1)	2 (2)	1 (1)	-	-
Some high school	9 (2)	2 (1)	1 (1)	-	6 (4)
High school (graduate or GED)	63 (13)	10 (10)	14 (10)	20 (18)	19 (13)
Additional training beyond high school (not college)	27 (5)	7 (7)	6 (4)	4 (4)	10 (7)
Some college	95 (19)	15 (15)	30 (22)	26 (23)	24 (16)
College graduate	191 (38)	43 (44)	54 (40)	37 (33)	57 (38)
Post-graduate	111 (22)	19 (19)	29 (22)	27 (24)	36 (24)
NUMBER OF CHILD(REN) AGED 10 YEARS OLD AND YOUNGER					
1	213 (43)	34 (35)	55 (41)	53 (46)	71 (47)
2	202 (40)	51 (52)	56 (42)	38 (33)	57 (38)
3	57 (11)	9 (9)	17 (13)	16 (14)	15 (10)

TABLE 1. Demographic characteristics of main food preparers (n = 503) in families with children ≤ 10 years of age who completed FightBAC!® concept surveys on food-handling practices and food safety knowledge (cont.)

DEMOGRAPHICS	TOTAL	CLEAN	SEPARATE	COOK	CHILL
			N (%)		
NUMBER OF CHILD(REN) AGED 10 YEARS OLD AND YOUNGER					
4	23 (5)	3 (3)	6 (4)	7 (6)	7 (5)
5	4 (1)	-	1 (1)	1 (1)	2 (1)
6	1 (<1)	1 (1)	-	-	-
FREQUENCY OF MEAL PREPARATION AT HOME					
All of the time	168 (33)	33 (34)	47 (35)	39 (34)	49 (32)
Nearly all of the time	215 (43)	43 (44)	54 (40)	49 (43)	69 (45)
Some of the time	114 (23)	22 (22)	31 (23)	26 (23)	35 (23)
Never	6 (1)	-	4 (3)	1 (1)	1 (1)
FREQUENCY OF MEAL CONSUMPTION AT A RESTAURANT, FAST FOOD, TAKEOUT, DELIVERY, CHILDCARE OR SCHOOL					
0–1 meals per week	159 (32)	26 (27)	51 (38)	35 (30)	47 (31)
2–3 meals per week	171 (34)	42 (43)	33 (24)	42 (37)	54 (35)
4–5 meals per week	88 (17)	12 (12)	30 (22)	24 (21)	22 (14)
6–7 meals per week	49 (10)	12 (12)	8 (6)	8 (7)	21 (14)
More than 7 meals per week	26 (5)	4 (4)	10 (7)	4 (4)	8 (5)
My child(ren) does not eat from a restaurant, fast food, takeout, delivery, childcare or school	10 (2)	2 (2)	4 (3)	2 (2)	2 (1)

[a]One ethnic background only

[b]Mexico, Puerto Rico, Cuba, South or Central American, or other Spanish culture or origin

[c]Hawaii, Guam, Samoa, or other Pacific islands

[d]Two or more ethnic backgrounds

TABLE 2. Food-handling practices and food safety knowledge responses of main food preparers (n = 98) in families with children ≤ 10 years of age for the CLEAN FightBAC!® survey

FOOD-HANDLING PRACTICE QUESTIONS	ALWAYS	MOST OF THE TIME	SOME OF THE TIME N (%)	RARELY	NEVER
I wash my hands with soap and running water before preparing food, even snacks.	60 (61)	26 (27)	12 (12)	-	-
I wash my hands with warm soapy water after cracking open raw eggs.	70 (71)	11 (11)	10 (10)	4 (4)	3 (3)
I wash my hands immediately after handling raw meat.[a, b]	90 (93)	5 (5)	2 (2)	-	-
When I prepare fresh fruits and vegetables for myself, I thoroughly rinse the fruits and vegetables under running tap water, including those with skins and rinds that are not eaten.	53 (54)	35 (36)	5 (5)	3 (3)	2 (2)
After playing with a pet, I wash my hands with soap and water before handling food. [a, b]	74 (76)	14 (14)	8 (8)	1 (1)	-
My child(ren) wash their hands with soap and running water before helping me in the kitchen or setting the table.	55 (56)	35 (36)	6 (6)	2 (2)	-
My child(ren) wash their hands with soap and running water right before eating a snack or meal.	33 (34)	42 (43)	18 (18)	5 (5)	-
After playing with a pet, my child(ren) wash their hands with soap and water before eating.[a]	45 (46)	32 (33)	14 (14)	6 (6)	-
When serving my children fresh fruits and vegetables, I thoroughly rinse fresh fruits and vegetables under running tap water, including those with skins and rinds that are not eaten.	54 (55)	37 (38)	5 (5)	1 (1)	1 (1)

FOOD SAFETY KNOWLEDGE QUESTIONS[c]	N (%)
Hand washing with soap and water before preparing food, including snacks.[a]	
Increases the chance of food poisoning	1 (1)
Decreases the chance of food poisoning + [b]	92 (95)
Makes no difference regarding food poisoning	4 (4)
After cracking raw eggs, hand washing with soap and water decreases the chance of getting food poisoning.[a]	
True + [b]	85 (88)
False	1 (1)
I don't know	11 (11)

TABLE 2. Food-handling practices and food safety knowledge responses of main food preparers (n = 98) in families with children ≤ 10 years of age for the CLEAN FightBAC!® survey (cont.)

FOOD SAFETY KNOWLEDGE QUESTIONS [c]	N (%)
Washing my hands immediately after handling raw meat decreases the chance of getting food poisoning.[a]	
True + [b]	91 (95)
False	-
I don't know	5 (5)
Rinsing fruits and vegetables under running tap water thoroughly can decrease the chance of food poisoning.[a]	
True + [b]	84 (87)
False	1 (1)
I don't know	12 (12)
A child is more likely than an adult to become sick from food poisoning.[a]	
True +	61 (63)
False	10 (10)
I don't know	26 (27)
Washing hands after changing a diaper:[a]	
Increases the chance of food poisoning	4 (4)
Decreases the chance of food poisoning + [b]	83 (86)
Makes no difference regarding food poisoning	10 (10)

[a]Missing 1–2 responses

[b]Responses that met Healthy People 2020 Objective/Goal (74%) for Clean concept. "Always" or "Never" food-handling responses (as applicable), and correct knowledge responses were coded as met goal

[c]Average knowledge score = 5.1 ± 1.1 (6-point scale)

+FightBAC!® recommendations or correct answer

percentage of children who always wash hands before helping in the kitchen or setting the table is comparable to the frequency reported (56% vs. 54%) by Bryd-Bredbenner et al. *(9)* among middle school children. In this study, fewer children were reported to always wash hands with soap and running water before eating a snack (34%) or after playing with a pet (46%) than prior to helping in the kitchen or setting a table. Since many children help with food preparation, appropriate hand washing is a critical practice for this population *(9, 28)*. Elementary school children who washed their hands at four scheduled times a day had fewer school absences from upper respiratory illness and gastrointestinal disturbances than children who maintained their usual hand washing practice *(38)*. Although 88–95% of main food preparers correctly responded that hand washing is necessary to decrease the chance of getting food poisoning, motivating main food preparers and their children to practice hand washing for food safety continues to be a needed. Safe practices by those caring for infants were of particular concern, because 14% of the participants were unaware that washing hands after changing a diaper can decrease the risk of food poisoning.

In this study, the reported habit of always rinsing fruits and vegetables under running tap water, including those with skins and rinds that are not eaten (54%), is similar to results observed in other groups (52–88%) *(24, 36, 41)*. However, more participants (87%) knew that this practice can reduce the risk of foodborne illness than consumers (41–43%) in a 2006 study *(21)*, many of whom believed that raw fruits and raw vegetables were not at all likely to have germs that could make them sick. Food safety messages on cleaning uneaten rinds and skins of produce after the 2006 study may have contributed to the higher knowledge scores found in this study among main food preparers. The significant difference found between gender and safe food-handling practices in the Clean Survey suggest the need for food safety messages that appeal to men.

FightBAC!® separate survey

The Healthy People 2020 Objective for the Separate FightBAC!® concept is "Separate: don't cross-contaminate," with the goal of 92% of

consumers meeting this objective. One food-handling practice and only a few food knowledge responses met the HP2020 goal.

The number of food preparers who never place cooked meat on the same plate where raw meat has been (93%) ***(Table 3)*** met the goal, a finding similar to that (80–100%) reported for this practice in other studies *(5, 8, 19, 21, 41)*. Other food-handling practices fell below the HP2020 goal, never placing raw meat above ready-to eat foods in the refrigerator (62%), and always separating raw meat from other food items when placing it in the grocery cart (37%). Other studies found that raw meat was incorrectly stored in the refrigerator *(5, 10)*. In a study by Li-Cohen et al., fewer consumers (28%) separated raw meat from other food items than main food preparers with young children did *(36)*. Educating on the practice of separating raw meat when purchasing and transporting is needed, as less than one-half reported this practice.

Participants' food knowledge met the HP2020 goal for two practices: never placing cooked meat on the same plate where raw meat has been (100%), and keeping raw meat and its juices away from other foods to prevent the chance of food poisoning (94%). Main food preparers with young children are more knowledgeable in these practices than other consumers are *(3)*.

Families with young children may be at higher risk for foodborne illness caused by cross-contamination from cutting boards or counters used for cutting raw meat, as fewer participants practiced safe procedures than other consumers do. Fewer participants (14–52%) reported always properly cleaning the cutting board or counter after cutting raw meat or poultry, compared with 55–71% of food handlers who clean their cutting board with soapy water after handling raw meat or poultry *(3, 8, 10, 36)*. More participants reported the unsafe practice of never washing the cutting board or surface with soap and bleach after contact with raw meat (31%), compared with participants in 1995 study that reported 19% followed this unsafe practice *(3)*. The unsafe practice of always wiping cutting boards and counters with a dish cloth (28%) is almost six times higher than the 5% practice reported by Li-Cohen et al. *(36)*; compared with our study, Anderson et al. *(5)* found a higher incidence (74%) for the same practice among other consumers. In this study, it is unclear if the question was interpreted to mean that water is used as one of the items in the process of cleaning/sanitizing versus being the only item used.

The number of participants who knew all four methods to correctly clean a cutting board or counter after use with raw meat was 12%, which may explain the high incidence of incorrect cleaning and sanitation practices reported. Mixed results were reported for knowledge and practices for washing the cutting board. Although 52% of participants reported that they always wash their cutting board or counter with hot soapy water after contact with raw meat, fewer participants knew that the practice was acceptable (44%), but more participants knew that the practice lowers the chance of food poisoning (88%). These findings indicate that young consumers who are main food preparers require education and motivation to correctly clean and sanitize cutting boards or counter surfaces exposed to raw meat. Targeting men with food safety messages for the Separate FightBAC!® concept is essential, as women reported significantly more food safety practices than men.

FightBAC!® cook survey

The HP2020 Objective for the Cook FightBAC!® concept is "Cook to proper temperature" with the goal of 50% of consumers meeting this objective. All food safety knowledge questions were answered correctly by 50% of main food preparers and two safe food-handling practices, both in the area of microwave cookery, were reported by at least 50% ***(Table 4)***.

The three food-handling practices meeting the HP2020 goal were: always stirring or rotating foods in the microwave or having a microwave with automatic turntable (82%), using microwave - safe containers to microwave foods (64%), and preventing their child(ren) from eating hamburger that is pink in the middle (70%) ***(Table 4)***. Other studies report that a similar percent of food handlers (58–70%) cook their hamburgers to the proper temperature *(2, 3, 21)*. It is not known how participants verify that undercooked hamburger is not consumed, as none reported always using a thermometer to check doneness of hamburger. Other studies have found that 2–33% of consumers use food thermometers *(5, 10, 19, 21, 24, 31, 34, 54)*. The practice of always cutting meat to check doneness (53–56%) suggests that this technique may be used by participants in place of food thermometer use and is practiced by more consumers in other studies (76%) *(5)*. Using a food thermometer to verify that endpoint cooking temperature has been reached is an important food-handling practice, as chicken breasts were more frequently undercooked (61%) than other foods *(5)*, and 25% of hamburgers brown first before reaching safe internal temperature *(53)*. Among food-handling practices, food thermometer use was the least frequent practice reported by consumers *(56)*. Daniels et al. *(17)* reported common reasons for observed non-use of a food thermometer during food handling in households. Forty-six percent of these consumers had never heard of the food safety principle of using a thermometer, 29% forgot to use it during food preparation, and 25% lacked motivation to use a food thermometer. Education for increasing thermometer use should address these causes and other barriers identified among main food preparers with young children.

The consumption of raw eggs in cookie dough, cake batter, and other items was reported as always avoided by 35% of the participants, which is lower than the figure among consumers in an FDA study *(21)* who ate raw eggs most or some of the time (42%). Main food preparers in this study reported eating raw hamburger (40%) and raw eggs (35%) in the past. Altekruse et al. *(4)* found 20% and 50% of consumers, respectively, who reported these practices. Main food preparers had higher awareness of the risk of consuming raw eggs than other consumers. Eighty-five percent knew that using raw eggs in recipes that will not be cooked is unsafe, while 34% of other consumers perceived that they were very likely to get ill from consuming raw eggs *(21)*.

More participants (98%) were aware that undercooked chicken and raw eggs are food vehicles for *Salmonella* than the fact that *E. coli* in undercooked hamburger can cause kidney failure in children (50%). An FDA survey found that other consumers also perceived that they were more likely to get ill from consuming raw chicken (63%) than raw beef (38%) *(21)*. Findings indicate that an increased emphasis on safe food handling of raw beef is needed in food safety messaging for primary food handlers with young children to improve knowledge and practices. Most participants (88%) knew the importance of reheating food until

TABLE 3. Food-handling practices and food safety knowledge responses of main food preparers (n = 136) in families with children ≤ 10 years of age for the SEPARATE FightBAC!® survey

FOOD-HANDLING PRACTICE QUESTIONS	ALWAYS	MOST OF THE TIME	SOME OF THE TIME N (%)	RARELY	NEVER
I put cooked meat on the same plate where raw meat has been.[a, b]	-	-	1 (1)	9 (7)	126 (93)
When purchasing raw meat at the grocery store, I put it in a separate bag (from other food items) before placing it in the cart.[a]	50 (37)	32 (24)	23 (17)	10 (7)	20 (15)
After cutting raw meat, I rinse the cutting board or counter with water.[a]	90 (68)	10 (8)	3 (2)	4 (3)	26 (20)
After cutting raw meat, I wipe the cutting board or counter with a dish cloth.[a]	38 (28)	9 (7)	12 (9)	15 (11)	61 (45)
After cutting raw meat, I wash the cutting board or counter with hot soapy water only. +	70 (52)	22 (16)	18 (13)	10 (7)	16 (12)
After cutting raw meat, I wash the cutting board or counter with hot soapy water, then rinse with bleach and water. +	19 (14)	10 (7)	15 (11)	21 (15)	71 (52)
After cutting raw meat, I clean the cutting board or counter with disinfectant (for example, Lysol, Clorox).[a] +	39 (29)	18 (13)	15 (11)	20 (15)	42 (31)
After cutting raw meat, I wash the cutting board in the dishwasher. +	44 (32)	19 (14)	21 (15)	11 (8)	41 (30)
I place raw meat above ready-to-eat foods in the refrigerator.	4 (3)	-	23 (17)	25 (18)	84 (62)
I place raw meat on a plate/container or into a bag/wrapper before placing it into the refrigerator.	90 (66)	28 (21)	11 (8)	2 (2)	5 (4)

FOOD SAFETY KNOWLEDGE QUESTIONS[c]	N (%)
It is safe to place cooked meat on the same plate where raw meat has been.[b]	
True	-
False +	136 (100)
I don't know	-

TABLE 3. Food-handling practices and food safety knowledge responses of main food preparers (n = 136) in families with children ≤ 10 years of age for the SEPARATE FightBAC!® survey (cont.)

FOOD SAFETY KNOWLEDGE QUESTIONS[c]	N (%)
Which is an acceptable way to clean a cutting board or counter after it is used for raw meat?	
(Choose ALL that apply)	
Rinse it well with water	26 (19)
Wipe it off with a dishrag	6 (4)
Wash with hot soapy water only +	60 (60)
Wash with hot soapy water, then rinse with bleach and water +	107 (44)
Clean with disinfectant (for example, Lysol, Clorox) +	75 (55)
Wash cutting board with dishwasher +	87 (64)
I don't know	2 (1)
After cutting raw meat, washing the cutting board with soap and hot water lowers the chance of food poisoning.	
True +	119(88)
False	5 (4)
I don't know	12 (9)
Where is the best place to store raw meat in the refrigerator? (Choose ALL that apply)	
On the top shelf	8 (6)
On the bottom shelf +	74 (54)
In the drawer labeled "meat" +	72 (53)
Below ready-to-eat foods +	65 (48)
It makes no difference	48 (35)
Keeping raw meat and its juices away from other foods can decrease the chance of food poisoning.[a,b]	
True +	127 (94)
False	3 (2)
I don't know	5 (4)
Placing raw meat in a separate bad (from other food items) before placing it in the grocery cart.[a,b]	
Increases the chance of food poisoning	-
Decreases the chance of food poisoning +	124 (92)
Makes no difference regarding food poisoning	11 (8)
A child is more likely than an adult to become sick from food poisoning.[a]	
True +	84 (62)
False	24 (18)
I don't know	27 (20)

[a]Missing 1–3 responses

[b]Responses that met Healthy People 2020 Objective/Goal (92%) for Separate concept. "Always" or "Never" food-handling responses (as applicable), and correct knowledge responses were coded as goal met

[c]Average knowledge score = 8.3 ± 1.9 (12-point scale)

+FightBAC!® recommendations or correct answer

TABLE 4. Food-handling practices and food safety knowledge responses of main food preparers (n = 115) in families with children ≤ 10 years of age for the COOK FightBAC!® survey

FOOD-HANDLING PRACTICE QUESTIONS	ALWAYS	MOST OF THE TIME	SOME OF THE TIME N (%)	RARELY	NEVER
I use a thermometer to test the doneness of chicken.[a]	3 (3)	5 (4)	11 (10)	34 (30)	60 (53)
I use a thermometer to test the doneness of hamburger.[a]	-	3 (3)	5 (4)	24 (21)	81 (72)
To test the doneness of chicken, I look at the juices, cut open the meat, or see if meat falls off the bones.[a]	64 (56)	33 (29)	12 (11)	1 (<1)	4 (4)
To test the doneness of hamburger, I cut the meat open or look at the color of the meat and its juices.[a]	60 (53)	30 (26)	11 (10)	5 (4)	8 (7)
I eat hamburger that is pink in the middle.[a]	3 (3)	13 (11)	25 (22)	28 (25)	45 (40)
I eat food containing raw eggs (for example, cookie dough, cake batter).[a]	-	7 (6)	35 (31)	31 (27)	40 (35)
I reheat leftover food until steaming or boiling.[a]	40 (35)	32 (28)	30 (26)	10 (9)	2 (2)
I follow the manufacturer's instructions when microwaving foods (for example, length of microwaving time).[a]	54 (48)	43 (38)	7 (6)	4 (4)	5 (4)
I use microwave-safe containers to microwave foods.[a, b]	72 (64)	24 (21)	11 (10)	4 (4)	2 (2)
I stir and rotate food in the microwave or my microwave has an automatic turntable.[a, b]	93 (82)	11 (10)	5 (4)	-	4 (4)
I know my microwave wattage.[a]	50 (45)	62 (55)	-	-	-
I use a thermometer to test the doneness of chicken when preparing chicken for my child(ren).[a]	9 (8)	5 (5)	9 (8)	29 (25)	62 (54)
I use a thermometer to test the doneness of hamburger when preparing hamburger for my child(ren).[a]	1 (<1)	3 (3)	6 (5)	30 (26)	74 (65)
My child(ren) eat hamburger that is pink in the middle.[a, b]	1 (<1)	7 (6)	9 (8)	17 (15)	80 (70)

FOOD SAFETY KNOWLEDGE QUESTIONS[c]	N (%)
E. coli (a harmful bacteria) in undercooked hamburger caused kidney failure in children.[a, b]	
True +	56 (50)
False	4 (4)
I don't know	52 (46)

TABLE 4. Food-handling practices and food safety knowledge responses of main food preparers (n = 115) in families with children ≤ 10 years of age for the COOK FightBAC!® survey (cont.)

FOOD SAFETY KNOWLEDGE QUESTIONS[c]	N (%)
Undercooked chicken and raw eggs can carry *Salmonella* (a harmful bacteria).[a,b]	
True +	112 (98)
False	-
I don't know	2 (2)
It is safe to use raw eggs in recipes that will not be cooked.[a,b]	
True	6 (5)
False +	97 (85)
I don't know	11 (10)
A child is more likely than an adult to become sick from food poisoning.[a,b]	
True +	76 (67)
False	16 (14)
I don't know	21 (19)
What is the best way to tell when chicken has cooked long enough? (Choose one)[a,b]	
The juices run clear	8 (7)
Cut open the meat	19 (17)
The meat falls off the bone	7 (6)
Test with food thermometer +	77 (69)
I don't know	1 (<1)
What is the best way to tell when hamburger has cooked long enough? (Choose one)[a,b]	
The juices run clear	7 (6)
Cut open the meat	9 (8)
The meat falls off the bone	25 (22)
Test with food thermometer +	71 (62)
I don't know	2 (2)
Using a thermometer when testing the doneness of chicken[a,b]	
Increases the chance of food poisoning	2 (2)
Decreases the chance of food poisoning +	97 (86)
Makes no difference regarding food poisoning	14 (12)
Using a thermometer when testing the doneness of hamburger[a,b]	
Increases the chance of food poisoning	2 (2)
Decreases the chance of food poisoning +	98 (87)
Makes no difference regarding food poisoning	13 (12)
Reheating food until steaming or boiling.[a,b]	
Increases the chance of food poisoning	2 (2)
Decreases the chance of food poisoning +	100 (88)
Makes no difference regarding food poisoning	12 (11)
Improper use of your microwave oven can result in undercooked food.[a,b]	
True +	107 (94)
False	2 (2)
I don't know	5 (4)

TABLE 4. Food-handling practices and food safety knowledge responses of main food preparers (n = 115) in families with children ≤ 10 years of age for the COOK FightBAC!® survey (cont.)

FOOD SAFETY KNOWLEDGE QUESTIONS [c]	N (%)
Improper use of your microwave oven can result in undercooked food.[a,b]	
True +	107 (94)
False	2 (2)
I don't know	5 (4)

[a]Missing 1–3 responses

[b]Responses that met Healthy People 2020 Objective/Goal (50%) for Cook concept. "Always" or "Never" food-handling responses (as applicable), and correct knowledge responses were coded as met goal

[c]Average knowledge score = 8.0 ± 2.9 (10-point scale)

+FightBAC!® recommendations or correct answer

steaming or boiling to decrease food poisoning, yet only 35% reported always following this practice.

Participants reported more safe food-handling practices when preparing food for their children than for themselves, specifically with the use of a food thermometer for chicken (8% vs. 3%), and never eating raw hamburger (70% vs. 40%) or consuming raw eggs (45% vs. 35%). Thus, at least to some degree, primary food handlers have adopted some practices to protect their children from foodborne illness in these areas. Continuing education in all areas of food safety, using the theme of protecting young children from harm, may be helpful.

FightBAC!® chill survey

The Healthy People 2020 Objective for the Chill FightBAC!® concept is "Refrigerate promptly" with the goal of 91% of consumers meeting this objective. Main food preparers met the HP2020 goal for four food-handling practices and four knowledge questions ***(Table 5)***.

Most primary food handlers use or discard leftover pizza (93%), hard-cooked eggs (97%) and raw hamburger (97%) within the recommended time frame. Approximately two-thirds of the participants always refrigerate leftover foods within two hours of cooking, a lower figure than the 83–85% of consumers reported in FDA *(21)* and *US Grocery Shopping Trends (24)* surveys.

Participants rely on sensory perception when judging if leftover food is safe to eat. More than half of the participants (8% always, 44% most of the time) eat leftover food if it looks or smells good. Fewer participants thawed frozen meat on the countertop all or most of the time (15%), compared with 21% reported in a study by Kwon et al. *(35)*. Two-thirds of main food preparers (66%) always throw away foods that have passed the expiration date, consistent with the practice reported in another study (63%) *(24)*.

Participants' knowledge met the HP2020 Goal for four questions: storing cooked (94%) or raw (99%) chicken and hamburger in the refrigerator for no more than four days before use, refrigerating leftover foods within two hours of cooking (96%), and correctly thawing meat in the refrigerator (93%). Compared with other consumers, food safety knowledge of main food preparers is higher in this area. Redmond and Griffith *(47)* reported that 84% of participants perceived that storing cooked meat at room temperature was unacceptable. A quarter of participants in another study (25%) incorrectly viewed cooked chicken left out for three hours as safe to consume *(2)*, and nearly two-fifths of participants (39%) strongly agreed that leftover foods can be kept at room temperature for several hours *(8)*. Regarding infant food safety, 12% of participants in our study believed that infant formula left at room temperature for more than two hours is safe.

Participants demonstrated more food safety knowledge than safe food-handling practices for the Chill Survey, with the exception of two areas: thawing frozen meat on the countertop (18% vs. 30%) and storing eggs at room temperature (78% vs. 95%). Inconsistent practice was noted for storing large quantities of hot foods in shallow containers in the refrigerator, another topic for future food safety education.

Preferred characteristics and delivery method for food safety information

With regard to the top three qualities desired in the delivery of food safety information, ease of understanding, use of scientific facts, and makes one feel their health is in danger were ranked first, second, and third, respectively. Following in rank order were the use of pictures/visuals, statistics with charts and graphs, and interactive qualities (for example, a hotline). Requesting materials that cause feelings of a health threat is consistent with results of other studies, which emphasized using detrimental health effects and a "shock-value" to

TABLE 5. Food-handling practices and food safety knowledge responses of main food preparers (n = 154) in families with children ≤ 10 years of age for the CHILL FightBAC!® survey

FOOD-HANDLING PRACTICE QUESTIONS	ALWAYS	MOST OF THE TIME	SOME OF THE TIME N (%)	RARELY	NEVER
I store raw eggs at room temperature.[b]	2 (1)	-	1 (1)	6 (4)	142 (95)
I thaw frozen meat on the countertop.	4 (3)	19 (12)	46 (30)	39 (25)	46 (30)
When storing large quantities of hot foods, I place them in shallow containers in the refrigerator.	20 (13)	35 (23)	34 (22)	30 (20)	33 (22)
I refrigerate leftover foods within two hours of cooking them.	103 (67)	40 (26)	8 (5)	2 (1)	1 (1)
I refrigerate leftover foods within two hours of buying them from a deli, restaurant, or grocery stores.	134 (87)	18 (12)	-	-	2 (1)
I will eat leftover food if it looks and/or smells good.	13 (8)	67 (44)	58 (38)	11 (7)	5 (3)
I throw away foods that have passed the expiration date.	102 (66)	44 (29)	7 (5)	1 (1)	-

	1–2 DAYS	3–4 DAYS	5–7 DAYS	MORE THAN A WEEK
How long do you keep foods like chili, soup, and stew in the refrigerator to eat later?	35 (23) +	78 (51) +	38 (25)	2 (1)
How long do you keep leftover pizza in the refrigerator to eat later?[b]	88 (58) +	54 (35) +	10 (7)	1 (1)
How long do you keep hard-cooked eggs in the refrigerator to eat later?[b]	59 (40) +	54 (36) +	31 (21) +	5 (3)
How long do you keep chicken nuggets or chicken patties in the refrigerator to eat later?	99 (68) +	36 (25)	9 (6)	2 (1)
How long do you keep raw chicken in the refrigerator before cooking?	117 (78) +	30 (20)	3 (2)	1 (1)
How long do you keep raw hamburger in the refrigerator before cooking?[b]	116 (77) +	30 (20) +	4 (3)	

FOOD SAFETY KNOWLEDGE QUESTIONS[c]	N (%)
It is safe to store eggs at room temperature.	
True	10 (7)
False +	120 (78)
I don't know	24 (16)

TABLE 5. Food-handling practices and food safety knowledge responses of main food preparers (n = 154) in families with children ≤ 10 years of age for the CHILL FightBAC!® survey (cont.)

If a leftover food looks and/or smells good, it is still safe to eat.	
True	18 (12)
False +	111 (74)
I don't know	22 (15)
What is the best way to handle leftover food? (Choose one)[b]	
Leave on the countertop to cool for longer than 2 hours	4 (3)
Put in refrigerator within 2 hours of cooking it +	147 (96)
Put in refrigerator within 4 hours of cooking it	2 (1)
It makes no difference	-
What is the best way to handle large quantities of hot food before refrigeration? (Choose one)	
Store hot foods in the same cookware in which they were cooked or one deep container	8 (5)
Divide hot foods into shallow containers +	131 (86)
It makes no difference don't know	14 (9)
In general, how long can you store cooked hamburger and chicken in the refrigerator to eat later? (Choose one)[b]	
1–2 days +	65 (43)
3–4 days +	77 (51)
5–7 days	10 (7)
More than a week	-
In general, how long can you store raw hamburger and chicken in the refrigerator before cooking? (Choose one)[b]	
1–2 days +	114 (75)
3–4 days +	36 (24)
5–7 days	2 (1)
More than a week	1 (1)
Deli foods or luncheon meat kept beyond the expiration date are safe:	
True	7 (5)
False +	135 (88)
I don't know	12 (8)
It is safe or okay to give an infant a bottle of baby formula that has been out of the refrigerator for longer than 2 hours?	
True	1 (1)
False +	136 (88)
I don't know	17 (11)
Check the correct way(s) to thaw frozen meat. (Choose ALL that apply)[a,b]	
In the refrigerator +	143 (93)
In the microwave +	92 (60)
On the countertop	27 (18)
Under running water +	62 (40)
In the sink of water	47 (31)

TABLE 5. Food-handling practices and food safety knowledge responses of main food preparers (n = 154) in families with children ≤ 10 years of age for the CHILL FightBAC!® survey (cont.)

A child is more likely than an adult to become sick from food poisoning.	
True +	89 (58)
False	29 (19)
I don't know	36 (23)

[a]Missing 1–4 responses

[b]Responses that met Healthy People 2020 Objective/Goal (91%) for Chill concept. "Always" or "Never" food-handling responses (as applicable), and correct knowledge responses were coded as met goal

[c]Average knowledge score = 10.9 ± 1.9 (14-point scale)

+FightBAC!® recommendations or correct answer

motivate participants to feel threatened enough to act *(9, 34, 40)*. The fact that approximately 80% of the participants had completed at least some college is a plausible reason for the selection of scientific facts in food safety information, despite the low ranking for graphs and charts.

When the top three choices for receiving food safety information were ranked, the food label was ranked as the top preferred method, followed by mail and television. The remaining preferences in rank order were e-mail, print media (brochure at a grocery store, cookbook, magazine, newspaper, and school newsletter), telecommunication media (radio, and hotlines for food safety information), classes or workshops, podcast or video and text message. The majority of food handlers prefer food safety information that appeals to their tactile perception (food label and mail) to telecommunication media (television and email). However, the results also illustrate the importance of using different forms of media in educating main food preparer in families with young children.

Study findings are limited to college educated main food preparers of Caucasian descent who frequently prepare meals at home. All practices were self reported. The use of both practice and knowledge questions on the surveys may have influenced responses in either area.

Significance to educators

Despite the fact that two thirds of main food preparers were aware that children are more likely than adults to become sick from foodborne illness, their food-handling practices and food safety knowledge placed their children at high risk for foodborne illness. Half of the participants in the Cook Survey (48%) were unaware that *E. coli* found in undercooked hamburger causes kidney failure in children. Although participants in Clean and Cook Surveys exceeded the HP2020 Objectives for knowledge, reported food safety handling practices by main food preparers in families with young children fell below HP2020 Objectives/Goals for almost all FightBAC!® concepts. Food safety educators may use a variety of media and selective messaging when educating and motivating primary food handlers in families with children 10 years old and younger. While continued food safety education is needed in all concept areas, study findings suggest a focus on FightBAC!® Separate and Chill concepts, as knowledge was low in both these surveys.

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