

Research Paper

Food Safety Attitudes, Behaviors, and Hygiene Measures among Predominantly Low-Income Parents in Houston, Texas

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MS 22-179: Received 8 June 2022/Accepted 31 August 2022/Published Online 1 September 2022

ABSTRACT

Foodborne infections in the United States affect racial-ethnic minority and low-income populations at higher rates than the general population. To identify the prevalence of food safety behaviors and demographic characteristics associated with food handling practices among a susceptible, high-risk population, a cross-sectional survey was administered to 106 parents with children enrolled at two elementary schools serving predominantly low-income families in Houston, Texas. Relationships between demographic characteristics and food safety behavioral outcomes were examined using cross-tabulations and Fisher's exact test. Most respondents were female (93.4%), Hispanic, Latino, or Mexican American (94.9%), and had no previous food handling employment experience (75.0%). The primary source of food safety information reported was the Internet (32.7%), and nearly half of parents (42.7%) reported that they did not consider contamination of food with germs a serious food safety problem. Hand washing before food preparation was more common (98.0%) than before touching the refrigerator handle (66.3%), after electronic device use (55.6%), or after handling raw animal proteins (77.6%). The prevalence of fresh fruit (98.0%) and vegetable (97.9%) washing and appropriate contaminated cutting board handling (89.0%) was high among parents. Self-reported gaps in food handling behaviors identified included lack of food thermometer ownership (80.4%), use of reusable cleaning tools (71.0%), inappropriate defrosting methods (67.4%), and washing of raw poultry (86.3%), seafood (84.9%), and meat (74.7%). Hand washing after electronic device use and defrosting methods were observed to vary significantly according to demographic characteristics. Food safety education with messages targeted to specific demographic groups may be necessary to reduce the risk of foodborne disease among low-income parents and young children.

HIGHLIGHTS

- Nearly half of parents did not consider food contamination a serious problem.
- Parents more commonly washed their hands prior to, not during, food preparation.
- Parents frequently reported the use of reusable tools to clean kitchen surfaces.
- Food safety education could be targeted to specific demographic groups.

Key words: Consumer behavior; Demographic disparities; Diarrheal disease; Foodborne illness; Sanitation; Susceptible populations

Foodborne illness remains a considerable public health concern in the United States because nearly 48 million cases occur annually (33). Nontyphoidal *Salmonella* and *Campylobacter* spp. alone are responsible for approximately 20% of all foodborne illnesses due to known pathogens (34). These two bacterial pathogens are also among the top three contributors to annual foodborne illness-related hospitalizations (19,336 and 8,463 cases, respectively) and deaths (378 and 76 cases, respectively). An estimated 20% of the U.S. population is at elevated susceptibility to

foodborne infections and is more likely to have increased recovery times along with severe clinical outcomes (10). Young children are uniquely susceptible to foodborne illness via environmental contamination because sensory behaviors (i.e., touch and taste) and extended floor contact time can facilitate self-inoculation (37).

Surveillance data in the United States indicate that racial-ethnic minority populations are also at an increased risk of certain foodborne illnesses. African American, Asian American, and Hispanic communities experience elevated rates of *Campylobacter*, *Listeria monocytogenes*, *Salmonella*, *Shigella*, and *Yersinia enterocolitica* infections, and various contributing factors to these disparities have been

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proposed (29). For example, Hispanic population groups have repeatedly experienced outbreaks of listeriosis associated with the consumption of unpasteurized, Latin-style cheeses, which may be linked to culture-based food preferences. Yet, other foodborne pathogens, such as *Campylobacter* and *Salmonella*, are primarily associated with environmental contamination instead of the consumption of specific foods and are preventable via proper cooking and safe food handling practices (25).

Another hypothesized contributor to the disparate incidence of foodborne illnesses is that food products available in predominantly racial-ethnic minority neighborhoods are of low microbiological quality (29, 36). For example, one microbiological study examined the quality of food products sold at retail markets in Philadelphia, PA, across locations with high populations of different demographic groups, including African American, Asian American, Hispanic, European American, and those with high- and low-socioeconomic status (36). The study determined that eggs more often had higher internal temperatures in areas with low-socioeconomic status compared with those with high-socioeconomic status and that the eggs were more often found unrefrigerated in markets in the low-socioeconomic and Asian areas. In addition, fecal coliforms were present in 100, 71, and 46% of ready-to-eat leafy greens samples from low-socioeconomic status, Asian American, and European American areas, respectively. However, a pilot study conducted in the same major city determined that *Salmonella* and *Campylobacter* contamination rates on poultry products available at the retail level did not vary across socioeconomic tracts (17). Ultimately, the consumer is considered the last line of defense against foodborne illness, highlighting proper consumer food handling practices as a critical prevention measure for home-acquired foodborne infections.

Evidence demonstrates that food handling habits vary according to consumers' demographic characteristics, yet reports conflict as to which groups may be at an increased risk of unsafe food handling behaviors (7, 13, 14, 28). A meta-analysis of 20 food safety studies found that hygienic behaviors, such as hand washing, were employed more frequently by African American and Asian American individuals than Hispanic or European American individuals (28). However, a national survey in the United States found that consistent practices to reduce microbial cross-contamination, such as proper washing of utensils and cutting boards after use with raw meat and before use with ready-to-eat foods, were more frequently reported by European American and Hispanic individuals (7). Although population-level indications of unique food safety behavioral gaps are unclear, food safety practices may be culturally linked. For example, focus groups among racial-ethnic minority consumers on food preparation habits found that Hispanic and Asian American consumers described washing poultry before cooking (13), a practice that has been observed to lead to an increased risk of bacterial cross-contamination (5, 24).

The disparate susceptibility to and burden of foodborne illness currently affects a large proportion of the U.S. population. Children from families of low-socioeconomic

status are at the highest risk of several foodborne infections, including campylobacteriosis, salmonellosis, and shigellosis (2, 21, 50). However, information on food safety habits according to individual demographic characteristics is conflicting (29). Understanding the prevalence of unsafe or risky food handling behaviors that may contribute to cross-contamination among parents of low-income families is critical to address children's exposure risk to bacterial foodborne pathogens and the disparate occurrence of foodborne infections. Consequently, the goal of this research was to identify food handling and hygiene practices among low-income parents of elementary-aged children that may lead to cross-contamination in the kitchen or an increased risk of foodborne infection. Specifically, this study assessed the prevalence of (i) hand washing behaviors, (ii) food safety attitudes, (iii) food handling behaviors, and (iv) kitchen cleaning methods. This study further examined relationships between parents' demographic characteristics and food safety behavioral outcomes.

MATERIALS AND METHODS

Participants and recruitment. This study was approved by the University of Texas Health Science Center Committee for the Protection of Human Subjects and was conducted in collaboration with Brighter Bites, a nonprofit nutritional intervention that operates in schools where at least 75% of students are receiving free or reduced-price lunches (Title 1) (35). Parents of children in attendance at two Brighter Bites-participating Houston Independent School District elementary schools (Texas) were invited via e-mail by Brighter Bites to participate in the electronic survey using a convenience sampling approach. Inclusion criteria required participants to be ≥ 18 years old and to be the parent or guardian of at least one child enrolled in either of the two participating elementary schools. Survey administration took place from May to June 2020, and the survey received a 16% response rate (106 of 666). Electronic consent was obtained before survey initiation, and a total of 106 parents completed the survey.

Survey instrument. The survey (Supplemental File 2) was self-administered in electronic format and required consent from parents before initiation. Survey questions were adapted from the U.S. Food and Drug Administration (FDA)'s Food Safety Survey and Kwon et al. (19, 46). The survey was intended to ascertain food safety attitudes; hand washing, kitchen cleaning, and food handling behaviors; and demographic information (i.e., age, education level, employment status, race/ethnicity, and gender). Other information collected by the survey included primary household language, any prior or current employment as a food handler, and primary source of food safety information. The questionnaire was translated into Spanish by a translation service and was pilot tested among a group of community members ($n = 10$) that included native Spanish speakers prior to final administration. Response options were in multiple-choice format, and the survey took approximately 10 min to complete. Choice of survey material language (English or Spanish) was available to all parents.

Statistical analysis. Survey data were collected via REDCap software (11) (Vanderbilt University, Nashville, TN) hosted at the University of Texas Health Science Center. Data cleaning and analysis were conducted using the R language (30) (version 3.6.3, R Foundation for Statistical Computing, Vienna, Austria) and

TABLE 1. Demographic characteristics of surveyed predominantly low-income parents of elementary-aged children, Houston, Texas, 2020

Demographic characteristics	Frequency (n = 106)	%
Age (yr)		
<30	20	18.9
30–34	27	25.5
35–39	33	31.1
40+	26	24.5
Sex		
Male	7	6.6
Female	99	93.4
Race/ethnicity ^a		
Black or African American	3	3.1
Mexican American, Latino, or Hispanic	93	94.9
White or European American	1	1.0
Other	1	1.0
Education ^a		
Never attended school or only attended kindergarten	2	2.0
Grades 1–8	25	25.5
Grades 9–11	23	23.5
High school graduate	23	23.5
College (years 1–3)	21	21.4
College graduate	4	4.1
Employment ^b		
Employed (full-/part-time)	33	34.0
Homemaker/stay-at-home-parent	47	48.5
Unemployed	17	17.5
Primary household language ^a		
Most or only English	5	5.1
Both English and Spanish equally	36	36.7
Most or only Spanish	57	58.2
Previous food handling employment ^c		
Yes	24	25.0
No	72	75.0

^a Missing values: 8.

^b Missing values: 9.

^c Missing values: 10.

RStudio software (32) (version 4.1.2; RStudio, Inc., Boston, MA). Descriptive statistics, including frequencies and percentages, were computed to summarize each variable. Food safety behavioral outcomes assessed using the frequency scale of “Always,” “Sometimes (but not always),” or “Never” were collapsed into response categories of “Always” or “Not always.” Food safety behavioral outcomes evaluated using a response range of possible actions or methods such as “Use as is,” “Rinse or wipe,” or “Wash with soap” were collapsed into categories of “Yes” or “No” or “Appropriate” or “Inappropriate” according to recommended or appropriate behaviors (42, 43, 45, 47). Food safety attitudes were assessed according to self-reported levels of concern for food contamination with germs as a food safety problem (46). Response options included “Serious food safety problem,” “Somewhat of a food safety problem,” and “Not a food safety problem at all,” which were collapsed into categories of “Serious” or “Not serious.” Univariate relationships between demographic charac-

TABLE 2. Reported sources of food safety information among predominantly low-income parents of elementary-aged children, Houston, Texas, 2020

Source	Frequency (n = 104) ^a	%
Internet	34	32.7
Television	27	26.0
Family	24	23.1
School	5	4.8
Friends	4	3.8
Government programs or hot line	4	3.8
None	3	2.9
Work	2	1.9
Newspaper or magazine	1	1.0

^a The sample size varies due to missing data.

teristics and self-reported food safety behavioral outcomes were evaluated using cross-tabulations and Fisher’s exact test. A *P* value of <0.05 was considered statistically significant.

RESULTS AND DISCUSSION

A total of 106 low-income parents or guardians of elementary-aged children completed the survey. Respondents were predominantly female (93.4%), between the ages of 35 and 39 years (31.1%), and identified as either Mexican American, Latino, or Hispanic (94.9%), with no previous employment as a food handler (75.0%) (Table 1). Nearly half of parents were homemakers (48.5%) and had less than a high school education (51.0%). Households were primarily Spanish speaking (58.2%), and only 5.7% indicated that they never cooked animal proteins, including poultry, meat, and seafood, from a raw state.

The most common primary source of food safety information reported was the Internet (32.7%), followed by television (26.0%), and family (23.1%) (Table 2). These results differ from a 2006 study conducted among a national U.S. sample of Women, Infants, and Children (WIC) clients, a program that aims to safeguard the health of low-income participants by providing access to nutritious foods (44), that found that, aside from the WIC program itself (78.7%), family (63.1%), television (60.7), and friends (42.9%) were the most frequently cited sources of food safety information (19). Notably, among WIC clients in the United States, the Internet was one of the least frequently reported sources (9.0%), whereas, in the present study, it was the most common. The preference for the Internet as a source of food safety information among parents is consistent with Internet use by an estimated three-quarters of Americans for searches related to health information (15).

The subsequent survey questions evaluated food safety behavioral outcomes in four main sections: hand washing behaviors, food safety attitudes, food handling behaviors, and kitchen cleaning methods. Responses to these questions were used to identify demographic characteristics related to risky food safety practices among low-income parents of elementary-aged children.

Hand washing. Nearly all parents reported always washing their hands before meal preparation (98.0%). This

TABLE 3. Frequency of hand washing with soap among predominately low-income parents of elementary-aged children according to demographic characteristics

Demographic characteristics	Hand washing frequency, <i>n</i> (%) ^a		
	Before touching refrigerator handle ^b	After electronic device use ^b	After handling raw poultry, meat, or seafood ^c
Age (yr)			
≤35	27 (64.3)	23 (62.2)	36 (75.0)
>35	32 (68.1)	17 (48.6)	40 (80.0)
Sex			
Male	4 (66.7)	0 (0.0)	5 (71.4)
Female	55 (66.3)	40 (57.1)	71 (78.0)
Race/ethnicity			
Hispanic	53 (64.6)	39 (60.9)	69 (77.5)
Non-Hispanic	4 (80.0)	0 (0.0)	3 (75.0)
Education			
Less than high school	29 (70.7)	21 (61.8)	40 (85.1)
High school or more	28 (60.9)	18 (51.4)	32 (69.6)
Employment status			
Employed (full-/part-time)	18 (62.1)	13 (50.0)	23 (71.9)
Homemaker/unemployed	39 (67.2)	26 (60.5)	48 (80.0)
Primary household language			
English or bilingual	25 (62.5)	15 (46.9)	31 (79.5)
Most or only Spanish	32 (68.1)	24 (64.9)	41 (75.9)
Previous food handling employment			
Yes	16 (72.7)	11 (68.8)	20 (83.3)
No	40 (62.5)	28 (53.8)	50 (74.6)

^a The sample size for each cross-tabulation varies due to missing data. Row percentages.

^b During food preparation.

^c Among those who “Always” or “Sometimes” prepare raw animal proteins from raw.

percentage is higher than that obtained by the 2019 U.S. Food Safety and Nutrition (FSN) survey, which indicated that the prevalence of self-reported hand washing before food preparation among the general U.S. population was 68% (48). Similar results were obtained from a survey conducted among WIC clients in Florida, where 75% of respondents reported hand washing before food preparation (40). The high prevalence of hand washing before meal preparation observed may be contributed to by self-report bias. Such bias was detected by a study conducted among Puerto Rican women that found a low agreement between reported and observed hand washing behaviors before meal preparation (33% accuracy) (9).

Bacterial cross-contamination potential during food preparation was evaluated through questions about proper hand washing (i.e., washing hands with soap) before touching the refrigerator door handle, after handling an electronic device, and after handling raw animal proteins. Only 66.3 and 55.6% of parents reported proper hand washing before touching the refrigerator door handle and after using an electronic device during food preparation (e.g., to take a call), respectively. A total of 77.6% of parents reported hand washing after handling raw animal proteins, which is similar to the prevalence of this behavior observed by the FSN survey among the general U.S.

population (76%) (48). In contrast, a lower prevalence of hand washing after electronic device handling (35%) compared with this study has been observed among the general population by the 2016 FDA Food Safety Survey (FSS) (46).

Parents >35 years old most frequently reported hand washing before touching the refrigerator handle (68.1%) and after raw animal protein handling (80.0%); however, parents ≤35 years old most frequently (62.2%) reported hand washing after electronic device use (Table 3). A meta-analysis of 20 food safety studies similarly observed that the frequency of good hygiene use, including proper hand washing, increased with age (28). Hispanic, Latino, or Mexican American parents less frequently reported hand washing before touching the refrigerator handle (64.6%) than non-Hispanic parents (80.0%) but were more likely to report hand washing after electronic device use (*P* value = 0.0127). Parents whose household language was primarily Spanish more frequently reported hand washing before touching the refrigerator handle (68.1%) and after electronic device use (64.9%). However, parents whose household language was primarily English or bilingual more frequently reported hand washing after handling raw animal protein (79.5%).

TABLE 4. Food safety attitude and frequency of inadequate food safety practices among predominately low-income parents of elementary-aged children according to demographic characteristics, Houston, Texas, 2020

Demographic characteristics	Frequency, n (%) ^a				
	Do not consider food contamination with germs a serious food safety problem	Do not own a food thermometer	Inappropriate raw animal protein defrosting methods ^{b,c}	Inappropriate contaminated cutting board handling ^{c,d}	Inappropriate kitchen counter cleaning tool ^e
Age (yr)					
≤35	24 (47.1)	36 (76.6)	30 (65.2)	6 (14.0)	35 (77.8)
>35	20 (38.5)	42 (84.0)	34 (69.4)	4 (8.3)	31 (64.6)
Gender					
Male	4 (57.1)	4 (66.7)	5 (71.4)	1 (14.3)	4 (66.7)
Female	40 (41.7)	74 (81.3)	59 (67.0)	9 (10.7)	62 (71.3)
Race/ethnicity					
Hispanic	40 (43.5)	73 (79.3)	59 (67.0)	10 (11.5)	63 (70.8)
Non-Hispanic	2 (40.0)	5 (100.0)	3 (75.0)	0 (0.0)	3 (75.0)
Education					
Less than high school	21 (42.9)	38 (76.0)	24 (52.2)	5 (10.9)	34 (70.8)
High school or more	21 (43.8)	40 (85.1)	38 (82.6)	5 (11.1)	32 (71.1)
Employment status					
Employed (full-/part-time)	13 (39.4)	26 (81.2)	21 (67.7)	4 (12.5)	23 (74.2)
Homemaker/unemployed	29 (46.0)	52 (81.2)	40 (66.7)	6 (10.3)	42 (68.9)
Primary household language					
English or bilingual	20 (48.8)	29 (72.5)	25 (65.8)	1 (2.6)	24 (63.2)
Most or only Spanish	22 (39.3)	49 (86.0)	37 (68.5)	9 (17.0)	42 (76.4)
Previous food handling employment					
Yes	10 (43.5)	19 (79.2)	17 (70.8)	2 (8.3)	17 (70.8)
No	31 (43.1)	59 (83.1)	44 (66.7)	8 (12.3)	48 (71.6)

^a The sample size for each cross-tabulation varies due to missing data. Row percentages.

^b Inappropriate defrosting methods included “On the counter,” “In sink of water,” and “Under running water.” Defrosting “In the refrigerator” was considered an appropriate response.

^c Among those who “Always” or “Sometimes” prepare raw animal proteins from raw.

^d Inappropriate contaminated cutting board handling included “Rinsing” or “Wiping” before use to prepare other food to be eaten raw for the same meal. Appropriate cutting board handling included “Washing with soap.”

^e Inappropriate kitchen counter cleaning tools included dish sponges and dishcloths. Appropriate responses included paper towels or disposable wipes.

Among parents with less than high school education, a higher prevalence of hand washing was observed before touching the refrigerator handle (70.7%), after electronic device use (61.8%), and after handling raw animal protein (85.1%) (Table 3). A statewide survey conducted in Kentucky found that consumers with high school education or below were more likely to engage in hand washing after handling raw meat than individuals with higher education (31). The previously mentioned meta-analysis found that although knowledge of good hygiene practices increased with education level, the use of good hygiene practices decreased (28). Other research has linked high education levels with unsafe food handling behaviors, and it has been hypothesized that this trend may be due to a belief that risk can be controlled (16). The low prevalence of hand washing behaviors reported among more educated parents in the present study may also be attributable to such an effect.

Food safety attitude. Parent food safety attitudes were evaluated by the extent to which they considered food contamination with germs a serious food safety problem. Over half of parents (57.3%) considered food contamination with germs a serious food safety problem, 29.1% considered it somewhat of a problem, and 13.6% did not consider it a problem. A lack of serious concern for food contamination was more prevalent among parents ≤35 years old (47.1%) than those >35 years old (38.5%) (Table 4). A similar lack of serious concern was reported by males (57.1%), Hispanic, Latino, or Mexican American respondents (43.5%), homemakers or unemployed parents (46.0%), or those whose primary household language was English or bilingual (48.8%). Among the general U.S. population, only 33% of respondents to the FSS considered food contamination with germs a serious food safety problem (46). Further, a mere 28% of respondents to the FSN survey thought it was very common for people in the United States to get food poisoning from food contaminated with bacteria,

and only 15% thought it was common for people to get food poisoning due to the way food is prepared in the home (48).

Overall, 42.7% of parents reported that they did not consider food contamination with germs a serious food safety problem, which may be linked to a greater risk of cross-contamination during food preparation. For example, one study found that low-income Puerto Rican meal preparers who considered food safety “important” or “somewhat important” had significantly higher coliform counts on their hands and were more likely to test positive for *Staphylococcus aureus* than those who considered food safety “very important” (8). Individuals who do not consider food contamination to be a serious food safety problem may possess a high level of confidence in the food system’s microbiological quality and a lowered sense of perceived risk from food and personal responsibility for foodborne illness prevention, which is known as optimistic bias (38). This phenomenon may help to explain the lack of serious concern for food contamination among the present study population, although this study did not evaluate confidence in the U.S. food system.

Food thermometers. Only 19.6% of parents reported that they owned a food thermometer, and only 27.8% indicated that they had consistently used it over the past year. A similarly low prevalence of food thermometer ownership has been observed among WIC clients in Florida (24.1%) (40). In contrast, the FSN survey detected a higher prevalence of food thermometer ownership among the general U.S. population (62.0%) (48). Barriers to food thermometer use documented among low-income and racial-ethnic minority populations include lack of ownership and a reported “threat to culinary skill” (13, 39). A low prevalence of food thermometer ownership and use among parents is concerning as children are more susceptible to common foodborne illnesses, such as salmonellosis and campylobacteriosis, which are associated with inadequate cooking of food (26).

Parents who more frequently lacked food thermometers included those >35 years old (84.0%), females (81.3%), those with high school education or higher (85.1%), those whose primary household language was Spanish (86.0%), and those with no previous food handling employment experience (83.1%) (Table 4). However, a survey among consumers in Kentucky found that food thermometer ownership was more likely as education and annual household income levels increased (31). As the present study population consisted of primarily low-income parents, the low overall prevalence of food thermometer ownership may be due to a lack of financial resources. All non-Hispanic and 79.3% of Hispanic, Latino, or Mexican American parents reported that they lacked food thermometers, but because the study sample was predominantly Hispanic, Latino, or Mexican American, limited inference can be made regarding differences in the prevalence of food thermometer ownership across racial-ethnic groups.

Defrosting methods. The most common defrosting method for raw animal proteins reported by parents was in

the sink with water (i.e., submerged in water; 38.9%), followed by defrosting in the refrigerator (32.6%), under running water (21.1%), and on the counter (7.4%). Defrosting methods were categorized as unacceptable or acceptable according to U.S. Department of Agriculture (USDA) guidance (45). Defrosting in the refrigerator was the only method considered acceptable for this analysis. Although thawing in cold water is also acceptable by the USDA, the survey question did not specify water temperature or how frequently the water was changed (every 30 min is recommended) (45), which could have impacted the results. Among WIC clients in Florida, defrosting food on the counter or in the sink with water (61.8%) was the most commonly reported method, as opposed to defrosting in the refrigerator, the microwave, or the sink under running water (40). However, according to the FSN survey, only 5 and 4% of the general U.S. population reports always defrosting frozen raw meat or chicken on the counter or in a container of water, respectively (48).

Parents >35 years old (69.4%), males (71.4%), non-Hispanic respondents (75.0%), those whose primary household language was Spanish (68.5%), and those with previous food handling employment experience (70.8%) more frequently reported inappropriate raw animal protein defrosting methods (Table 4). These results differ from a study conducted among Puerto Rican women that found those whose primary household language was Spanish (36%) and those ≥ 41 years old (38%) more frequently reported thawing in the refrigerator than individuals whose primary household language was English only or bilingual (21%) or who were <40 years old (23%) (9). Although two other studies have found that Hispanic consumers more frequently report inappropriate thawing methods than European American individuals (14, 19), defrosting in a sink of water was the most common defrosting method reported among Hispanic WIC clients (26.7%) (19), a preference that was also observed among the present study population. Parents who had high school education or higher were more likely to report inappropriate defrosting methods (82.6%) than those with less than high school level education (52.2%; P value = 0.0035). Yet, the previously mentioned study conducted among Puerto Rican women did not observe a difference in refrigerator thawing frequency according to high school graduation status (30% each, respectively) (9). Differences in study population size and composition may contribute to the observed variations in reported behaviors.

Cutting board handling. Inappropriate cutting board handling included rinsing or wiping a contaminated cutting board used for raw animal protein before use with other food to be eaten raw for the same meal. The prevalence of inappropriate cutting board handling among parents was low (11.0%). Most parents indicated they would wash a cutting board with soap (89.0%), which was considered the appropriate response. A high prevalence of washing cutting boards with soap or bleach or using a different cutting board has also been observed among WIC clients in Florida (87.4%) (40). A high frequency of appropriate cutting board

handling has further been observed among the general U.S. population, as determined by the FSN survey, where only 11% of respondents reported that they would rinse or wipe a cutting board after use to cut raw meat or chicken (48).

A low prevalence of self-reported inappropriate cutting board handling was observed among those ≤ 35 years old (14.0%), males (14.3%), Hispanic, Latino, or Mexican American respondents (11.5%), employed respondents (12.5%), and those without previous food handling employment experience (12.3%) (Table 4). A meta-analysis of food safety studies similarly found that individuals < 30 years old less frequently reported behaviors to prevent cross-contamination, including washing cutting boards before reuse (64.6%) (28). Parents whose primary household language was Spanish were more likely to report inappropriate cutting board handling (17.0%) than those whose primary language was English or bilingual (2.6%; P value = 0.0411). The prevalence of inappropriate cutting board handling was similar among parents regardless of education level; however, the previously mentioned meta-analysis found that individuals with less than high school education (79.6%) engaged in behaviors intended to reduce cross-contamination more frequently than high school graduates (76.4%) and those with higher education (72.3%) (28).

Kitchen counter cleaning tools. A preference for reusable kitchen cleaning tools was observed among low-income parents. Dishcloths (36.6%) and dish sponges (34.4%) were more commonly used to clean the kitchen counter after food preparation than paper towels (19.4%) and disposable wipes (9.7%). These results differ from the FSS that found that paper towels are the preferred tool among the general U.S. population (35%) to clean the kitchen counter after preparing raw meat or chicken, followed by sanitizer wipes (32.0%), dishcloths (29.0%), and sponges (15.0%) (46). Because both dish sponges and cloths are known to harbor fecal coliforms and foodborne pathogens (4), their use was categorized as inappropriate for this analysis. Ultimately, 71% of parents reported using an inappropriate tool to clean the kitchen counter after food preparation. The use of dish sponges to clean other surfaces, such as countertops, has also been observed previously (27); however, these practices lead to potential cross-contamination of food because microorganisms present within sponges can attach to other surfaces during cleaning (38).

Among parents, females (71.3%), non-Hispanic respondents (75.0%), employed respondents (74.2%), and those whose primary household language was Spanish (76.4%) most frequently reported using inappropriate cleaning tools (Table 4). Individuals > 35 years old less frequently reported using inappropriate cleaning tools (64.6%) than those ≤ 35 years old (77.8%). An audit of home kitchens in Pennsylvania found that individuals with high school education or below were more likely to lack paper towels or hand towels in the kitchen (17%) than individuals with higher education (2%); however, counter cleaning tool use was not observed to vary with education in the present study. The home audit study also found that low-

income households ($< \$15,000/\text{year}$) more frequently lacked paper towels or hand towels (20%) in the kitchen compared with higher-income households ($\geq \$15,000/\text{year}$; 6%) (3). The overall preference for reusable cleaning tools among the present study population may be contributed to by a lack of financial resources to obtain the materials necessary to reduce the risk of cross-contamination while cleaning kitchen surfaces.

Washing raw animal proteins. The USDA recommends against washing raw poultry and meat because bacteria can be splashed onto surfaces and lead to cross-contamination (42). Yet among parents that reported preparing animal proteins from a raw state, most indicated that they always washed raw poultry (86.3%), seafood (84.9%), and meat (74.7%) before food preparation. This prevalence of raw poultry washing is higher than that observed among the general U.S. population by the FSN survey, which found that only 45 and 49% of consumers washed chicken pieces or whole poultry, respectively, before cooking (42). In the present study, parents with less than high school education or those with Spanish as their primary household language more frequently reported washing raw poultry (87.0 and 88.9%, respectively) and raw meat (76.1 and 75.5%, respectively), whereas those with high school education or higher and those with predominantly English or bilingual households more frequently reported washing raw seafood (86.7 and 89.5%, respectively) (Table 5).

Parents > 35 years old more frequently reported washing raw seafood (87.8%) than those ≤ 35 years old (81.8%), but the prevalence of raw poultry and meat washing did not vary according to age (Table 5). These results differ from a 2017 national U.S. survey that found that millennial parents (21 to 40 years old) were less likely to wash raw poultry (38.8%) than were older adults (≥ 65 years; 30.8%) (18). Resistance to changing food handling practices, such as washing raw animal proteins, has been documented among WIC clients in Florida because they had learned their food handling practices from their mothers (39). Among low-income pregnant women, mothers have also been reported as the dominant source of information on healthy behaviors (20). In the present study population, because family is one of the top three reported sources of food safety information (23.1%), the generational propagation of food safety misinformation may contribute to the lack of variation in the prevalence of raw poultry washing according to age.

Among parents who reported washing at least one type of raw animal protein product, the use of plain water (53.7%) was slightly more common than cleaning solutions made with bleach, citrus juice, salt, or vinegar. Similarly, nearly all respondents to the FSS who washed raw poultry before cooking reported that they used plain water to wash raw chicken pieces (94%) or whole poultry (90%), as opposed to a cleaning solution (46). No significant variation in washing methods was observed according to the demographic characteristics evaluated (Table S1). A documented reason consumers wash raw poultry is the

TABLE 5. Frequency of washing raw animal proteins prior to preparation among predominately low-income parents of elementary-aged children according to demographic characteristics, Houston, Texas, 2020

Demographic characteristics	Washing frequency, <i>n</i> (%) ^a		
	Raw poultry	Raw meat	Raw seafood
Age (yr)			
≤35	39 (86.7)	34 (75.6)	36 (81.8)
>35	43 (86.0)	37 (74.0)	43 (87.8)
Sex			
Male	7 (100.0)	3 (42.9)	4 (57.1)
Female	75 (85.2)	68 (77.3)	75 (87.2)
Race/ethnicity			
Hispanic	75 (85.2)	64 (72.7)	72 (83.7)
Non-Hispanic	4 (100.0)	4 (100.0)	4 (100.0)
Education			
Less than high school	40 (87.0)	35 (76.1)	37 (82.2)
High school or more	39 (84.8)	33 (71.7)	39 (86.7)
Employment status			
Employed (full-/part-time)	29 (90.6)	23 (71.9)	27 (84.4)
Homemaker/unemployed	49 (83.1)	44 (74.6)	48 (84.2)
Primary household language			
English or bilingual	31 (81.6)	28 (71.8)	34 (89.5)
Most or only Spanish	48 (88.9)	40 (75.5)	42 (80.8)
Previous food handling employment			
Yes	23 (95.8)	21 (91.3)	21 (91.3)
No	54 (81.8)	46 (68.7)	54 (83.1)

^a The sample size for each cross-tabulation varies due to missing data. Row percentages. Among those that “Always” or “Sometimes” prepare raw animal proteins from raw.

desire to remove materials such as blood, slime, bacteria, and fecal matter from the surface of the chicken (49). Further, some consumers feel that using either saline or acidic cleaning solutions to wash raw poultry is sufficient to eliminate bacteria. However, laboratory-based evaluations of raw poultry washing methods, including plain water (23) and acidic solutions (10% lemon juice and white vinegar solutions) (12), indicate that none of these methods are effective at reducing microbial loads.

Washing fresh produce. The FDA recommends cleaning produce by rubbing it gently under plain running water (47). Use of commercially available produce cleaners, detergents, or soap to clean produce is not recommended because the FDA has not approved these products for use on food. When asked about their fresh fruit and vegetable washing habits, most parents indicated that they always washed fresh fruits (98.0%) or vegetables (97.9%) before they prepared, cooked, or ate them. Similarly, a high prevalence of always rinsing fresh fruits (76.5%) and vegetables (75.3%) has been found among WIC clients in Florida (40). Although nearly all parents indicated that they washed fresh fruits and vegetables, a high level of agreement has been documented between reported and observed lettuce washing behaviors among Hispanic women (92.0% accuracy) (9).

Parents were asked how they wash both melons and leafy greens. The most common washing method for melons was rubbing under running water (71.1%), followed by holding under running water (13.4%), using a produce cleaner (10.3%), or soaking in water (5.2%). Properly washing melons before cutting or peeling is critical because bacteria on the outer rind can cross-contaminate the cut melon fruit (41). Among the general U.S. population, rubbing melons under running water with a brush, cloth, or hands (91%) is the most common method reported (46), which is higher than the prevalence of this behavior in the present study population. Similarly, the most common washing method for leafy greens consisted of rubbing under running water (63.5%); however, more parents reported soaking in water (17.7%) than holding under running water (14.6%) or using a produce cleaner (4.2%). Parents with high school education or higher more frequently reported rubbing both melons and leafy greens under running water (78.3 and 68.1%, respectively) (Table S2); however, a national U.S. mail survey in 2000 conversely observed that individuals with more formal education were less likely to wash melons (22). Melons and leafy greens are frequently identified as food vehicles in multistate fresh produce outbreaks in the United States (6). Therefore, consumer use of proper washing methods for fresh produce is necessary to prevent cross-contamination and foodborne illness, especially among susceptible populations such as children.

Kitchen cleaning. The majority of parents indicated that they clean the kitchen counter after food preparation (96.9%) and the kitchen sink after washing the dishes (94.9%). The most common cleaning method for both the kitchen counter and the sink included the use of disinfectant (62.9 and 56.7%, respectively) as opposed to soap and water (29.9 and 39.2%, respectively), or water alone (7.2 and 4.1%, respectively). These findings are similar to a national U.S. survey that found that most consumers clean the kitchen sink with a cleaning solution (69%), dishwashing liquid (48%), or bleach (27%) and that the use of water alone (11%) is not common (22). For cleaning, the USDA recommends washing kitchen surfaces with warm water and soap, followed by a commercial disinfectant or sanitizer product approved for use on food contact surfaces (42). Due to the wording of the survey question, this study cannot differentiate between parents who clean first with soap and water followed by disinfectant rather than disinfectant alone, although the use of disinfectants on unwashed surfaces can reduce their effectiveness (38). The frequency of cleaning both the kitchen counter and sink with disinfectant was higher among parents >35 years old (66.0 and 60.8%, respectively) than those ≤35 years old (59.6 and 52.2%, respectively) (Table S3). A home food safety audit conducted in Pennsylvania found a lack of sanitizing or disinfectant cleaners within the households of individuals 18 to 24 years old (3); however, this study did not evaluate disinfectant ownership.

Disposable dish sponges. Parents commonly reported using dish sponges to wash dishes (79.6%); however, dish sponges present ideal conditions for the survival and growth of bacteria (38) and can contribute to cross-contamination within home kitchens. Most parents reported replacing their dish sponge every 2 weeks (42.9%), as opposed to once a week (32.5%), and 24.7% of parents reported not replacing their dish sponge for a month or more. A survey among a sample of Swiss consumers similarly found that dish sponge replacement was most common every 2 weeks or more (52%); 31% changed their dish sponge approximately once every 4 to 5 days to once a week and 17% daily or every 2 to 3 days (1). Another study among European consumers found that most respondents used time to gauge when their dish sponge should be replaced (65%) instead of visual cues or after the completion of tough cleaning jobs (27). Most of these consumers also reported replacing their dish sponges after 3 days or more (71%). Notably, parents whose primary household language was English or bilingual (50.0%) and who had previous food handling employment experience (50.0%) more frequently reported replacing their dish sponge once a week compared with those whose primary household language was Spanish (21.7%) or who did not have previous food handling employment experience (27.6%) (Table S4). Almost all parents also reported squeezing the excess water out of the dish sponge after washing the dishes (96.1%). Although evidence indicates that dry storage of dish sponges may reduce long-term bacterial survival and most consumers store their sponge

next to the sink (62%) (27), questions pertaining to dish sponge storage were not asked in the present study.

The present study surveyed low-income parents of elementary-aged children ($n = 106$) to identify the prevalence of food safety behaviors and demographic characteristics associated with food handling practices. Survey respondents were predominantly female and Hispanic, Latino, or Mexican American, and approximately half of parents were homemakers and had less than a high school level education. The prevalence of consumer practices was evaluated based on survey responses to four main food safety categories: food safety attitudes, hand washing, kitchen cleaning, and food handling behaviors. Parents primarily used the Internet to obtain food safety information, but a lack of serious concern for food contamination with germs was prevalent. Hand washing was common among parents before food preparation yet was notably less frequent during food preparation. Appropriate food safety behaviors frequently reported by parents included washing fresh fruit and vegetables and washing contaminated cutting boards with soap and water before reuse. Self-reported gaps in food safety behaviors identified included lack of food thermometer ownership, inappropriate defrosting methods for raw animal proteins, and washing of raw animal proteins. Although parents more frequently reported cleaning the kitchen counter after food preparation and the sink after washing the dishes, disinfectant use to clean these surfaces was less common. Most parents indicated that they used reusable rather than disposable cleaning products, and disposable dish sponges were replaced infrequently. The frequencies of certain food safety behaviors were also found to vary according to parent demographic characteristics. Multiple approaches may be necessary to combat disparities in foodborne disease incidence among low-income families. First, food safety education programs could target messages to specific demographic groups. The impact of educational materials that are available in consumers' preferred languages, that emphasize the consequences of unsafe food handling practices, and that highlight children's susceptibility to foodborne illnesses could also be explored in future studies. Second, the development of financial assistance programs or distribution of appropriate food safety tools, such as food thermometers, disinfectant cleaners, and paper towels, by nutritional programs or food pantries may reduce the risk of cross-contamination and foodborne illness.

Limitations of this study include self-reported data collection methods, which are susceptible to self-report bias. Also, due to the small sample size, this study was unable to evaluate multivariate relationships between demographic characteristics and food safety behavioral outcomes. The small sample size may additionally limit the generalizability of study results. However, parents were recruited from two schools in a diverse school district that is the largest in Texas and the seventh-largest in the United States. Because the study population was predominantly female and Hispanic, Latino, or Mexican American, limited conclusions can be made regarding food safety-related behavioral variability by sex or race and ethnicity.

Additionally, the survey was in multiple-choice format and did not consider all possible parent responses, which may impact the results of the study. Survey administration occurred from May to June 2020; however, the potential impact of the COVID-19 pandemic on the results of this study is unknown. Future research could reevaluate the food safety behaviors of the same target population to assess possible temporal trends. Future research should also consist of larger studies on the associations between demographic characteristics and food safety behavioral outcomes, with the power to control for confounding factors. In addition, culturally sensitive food safety educational programs should be developed and evaluated for effectiveness to improve food safety knowledge and practices among low-income parents.

ACKNOWLEDGMENTS

The authors thank the staff and volunteers of Brighter Bites for their generous support and assistance with recruitment and data collection. The authors also extend gratitude to Ru-Jye Chuang for assistance with data collection. The findings and conclusions in this study are those of the authors and do not necessarily represent the views of the FDA.

SUPPLEMENTAL MATERIAL

Supplemental material associated with this article can be found online at: <https://doi.org/10.4315/JFP-22-179.s1>

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