

Research Paper**Canadian Consumer Food Safety Practices and Knowledge:
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ABSTRACT

Understanding consumers' food safety practices and knowledge supports food safety education for the prevention of foodborne illness. The objective of this study was to describe Canadian consumer food safety practices and knowledge. This study identifies demographic groups for targeted food safety education messaging and establishes a baseline measurement to assess the effectiveness of food safety interventions over time. Questions regarding consumer food safety practices and knowledge were included in a population-based telephone survey, Foodbook, conducted from November 2014 to March 2015. The results were analyzed nationally by age group and by gender. The results showed that approximately 90% of Canadians reported taking the recommended cleaning and separating precautions when handling raw meat to prevent foodborne illness. Only 29% of respondents reported using a food thermometer when cooking any meat, and even fewer (12%) reported using a food thermometer for small cuts of meat such as chicken pieces. The majority (>80%) of Canadians were aware of the foodborne illness risks related to chicken and hamburger, but fewer (<40%) were aware of the risks related to frozen chicken nuggets, alfalfa sprouts, soft unpasteurized cheese, and unpasteurized juices. Generally, men were less likely to follow cooking instructions on packaging and took fewer steps to prevent cross-contamination than women. The youngest (18 to 29 years) age group was less likely to take steps to avoid cross-contamination and was less aware of the risks associated with eating an undercooked hamburger. The oldest (60+ years) respondents were less likely to be aware of the risks associated with raw eggs, alfalfa sprouts, and unpasteurized juice than the middle (30 to 59 years) age group. As a priority, food safety education in Canada should focus on increasing people's awareness of high-risk foods, specifically foods for which the awareness of risk found in this study was low; targeting messaging to demographic groups as appropriate; and promoting the use of food thermometers when cooking meat and poultry.

Key words: Consumer practices; Foodbook; Foodborne illness; Food safety; Knowledge; Survey

Foodborne illness is an important public health issue worldwide (32). In Canada, an estimated 1 in 8 people (4 million) experience foodborne illness each year, resulting in an estimated 11,500 hospitalizations and 240 deaths annually (30, 31). The prevention of foodborne illness requires the collaboration of all members of the food continuum, from farm producers to consumers. Consumer practices at home play an important role in preventing illness and are considered the last line of defense against foodborne illness. In Canada, local, provincial-territorial, and federal public health and food safety organizations; industry commodity groups; academia; and nongovernmental organizations contribute to promoting safe food handling in the home (3, 8). However, knowledge about foodborne risks and in-home consumer practices regarding food safety in Canada is limited. Identifying the behaviors that place people at risk for contact with foodborne pathogens and gaining insight

into consumers' awareness of high-risk foods allow for targeted messaging and improved risk communications regarding foodborne illness issues.

In 2014, a review (22) of the Canadian literature on consumer food safety practices identified a need for a baseline study to evaluate current food safety knowledge and practices among Canadians. A module of questions related to consumer food safety knowledge and practices was developed and incorporated into a national population survey on food consumption: the Foodbook study (2). Foodbook was completed in 2015, and the results of the consumer food safety knowledge and practices module are presented here.

The objectives of this study were to describe Canadian consumer food safety practices and knowledge nationally by age group and by gender, and to identify knowledge gaps or poor food safety practices to better target food safety education messaging. This study also establishes a baseline for the prevalence of consumer food safety knowledge and practices to allow comparisons over time and to assess the

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effectiveness of food safety interventions through public education intended to reduce foodborne illness.

MATERIALS AND METHODS

Data collection and questionnaire development. The data were obtained from Foodbook, a population-based telephone survey conducted in all Canadian provinces and territories from April 2014 to April 2015. The study design and sampling methodology for the Foodbook study have been detailed elsewhere (2). A module of questions regarding consumer food safety practices and knowledge was included in the Foodbook study from November 2014 to April 2015. The questions from this module were asked only of survey participants 18 years or older. The Foodbook study was reviewed and approved by Health Canada and the Public Health Agency of Canada's Research Ethics Board (REB 2013-0025), as well as by the Newfoundland and Labrador Health Research Ethics Authority to meet a unique provincial legal requirement (HREB 13.238).

Questions related to consumer food safety practices and knowledge were developed in consultation with food safety stakeholders, including the Canadian Partnership for Consumer Food Safety Education, provincial-territorial and federal governments, academia, and industry. Through an initial electronic survey, stakeholders identified five priority themes: clean, separate, cook, chill, and awareness of high-risk foods (knowledge). Using these themes, a total of 23 draft questions were developed based on food safety questions from the Canadian literature (22) and presented to the stakeholders for the second phase of consultations. A final set of 12 questions was included in the Foodbook survey, with the questions representing each of the five priority themes (the questions are provided in Supplementary Appendix 1).

Statistical analysis. The data were cleaned and analyzed using Stata 13.1 for Windows (StataCorp LP, College Station, TX). The responses were combined when appropriate to develop measures of safe food handling practices, and refusals were removed from the denominators such that all measures reported reflected the population of respondents. The proportions were weighted using the survey weight available on the data file, as described in the Foodbook report (2). Adjusted Wald tests were used to assess the significant differences between the genders and among the age groups (youngest, 18 to 29 years; middle, 30 to 59 years; and oldest, 60+ years), using a *P* value cutoff of ≤ 0.05 . Bonferroni *P* value adjustments were applied for comparisons made among age groups to account for multiple testing.

RESULTS

The study population included a total of 2,474 completed interviews. The survey response rate was 23%. The demographic characteristics of the study population compared to the Canadian population can be found in Table 1.

Clean. Of the respondents who cooked meat, 93% reported washing their hands with soap and water or using hand sanitizer after handling meat (Table 2). Similarly, 93% reported cleaning the preparation surfaces after preparing raw meat or poultry with one or more suitable cleaning methods (i.e., soap and water, disinfectant, or a dishwasher). More specifically, washing food preparation surfaces with soap and water was reported by 78% of respondents, while disinfectant, bleach, or vinegar was used by 39%. Signif-

TABLE 1. Demographic characteristics of survey participants

	<i>n</i>	% total respondents	Weighted % total	% Canadian population
Gender				
Women	1,516	61.3	49.9	50.8
Men	958	38.7	50.1	49.1
Age (yr)				
18–29	242	9.8	8.8	20.6
30–59	801	32.5	60.3	53.7
60+	1,425	57.7	30.9	25.7
Household income				
<\$30,000	503	24.1	16.1	9.8
\$30,000–\$59,000	622	29.8	29.4	22.8
\$60,000–\$79,000	323	15.5	16.3	14.5
≥\$80,000	642	30.7	38.2	52.8
Education				
High school or less	890	39.8	29.8	35.9
>High school,				
< Bachelor's degree	786	35.2	36.4	38.3
Bachelor's degree and above	560	25.0	33.8	25.9

icantly more women than men reported cleaning food preparation surfaces after preparing raw meat. Significantly more respondents ages 60+ years reported using bleach than respondents in the middle and youngest age groups.

Separate. Approximately 90% of respondents reported taking precautions to avoid cross-contamination when using cutting boards for raw meat and other foods. About two-thirds of respondents followed the practice recommended by Health Canada (8), to use separate cutting boards for raw meat and other foods. The use of separate cutting boards was the most common practice to prevent cross-contamination by all three age groups. However, the older two age groups reported cleaning the same cutting board between preparing raw meat and other foods or preparing other foods before raw meat more often than the youngest (18 to 29 years) age group. Always using separate plates for raw meats and cooked meats (e.g., when barbecuing) was reported by 88% of respondents; however, men were significantly less likely to report always following this practice. Similarly, many respondents indicated making efforts to separate raw meat, poultry, and fish from other foods in the refrigerator (91%), but fewer men reported following steps to prevent cross-contamination in the refrigerator than did women (87 compared with 95%). The most common behavior reported for this question was wrapping raw meat in a second plastic bag (60%).

Cook. Of the respondents who cooked meat, 29% reported using a thermometer to know when meat was cooked enough to eat (Table 3). Visual observation was the most commonly reported approach for determining when meat was done (65%), and a significantly higher proportion (75%) of the youngest age group responded that this was generally their method for knowing when their meat was

TABLE 2. Weighted proportion of self-reported behaviors related to clean and separate food safety practices

	Weighted %	Confidence interval		Gender		Age group (yr)		
		Lower	Upper	Men ^a	Women	18–29 ^a	30–59 ^b	60+
Clean								
Usual practice for cleaning food preparation surfaces (e.g., cutting board, counter, sink) after preparing raw meat or poultry ^c								
Clean using soap or disinfectant	93.1	90.4	95.7	89.6	96.6 ^d	91.9	92.8	94.3
Soap and water	78.2	74.4	81.9	73.3	83.1 ^d	77.2	80.4	74.5
Disinfectant, bleach, or vinegar	38.5	34.0	43.1	31.4	45.6 ^d	46.4	34.6	44.1
Disinfectant	18.6	15.7	21.5	17.5	19.7	32.7	15.5	20.6
Bleach	14.8	12.1	17.4	10.2	19.3 ^d	5.6	11.5	24.0 ^{d,e}
Vinegar	14.3	10.7	17.9	10.6	18.1 ^d	11.4	14.9	14.0
Dishwasher	28.7	24.4	33.0	22.9	34.5 ^d	23.4	28.6	30.3
Water only	3.3	1.1	5.5	5.1	1.5	3.3	4.1	1.9
Other	2.6	1.7	3.5	1.8	3.3	1.2	1.6	4.5 ^{d,e}
Don't clean	0.1	0.0	0.3	0.3	0.0	0.9	0.0	0.2
Don't know/not sure	2.1	0.7	3.5	3.5	0.7	3.1	2.1	1.8
Washes hands after handling raw meat or poultry (wash hands with soap and water or use hand sanitizer)								
	92.9	90.0	95.7	92.0	93.6	91.6	94.3	90.3
Separate								
Usual practice to prevent cross-contamination from a cutting board when preparing raw meat and other foods (e.g., vegetables)								
Takes steps to prevent cross-contamination	90.5	87.8	93.2	89.2	91.8	92.7	90.9	89.2
Uses separate cutting boards for raw meat and other foods	66.7	61.8	71.6	65.6	67.9	76.3	65.9	65.9
Cleans the cutting board after preparing raw meat before preparing other foods	19.7	15.3	24.1	20.1	19.4	8.0	21.3 ^d	20.0 ^d
Cuts other foods before cutting raw meat	4.2	2.4	6.1	3.7	4.7	8.8	3.7	3.7
Does not use separate cutting boards	9.3	6.6	12.0	10.6	8.1	6.8	9.1	10.4
Always uses separate plate after taking raw meat or poultry from a plate to put on the barbeque or cooking pan								
	88.0	85.1	90.8	84.0	91.8 ^d	80.6	89.8	86.1
Takes steps when storing raw meat, poultry, or seafood in the refrigerator to prevent contamination of other foods								
Puts meat, poultry, or seafood on the bottom shelf of the refrigerator	26.9	22.7	31.1	19.0	34.8 ^d	36.1	28.8	20.7
Wraps meat, poultry or seafood in a second plastic bag	59.8	54.9	64.8	57.1	62.6	47.9	60.7	61.7 ^d
Places meat, poultry or seafood on a plate	29.0	24.8	33.1	23.9	34.0 ^d	24.3	29.9	28.4
Puts meat, poultry or seafood in a container	42.1	37.1	47.1	40.4	43.7	36.6	45.3	36.9
Other	8.0	5.6	10.4	9.5	6.5	7.0	5.7	12.6 ^e

^a Reference group 1.^b Reference group 2.^c Open or check box questions.^d Significantly different ($P \leq 0.05$) from reference group 1.^e Significantly different ($P \leq 0.05$) from reference group 2.

cooked enough to eat than did the respondents in the two older age groups. Thermometer use was most often reported for whole poultry (chicken 33%; turkey 42%) or roasts (36%), while its use for cuts of poultry was much less commonly reported (12%). Ground meat or meat mixtures (9%) and fish (3.5%) were products for which thermometer use was rarely reported. These findings were consistent for all age and gender groupings. Most respondents (87%) reported that they generally followed the cooking instructions on food labels; however, men were significantly less likely to report following cooking instructions than were women.

Chill. Respondents reported typically refrigerating leftovers within 2 h after cooking (81%) (Table 3).

Knowledge. Overall, the majority of respondents reported hearing about the risks of foodborne illness associated with chicken (86%) and hamburger (81%) (Table 4). More than half of respondents reported hearing about risks associated with raw eggs, unpasteurized milk, deli meats, and raw oysters. Less than 40% of respondents reported hearing about the risks associated with soft unpasteurized cheeses, alfalfa sprouts, unpasteurized juice, and frozen chicken nuggets. Of note, the percentage of

TABLE 3. Weighted proportion of self-reported behaviors related to cook and chill food safety practices

	Weighted %	Confidence interval		Gender		Age group (yr)		
		Lower	Upper	Men ^a	Women	18–29 ^a	30–59 ^b	60+
Cook								
Practice to know when meat is cooked enough to eat ^c								
Visually (i.e. no pink meat visible)	65.3	60.6	69.9	63.9	66.6	74.8	67.0	59.0 ^d
Always cooks thoroughly	29.2	24.4	33.9	26.2	32.1	29.3	28.0	31.7
Thermometer	29.0	24.9	33.2	26.3	31.7	27.6	28.9	29.5
Time	27.1	23.3	30.8	26.1	28.0	35.4	24.2	29.8
Meat juices run clear	22.9	19.1	26.8	20.5	25.3	17.7	23.8	22.8
Taste	9.6	6.6	12.5	8.4	10.7	15.7	9.0	8.4
Don't cook meat	2.1	0.7	3.4	2.5	1.7	1.8	1.9	2.5
Other method	6.7	3.0	10.3	8.2	5.2	2.6	7.5	5.9
Don't know/not sure	2.5	0.3	4.7	4.6	0.4	0.7	3.2	1.7
Uses a food or meat thermometer when cooking the following:								
Whole turkey	41.7	36.6	46.7	43.3	40.1	35.8	44.9	37.3
Roasts	35.7	30.8	40.6	35.7	35.7	30.8	38.9	30.7
Whole chicken	33.2	28.4	38.1	34.4	32.1	31.7	35.7	29.1
Pork cuts	12.9	9.6	16.3	10.7	15.1	21.3	13.9	8.9 ^d
Chicken or turkey pieces	12.3	9.5	15.2	12.0	12.7	17.9	12.0	11.0
Steak	10.5	7.4	13.5	9.5	11.4	11.0	11.2	8.4
Any type of ground meat or meat mixtures (i.e., meatballs, sausages, hamburgers)	8.9	6.4	11.5	6.8	11.1	14.2	8.8	7.9
Fish	3.5	1.9	5.1	3.5	3.6	3.1	4.1	2.5
Follows the cooking and storage instructions on food labels	87.3	83.3	91.2	83.0	91.4 ^d	85.2	86.5	89.1
Chill								
Refrigerates leftovers within 2 h after cooking	81.1	75.9	86.4	76.8	85.3	78.9	78.7	86.6

^a Reference group 1.

^b Reference group 2.

^c Open or check box questions.

^d Significantly different ($P \leq 0.05$) from reference group 1.

^e Significantly different ($P \leq 0.05$) from reference group 2.

respondents who reported hearing of risks associated with frozen chicken nuggets (23%) was lower than the percentages for pasteurized milk (25%) and hard cheese (24%), which were added as control items and are not considered to be high-risk food items. The youngest age group was significantly less likely to report being aware of the risks associated with sprouts than was the middle age group. Compared with the middle age group, those ages 60+ were less likely to report hearing about risks associated with raw eggs, sprouts, unpasteurized milk, and soft unpasteurized cheese.

In terms of respondents' ability to identify activities or practices that could cause foodborne illness, the majority of respondents identified that eating cooked chicken or hamburger when the meat is still pink inside could lead to foodborne illness (85 and 78%, respectively). The youngest age group had a lower percentage of respondents who identified the risk of foodborne illness associated with eating hamburger that is still pink inside than did the other two age groups. Approximately 69% of respondents reported that

thawing meat at room temperature was a risk for foodborne illness. Just over half of respondents identified eating salad dressing that contained raw eggs and consuming undercooked eggs as activities that could result in foodborne illness.

Sixty-two percent of respondents identified all four priority groups of people who are at greater risk of foodborne illness (people with weakened immune systems, children younger than 6 years, the elderly, and pregnant women) than the general population. The most commonly identified at risk group was people with weakened immune systems, with 91% of respondents identifying this group (Table 4). The 60+ age group respondents were less likely than the two younger age groups to identify pregnant women as being at increased risk. Respondents were also given the opportunity to describe other at-risk groups through an open-ended question. The most commonly identified groups in the open-ended responses were people with preexisting health conditions (i.e., disability or chronic disease), people living in low socioeconomic situations, and teens or youth.

TABLE 4. Weighted proportion of respondents that identified high-risk food, activities, and high-risk groups

	Weighted %	Confidence interval		Gender		Age group (yr)		
		Lower	Upper	Men ^a	Women	18–29 ^a	30–59 ^b	60+
Reported hearing of risks associated with the following foods:								
Chicken	86.3	83.1	89.5	85.8	86.7	82.1	88.7	82.6
Hamburger	81.2	76.3	86.1	78.0	84.4	78.6	80.7	83.0
Raw eggs	64.4	59.6	69.1	58.3	70.4 ^c	55.2	70.6	54.5 ^d
Unpasteurized milk	62.0	57.3	66.7	58.9	65.0	54.9	66.8	54.8 ^d
Deli meats	56.7	51.7	61.7	52.2	61.2	54.6	58.9	53.0
Raw oysters	50.0	45.1	55.0	50.0	50.1	46.7	53.7	44.0
Soft unpasteurized cheeses	39.1	34.0	44.2	38.1	40.1	38.0	46.4	25.4 ^d
Alfalfa sprouts	37.1	32.1	42.1	33.5	40.7	23.4	42.4 ^c	31.3 ^d
Unpasteurized juice	29.9	25.6	34.2	27.0	32.7	21.2	33.6	24.9 ^d
Pasteurized milk	24.6	20.0	29.2	26.6	22.6	28.8	26.3	20.3
Hard cheeses	23.6	18.6	28.6	25.8	21.3	23.2	27.9	15.0 ^d
Frozen chicken nuggets	23.0	19.1	27.0	22.1	23.9	26.9	23.6	21.2
Identified the following activities could cause foodborne illness:								
Eating chicken that is cooked so that the meat is still pink inside	84.8	81.3	88.3	83.3	86.2	75.1	86.9	83.2
Eating a hamburger that is cooked rare so that the meat is still pink inside	77.8	73.5	82.0	75.7	79.8	59.4	78.8 ^c	80.6 ^c
Thawing meat at room temperature	68.9	64.3	73.6	61.7	76.2 ^c	63.2	70.3	68.0
Eating salad dressing made with raw egg	59.6	54.7	64.5	51.8	67.5 ^c	48.2	64.3 ^c	53.9 ^d
Eating moldy cheese	55.4	50.6	60.2	57.6	53.2	63.9	57.7	48.1 ^c
Eating undercooked eggs	53.5	48.6	58.4	50.2	56.8	43.3	57.9	47.8
Identified the following groups of people are at greater risk of foodborne illness compared with the general population:								
People with weakened immune systems	91.4	89.3	93.5	90.7	92.1	88.4	93.5	88.2
Children under 6 yr of age	87.7	84.5	90.9	85.9	89.4	89.8	89.6	83.1
Elderly	83.3	79.9	86.7	83.0	83.6	83.3	85.8	78.6
Pregnant women	75.8	71.8	79.9	72.9	78.7	81.0	78.5	69.0 ^{c,d}

^a Reference group 1.

^b Reference group 2.

^c Significantly different ($P \leq 0.05$) from reference group 1.

^d Significantly different ($P \leq 0.05$) from reference group 2.

DISCUSSION

This study establishes a national picture of the food safety practices and knowledge of Canadians, highlighting the progress and gaps in food safety practices and knowledge. In general, the majority of Canadians reported following the recommended food safety practices for the clean, chill, and separate themes, with responses falling in the 81 to 93% range. However, this still indicates that 1 in 10 Canadians may use unsafe practices that put him or her at risk for foodborne illness. Furthermore, cooking practices specific to meat thermometer use highlight an area that needs improvement among Canadian consumers.

Visual inspection was reported by most respondents as their primary method for determining when meat is done. However, research (17) indicates this is not a reliable method of knowing that the product has reached safe internal cooking temperatures. Checking the temperature of cooked meat, poultry, and seafood with a food thermometer is the only reliable way to make sure the food has reached a

safe internal cooking temperature (14). All the demographic groups reported low thermometer use when cooking meats (around 29%), which is similar to the results of previous Canadian and international studies (16, 22). Some of the barriers to thermometer use may be practical, including not owning a food thermometer (52% of Canadians reported owning a meat thermometer (15)) or having difficulty using food thermometers on small cuts of meat, or they may reflect attitudes and social norms (28, 33). These areas may be addressed through a better understanding of these barriers and through the use of targeted interventions to promote behavior change.

The respondents were most aware of foodborne illness risks associated with commonly consumed meat products that require cooking (e.g., raw chicken and raw hamburger). In contrast, the knowledge of the risks associated with several ready-to-eat foods was lower. Because there is no cooking-kill step for ready-to-eat products, increased messaging regarding their potential risks may be beneficial.

The awareness of deli meat as a risk for foodborne illness was lower in this study (57%) than in a study (4) completed shortly after a large Canadian listeriosis outbreak in 2008, in which 73% of respondents acknowledged this risk (5). Most notably, almost half of the 60+ age group were not aware of the risk of foodborne illness associated with deli meat, despite 37% of this age group reporting eating deli meat in the previous 7 days (25) and despite the risk of illness from listeriosis being higher in older adults (7, 24). Clear risk messaging about ready-to-eat products is required to support informed decisions on whether or not to consume these products.

The knowledge of the risks associated with uncommonly consumed, ready-to-eat products such as unpasteurized juice and raw oysters could be improved; 38 and 50% of respondents, respectively, reported they were not aware of the risks associated with these products. Interventions may be most effective if they directly target the consumers of these products at the point of purchase because broad messaging may not reach the intended audience. In the Foodbook study, 7.8% of respondents had consumed unpasteurized fruit juice and 0.4% of respondents had consumed raw oysters in the 7 days preceding interview (2). Therefore, it can be assumed that there are Canadians who are consuming these products while unaware of their risks.

Salmonella and the control of poultry-related human salmonellosis are currently of particular interest in Canada (12, 13). In terms of the risks associated with poultry, this survey identified that respondents were aware of the foodborne disease risks associated with chicken generally; however, they were not aware of the risks associated with raw frozen chicken nuggets. All age groups reported a low awareness of the risks associated with frozen chicken nuggets. Salmonellosis outbreaks associated with frozen breaded chicken products have occurred recently in Canada (18, 26, 29), and FoodNet Canada integrated surveillance results (9, 11) have indicated that approximately 30% of the raw chicken nuggets sampled tested positive for *Salmonella*. Chicken nuggets are consumed frequently by Canadians (16.5% of respondents over the previous 7 days and 30% of respondents in the <10-year age group) (2). Therefore, because the hazard is present and the exposure is common, these products, if they are not cooked thoroughly, pose a risk to the Canadian population. There are many different types of frozen chicken nuggets; some are fully cooked, and others are raw. However, both the cooked and uncooked versions have a similar appearance, which may result in a perceived lower risk and an assumption that all are fully cooked. The lack of consumer awareness and attention to labeling may be a barrier to the safe preparation and consumption of these products.

Other poultry-related risks that were identified included the need for improved thermometer use when consumers cook whole poultry and poultry pieces, as well as a need for increased knowledge surrounding the risks of thawing meat at room temperature. With respect to eggs, only about half of respondents reported being aware of the risk associated with eating undercooked eggs. The consumption data show that over 87% of Canadians reported the consumption of any poultry and that 15% of Canadians reported eating raw or

undercooked eggs over a 7-day exposure period (2). Therefore, the results of this study support the development of targeted consumer education, specifically, messaging to address the role of handling, preparation, and thorough cooking of known sources of *Salmonella*, including eggs and poultry.

Although there is a potential element of risk in all foods, some foods are associated with a higher risk of microbial contamination than others. Food items such as pasteurized milk and hard cheese were included in the survey list of risky foods as control items to provide quality control and to assess the validity of the responses to the survey questions. Interestingly, the level of reported risk for these control items was similar to the level of awareness of the risk associated with some high-risk foods (e.g., frozen chicken nuggets). These results could indicate a true lack of awareness of high-risk foods such as frozen chicken nuggets, but they may also reflect acquiescence bias (a form of response bias in which respondents have the tendency to agree with a statement when in doubt) (20). Nevertheless, only 5% of respondents indicated a positive response to all the listed food items in the survey, suggesting a small effect of acquiescence bias in this study. Therefore, the control food items were useful in identifying high-risk foods for which the respondents had a low awareness for targeted food safety messaging.

Similarly, consuming moldy cheese was considered an activity that could cause foodborne illness by more than half of the respondents, despite it being included as a control item. The responses to this question may have also been subject to acquiescence bias, or they may reflect ambiguity regarding the type of cheese (i.e., hard versus soft) because this was not specified. Cheddar and parmesan are hard cheeses, which would not present a high risk if moldy. Furthermore, some cheeses are deliberately infected with fungi (e.g., blue cheeses) and are meant to be eaten that way. But for most soft cheeses, the presence of mold suggests an infection by potentially harmful pathogens. Future surveys could consider adding further specificity to the questions to better assess the level of risk awareness.

In Canada, differences exist in foodborne illnesses by age group, with higher reported rates of illness in 20- to 29-year-olds than in 30- to 59-year-olds for both *Salmonella* and *Campylobacter* infections (24) and with increased severity of illness in older adults (28). Consumer food safety practices and knowledge may contribute to this pattern, and this study identified some differences among the demographic groups. Food safety practices related to avoiding cross-contamination (i.e., cleaning cutting boards after preparing raw meat and before preparing other foods) and the awareness of the foodborne illness risk associated with eating an undercooked hamburger were lower among the youngest age group than among the two older age groups. Limited knowledge of the common sources of foodborne illness has also been identified in college and university students in the United States (1), and low food safety knowledge has been found in Canadian high school students (19). The oldest age group had a lower awareness of the risks associated with raw and undercooked eggs, sprouts, and unpasteurized juice than did the middle age

group. Another Canadian study (21) also showed that there was a decreased knowledge of the foodborne disease risks associated with high-risk foods among individuals over the age of 64 years.

Some differences in practices and knowledge between the genders were observed, including the lower reported use of separate clean plates (for raw and cooked meats) when barbecuing, a lower awareness of the risk of thawing meat at room temperature, and a generally lower awareness of high-risk foods by men than by women. Other studies (6, 21, 23) have also reported that women have safer food handling practices and a greater knowledge than men. Therefore, communication approaches targeting different demographic groups continues to be important.

Currently, a federal targeted food safety education campaign (10) focuses on four vulnerable populations: older adults, young children, those with weakened immune systems, and pregnant women. The vulnerable populations for foodborne illness were generally well identified by the survey respondents (over 75% for each group). This is an improvement from a 2010 Canadian public opinion research study (5), in which 60% identified the elderly and young children and 54% identified people with preexisting health issues as high-risk groups, but only 9% identified pregnant women as a high-risk group. Interestingly, the 60+ years age group had the lowest percentage of respondents identifying the elderly as being at a higher risk for foodborne illness than younger adults. Continued efforts to reach older adults with food safety messaging and to increase their awareness of high-risk foods are warranted.

There are limitations to this study and its findings that should be considered when interpreting the results; these mainly reflect the sampling strategy for the Foodbook study. People without a land line or cellular telephone number were excluded from the survey, and although the survey was available in a broad number of languages, some respondents may have been excluded if the surveyor was unable to determine the respondent's preferred language. Similarly, due to privacy concerns, information on cultural and ethnic groups was not collected for this study, and therefore, messaging and interventions cannot be targeted at this level. Because only individuals 18 years and older were included in this module, and owing to the methods used to weight the data (weights were developed for wide age ranges: 18 to 64 years and 65 years and older), narrow age groups such as those 18 to 40 years are under-represented in the weighted Foodbook sample compared with the general Canadian population. In addition, the data for this module were collected from November to April only, and the reported practices may differ by seasonal cooking preferences.

Outside the limitations of the sampling strategy, the data analysis identified that it would have been preferable to ask respondents if they handled meat as a binary (yes-no) question before asking for information regarding their practices when handling meat. Efforts were taken to remove individuals from the denominator of questions regarding the handling meat if they never handled it, but it was difficult to identify these individuals. For example, some respondents consumed meat but reported not handling it, while other

respondents reported being vegetarians but handled raw meat when preparing meals for others. The authors do not expect that the results were affected greatly by this oversight, but we do recommend adding this layer of questions to future surveys.

In addition, it is important to note that these findings reflect participants' reported usual behavior and not their actual behavior. Therefore, the results may be inflated due to social desirability bias (27). A review of the literature (22) examining consumer food safety practices and knowledge identified several international observational studies showing that reported behavior is higher than observed behavior. A recent observational study (19) of Canadian youth demonstrated the over-reporting of safe food handling and preparation practices, and more observational studies are needed in Canada to understand behaviors in the home.

Further analyses of the Foodbook study results may include an assessment of the educational background and economic status of respondents to understand the differences among socioeconomic groups regarding food safety knowledge and practices in the Canadian context. In addition, targeted studies to improve our understanding of practices and knowledge in families with young children, among people with weakened immune systems, and in other language and cultural groups in Canada are also needed. Furthermore, to plan and implement effective food safety interventions to apply the knowledge gained through this study, greater knowledge is needed about the barriers to behavior change (i.e., awareness, inconvenience, and product labeling) for Canadians.

This study provides current national data on Canadian consumer food safety practices and knowledge, and can be used to inform and measure the effectiveness of food safety education interventions in the future. As a priority, food safety education in Canada should focus on increasing consumer awareness of high-risk foods, specifically foods for which the respondents showed a low awareness (e.g., raw chicken nuggets) in this study, and on the use of a food thermometer when cooking meat and poultry. In addition, continued messaging targeting high-risk groups is important, with greater consideration being given to targeting people 60 years and older, as well as young adults.

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SUPPLEMENTAL MATERIAL

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