



What's in Your Freezer? Frozen Food Consumption Frequency, Food Safety Risk Perceptions, and Appliance Use – Minnesota, 2023

ABSTRACT

Frozen food products have been implicated in outbreaks of foodborne disease, causing illness and affecting high-risk populations. Although national surveys collect data on preparation and consumption of frozen food products, data gaps exist regarding the specificity of frozen food products. The objective of this study was to characterize the frequency of consumption of frozen food products, appliance ownership and use, and perceptions of food safety among Minnesota adults. We conducted a survey at the 2023 Minnesota State Fair, receiving 1,719 complete surveys from Minnesota residents at least 18 years of age. Overall, 38.9% of respondents perceived frozen foods were safer than canned, fresh, or restaurant foods and 45.3% of respondents regarded food safety as the most important reason to follow packaging cooking instructions, with no significant differences by frozen food consumption frequency. Differences in frozen food consumption were seen by age: frozen convenience foods like frozen snacks and meals were more often consumed by younger respondents, whereas older adults consumed more meal

components like frozen pre-cooked shrimp and vegetables. This study delivers a more comprehensive look at the consumption of specific types of frozen food and provides context that can be useful in foodborne disease outbreak investigations and risk assessments.

INTRODUCTION

Outbreaks of foodborne illness are a significant public health concern in the United States. While many outbreaks are associated with contaminated raw ingredients and mishandling at the point of service, foodborne illness outbreaks attributed to a range of frozen food products also occur: frozen, breaded, stuffed chicken products have been implicated in *Salmonella* outbreaks over the last two decades (9); frozen fruits, vegetables and ice cream have been implicated in *Listeria monocytogenes* outbreaks and are a growing concern (7); and, frozen products including pizza and falafel have been implicated in Shiga toxin-producing *Escherichia coli* (STEC) outbreaks (3).

Frozen foods present a unique challenge in the context of consumer food safety. Although foodborne pathogens cannot

*Author for correspondence: Email: edmun058@umn.edu

grow at freezer temperatures, they may persist in frozen foods at levels capable of causing disease and can grow if frozen foods are thawed before consumption (1). Many consumers do not perceive that frozen foods may pose a food safety risk: 40% and 49% of consumers reported uncooked frozen packaged vegetables and frozen packaged fruit, respectively, are not at all likely to contain bacteria or other pathogens that could make people sick (8). When asked about agreement with the statement that “prepackaged frozen vegetables can contain germs that can make people sick”, fewer respondents aged ≥ 65 years as well as respondents with cancer agreed when compared to the average respondent (2). Furthermore, the marketplace contains both ready-to-eat (RTE) products that may be consumed without further preparation, such as frozen fruits, as well as not-ready-to-eat (NRTE) products that must be cooked to ensure food safety, such as many frozen vegetables. However, the distinction between RTE and NRTE products may not always be apparent to consumers despite the inclusion of cooking instructions on packages of NRTE products.

National surveys have gathered data on some frozen food consumption, through the National Health and Nutrition Examination Survey and the FoodNet Population Survey, as well as on consumer behaviors related to food safety, through the Food and Drug Administration’s (FDA) Food Safety and Nutrition Survey (4, 5, 8). However, frozen foods and their preparation and handling and perceptions of risk are not the sole focus of either of these surveys. Therefore, data gaps exist in our understanding of preparation and consumption of specific frozen foods, including ones that have been implicated in foodborne illness outbreaks. To address these gaps, we aimed to characterize the frequency of consumption for a variety of frozen food products, appliance ownership and use, and perceptions of food safety.

MATERIALS AND METHODS

Target population and sampling strategy

We conducted a survey at the 2023 Minnesota State Fair during August 24 – August 31, 2023. The University of Minnesota operates the Driven 2 Discover (D2D) Research Facility within the state fairgrounds for researchers to conduct studies, allowing up to 10 studies to be conducted concurrently. In 2023, over 1.8 million people attended the Minnesota State Fair, which ran from August 24 – September 4, 2023. More than 55,000 fairgoers visited the D2D Research Facility, 17,260 of whom were enrolled in the 47 studies conducted during the 2023 Fair (6). Volunteers recruited fairgoers in front of and inside the D2D Research Facility to participate in our survey. A sign directly in front of the research bay included the name of the research study (“What’s in Your Freezer?”) and the eligibility criteria (Minnesota resident, aged ≥ 18 years). Participants completed the survey in English individually on tablets.

Informed consent

Participants were verbally given an overview of the informed consent and were also presented with written informed consent on a tablet. Before accessing the survey questions, participants had to select that they agreed to participate in the study. Participants were provided with a drawstring backpack or a clear tote bag after taking the survey. The study was reviewed and approved by the University of Minnesota Institutional Review Board (IRB ID: STUDY00019164).

Data collection instrument

We used REDCap (Research Electronic Data Capture) hosted at University of Minnesota to develop and deliver a 10- to 15-minute survey to identify frozen food preparation practices and consumption frequency (10). The survey included questions about demographics, ownership and use of kitchen appliances (“I have this appliance and use it”, “I have this appliance but do not use it”, and “I do not have this appliance”); consumption of frozen foods by category within the last year (“Never”, “Every few months”, “Monthly”, “Weekly”, and “Daily”); reasons for purchasing frozen foods; use of frozen food delivery services (“Yes”, “I have in the past, but don’t currently”, and “I have never used this service”); ranking of reasons for following cooking instructions on frozen food packages (ranked among improved food taste/texture, improved food safety, for use in recipes presented on packaging, and convenience); and, their ranking of foods likely to be contaminated with germs (ranked among canned foods, foods from restaurants, fresh foods, and frozen foods).

If participants indicated ever consuming smoothies, frozen vegetables, frozen potato products, or frozen breaded chicken products, they were directed to additional modules corresponding to each of these product categories. These modules consisted of questions about consumption of specific foods within these categories; how often participants follow cooking instructions on packaging (“Always”, “Sometimes”, and “Never”); how they were purchased (“Purchased frozen & uncooked/raw”, “Purchased frozen & fully cooked”, “Purchased frozen & unsure if raw”); and, how they were prepared (i.e. what appliance the participant used most often to prepare the food).

Data analyses

Descriptive statistics were calculated, including proportions for categorical variables. Zip codes were used to identify participants’ residency within the Twin Cities 7-county metropolitan area. Two indices of frozen food consumption frequency were created: one based upon all frozen foods respondents were asked about, and another based upon just the frozen foods that typically have cooking instructions on the package (potato products, vegetables, pizzas, meals, snacks/appetizers, dumplings, breaded chicken products, and desserts). For each of these indices,

respondents were categorized into three categories: at least one frozen food consumed daily, at least one frozen food consumed at least weekly but less than daily, and no frozen foods consumed more frequently than monthly. Responses for the most important reason for following cooking instructions on packaging, food types most contaminated with germs, and reasons for purchasing frozen foods were compared by age group and frozen food consumption levels via Pearson's chi-squared tests. Statistical significance for Pearson's chi-squared tests was set at $p < 0.05$. Analyses were conducted using R version 4.2.1 (<https://www.r-project.org/>) and figures were produced using the packages ggplot2 and corplot.

RESULTS

Participants

The survey was administered to 1,745 individuals, of whom 1,732 (99.3%) completed the survey. Thirteen respondents were excluded because they did not meet the eligibility criteria of Minnesota residency (out of state zip codes were provided in the survey). The analytic sample included 1,719 respondents.

Demographics

Most respondents identified as women (68.8%) and 84.7% of respondents were non-Hispanic white (Table 1). The median age of respondents was 53 years (interquartile range, 33 years). Most respondents attained at least a 4-year college degree (70.0%) and respondents overwhelmingly resided in the Twin Cities 7-county metropolitan area (85.1%).

Appliance ownership and use

Nearly all respondents reported having a stove (98.8%), oven (98.6%), and microwave oven (98.1%) in their home (Table 2). Most participants also reported having slow cookers (85.7%), toasters (84.0%), traditional blenders (78.5%), grills (74.1%), food processors (57.8%), and air fryers (55.0%). Fewer than half of respondents indicated owning a combined pressure cooker/slow cooker (e.g., Instant Pot®) (48.9%), smoothie blender (48.6%), toaster oven (36.8%), rice cooker (36.3%), or pressure cooker (20.3%).

Pressure cookers were the least used appliance; 43.3% of owners reported not using them. Over a quarter of those who own combined pressure cooker/slow cookers, food processors, and traditional blenders reported not using them. Toasters were commonly used by those who had them (93.8%). The remaining appliances had usage rates between 78.3% and 88.1%.

Rice cooker and smoothie blender ownership was more common among younger respondents while pressure cooker, toaster, and food processor ownership was more common among older respondents (Supplemental Figures 1 & 2). Slow cooker, grill, traditional blender, combined pressure cooker/

slow cooker ownership and use peaked among those aged 45–64 years.

Frozen food consumption frequency

Almost all (98.2%) respondents completed one or more modules on consumption of smoothies, frozen vegetable, frozen potato, or frozen breaded chicken products within the past year. More than 70% of respondents were given at least three additional survey modules to complete, indicating consumption of three or four of the food product categories.

Among respondents who ever consumed frozen foods, the most consumed items included frozen vegetables (92.3%), ice cream and frozen novelties (91.1%), frozen pizzas (86.3%), frozen berries (81.2%), and frozen potato products (81.1%) (Table 3). The frozen foods most consumed weekly or daily included frozen vegetables (39.7%), ice cream and frozen novelties (38.8%), and frozen berries (29.8%).

The frozen food products most commonly reported as never consumed in the last year included frozen fruit juice concentrate (68.3%), frozen desserts, other than ice cream and frozen novelties (52.6%), frozen dumplings (52.0%).

Frozen dumplings, snacks/appetizers, breaded chicken products, and meals were more frequently consumed by younger respondents; the most pronounced relationship was seen for frozen snacks/appetizers which 87.5% of respondents in the 18–24 age group consumed in the last year, compared with 44.2% of those in the ≥65 age group (Fig. 1). The opposite trend was seen for frozen pre-cooked shrimp which was increasingly consumed by older respondents; 59.7% of respondents in the ≥65 age group consumed frozen pre-cooked shrimp in the last year compared to 43.1% of respondents in the 18–24 age group.

Perceptions of risk and reasons for purchasing frozen food

Participants ranked canned foods (3.3) and frozen foods (3.2) high on a scale (1=riskiest–4=safest) of safety from contamination from germs, compared to fresh foods (1.9) or foods from restaurants (1.6) (Supplemental Table 2). The proportion of participants who identified frozen foods as the safest option varied significantly by age group, with 46.1% of respondents aged 55–64 years compared to only 30.7% of respondents aged 18–24 years identifying frozen foods as the safest option (Supplemental Table 3). Although not statistically significant, there was an increasing trend towards perceiving frozen foods as the safest option with increasing frequency of frozen food consumption of all frozen foods as well as frozen foods typically including cooking instructions.

Food safety was chosen as the most important reason for following cooking instructions on food packages by 45.3% of participants (Supplemental Table 6). Food safety was ranked most important by half of all respondents aged 18–24 years, decreasing to 41.8% of respondents aged ≥65 years, but the difference between age groups was not statistically

TABLE 1. Demographics of survey respondents overall and per additional survey module received

	Overall (n=1719), N (%)*	Smoothies (n=1091), N (%)*	Vegetables (n=1569), N (%)*	Potatoes (n=1377), N (%)*	Breaded chicken (n=1015), N (%)*
Race/ethnicity					
Hispanic	58 (3.5)	50 (4.8)	53 (3.5)	44 (3.3)	33 (3.4)
NH American Indian or Alaskan Native	21 (1.3)	18 (1.7)	18 (1.2)	16 (1.2)	14 (1.4)
NH Asian, Hawaiian, or Pacific Islander	120 (7.3)	89 (8.5)	104 (6.9)	83 (6.2)	83 (8.4)
NH Black or African American	38 (2.5)	31 (3.0)	34 (2.2)	30 (2.2)	22 (2.2)
NH White or Caucasian	1401 (84.7)	852 (81.1)	1292 (85.3)	1148 (86.1)	818 (83.2)
NH Other, including multiracial	16 (1.0)	10 (1.0)	13 (0.9)	13 (1.0)	13 (1.3)
No response	65	41	55	43	32
Age					
18-24	139 (9.6)	105 (11.5)	119 (9.0)	113 (9.8)	97 (11.5)
25-34	243 (16.8)	186 (20.3)	217 (16.4)	181 (15.7)	159 (18.9)
35-44	166 (11.5)	118 (12.9)	156 (11.8)	147 (12.7)	118 (14.0)
45-54	196 (13.5)	139 (15.2)	184 (13.9)	168 (14.6)	138 (16.4)
55-64	285 (19.7)	174 (19.0)	261 (19.8)	232 (20.1)	148 (17.6)
≥65	418 (28.9)	193 (21.1)	384 (29.1)	313 (27.1)	181 (21.5)
No response	272	176	248	223	174
Gender					
Man	511 (30.2)	309 (28.8)	439 (28.4)	395 (29.1)	311 (31.0)
Woman	1164 (68.8)	750 (69.9)	1090 (70.5)	952 (70.1)	684 (68.3)
Non-binary or other	17 (1.0)	14 (1.3)	17 (1.1)	11 (0.8)	7 (0.7)
No response	27	18	23	19	13
Education					
High school diploma/GED or less	149 (8.9)	96 (9.0)	127 (8.3)	119 (8.8)	109 (10.9)
Some college/associate's degree	355 (21.1)	212 (19.8)	328 (21.3)	314 (23.3)	226 (22.6)
Bachelor's/4-year degree	592 (35.2)	387 (36.1)	538 (35.0)	471 (35.0)	339 (33.9)
Graduate or professional degree	584 (34.8)	376 (35.1)	545 (35.4)	443 (32.9)	325 (32.5)
No response	39	20	31	30	16
7-County metropolitan area					
Metro	1290 (85.1)	819 (85.8)	1184 (84.9)	1030 (84.1)	758 (83.8)
Non-metro	225 (14.9)	135 (14.2)	211 (15.1)	195 (15.9)	147 (16.2)
No response	204	137	174	152	110

*Column percentages, not including missing values.

TABLE 2. Survey respondents' appliance ownership and use

Appliance	Have and use, N (%)*	Have and do not use, N (%)*	Do not have, N (%)*	Have, N (%)*	Do not use, N (%)*	Percentage have that do not use
Air fryer	760 (46.9)	131 (8.1)	730 (45.0)	891 (55.0)	861 (53.1)	14.7
Food processor	692 (42.0)	260 (15.8)	696 (42.2)	952 (57.8)	956 (58.0)	27.3
Grill	1082 (65.3)	146 (8.8)	430 (25.9)	1228 (74.1)	576 (34.7)	11.9
Instant pot	569 (35.0)	227 (13.9)	832 (51.1)	796 (48.9)	1059 (65.0)	28.5
Microwave oven	1654 (96.9)	20 (1.2)	33 (1.9)	1674 (98.1)	53 (3.1)	1.2
Oven	1597 (95.3)	56 (3.3)	23 (1.4)	1653 (98.6)	79 (4.7)	3.4
Pressure cooker	185 (11.5)	141 (8.8)	1278 (79.7)	326 (20.3)	1419 (88.5)	43.3
Rice cooker	481 (29.3)	115 (7.0)	1047 (63.7)	596 (36.3)	1162 (70.7)	19.3
Slow cooker	1157 (70.3)	254 (15.4)	235 (14.3)	1411 (85.7)	489 (29.7)	18.0
Smoothie blender	616 (38.0)	171 (10.6)	832 (51.4)	787 (48.6)	1003 (62.0)	21.7
Stove	1612 (97.6)	19 (1.2)	20 (1.2)	1631 (98.8)	39 (2.4)	1.2
Toaster	1285 (78.8)	85 (5.2)	261 (16.0)	1370 (84.0)	346 (21.2)	6.2
Toaster oven	486 (30.5)	100 (6.3)	1006 (63.2)	586 (36.8)	1106 (69.5)	17.1
Traditional blender	950 (57.8)	340 (20.7)	353 (21.5)	1290 (78.5)	693 (42.2)	26.4

*Row percentages not including missing values.

TABLE 3. Survey respondents' frozen food consumption frequency

In the last year, approximately how often did you prepare and eat prepackaged frozen foods at home?

	Never, N (%)*	Ever, N (%)*	Every few months, N (%)*	Monthly, N (%)*	Weekly or daily, N (%)*
Frozen potato products	320 (18.9)	1377 (81.1)	624 (36.8)	471 (27.8)	282 (16.6)
Frozen vegetables	130 (7.7)	1569 (92.3)	388 (22.8)	507 (29.8)	674 (39.7)
Frozen pizzas	232 (13.7)	1464 (86.3)	463 (27.3)	620 (36.6)	381 (22.5)
Frozen meals	516 (30.8)	1157 (69.2)	505 (30.2)	354 (21.2)	298 (17.8)
Frozen snacks/appetizers	606 (36.2)	1066 (63.8)	537 (30.1)	317 (19.0)	212 (12.7)
Frozen dumplings	881 (52.0)	812 (48.0)	485 (28.6)	218 (12.9)	109 (6.4)
Frozen breaded chicken products	672 (39.8)	1015 (60.2)	444 (26.3)	310 (18.4)	261 (15.5)
Frozen pre-cooked shrimp	815 (48.3)	872 (51.7)	465 (27.6)	306 (18.1)	101 (6.0)
Frozen desserts	882 (52.6)	796 (47.4)	533 (31.8)	178 (10.6)	85 (5.1)
Frozen novelties	151 (8.9)	1542 (91.1)	392 (23.2)	493 (29.1)	657 (38.8)
Frozen berries	319 (18.8)	1380 (81.2)	457 (26.9)	416 (24.5)	507 (29.8)
Other frozen fruit	534 (31.9)	1142 (68.1)	450 (26.8)	347 (20.7)	345 (20.6)
Frozen fruit juice concentrate	1144 (68.3)	530 (31.7)	308 (18.4)	118 (7.0)	104 (6.2)

*Row percentages not including missing values.

TABLE 4. Survey respondents' reasons for purchasing frozen food products

	Convenience, N (%)*	Prevent food waste, N (%)*	Availability, N (%)*	Lower price, N (%)*	Flavor, N (%)*	Other, N (%)*	Number of reasons, Mean (SD)
Overall	1407 (81.8)	799 (46.5)	789 (45.9)	621 (36.1)	234 (13.6)	60 (3.5)	2.3 (1.1)
Age: chi square <i>p</i> -value	0.027	<0.001	0.126	<0.001	0.004	0.964	
18-24	127 (91.4)	53 (38.1)	80 (57.6)	79 (56.8)	23 (16.5)	3 (2.2)	2.6 (1.1)
25-34	196 (80.7)	148 (60.9)	107 (44.0)	129 (53.1)	15 (6.2)	9 (3.7)	2.5 (1.1)
35-44	141 (84.9)	93 (56.0)	76 (45.8)	68 (41.0)	25 (15.1)	7 (4.2)	2.5 (1.2)
45-54	158 (80.6)	99 (50.5)	87 (44.4)	75 (38.3)	27 (13.8)	8 (4.1)	2.3 (1.2)
55-64	236 (82.8)	117 (41.1)	130 (45.6)	75 (26.3)	39 (13.7)	10 (3.5)	2.1 (1.2)
≥65	339 (81.1)	168 (40.2)	195 (46.7)	89 (21.3)	73 (17.5)	13 (3.1)	2.1 (1.1)
Frozen food consumption: chi square <i>p</i> -value	0.003	<0.001	<0.001	<0.001	<0.001	0.075	
Monthly or less	275 (76.0)	141 (39.0)	134 (37.0)	100 (27.6)	31 (8.6)	18 (5.0)	1.9 (1.1)
Weekly (but not more)	815 (82.8)	455 (46.2)	450 (45.7)	356 (36.2)	131 (13.3)	26 (2.6)	2.3 (1.1)
Daily	317 (85.0)	203 (54.4)	205 (55.0)	165 (44.2)	72 (19.3)	16 (4.3)	2.6 (1.2)

*Respondents could check all that apply, row percentages will not add to 100%.

significant. The importance placed on food safety was similar between daily, weekly, and monthly or less frequent consumers of all frozen foods, but daily consumers of frozen foods typically including cooking instructions were least likely to cite food safety as the most important reason for following cooking instructions.

Convenience was the most frequently chosen reason for purchasing frozen foods (81.8%) (Table 4). This was significantly more common among participants aged 18-24 years (91.4%). The next most common reason, preventing food waste, was chosen by 46.5% of participants. Only 38.1% of participants aged 18-24 years identified preventing food waste as a reason to purchase frozen foods compared to 60.9% of participants aged 25-34 years. This percentage decreased significantly to 40.2% among participants aged ≥65 years ($p < 0.001$). Participants aged 18-24 years were most likely to choose lower price as a reason to purchase frozen foods (56.8%). The percentage of respondents choosing lower price as a reason to purchase frozen foods decreased significantly by age group to 21.3% in the ≥65 age group ($p < 0.001$). Across all age groups, flavor was the least commonly specified reason for purchasing frozen food products. Overall, the number of reasons cited for purchasing frozen foods decreased from 2.6 for participants aged 18-24 years to 2.1 for participants aged ≥65 years. Each of the reasons for purchasing frozen foods was significantly more likely to be chosen by frequent consumers of frozen foods.

DISCUSSION

Overall, frozen foods were perceived to be safer than fresh foods and foods from restaurants. Only canned foods were perceived to be safer than frozen foods. The assumption that frozen foods are safer from contamination with pathogens potentially poses risks for foodborne illness if cooking instructions are not viewed as important to ensure food safety or are not followed. Fewer than half of all respondents indicated that the most important reason for following cooking instructions is for food safety. Older respondents were least likely to indicate food safety as the most important reason, which is a concern due to their increased risk of severe illness if infected with *L. monocytogenes* (12). Previous research showed that among women of child-bearing age, who are also at increased risk for severe listeriosis when pregnant, only 56% indicated ever reading the cooking instructions on frozen vegetable packaging (11). If food safety is not perceived as an important issue, then reading and following cooking instructions may also be viewed as less important to consumers, who may then not follow the instructions.

Age-related differences in perceptions of safety matter in consideration of age-related differences in the handling and consumption of frozen foods. Items that might comprise a snack or meal, such as frozen appetizers, dumplings, prepackaged meals, and breaded chicken were more often consumed by younger respondents. Younger respondents

were more likely to purchase frozen foods due to convenience than older respondents. Older respondents were more likely to consume items used as a component of a meal, such as frozen pre-cooked shrimp and frozen vegetables. Similar to our findings, the FoodNet Population Survey results indicated that frozen snack consumption declined with age and frozen vegetable consumption increased with age (among those ≥ 18 years) (4). Further research is warranted to understand whether frozen foods prepared and served as one item or as ingredients in a meal are more or less likely to be properly handled compared with frozen foods consumed as a single item.

Toaster ovens and air fryers were more likely to be used by younger respondents while slow cookers and grills were more likely to be used by older respondents. Given the range in use of appliances beyond microwaves, conventional ovens, and stoves, it is important for frozen food cooking instructions to reflect the appliances used by consumers. However, we did not ask how frequently respondents used each of their appliances, so it is unclear how frequently toaster ovens and air fryers were used by those who indicated using them.

Although differences were seen by age group across frozen food consumption, appliance use, perceptions of food safety, and reasons for purchasing frozen foods, our sample skewed heavily towards older respondents. This may limit the representativeness of our results. Nearly half of our respondents were at least 55 years of age. However, this can also be viewed as an asset of our study since *L. monocytogenes* is specifically a concern amongst older individuals. Further,

the sample also skewed heavily toward individuals with higher education; 70% of the sample reported attaining a 4-year college degree or more. To the extent that education influences perceptions of food safety and importance of following cooking instructions, our results may be similarly biased.

This study provides a characterization of the frequency of frozen food consumption for a variety of frozen food types. Ultimately, these data can help support outbreak investigations by providing baseline exposure data on consumption of various frozen foods that can be compared to aggregated case exposures. Similarly, these data can be used to improve population exposure estimates in future risk assessments of frozen foods. Additionally, these data can serve to inform frozen food manufacturers about the appliances consumers have and use, helping them develop more relevant cooking instructions. Further investigation of preparation practices of frozen foods will be useful in highlighting potential risks involved with specific food items.

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SUPPLEMENTAL TABLES

SUPPLEMENTAL TABLE 1. Frozen food consumption frequency categories of survey respondents

Frozen food consumption	N
All foods	
Monthly or less	362
Weekly (but not more)	984
Daily	373
Foods with cooking instructions	
Monthly or less	633
Weekly (but not more)	923
Daily	163

SUPPLEMENTAL TABLE 2. Survey respondents' perceptions of risk among food categories: ranked riskiness/likelihood of contamination of food categories where 1=riskiest and 4=least risky

	Canned foods, Mean (SD)	Foods from restaurants, Mean (SD)	Fresh foods, Mean (SD)	Frozen foods, Mean (SD)
Overall	3.3 (0.8)	1.6 (0.8)	1.9 (0.9)	3.2 (0.8)
Age				
18-24	3.2 (0.9)	1.7 (0.9)	2.2 (1.0)	3.0 (0.9)
25-34	3.3 (0.8)	1.5 (0.7)	2.0 (0.9)	3.2 (0.8)
35-44	3.1 (0.9)	1.6 (0.9)	2.1 (1.0)	3.3 (0.8)
45-54	3.4 (0.7)	1.5 (0.7)	1.8 (0.8)	3.3 (0.7)
55-64	3.3 (0.8)	1.5 (0.7)	1.8 (0.8)	3.4 (0.6)
≥65	3.3 (0.8)	1.6 (0.8)	1.9 (0.9)	3.3 (0.7)
Frozen food consumption				
All foods				
Monthly or less	3.2 (0.9)	1.7 (0.8)	2.0 (1.0)	3.1 (0.8)
Weekly (but not more)	3.3 (0.8)	1.6 (0.8)	1.9 (0.9)	3.2 (0.8)
Daily	3.3 (0.8)	1.5 (0.8)	2.0 (0.8)	3.3 (0.7)
Foods with cooking instructions				
Monthly or less	3.3 (0.8)	1.6 (0.8)	2.0 (0.9)	3.2 (0.8)
Weekly (but not more)	3.3 (0.8)	1.6 (0.8)	1.9 (0.9)	3.2 (0.8)
Daily	3.3 (0.8)	1.5 (0.8)	2.0 (0.8)	3.3 (0.8)

SUPPLEMENTAL TABLE 3. Food categories that survey respondents indicated as the least risky/likely to be contaminated

	Canned foods, N (%)*	Foods from restaurants, N (%)*	Fresh foods, N (%)*	Frozen foods, N (%)*	Chi square p-value
Overall	728 (47.9)	56 (3.7)	144 (9.5)	592 (38.9)	
Age					<0.001
18-24	62 (45.3)	9 (6.6)	24 (17.5)	42 (30.7)	
25-34	114 (49.6)	6 (2.6)	19 (8.3)	91 (39.6)	
35-44	58 (36.7)	11 (7.0)	20 (12.7)	69 (43.7)	
45-54	97 (54.5)	6 (3.4)	8 (4.5)	67 (37.6)	
55-64	115 (47.3)	4 (1.6)	12 (4.9)	112 (46.1)	
≥65	171 (49.9)	13 (3.8)	34 (9.9)	125 (36.4)	
Frozen food consumption					
All foods					0.197
Monthly or less (and never)	152 (50.8)	12 (4.0)	36 (12.0)	99 (33.1)	
Weekly (but not more)	412 (47.1)	34 (3.9)	82 (9.4)	347 (39.7)	
Daily	164 (47.4)	10 (2.9)	26 (7.5)	146 (42.2)	
Foods with cooking instructions					0.321
Monthly or less	269 (49.4)	14 (2.6)	58 (10.6)	204 (37.4)	
Weekly (but not more)	391 (47.5)	34 (4.1)	76 (9.2)	323 (39.2)	
Daily	68 (45.0)	8 (5.3)	10 (6.6)	65 (43.0)	

*Row percentages not including missing values.

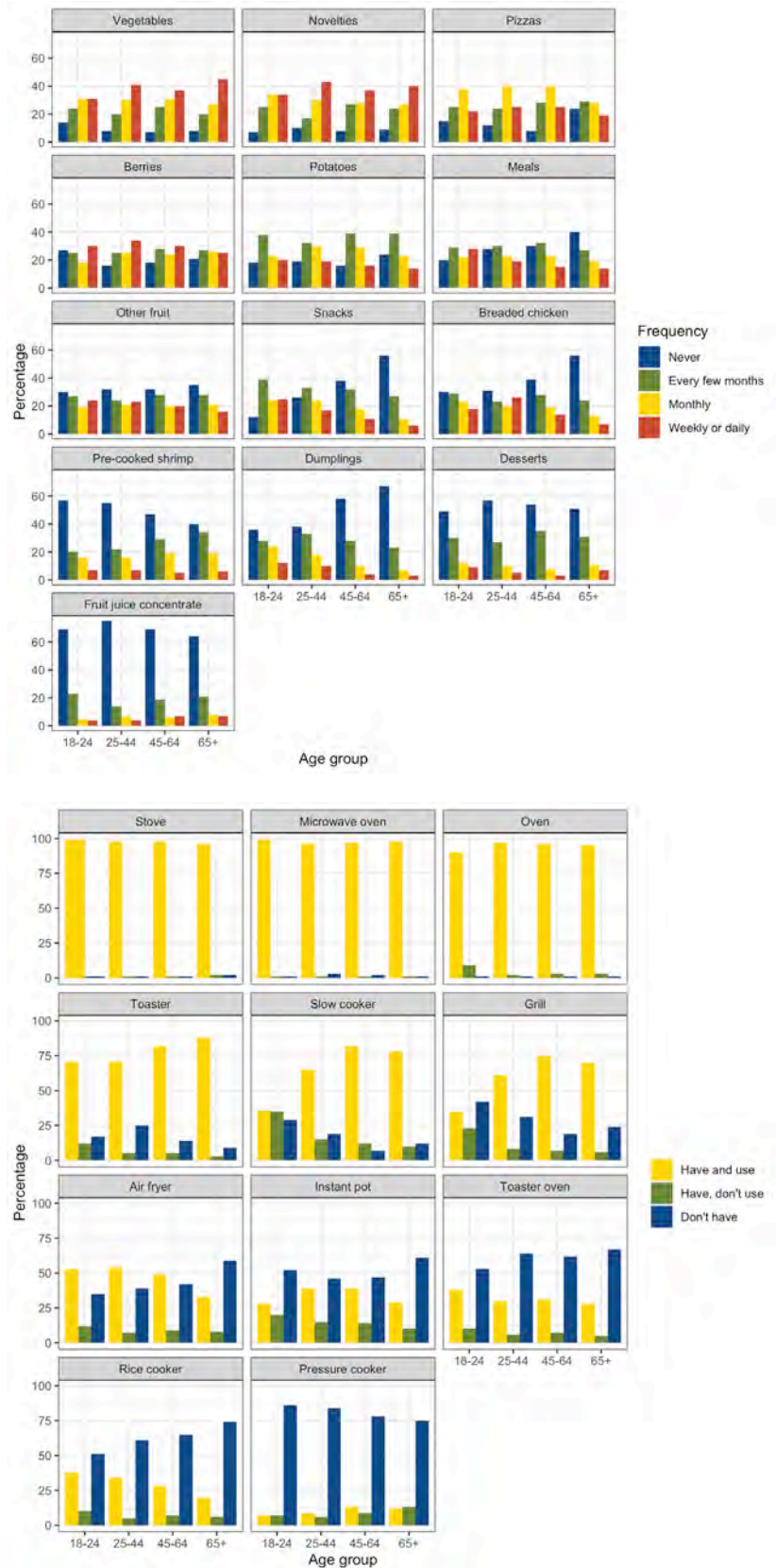
SUPPLEMENTAL TABLE 4. Survey respondents' perceptions of the importance of following packaging cooking instructions: ranked importance of reasons where 1=most important and 4=least important

	Convenience, Mean (SD)	Food safety, Mean (SD)	Food taste/texture, Mean (SD)	Recipes present, Mean (SD)
Overall	2.7 (1.1)	1.9 (1.0)	2.1 (0.9)	3.1 (0.9)
Age				
18-24	2.7 (1.1)	1.9 (1.0)	2.2 (0.9)	3.2 (0.9)
25-34	2.8 (1.1)	1.8 (1.0)	2.0 (0.9)	3.3 (0.9)
35-44	2.9 (1.1)	1.9 (1.1)	2.1 (1.0)	3.1 (0.9)
45-54	2.6 (1.1)	2.0 (1.1)	2.2 (1.0)	3.0 (0.9)
55-64	2.8 (1.2)	1.9 (1.1)	2.0 (0.9)	3.0 (0.9)
≥65	2.5 (1.1)	1.9 (1.0)	2.0 (0.9)	3.1 (1.0)
Frozen food consumption				
All foods				
Monthly or less	2.7 (1.1)	1.9 (1.0)	2.1 (0.9)	3.1 (0.9)
Weekly (but not more)	2.7 (1.1)	1.9 (1.0)	2.1 (0.9)	3.1 (0.9)
Daily	2.8 (1.1)	1.9 (1.0)	2.0 (0.9)	3.1 (0.9)
Foods with cooking instructions				
Monthly or less	2.7 (1.1)	1.9 (1.0)	2.0 (0.9)	3.1 (0.9)
Weekly (but not more)	2.7 (1.1)	1.9 (1.0)	2.1 (0.9)	3.1 (0.9)
Daily	2.7 (1.2)	1.9 (1.0)	2.1 (1.0)	3.1 (0.9)

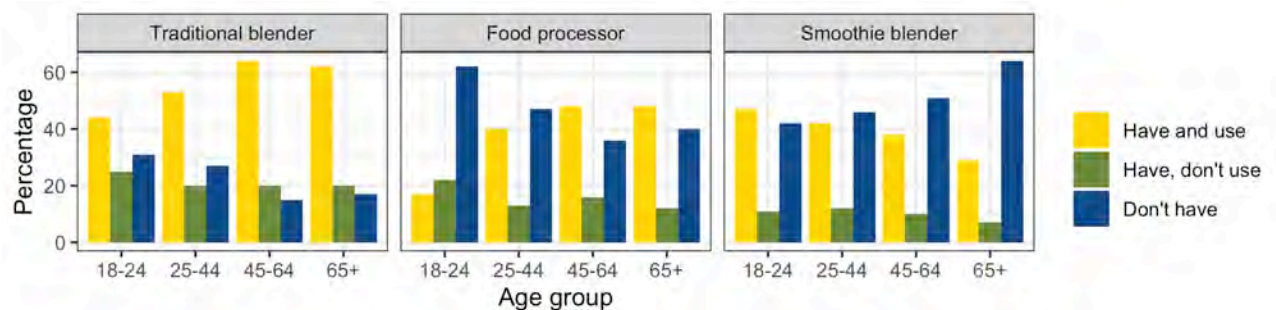
SUPPLEMENTAL TABLE 5. Reasons that survey respondents indicated as the most important regarding following packaging cooking instructions

	Convenience, N (%) [*]	Food safety, N (%) [*]	Food taste/ texture, N (%) [*]	Recipes present, N (%) [*]	Chi square <i>p</i> -value
Overall	352 (21.7)	736 (45.3)	445 (27.4)	91 (5.6)	
Age					0.212
18-24	27 (20.1)	68 (50.7)	33 (24.6)	6 (4.5)	
25-34	39 (16.3)	116 (48.5)	75 (31.4)	9 (3.8)	
35-44	28 (17.1)	80 (48.8)	48 (29.3)	8 (4.9)	
45-54	44 (23.5)	83 (44.4)	49 (26.2)	11 (5.9)	
55-64	60 (22.3)	119 (44.2)	70 (26.0)	20 (7.4)	
≥65	100 (26.0)	161 (41.8)	96 (24.9)	28 (7.3)	
Frozen food consumption					
All foods					0.660
Monthly or less	71 (21.8)	147 (45.1)	85 (26.1)	23 (7.1)	
Weekly (but not more)	207 (22.1)	428 (45.7)	250 (26.7)	52 (5.5)	
Daily	74 (20.5)	161 (44.6)	110 (30.5)	16 (4.4)	
Foods with cooking instructions					0.320
Monthly or less	127 (21.6)	252 (42.9)	175 (29.8)	33 (5.6)	
Weekly (but not more)	189 (21.5)	420 (47.8)	220 (25.0)	50 (5.7)	
Daily	36 (22.8)	64 (40.5)	50 (31.6)	8 (5.1)	

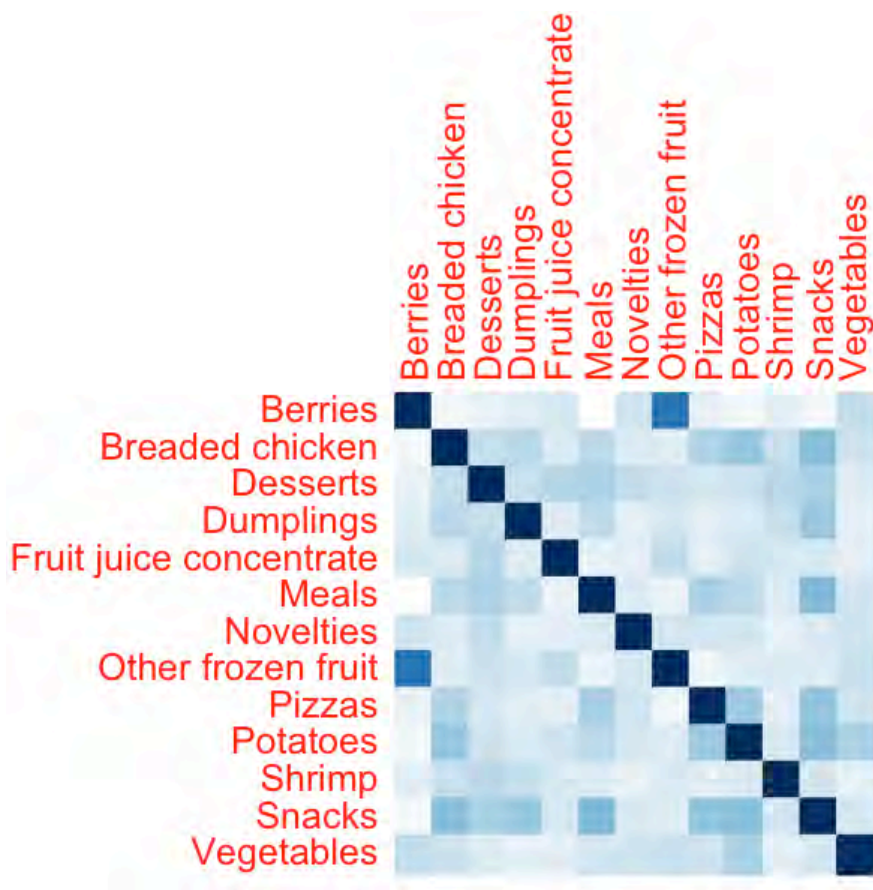
^{*}Row percentages not including missing values.



Supplemental Figure 1. Survey respondents' appliance ownership and use by age (cooking appliances).



Supplemental Figure 2. Survey respondents' appliance ownership and use by age (mixing appliances).



Supplemental Figure 3. Survey respondents' frozen foods consumed correlations.