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# Predictors of Safe Food Handling among Canadian Seniors Living at Home

## ABSTRACT

Seniors (age 65+) account for 6 million people in Canada, and these numbers continue to rise. Older adults are at increased risk for foodborne illness because of their decline in immune function and gut function, as well as underlying chronic conditions. In this study, a subset of previously collected survey data was analyzed to identify potential determinants related to safe storage and temperature control food safety practices among seniors at home. Data from seniors across Canada (n = 1078) were collected in 2014–2015, using a population-based, structured telephone survey. Three safe food-handling outcomes and nine determinants were examined, using logistic regression models. Most participants were women (66%) and lived with others (51%). Most seniors followed instructions on food labels (90%) and refrigerated leftovers within recommended guidelines (82%), but only a small proportion of respondent's stored raw meats on the bottom shelf of the refrigerator (20%). Models revealed that women and younger seniors (65–74) were more likely than men and older seniors to have better food handling outcomes. Recommendations are provided based on these findings to improve targeted messaging and highlight areas for future research among seniors.

## INTRODUCTION

Roughly 52 million North Americans are affected by foodborne illness every year *(37, 44, 45)*. Food can be contaminated along the food chain, such as in agriculture, production, storage, transportation, retail and consumption *(35, 61)*. Within the chain, improper handling of food at home or in foodservice and retail settings are major contributors to illness *(17, 59)*. A U.S.-based study using outbreak data found that dairy products, vegetables, and poultry were the most frequent foods associated with hospitalizations and deaths from foodborne illness *(28)*. *Salmonella* is commonly linked to eggs, poultry, cheese, and contaminated raw fruits and vegetables, whereas *Listeria monocytogenes* is linked to soft cheeses and ready-to-eat deli meats *(57)*. Given that pathogens such as nontyphoidal

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*Salmonella* spp. and *L. monocytogenes* account for 52% of deaths due to foodborne illness in Canada *(37, 44)*, it may be beneficial to reduce the risk of cross-contamination and growth of these pathogens in foods by improving consumer food handling of these commonly implicated foods.

Approximately 6 million people in Canada are seniors (65+) and projections show that one in four people in North America will be categorized as a senior by 2060 *(46, 56)*. Older adults have increased susceptibility to foodborne illness, and also have the most severe cases as well as the highest rates of hospitalizations and deaths from gastrointestinal-related issues because of weakened immune function and other age-related factors (e.g., chronic diseases, gastrointestinal changes) *(17, 60)*. Seniors are four times more likely than the general population to acquire *Listeria* infection *(10)* and have the highest infection-related hospitalization rate due to *Salmonella (10, 11)*. If no major interventions are implemented to reduce the likelihood of exposure, the incidence of *Salmonella* infections is expected to increase over the next decade, because of the aging population in Canada *(29, 54)*. As older adults continue to experience a decline in gastrointestinal-related *(40)* and immune function *(4)*, the need for campaigns to reduce the risk of exposure to foodborne pathogens among them is of particular importance. Public health initiatives and food safety interventions that target behavior change within these high-risk groups with effective messages are recommended to reduce the burden of foodborne disease *(1, 38, 53, 54)*.

The Centers for Disease Control and Prevention (CDC) recommends that consumers keep raw meat away from other foods to avoid cross-contamination, refrigerate leftovers within 2 hours in shallow containers, and use leftovers within 3–4 days *(9)*. These storage practices help decrease the risk of infection by pathogens such as *Salmonella* and *Listeria* which are commonly associated with poor refrigeration and cross-contamination prevention at home *(57)*. Previous research has shown consumers, including older adults, have poor food storage and temperature control practices *(8, 13, 21, 22)*. One study reported that older adults had different food handling practices than younger people, with seniors reporting storing foods for longer than recommended in guidelines *(51)*. Furthermore, research on associations between factors that contribute to practices has typically presented only unadjusted estimations (i.e., crude odds ratios) and has investigated a small number of predictors. In 2014, a database was established to determine Canadians' food exposure and food safety practices via a telephone survey known as the Foodbook study *(34)*. This study was conducted to determine possible sources of foodborne infections and set a baseline for determining the effectiveness of interventions over time *(34)*. The study found most Canadians were not aware of risks associated with frozen chicken nuggets and sprouts; men were less likely than women to perform safe food handling at home; and older adults (60+) were less likely than younger (30–59 years) respondents to be aware of risks associated with raw eggs, alfalfa sprouts and unpasteurized juices *(26)*. Although these results have value and identify gaps across various consumer groups, only weighted proportions and differences in means were reported, and the authors were unable to study the older demographic group in detail. Therefore, the objectives of this study were to (a) investigate the potential relationship between seniors' food storage and temperature control practices at home and their demographic profiles by examining these determinants using multivariable approaches and (b) provide well-defined recommendations for future food safety interventions and education for seniors.

## MATERIALS AND METHODS

### Data preparation

The Foodbook study examining food safety practices was part of a nationwide telephone survey conducted in various languages (English, French, Inuktitut, and others offered through translation) across all Canadian provinces and territories between November 2014 and April 2015 *(26, 33)*. The original study included data from individuals aged 18 years and older, but for the purposes of this study, only data provided by seniors (65+) are used. The Foodbook study was reviewed and approved by Health Canada and the Public Health Agency of Canada's Research Ethics Board (REB 2013-0025), and the analysis for this study was reviewed and approved by the University of Guelph's Research Ethics Board (REB 19-01-025). More information on data collection can be found in the original Foodbook report *(34)*. After being received, the data were cleaned, using StataSE 15.1 for Windows (StataCorp LP, College Station, USA), by dropping all data points from the 18–64 age groups as well as data on participants who did not provide their age. Metropolitan zones provided in the dataset were collapsed and categorized into whether or not the participant lived in a metropolitan area. Survey weights were provided in the data set which reflected the weights of the t predictors for the following food safety practices for three models: (i) folloproportions, and all analyses were conducted using survey weights *(34)*. Weighting ensured that the sample was representative of the Canadian population.

### Statistical analyses

Logistic regression analysis was completed to determine significanwing safe cooking and storage instructions on labels; (ii) correctly refrigerating leftovers within two hours after cooking; and, (iii) putting raw meat, poultry or seafood on the bottom shelf of the refrigerator to prevent contamination of other foods. In cases where the questionnaire provided more than two response options, such as for following labels (yes, no, or not sure) and correctly refrigerating leftovers (multiple-choice), the outcomes were dichotomized (correct/best vs. incorrect practice).

A pre-specified number of explanatory variables consisting of demographic characteristics, one knowledge, and one practice were selected as potential covariates for analysis. These variables were sex, age category (65–74 vs. 75+), education level, income (< $30,000; $30,000–59,999; $60,000–79,999; ≥ $80,000), number of individuals in household (1; 2; 3 or more), province or territory of residence, living in a metropolitan area (i.e., an area that has a total population of ≥ 100,000 of which ≥ 50,000 live in the core) (yes vs. no), awareness that the elderly are at increased risk for foodborne illness (yes vs. no), and whether individuals follow food safety instructions on labels (yes vs. no). Basic assumptions for conducting regression models had to be met *(46)*. Education level was collapsed from seven to four categories (less than high school; high school equivalency; trade certificate or some college; bachelor's degree or above), because some levels did not have enough observations to conduct regression analysis. The household size variable violated the assumption for linearity (i.e., no linear relationship between predictor and outcome), and the variable was transformed from a continuous to a categorical variable to overcome this violation *(18)*.

Univariable logistic regression models were run with the appropriate survey weighting to examine associations between each predictor and outcome, and predictors were excluded from multivariable analysis, using a liberal *P*-value of ≥ 0.20. This was applied as a selection strategy to reduce the number of initial variables in the model while also minimizing the risk of excluding relevant variables *(23, 43)*. Next, correlations were assessed between predictor variables to examine whether any variables were highly correlated, using a cut-off value of ≥ 0.8. If any highly correlated variables were encountered, then the more important variable was selected for inclusion in analysis. If the removal of any explanatory variables resulted in a change of ≥ 20% in the coefficient in any variable of interest, they were re-introduced into the model as a confounding factor *(5)*. Two-way interaction effects were tested for between predictor variables in the final models. All three multivariable models were estimated to determine odds ratios (ORs) with corresponding 95% confidence intervals (CIs). A hierarchical stepwise regression approach was applied to remove insignificant variables (≥ 0.05) if they did not have a confounding effect. This process continued until no further variables could be removed. Model fit was assessed using F-adjusted mean residual goodness-of-fit tests *(2)*. Crude and adjusted odds ratios (ORs), 95% confidence interval (CI), *P*-values for the Wald tests were estimated for each model. Crude ORs from univariable models report only the association between the predictor and outcome, whereas multiple regression techniques provide adjusted ORs that account for confounders. All data were analyzed using StataSE 15.1 for Windows (StataCorp LP, College Station, TX, USA).

## RESULTS

### Characteristics of study participants

*Table 1* shows demographic characteristics of the 1078 survey respondents. Most participants were in the 65–74 age category (58%, n = 628) rather than in the 75+ category (42%, n = 450). Of the respondents, 66% (n = 712) were women. Most participants were well educated, with 51% (n = 546) reporting having at least a trade certificate (i.e., professional certification or professional designation), and some college or university completed. Most participants reported having a total household income of less than $60,000 (73%, n = 655), while the number of individuals living in the household was evenly split (1= 49% vs. ≥ 2 = 51%). Fewer than half of the respondents (44%, n = 472) reported living in a census metropolitan area. Study participants resided in the following provinces: British Columbia (11%, n = 119), Alberta (12%, n = 127), Ontario (16%, n = 173), and Quebec (16%, n = 172). The smallest frequencies were in Northwest Territories (3%, n = 33) and Nunavut (2%, n = 23).

Knowledge and practice frequencies are presented in *Table 2*. When respondents were asked whether the elderly were at greater risk of foodborne illness compared with the general population, most agreed they were (78%, n = 832). Most older participants reported following the recommendations for cooking and storage (90%, n = 934) and for refrigerating leftovers within 2 hours of cooking (82%, n = 884). On the other hand, only a small proportion of respondents reported taking adequate steps to store raw meats, poultry, and seafood safely by placing them on the bottom shelf of the refrigerator (80%, n = 834).

### Determinants of food safety storage practices

The results from final regression models included following instructions on food labels *(Table 3)*; refrigerating leftovers within 2 hours *(Table 4)*; and safely storing meats, poultry, and seafood in the refrigerator to prevent cross-contamination *(Table 5)*.

Gender, number of individuals in the household, and education were significantly associated with following instructions on food labels, whereas income was left in the model as a confounder *(Table 3)*. The odds of following instructions on food labels were significantly higher for women than for men (OR = 2.42, 95% CI: 1.15–5.09, $P < 0.05$). Participants in two-individual households were more likely than those in larger households to follow instructions (OR = 4.26, 95% CI: 1.38–13.13, $P < 0.05$). Individuals with a high school diploma were significantly more likely than those with less than a high school education to follow instructions (OR = 4.27, 95% CI: 1.50–12.13, $P < 0.01$).

Gender and income were significantly associated with seniors refrigerating leftovers within 2 hours of cooking, and education was left in the model because it was a confounding

**TABLE 1. Demographic characteristics of Canadian seniors participating in the Foodbook study (N = 1078) and their frequencies and percentages**

| Variable | n | Total respondents (%) | Weighted total (%) |
|---|---|---|---|
| **Age category** | | | |
| 65–74 | 628 | 58.3 | 56.6 |
| 75+ | 450 | 41.7 | 43.4 |
| Sex | | | |
| Male | 366 | 34.0 | 36.9 |
| Female | 712 | 66.1 | 63.1 |
| **Education level** | | | |
| Less than high school | 260 | 24.6 | 25.2 |
| High school | 249 | 23.6 | 23.9 |
| Trade certificate or some college | 321 | 30.4 | 30.7 |
| Bachelor's degree or above | 225 | 21.3 | 20.2 |
| **Income category**[a] | | | |
| < $30,000 | 322 | 35.9 | 34.3 |
| $30,000–$59,999 | 333 | 37.1 | 39.9 |
| $60,000–$79,999 | 109 | 12.1 | 11.9 |
| ≥ $80,000 | 134 | 14.9 | 13.8 |
| **Number of people in the household** | | | |
| 1 | 524 | 49.0 | 38.7 |
| 2 | 462 | 43.2 | 48.4 |
| ≥ 3 | 84 | 7.9 | 12.9 |
| **Province or territory of residence** | | | |
| Ontario | 173 | 16.1 | 36.6 |
| Quebec | 172 | 15.9 | 27.7 |
| Alberta | 127 | 11.8 | 9.3 |
| British Columbia | 119 | 11.0 | 12.1 |
| Saskatchewan | 86 | 8.0 | 3.0 |
| Manitoba | 82 | 7.6 | 3.9 |
| New Brunswick | 71 | 6.6 | 2.5 |
| Nova Scotia | 63 | 5.8 | 3.0 |
| Prince Edward Island | 42 | 3.9 | 0.4 |
| Newfoundland and Labrador | 40 | 3.7 | 1.4 |
| Yukon | 47 | 4.4 | 0.1 |
| Northwest Territories | 33 | 3.1 | 0.1 |
| Nunavut | 23 | 2.1 | 0.03 |
| **Resides in a Census Metropolitan Area** | | | |
| Yes | 472 | 43.9 | 38.7 |
| No | 606 | 56.2 | 61.3 |

[a]Values are in Canadian dollars.

**TABLE 2. Frequencies and percentages of food safety knowledge and practices of Canadian seniors participating in the Foodbook study (N = 1078)**

| Variable | n[a] | Total respondents (%) | Weighted total (%) |
|---|---|---|---|
| **To the best of your knowledge, which of the following groups of people would be at greater risk of foodborne illness compared to the general population? (Elderly)** | | | |
| **Yes** | 832 | 77.5 | 76.2 |
| **No** | 241 | 22.5 | 23.8 |
| **In general, do you follow the cooking and storage instructions on food labels?** | | | |
| **Yes** | 934 | 89.6 | 89.7 |
| **No** | 108 | 10.4 | 10.3 |
| **Typically, how long after cooking food do you refrigerate the leftovers? (Correct answer: within 2 hours of cooking)** | | | |
| **Correct** | 884 | 82.0 | 80.2 |
| **Incorrect** | 194 | 18.0 | 19.8 |
| **When storing raw meat, poultry or seafood in your refrigerator, what steps do you take to prevent contamination? (Correct answer: Put raw meat, poultry or seafood on the bottom shelf of the refrigerator)** | | | |
| **Correct** | 214 | 20.4 | 20.3 |
| **Incorrect** | 834 | 79.6 | 79.7 |

[a] Values may not add up to 1078 because of lack of response.

variable. The likelihood of refrigerating leftovers within 2 hours was significantly greater for women than men (OR = 2.72, 95% CI: 1.49–4.98, $P < 0.01$) *(Table 4)*. Those in the highest income category were more likely to store leftovers correctly than those in the lowest (OR = 3.66, 95% CI: 1.30–10.25, $P < 0.05$).

Associations were estimated for safe storage of raw meats, poultry and fish in the refrigerator *(Table 5)*. Gender was a confounder. Younger seniors (65–74) were significantly more likely than older seniors to store these items on the bottom shelf of the refrigerator (OR = 1.82, 95% CI: 1.06–3.13, $P < 0.05$). Those with a high school diploma were significantly more likely than those with no diploma (OR = 2.82, 95% CI: 1.18–6.72, $P < 0.05$) to store raw meats safely in the refrigerator. The highest earners were less likely to store meats safely than those in all other income categories. Specifically, those in the $30,000–$59,999 bracket (OR = 2.78, 95% CI:1.16–6.66, $P < 0.05$) and the $60,000–$79,999 bracket (OR = 3.51, 95% CI: 1.27–9.76, $P < 0.05$) were significantly more likely than the highest earners to store raw meats on the bottom shelf of the refrigerator. Lastly, those who followed instructions on food labels were significantly more likely to store meats, poultry, and fish safely in the refrigerator (OR = 2.94, 95% CI: 1.08–8.02, $P < 0.05$). Province of residence and whether participants lived in a metropolitan zone were not significant predictors in any of the models.

## DISCUSSION

The present study found that most older adults were aware they are at increased risk for foodborne illness and reported good storage practices. Most participants reported following instructions on food labels. Previous research supports these findings, with older respondents having heard a great deal about proper cooking and cooling instructions *(14, 52)*, and subsequently reporting that they closely followed safe handling instructions on food packaging *(39, 52)*. Furthermore, respondents in this study reported refrigerating leftovers within two hours of cooking foods. This is strongly supported by other consumer food safety studies that show that older consumers tend to be aware of recommendations on storing and reheating leftovers *(52)* and immediately refrigerating leftovers *(22, 31, 36, 62)*.

The findings showed that advanced seniors (75+) were less likely to store raw meats, poultry and seafood safely in the refrigerator despite being aware that the elderly are at increased risk of foodborne illness. In fact, no association was observed between being aware that the elderly are at greater risk for foodborne illness and safe storage practices. Knowledge that the elderly are at greater risk for illness may not be an accurate proxy for whether individuals are taking steps to ensure safer food handling at home.

A survey of Canadian consumers found that older adults were aware that certain groups of people were at greater risk

**TABLE 3. Determinants of Canadian seniors following cooking and storage instructions on food labels at home (stepwise hierarchical logistic regression approach with corresponding odds ratios and *P*-values)**

| Variable | OR (95% CI) | *P*-value |
|---|---|---|
| **Sex** | | |
| Female vs. male (reference) | 2.42 (1.15; 5.09) | 0.020 |
| **Number of individuals in household** | | |
| 1 | 2.76 (0.84; 9.08) | 0.095 |
| 2 | 4.26 (1.38; 13.13) | 0.012 |
| ≥ 3 | (reference) | |
| **Education level** | | |
| Less than high school | (reference) | |
| High school | 4.27 (1.50; 12.13) | 0.006 |
| Trade certificate or some college | 2.19 (0.90; 5.32) | 0.084 |
| Bachelor's degree or above | 2.49 (0.64; 9.74) | 0.189 |
| **Income category** | | |
| < $30,000 | (reference) | |
| $30,000–$59,999 | 0.56 (0.23; 1.36) | 0.200 |
| $60,000–$79,999 | 0.65 (0.12; 3.51) | 0.616 |
| ≥ $80,000 | 1.00 (0.19; 5.15) | 0.999 |

Abbreviations: OR = odds ratio; CI = confidence interval.

**TABLE 4. Determinants of Canadian seniors refrigerating leftovers within 2 hours of cooking them at home (stepwise hierarchical logistic regression approach with corresponding odds ratios and *P*-values)**

| Variable | OR (95% CI) | *P*-value |
|---|---|---|
| **Sex** | | |
| Female vs. male (reference) | 2.72 (1.49; 4.98) | 0.001 |
| **Age category (in years)** | | |
| 65–74 vs. 75+ (reference) | 1.21 (0.66; 2.32) | 0.535 |
| **Education level** | | |
| Less than high school | (reference) | |
| High school | 1.51 (0.64; 3.58) | 0.347 |
| Trade certificate or some college | 1.22 (0.51; 2.93) | 0.654 |
| Bachelor's degree or above | 1.65 (0.60; 4.52) | 0.331 |
| **Income category** | | |
| < $30,000 | (reference) | |
| $30,000–$59,999 | 1.45 (0.68; 3.10) | 0.331 |
| $60,000–$79,999 | 1.77 (0.67; 4.73) | 0.252 |
| ≥ $80,000 | 3.66 (1.30; 10.25) | 0.014 |

Abbreviations: OR = odds ratio; CI = confidence interval.

**TABLE 5. Determinants of Canadian seniors storing meats, poultry and fish in the bottom shelf of the refrigerator at home (stepwise hierarchical logistic regression approach with corresponding odds ratios and *P*-values)**

| Variable | OR (95% CI) | *P*-value |
|---|---|---|
| **Sex** | | |
| Female vs. male (reference) | 1.25 (0.69; 2.27) | 0.469 |
| **Age category (in years)** | | |
| 65–74 vs. 75+ (reference) | 1.82 (1.06; 3.13) | 0.031 |
| **Education level** | | |
| Less than high school | (reference) | |
| High school | 2.82 (1.18; 6.72) | 0.019 |
| Trade certificate or some college | 1.21 (0.54; 2.68) | 0.647 |
| Bachelor's degree or above | 1.51 (0.62; 3.65) | 0.360 |
| **Income category (high vs. low)** | | |
| < $30,000 | (reference) | |
| $30,000–$59,999 | 1.25 (0.62; 2.53) | 0.539 |
| $60,000–$79,999 | 1.58 (0.66; 3.80) | 0.307 |
| ≥ $80,000 | 0.45 (0.17; 1.16) | 0.099 |
| **Income category (low vs. high)** | | |
| < $30,000 | 2.23 (0.86; 5.77) | 0.099 |
| $30,000–$59,999 | 2.78 (1.16; 6.66) | 0.022 |
| $60,000–$79,999 | 3.51 (1.27; 9.76) | 0.016 |
| ≥ $80,000 | (reference) | |
| **Follows cooking and storage instructions on food labels:** | | |
| Yes vs. no (reference) | 2.94 (1.08; 8.02) | 0.035 |

Abbreviations: OR = odds ratio; CI = confidence interval.

for foodborne illness, but only 10% of older respondents considered themselves to be at a greater risk than average for complications from foodborne illness *(14)*. Moreover, older people do not like to be labelled as old *(47)*, partly due to factors such as ageism and declining self-image with increasing age *(27, 47)*. The Public Health Agency of Canada (PHAC) recommends that campaigns avoid ageist language (e.g., "feeble") and instead use more appropriate terms (e.g., seniors, older persons, older adults) *(32)*. However, education materials intended for older adults using this language may still result in younger groups (age 60–69) avoiding them because of societal perceptions. Campaigns should be carefully crafted to appeal to this group as much as possible (e.g., avoid exclusive imagery of advanced seniors, use inclusive language).

Most participants failed to refrigerate raw meats, poultry, and seafood safely, in that they did not store them on the bottom shelf as a cross-contamination prevention measure. Although the literature has not recorded such similarly low proportions, studies that have measured this practice have shown that it is in general underperformed in this group of consumers *(14, 19, 52)*. The PHAC's Foodbook report on food exposures showed that 66% of seniors reported consuming seafood, which is a greater figure than for any other age demographic *(34)*. Thus, increased efforts may be necessary to educate older adults on the risks associated with consuming contaminated seafood as well as on safe storage practices, to improve their attitudes and intentions to perform safe food handling.

Those in the highest income category were less likely to store meats, poultry, and fish safely in the refrigerator. Partic-

ipants with a high school education were more likely to store meats properly in the refrigerator than were those with some college or university education. There is evidence that those with higher education and income take more risks, such as consuming high-risk foods (e.g., runny eggs, undercooked meats) and having poorer food safety practices in general *(1, 6, 7, 30)*. The results from the current analysis were not unanimous across all models in showing that highly educated individuals and high earners had poorer practices than those in lower categories, but it is worth noting that these subgroups could benefit from receiving food safety education.

In all analyses, women were more likely than men to perform safe storage practices. Previous studies have shown that women and older individuals spend more time cooking at home *(1, 50)*, and women report having the main responsibility for meal preparation in their household *(15, 41)*. A meta-analysis of consumer food safety knowledge and practices found that women were generally more knowledgeable and had better practices, compared with men *(30)*. Recommendations from previous research include that food safety education be targeted to improve the practices of men *(1, 7)*. There is evidence that social responsibilities impact men's cooking at home *(48, 49)*. One possible approach of improving food safety among men could be appealing to their subjective norm by outlining the importance of how their significant other and family would expect them to perform safe practices at home, and how the impact of one's own practices can affect others in the same household *(24, 38)*.

The current study found that those who followed food label instructions were also more likely to store meats safely in the refrigerator. This is perhaps due to better food safety attitudes and perceived behavioral control among the seniors who read labels, which translates to better food handling *(63)*. Perceived control has been shown to be a strong predictor of various food handling intentions *(24, 25, 38)*, and although perceived control was not measured directly in the Foodbook survey, it is recommended that behavior change campaigns include components on controllability and self-efficacy to improve safe food handling outcomes. For instance, messaging can emphasize how simple some food safety practices can be, and campaigns could increase self-confidence among older adults by having participants demonstrate safe storage. Future surveys similar to the Foodbook study should use a theory-based approach (e.g., The Theory of Planned Behavior) to inform the development of their questionnaire. Additionally, these theories of behavior change can be used as a framework for the design of educational materials and interventions in this vulnerable population.

Some limitations were identified. First, weighting was applied to improve the quality and strength of survey data, primarily through adjustment of the province and household variables to reflect Canadian demographics. Most frequencies were unaffected after weighting, indicating a low risk. Ideally, a more robust sample design ensuring collection by province and household would have avoided the need to use weighting procedures. Second, only a small number of food handling behaviors were selected for analysis, and their determinants may not reflect other safe food handling behaviors among older adults. Food safety practice gaps within demographics cannot be generalized to other food handling outcomes at home. Third, the item on storing raw meats on the bottom shelf of the refrigerator may not provide a complete picture of safe storage. The Government of Canada recommends placing raw meats in a sealed container or wrapping them securely to prevent cross-contamination in the refrigerator *(16)*. The findings from this outcome should be interpreted with caution and should serve only as a best practice, and future questionnaires should consider other recommended practices (e.g., using sealed containers). Another key limitation of the study is that the questionnaire involved self-report measures, leading to the possibility of social desirability bias toward the interviewer and other individuals in the household who were listening in during the telephone call *(3)*. This would bias the results and overestimate the prevalence of food safety practices. Research in healthcare have found that socially desirable responses are more common with increased age, in older women, and in women of lower socioeconomic status *(12, 20, 58)*. It is unclear whether misclassification bias would be present in the results, since this study investigated only food handling outcomes, but caution is advised in interpreting the findings.

Areas for future research include identifying other poor storage habits that may be present in this demographic and performing field research in which kitchen audits and in-person observations can be conducted to acquire a better understanding of older Canadians' management of food safety. Furthermore, because so many older adults suffer from health conditions (e.g., arthritis, osteoporosis) and reduced mobility *(42)*, research should consider the impact these could have on performing safe food handling at home.

## CONCLUSIONS

Seniors are likely to engage in incorrect storage practices, putting them at greater risk of foodborne illness. The older demographic requires increased attention, considering the inevitable shift in demographics toward older adults in North America. This study successfully identified determinants of safe food storage and temperature control practices among seniors, which support and build on previous research. Although food safety messaging is typically created for all consumers, older consumers may have different food handling practices than those of other demographic groups, and it may be beneficial to have tailored messaging and interventions for seniors. Young seniors and men are key groups of older adults that need to be targeted for safe food handling interventions. Through use of ageism-free messaging along with an appropriate theory of behavior change, effective strategies might

include emphasizing improvement in attitudes, subjective norms, and perceived control to successfully improve older adults' food safety practices.

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