Older adults’ cognitive risk factors associated with listeriosis

Older adult consumer knowledge, attitudes and self-reported storage practices of ready-to-eat food products and risks associated with listeriosis

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ABSTRACT

Consumer implementation of recommended food safety practices, specifically relating to time and temperature control of ready-to-eat (RTE) food products associated with listeriosis are crucial. This is particularly the case for at-risk consumers such as older adults, given the increased listeriosis incidence reported internationally among adults aged ≥60 years. However, data detailing older adults cognitive risk factors associated with listeriosis are lacking. Combining knowledge, self-reported and attitudinal data can achieve a cumulative multi-layered in-depth understanding of consumer food safety behavior and cognition. This study aims to ascertain older adult’s cognition and behavior in relation to domestic food handling and storage practices that may increase the risks associated with *L. monocytogenes*. Older adults (≥60 years) (*n*=100) participated in an interview and questionnaire to determine knowledge, self-reported practices and attitudes towards recommended practices. Although the majority (79%) had positive attitudes towards refrigeration, 84% were unaware of recommended temperatures (5˚C) and 65% self-reported to ‘never’ check their refrigerator temperature. Whilst most (72%) were knowledgeable of ‘use-by’ dates indicating food safety and 62% reporting to ‘always’ take note; conversely, neutral attitudes were held and 67% believed it safe to eat food beyond ‘use-by’ dates and 57% reported to do so. Attitudes towards consuming foods within recommended two days of opening were neutral, with 55% aware of recommendations, <84% reported consuming RTE foods beyond recommendations. Although knowledgeable of some key practices, older adults self-report potentially unsafe practices when storing RTE-foods at home, which may increase risks associated with *L. monocytogenes*. This study has determined that older adults’ food safety cognition may impact on behaviors, understanding consumer food safety cognition is essential for developing targeted food safety education.
Data from the United Kingdom indicate that listeriosis incidence has dramatically increased in recent years (29) with the majority reported to be non-pregnancy associated cases (30) and associated with older adults (34, 55). Given the increased incidence of illness associated with *Listeria monocytogenes* among older adult consumers in the United Kingdom, research on the food handling, storage and consumption practices of older adult consumers has been recommended to determine contributory factors associated with listeriosis in the domestic kitchen (1). There is a need to establish how food is stored and handled by this consumer group and also the reasons for this.

The role of the consumer as being ‘the final line of defense’ for ensuring the safety for food products in the domestic setting is widely recognized (38, 47, 51). Consequently, specific consumer food safety recommendations exist in relation to controlling the risks associated with *L. monocytogenes* in the home kitchen: (i) following ‘use-by’ dates on unopened pre-packed ready-to-eat (RTE) food products, (ii) consuming RTE food products within two days of opening and (iii) ensuring the safe operating temperatures of domestic refrigerators (≤5˚C) (15). Implementation of such practices relating to time and temperature control of RTE food products associated with *L. monocytogenes* may reduce the risks associated with listeriosis, such practices are of particular importance to older adults as the risk of listeriosis increases with increasing age (44). Food products that are typically associated with listeriosis, are able to support *L. monocytogenes* growth (19), are often RTE (33) with extended refrigerated shelf life (35). Such foods include RTE meat products (28, 42, 56), RTE smoked fish products (24, 26, 28), dairy products (4, 40) and soft cheeses (7, 9).

Behavioral data has determined that older adults fail to adhere to recommendations which result in inadequate storage practices of RTE food (18). However, there is a need to combine such data with social cognitions including knowledge, attitudes and self-reported practices, to provide a more in-depth understanding of older adults domestic food safety practices and find out why such behaviors are implemented, cumulatively this data can be used to inform the development of risk communication (18). A review which assessed the inclusion of the key risk factors associated with listeriosis in consumer food safety studies established the need for attitudinal data, in conjunction with knowledge and self-reported practices, particularly of older adult consumers. Combining such cognitive and
behavioral findings will give a more in-depth insight to why food safety practices are implemented (17).

Self-reported data has been widely used in consumer food safety research (74 – 96% of consumer food safety studies undertaken 1977 – 2013 have included self-reported practices data) (17, 47) and is beneficial for determining an insight into consumer behavior when it is not possible to determine actual behavior through observation. Although widely used, limitations are recognized (8), self-reported practice data may be subject to social desirability bias (32), as respondents may over-report ‘good’ food safety practices or under-report ‘bad’ behaviors (16) in attempting to give what they perceive to be the correct response and portray a positive image (47, 49).

Consumer knowledge of food safety is one of the most commonly researched components of consumer food safety research (44 – 75% of studies undertaken 1977 – 2013 include assessment of consumer knowledge) (17, 47). Data on the association between knowledge and behavior suggest that no significant relationships exist between knowledge and actual behavior (14, 23, 43, 61). However, determination of knowledge and self-reported practice data does give an insight as to whether consumers are aware of food safety practices.

Attitudes can be considered to be determinants of behavior as they are reported to predispose people to certain behaviors (31). Consumer attitudes, particularly towards food safety, are understood to influence behavior (48) and give insight as to why some food safety practices are implemented and some are not. Attitudinal data have been less frequently included in consumer food safety studies than knowledge and self-reported practice data. Indeed, data regarding older adult attitudes towards risk factors associated with listeriosis in the domestic kitchen are particularly lacking (17).

Combining knowledge, self-reported and attitudinal data can achieve a cumulative multi-layered in-depth understanding to consumer food safety behaviors and cognition. Such findings can inform the development of targeted food safety educational initiatives.
Consequently, the aim of this study is to ascertain older adult consumers’ knowledge, self-reported practices and attitudes towards domestic food handling and storage practices that may increase the risks associated with *L. monocytogenes*.

**MATERIALS AND METHODS**

One hundred older adult consumers were recruited (using online advertising and posters on community notice boards) and consented to participate in the study. Predetermined recruitment criteria included being aged ≥60 years, living independently and not in residential care homes, from South Wales, UK and reported being responsible for preparing and storing raw and RTE food products at home. Supermarket vouchers worth £10 were offered to participants as an incentive for participation in the study. A review of background literature and UK consumer food safety recommendations informed the development of questions for a questionnaire and interview. Ethical approval was granted from the Cardiff School of Health Sciences (Cardiff Metropolitan University) Research Ethics Committee (Ref 2221).

**Data collection.** Collection of data was conducted at the Food Industry Centre (Cardiff Metropolitan University). Self-reported practice and knowledge data was determined using a self-complete questionnaire and attitudinal data was determined using a computer-assisted personal interview (CAPI). The questionnaire consisted of multiple choice questions based on knowledge and self-reported practices of the key practices associated with listeriosis, response scales included three point “always, sometimes, never” scales. The CAPI technique allowed for the determination of older adult consumers’ attitudes towards the key practices associated with listeriosis. The CAPI included six sections using different response scales including five point Likert-type scales to determine agreement and importance and a variation of a visual analogue scale was used to determine likelihood. Each CAPI was audio recorded and took up to 60 minutes to complete.

**Data analysis.** Data were entered and stored in a specifically designed Microsoft Access 2010 (Microsoft; Redmond, WA, USA) database and were analyzed using Microsoft Excel 2010 (Microsoft; Redmond, WA, USA). Qualitative data analysis software NVivo 10 (QSR International
Pty Ltd; Australia) was utilized for the analysis of qualitative data. Descriptive and inferential
statistics were conducted using SPSS Statistics 20 (IBM® Software Group; Chicago, IL, USA).
Validity and reliability of the methods were determined to ensure reproducibility. The internal
reliability of the Likert-type scales and a variation of a visual analogue scale used in the CAPI was
determined using a Cronbach's alpha test for coefficient of reliability. A reliability coefficient ($\alpha$
<0.86) indicating good internal consistency was determined.

RESULTS

Respondent demographic. A total of one hundred older adults’ from South Wales, UK
participated in the study. Eighty percent were female and reported being responsible for the majority
of food preparation and storage practices in the home, 44% reported to live in single person
households whereas 56% lived with others (spouse or family). The majority (86%) of participants
were ‘retired’ and reported being from socioeconomic groups ABC1 (UK upper - lower middle class
social status) (85%). The majority (65%) were aged between 60 and 69 years, 28% were aged between
70 and 79 years and 7% were over the age of 80 years.

Older adult consumers’ awareness of listeriosis and associated food products. The majority
(88%) of older adults were able to name at least one pathogen associated with foodborne illness, the
most frequently named pathogens when unprompted were *Salmonella* (62%) and *E. coli* (49%); only
20% named *L. monocytogenes* or listeriosis. Similarly, when prompted, the majority reported
awareness of *Salmonella* (99%) and *E. coli* (100%) however, a greater proportion reported awareness
of *L. monocytogenes* (87%) than when unprompted. Awareness of food products associated with *L.
monocytogenes* was lacking, with 55% unable to identify any food products associated with *L.
monocytogenes*, 9% of sample only identified one food product, 16% identifying two, 8% identifying
three, one person correctly identified six associated food products. Soft cheese and unpasteurized milk
were the food products most frequently believed to be associated with *L. monocytogenes* by older
adults in this study (see Table 1). A lack of awareness of the association of RTE meat and fish
products was determined. When prompted, 44% perceived the risk of listeriosis to be greatest for
‘pregnant women’, no participants perceived ‘themselves’ to be at risk from *L. monocytogenes*, and less than a third (30%) perceived the ‘vulnerable elderly’ to be at an increased risk of becoming ill with *L. monocytogenes*. Data indicated limited awareness of behaviors required to control the risks associated with *L. monocytogenes* whereby 18% perceived food avoidance to be a control behavior, 6% ensuring dairy produce are pasteurized and adherence to ‘use-by’ dates by 3%.

**Knowledge of risk factors associated with listeriosis.** In the UK, the ‘use-by’ dates on food products indicates the period following production that a food product can be consumed safely, the majority (72%) of older adults knew that the ‘use-by date’ was the date that was the best indicator of food being safe or not to eat. However, confusion existed as 14% of older adults thought that the ‘best before end’ date indicated food safety and 13% thought that all date labels had the same meaning or that they did not know which was the best indicator of food being safe to eat.

Older adults’ knowledge of the maximum storage length for food products associated with *L. monocytogenes* after opening or purchase was determined (Figure 1). Findings indicate that the majority of participants in this study (56 – 84%) thought that all food products associated with *L. monocytogenes* could be stored and remain safe for consumption for longer than the UK recommendation of two days after purchase or opening (15). Just over half (51%) of responding older adults were aware that, for example, smoked salmon should be stored for up to a maximum two days after opening. Overall, approximately two-thirds (69%) of older adults believed that a period longer than two days to be the maximum safe storage length, with <21% believing RTE meat products could be stored for five days or longer after purchase or opening.

Only 13% of older adults in this study knew that 5°C was the maximum operating temperature to ensure safe food storage. The majority (62%) stated that they did not know what the recommended maximum temperature should be, whilst 25% gave the incorrect answer. Cumulatively 87% did not know the recommended maximum operating temperature for domestic refrigerators.

**Attitudes towards risk factors associated with listeriosis.** Overall, the majority (73%) of older adults were found to have a neutral attitude towards food safety. Attitudinal scores of participants that
reported living alone were significantly lower than those that live with others ($U = 951.5$, $z = -1.949$, $p < 0.05$, $r = 0.19$). Attitudes towards practices that reduce the risks associated with cross-contamination such as adequate hand washing after handling raw poultry were more positive than attitudes towards listeriosis risk reducing practices. Attitudes towards ‘use-by’ dates were predominantly neutral and this indicates a lack of awareness, with 47% having a negative attitude and 42% having a positive attitude. In addition, 45% indicated that they personally do not need to follow ‘use-by’ dates to judge that food is safe to eat. Around a third (32%) had a negative attitude towards ‘use-by’ dates becoming invalid after opening and an overall neutral attitude was express towards the wastefulness of throwing food out that is past it’s ‘use-by’ dates (39% positive; 39% negative) (see Table 2).

With regards to following storage instructions, the majority (85%) had a positive attitude towards it being essential to always store food according to storage instructions to ensure that it is safe to eat. Just over half (55%) indicated a positive attitude regarding RTE foods only being safe to eat for two days after purchase, however, the majority (62%) believed that the smell and appearance of food were reliable methods of ensuring that food is safe to eat (see Table 2).

Attitudes towards domestic refrigerator safe operating temperatures determined that the majority (88%) indicated a concern about the length of time the refrigerator door is open for. Although 79% had a positive attitude towards ensuring a refrigerator runs at 5°C or less is essential for maintaining the safety of foods, only 25% had a positive attitude towards the need to check the actual temperature of the refrigerator (see Table 2).

Analysis of qualitative responses during the CAPI indicate that although older adults may be aware of the recommended practices to reduce the risks associated with listeriosis, such recommendations may not always be implemented or adhered to:

“Checking the fridge temperature? I know it’s somewhat important, although I don’t do it.”

(Participant 95. Male aged 60 – 69 years.)
“Well if it’s not too far past the use-by date, I’ve got to think about that one, ’cos, you know, well if it smells OK, I think then that it is wasteful to throw it, I would be concerned that that is wasteful.”

(Participant 100. Female aged 60 – 69 years.)

“I eat things beyond the ‘use-by’ date, I do it a lot, because I go a lot on the way it looks and smells.” (Participant 14. Female aged 60 – 69 years.)

Self-reported risk factors associated with listeriosis. The most frequently reported methods used to judge that food would be safe to eat before consumption was to check the ‘use-by’ date on food items (72%) or to consider when a food product had been opened (70%). A large proportion of older adults (<70%) also reported relying on senses of smell, taste and appearance to check if safe to eat. Although 80% of participants reported that smoked fish and shellfish would not be consumed beyond the ‘use-by’ date, older adults indicated that other food products associated with listeriosis including refrigerated packets of sliced cured meats (60%), packets of cooked sliced meats (50%) and pre-packed refrigerated pâté (40%) would be consumed beyond the ‘use-by’ date (see Table 3).

Data in Table 4 indicate that older adults do not adhere to recommendations for consumption of RTE foods associated with L. monocytogenes within two days of purchase/opening. Although the majority (89 – 94%) reported that RTE cooked fish or shellfish would be stored and consumed within two days of either purchase from the deli counter or after opening, a large number of participants indicated that after purchase/opening, they would store soft cheese (70 – 83%), cooked sliced meats (67 – 70%), sliced cured meats (47 – 78%) and pâté (62 – 38%) for durations beyond the recommended two days.

Self-reported temperature monitoring of domestic refrigerators determined that 99% of older adults in this study reported they believed their domestic refrigerator to be ‘cold enough’, however, 72% reported that they do not know the temperature of their home refrigerator. Of the 28% that reported they knew the temperature, it was determined that only 18% (5% of all older adults) stated a temperature in degrees (Celsius or Fahrenheit). Considerable confusion between the actual temperature of the refrigerator and the number displayed on the dial of the refrigerator was identified.
The reported frequency of checking refrigerator temperature is illustrated in Figure 2. It can be seen that the majority of participants (55%) reported ‘never’ checking their refrigerator operating temperature. The most reported frequency of checking refrigerator operating temperature was ‘every week’ (16%).

Statistical analyses were conducted to determine potential differences between participant demographic and self-reported practices using the Chi-square test for independence. A greater percentage of female participants (79%) reported to ‘always’ check the ‘use-by’ date on food products than male participants (45%); \(X^2(2, n = 97) = 13.890, p <0.01, \text{Cramer's } \ V = 0.378\).

**Comparison of cognitive and behavioral listeriosis risk factors.** A cumulative comparison of knowledge, attitudinal and self-reported findings from this study according to the three key practices associated with listeriosis is presented in Table 5. It can be seen that although some older adults were knowledgeable of recommendations failure to reported implementation was widespread.

Furthermore, significant associations according to older adult consumers’ cognitive and behavioral factors in relation to each of the key listeriosis risk-reducing behaviors, findings are summarized in Table 6. Key findings included the following: A negative attitude towards the importance of ‘use-by’ dates was significantly associated \((p<0.001)\) with self-report consumption of food beyond the ‘use-by’ date. No significant associations \((p>0.05)\) were determined between knowledge of ‘use-by’ dates and self-reported practices. Associations were determined between attitudes and knowledge of safe domestic refrigerator operating temperatures \((\leq 5’C)\), whereby older adults’ that were knowledgeable of recommended refrigeration temperatures were significantly more likely \((p<0.001)\) to self-report that refrigerator temperature would be checked, and older adults that had positive attitudes towards the importance of refrigeration were significantly more likely \((p<0.001)\) to self-report that refrigerator temperature would be checked. Similarly, with regards to consumption of RTE food products within two days of opening, older adults with knowledge of the maximum recommended storage length after opening were significantly more likely \((p<0.05)\) to self-report that RTE food products would be...
consumed within two days of opening, and those with a positive attitude were significantly more likely
\((p<0.05)\) to self-report that RTE food products would be consumed within two days of opening.
DISCUSSION

Cumulative findings from this study have determined that although some older adults were knowledgeable of recommended food safety practices to reduce the risks associated with listeriosis, self-reported failure to implement such practices was widespread. Furthermore, significant associations were determined between older adults’ self-reported practices according to knowledge of key practices and their attitudes towards such practices.

**Older adult consumers’ awareness of listeriosis and associated food products.** Older adult consumers in this study indicated increased awareness of *Salmonella* (99%) and *E. coli* (100%), such findings correspond with previous data suggesting consumer awareness of these pathogens (11, 57, 59). Although many reported awareness of *L. monocytogenes* (87%), more than half (55%) were unaware of food products associated with *L. monocytogenes* prevalence, soft cheese (36%) and unpasteurized milk (33%) were most frequently associated with *L. monocytogenes*. Despite being aged ≥60 years and considered to be at an increased risk of listeriosis, pregnant women (44%) were considered to be at greatest risk of listeriosis, no participants perceived themselves to be at risk from *L. monocytogenes*, thus suggesting perceived personal invulnerability, however there is a need for research to determine older adults’ perceptions of risk, control and responsibility of food safety. Only 3% identified adherence to ‘use-by’ dates as a control measure for listeriosis. Similarly, previous research suggests that fewer older adult consumers have heard of *Listeria* than other pathogens and that the majority are unaware of risk-reducing behaviors (39).

**Following ‘use-by’ dates on unopened pre-packed RTE food products.** The ‘use-by’ dates on food products in the UK is an indicator of food safety. It is essential for consumers to adhere to ‘use-by’ dates on unopened RTE food products as they are calculated to ensure that 100 CFU/g *L. monocytogenes* are not exceeded in food products that can support growth from the time of production to consumption (10, 58). Previous consumer food safety research based on respondents from the general population found that 49 – 62% of consumers were knowledgeable of ‘use-by’ dates being the best indicator of food safety (27, 45), and 46% of consumers reported to ‘never’ eat food beyond its
expiry date (41). Previous data on consumer attitudes towards adherence of ‘use-by’ dates indicated that 73 - 75% considered it was very important to avoid the consumption of foods that have expired dates (57). Although the majority (72%) of older adults in this study indicated awareness that the ‘use-by’ date was the best indicator for food safety, 66% failed to express a positive attitude towards avoiding the consumption of food beyond the ‘use-by’ date; only 39% believed that it was essential to ‘always’ eat food by the ‘use-by’ date to ensure the safety of food. Some older adults expressed concerns regarding the potential wastefulness caused by adhering to ‘use-by’ dates, indeed, the perception of wastefulness may increase the risk of foodborne listeriosis due to the prolonged storage of RTE foods that may allow for critical limits of *L. monocytogenes* to be exceeded prior to consumption.

Contradictions were determined regarding ‘use-by’ dates. Even though 62% reported to ‘always’ take note of the ‘use-by’ date of food labels, only 42 - 43% reported that they were unlikely to consume soft cheese three days beyond and cooked meat from a sealed pack two days beyond the ‘use-by’ date. In addition to this, 57% of older adults self-reported that they do consume food that have expired ‘use-by’ dates. Previous data indicate that 18 – 40% of consumers report never eating food products beyond the expiration date (17). Older adults in this study, RTE food products commonly associated with *L. monocytogenes* were frequently reported to be consumed beyond the expiry of the ‘use-by’ date, including; sliced cured meat (60%), sliced cooked meat (50%), pâté (40%), pre-pared salad bags (65%). A significantly greater (*p* <0.01) percentage of female participants (79%) reported to ‘always’ check the ‘use-by’ date on food products than male participants (45%), such demographic differences in self-reported practices may be utilized to inform the development of targeted consumer food safety education.

Although knowledge of ‘use-by’ dates was determined to be greater among the older adult consumers of this study than among consumers from the general population (27, 45), self-reported consumption of food products beyond the ‘use-by’ date was reported by a larger proportion of older adults (41). Unsurprisingly, negative attitudes towards the importance of ‘use-by’ were significantly associated (*p*<0.001) with self-reported consumption of food beyond the ‘use-by’ date. Such findings
have implications for the development of food safety education whereby influencing attitudinal change may be of benefit among older adults rather than solely raising awareness and increasing knowledge.

Ensuring refrigerator operating temperature is ≤5.0°C. Given the ability of *L. monocytogenes* to survive and grow at refrigeration temperatures (2), refrigeration temperatures are critical in controlling *L. monocytogenes* (35), therefore refrigeration temperatures ≤5.0°C are recommended to safeguard consumers from the risks associated with listeriosis (15, 20). Previous food safety research involving consumers from the general population has determined that large proportions of consumers lack knowledge of safe refrigeration temperatures. Indeed, 93% of Irish consumers (25), 79 - 84% of UK consumers (22, 52), 68% Australian consumers (36) and 44% Slovenian consumers (37), reportedly lacked knowledge of recommended refrigeration temperatures. Previous studies indicate positive consumer attitudes towards refrigeration, with 97% of consumers believing it to be important to keep a refrigerator at the correct temperature (25). However, self-report data have determined that 65% consumers in Trinidad (5); 71% UK consumers (60); 75% Australian consumers (36), reportedly do not or have never checked/measure the operating temperature of their refrigerator. Failure to ensure safe refrigeration temperatures may have implications for food safety.

Although the majority of older adults’ (79%) had a positive attitude towards refrigeration temperatures being essential to maintain food safety, fewer (52%) had a positive attitude towards the importance of actually checking that the refrigerator is operating between 0 - 5.0°C. Despite the majority of older adults in this study (72%) reporting that they did not know the operating temperature of their domestic refrigerator, 65% reported to ‘never’ check that their refrigerator is operating between 0 - 5.0°C and 44% reported that they do not check if their refrigerator is cold. Additionally, findings indicate that the majority of older adults (87%) do not know that 5.0°C is the recommended maximum operating temperature of a domestic refrigerator to ensure the safety of food.

Although older adult knowledge of safe refrigeration temperatures concur with previous research that indicate the majority of consumers from the general population are also unaware of recommended temperatures (22, 25, 52); attitudes towards the importance of refrigeration and checking refrigeration
temperatures were less positive among older adults’ than the general population (25). Self-reported checking of refrigerator operating temperature among older adults’ corresponded to that of the general population (5, 60). Significant associations (p<0.001) were determined between knowledge and positive attitudes towards recommended refrigeration temperatures and self-reported frequency of checking refrigerator operating temperatures. Consequently, such findings have implications for food safety educators as older adults lack awareness of refrigeration temperatures, failure to check operating temperature may result in older adults unintendedly storing RTE food products at potentially unsafe temperatures that can increase the risk of listeriosis.

**Consuming RTE food products within two days of opening.** Modified atmosphere packaging (MAP) is commonly used to extend the shelf life of RTE food products (6, 53), however post-opening of such packaging will result in increased levels of *L. monocytogenes* (54). It is reported that the risk of listeriosis can be decreased by reducing the storage length of deli meats (21, 35). Consequently, recommendations indicate that RTE food products should be consumed within two days of purchase or opening (15). A lack of consumer food safety data relating to the adherence of storage duration guidelines has been identified, particularly in relation to consumer attitudes (17). However, previous data indicate that the majority of consumers (96%) were aware that the improper storage of food may represented a health hazard (3) and 40 - 69% reported to ‘always/usually’ follow manufacturer’s instructions for storage of food products (25, 45); furthermore the majority of consumers have reported consumption of foods within two days of purchase/opening (41).

This study has undertaken an in-depth cognitive analysis of food storage practices post-opening packaging of RTE foods. Findings indicate that the majority (68%) of older adults had positive attitudes towards the importance of consuming RTE food within two days of preparing, opening or purchase, but knowledge of recommended safe storage length after opening RTE food was lacking, with 56 – 84% believing that RTE foods associated with *L. monocytogenes* could be stored beyond the recommended two days after purchase or opening. Furthermore, many older adults reported prolonged storage of RTE food beyond the recommended two days in the home; with only 28% reporting that
RTE food would be consumed within the two days. In addition, older adults reported that RTE food products from the delicatessen counter (70% soft cheese and 47% sliced cured meat) would be stored and intended for consumption beyond the recommended two days after purchase and pre-packed RTE foods were reported to be stored for durations exceeding recommendations (83% soft cheese, 78% sliced cured meat, 70% sliced cooked meats and 62% pâté). Findings suggest that older adults frequently consume RTE food products associated with *L. monocytogenes* subjected to prolonged storage which may increase the risk of listeriosis.

A comparison of the results from this study specific to findings relating to storage of opened RTE food products was limited due to the lack of previous data. Although positive attitudes towards the importance of storage and consumption of opened RTE food were expressed by the majority of older adults, self-reported data did not concur with recommended practices. Storage of RTE food products for prolonged times was reportedly wide-spread among older adults which does not compare with previous research where the majority of consumers from the general population are reported to consume RTE food products within two days (40). Older adult knowledge and positive attitudes towards consuming food within two days of opening/purchasing were significantly associated with the self-reported frequency of consuming food within recommendations, such findings can be utilized to design and develop food safety education to increase awareness and improve attitudes to enable behavioral change when storing RTE food products in the home after opening.
Conclusions. Although the majority of older adults reported to be aware of listeriosis, only around a third were aware of associated food products. Cumulatively, older adult consumers’ knowledge of key practices required to reduce the risks associated with listeriosis were comparable to consumers of the general population. However, self-reported practices relating to ‘use-by’ date adherence and storage of opened RTE food were determined to be lower among older adults than data suggest for the general population. Furthermore, older adults’ attitudes towards the three key risk-reducing storage practices were more negative than those of general population consumers. Such findings can have implications for the safety of food in older adult domestic kitchens.

This research study has not only addressed the identified lack of older adults’ food safety cognitive data by combining data collection methods and measures; it has identified the potential risk factors associated with listeriosis in older adults’ domestic food safety practices, self-reported malpractices among older adults were determined to be greater than literature suggests for consumers from the general population.

There is a need to improve older adult consumers’ food safety behavioral practices related to the key storage practices to reduce the risk of listeriosis, cognitive data such as data collated in this study is needed to inform development of targeted food safety educational initiatives. From this study, it can be suggested that to enable a behavioral change to reduce the potential risks associated with listeriosis among older adults, there is a need to make older adults aware of the potential risk to them from *L. monocytogenes* and the association to practices which they may fail to implement in the domestic kitchen.

However, given that it has been determined in this research study that no significant associations existed between older adults’ knowledge and attitudes towards the key food safety practices required to reduce the risks associated with *L. monocytogenes*. Furthermore, attitudes were significantly associated with self-reported practices. Consideration is given to the impact of attitudes on the implementation of food safety practices as consumer attitudes have been determined to be significant determinants of consumer behaviors (50).
Given that attitudes have been reported to be a determinant of behavior, findings from this study regarding older adults’ attitudes towards ‘use-by’ dates, post-opening storage durations and refrigerator operating temperatures were significantly associated with self-reported practices. Therefore an initiative to approach attitudes may help to increase implementation of risk reducing food storage behaviors. Consequently, to enable the development of targeted consumer food safety education that aims to reduce the risks of listeriosis among the older adult age group by improving the implementation of food safety practices, there is a need to direct educational efforts to change older adult consumers’ attitudes and not only increase knowledge.

Furthermore, the industry may be able to reduce the risks associated with listeriosis through the development of intelligent refrigerator designs, the incorporation of integral thermometers and accurately calibrated thermostats would aid future consumers in preventing inadequate storage temperatures in the home, without behavior modification such as purchase, usage and calibration of thermometer, similarly the availability of smaller food packages may prevent consumers from subjecting RTE food products to prolonged storage after opening.

Potential limitations acknowledged and considered in this study include the potential for social desirability bias and issues relating to consumers over-reporting ‘good’ behaviors determined from self-reported practices. Furthermore, research indicates that discrepancies may exist between self-reported practices and actual behaviors (12, 13, 46). Despite this, considerable proportions of older adult consumers reported implementation of food safety malpractices associated with listeriosis. Furthermore, findings from this study are important for determining needs for food safety communication initiatives as findings from this study suggest many reported malpractices.

There is a need to combine the findings of this research study with ‘in home’ observed domestic kitchen behaviors associated with listeriosis. Such data would provide a more detailed understanding of how older adults’ cognition of listeriosis risk factors impact upon handling practices of RTE food products and implementation of food safety behaviors in the domestic kitchen. Such findings would give a greater understanding of the cognitive and behavioral associations of listeriosis risk factors in
the domestic kitchen that would inform food safety educators to facilitate the design and development of targeted food safety education for older adults to reduce incidence of listeriosis.
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REFERENCES


Figure legends

FIGURE 1. Frequency of knowledge of recommended storage length for food products associated with listeriosis after purchase or opening

FIGURE 2. Reported frequency of checking refrigerator operating temperature ($n = 100$)
Table 1 Awareness of food products associated with *L. monocytogenes* among older adults

<table>
<thead>
<tr>
<th>Food products</th>
<th>n</th>
<th>Aware of the association with <em>L. monocytogenes</em> (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft cheese</td>
<td>100</td>
<td>36</td>
</tr>
<tr>
<td>Unpasteurized milk</td>
<td>100</td>
<td>33</td>
</tr>
<tr>
<td>Pâté</td>
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<td>13</td>
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<tr>
<td>Smoked salmon</td>
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<td>Pre-packed sandwiches</td>
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</tr>
<tr>
<td>Pre-packed salads</td>
<td>89</td>
<td>3</td>
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<tr>
<td>Sliced cured meat</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>Cooked sliced meat</td>
<td>100</td>
<td>0</td>
</tr>
</tbody>
</table>
Table 2 Older adult attitudes towards recommended food safety practices

<table>
<thead>
<tr>
<th>Attitudes towards food safety</th>
<th>n</th>
<th>Positive attitude (%)</th>
<th>Neutral attitude (%)</th>
<th>Negative attitude (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am concerned about the length of time the refrigerator door is open for</td>
<td>100</td>
<td>88</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>It is essential to always store food according to storage instructions to ensure that it is</td>
<td>99</td>
<td>85</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>maintaining the safety of foods</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ensuring a refrigerator runs at 5°C or less is essential for</td>
<td>97</td>
<td>79</td>
<td>18</td>
<td>3</td>
</tr>
<tr>
<td>Chilled ready-to-eat foods are only safe to eat for two days after purchase</td>
<td>89</td>
<td>55</td>
<td>16</td>
<td>29</td>
</tr>
<tr>
<td>Chilled ready-to-eat food out of the refrigerator is safe to eat as long as it not eaten after</td>
<td>88</td>
<td>52</td>
<td>17</td>
<td>31</td>
</tr>
<tr>
<td>Four hours</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>‘use-by’ dates become invalid once a food item is opened</td>
<td>98</td>
<td>46</td>
<td>22</td>
<td>32</td>
</tr>
<tr>
<td>It is essential to always eat food by the ‘use-by’ date to ensure that it is safe to eat</td>
<td>100</td>
<td>39</td>
<td>19</td>
<td>42</td>
</tr>
<tr>
<td>I am not concerned about eating food past its ‘use-by’ date</td>
<td>100</td>
<td>47</td>
<td>19</td>
<td>34</td>
</tr>
<tr>
<td>A sealed pack of sliced cooked ham, two days past it’s ‘use-by’ date is still safe to eat</td>
<td>98</td>
<td>48</td>
<td>18</td>
<td>34</td>
</tr>
<tr>
<td>Other people need ‘use-by’ dates more than I do</td>
<td>99</td>
<td>34</td>
<td>34</td>
<td>31</td>
</tr>
<tr>
<td>Following ‘use-by’ dates will not reduce the likelihood of food poisoning</td>
<td>100</td>
<td>54</td>
<td>21</td>
<td>25</td>
</tr>
<tr>
<td>There is no need to check the actual temperature of my refrigerator</td>
<td>100</td>
<td>51</td>
<td>24</td>
<td>25</td>
</tr>
<tr>
<td>I do not need to follow storage instructions to ensure that food is safe to eat</td>
<td>100</td>
<td>76</td>
<td>3</td>
<td>21</td>
</tr>
<tr>
<td>Following on-pack storage guidance will not reduce the likelihood of food poisoning</td>
<td>100</td>
<td>69</td>
<td>12</td>
<td>19</td>
</tr>
<tr>
<td>Storage instructions on foods are for inexperienced cooks</td>
<td>100</td>
<td>71</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Chilled ready-to-eat foods out of the refrigerator are safe to eat as long as they are eaten</td>
<td>100</td>
<td>24</td>
<td>12</td>
<td>65</td>
</tr>
<tr>
<td>on the same day</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The smell and appearance of food means that you can tell if it is safe to eat</td>
<td>90</td>
<td>26</td>
<td>12</td>
<td>62</td>
</tr>
<tr>
<td>It is safe to eat sliced cooked ham from an opened packet as long as it is within the ‘use-by’</td>
<td>97</td>
<td>32</td>
<td>18</td>
<td>51</td>
</tr>
<tr>
<td>date</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I personally do not need to follow ‘use-by’ dates to judge that food is safe to eat</td>
<td>100</td>
<td>45</td>
<td>13</td>
<td>42</td>
</tr>
<tr>
<td>Throwing food out that is only a few days past it’s ‘use-by’ date is wasteful</td>
<td>100</td>
<td>39</td>
<td>22</td>
<td>39</td>
</tr>
</tbody>
</table>
Table 3 Reported consumption of food products after expired 'use-by' date

<table>
<thead>
<tr>
<th>Food products</th>
<th>n</th>
<th>Same day / Never after 'use by date' (%)</th>
<th>After the ‘use-by’ date (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoked fish and shellfish</td>
<td>79</td>
<td>81</td>
<td>19</td>
</tr>
<tr>
<td>Tub/pre-packed refrigerated pâté</td>
<td>74</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>Refrigerated packets of cooked sliced meats</td>
<td>82</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Container of soft cheese/spread</td>
<td>84</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>Refrigerated packets of sliced cured meats</td>
<td>74</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>Pre-packed mixed salad bags</td>
<td>80</td>
<td>36</td>
<td>64</td>
</tr>
<tr>
<td>Packs of pre-cut fruits</td>
<td>52</td>
<td>59</td>
<td>41</td>
</tr>
</tbody>
</table>
Table 4: Self-reported storage of food products associated with *L. monocytogenes* after purchase/opening.

<table>
<thead>
<tr>
<th>Food products associated with <em>L. monocytogenes</em></th>
<th>Reported storage after purchase/opening</th>
<th>n</th>
<th>≤2days (%)</th>
<th>&gt;2days (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooked fish or shellfish from the deli counter</td>
<td></td>
<td>71</td>
<td>94</td>
<td>6</td>
</tr>
<tr>
<td>Cut fresh pâté from the deli counter</td>
<td></td>
<td>60</td>
<td>77</td>
<td>23</td>
</tr>
<tr>
<td>Cooked sliced meat from the deli counter</td>
<td></td>
<td>84</td>
<td>67</td>
<td>33</td>
</tr>
<tr>
<td>Items from the salad counter</td>
<td></td>
<td>80</td>
<td>59</td>
<td>41</td>
</tr>
<tr>
<td>Sliced cured meats from the deli counter</td>
<td></td>
<td>73</td>
<td>53</td>
<td>47</td>
</tr>
<tr>
<td>Soft cheeses from the deli counter</td>
<td></td>
<td>77</td>
<td>30</td>
<td>70</td>
</tr>
<tr>
<td>Refrigerated packet of RTE cooked fish and shellfish</td>
<td></td>
<td>78</td>
<td>89</td>
<td>12</td>
</tr>
<tr>
<td>Refrigerated packs of pre-cut fruits</td>
<td></td>
<td>41</td>
<td>56</td>
<td>44</td>
</tr>
<tr>
<td>Refrigerated packet of smoked fish</td>
<td></td>
<td>80</td>
<td>53</td>
<td>48</td>
</tr>
<tr>
<td>Pre-packed mixed salad bags</td>
<td></td>
<td>80</td>
<td>41</td>
<td>59</td>
</tr>
<tr>
<td>Refrigerated packet of pâté</td>
<td></td>
<td>73</td>
<td>38</td>
<td>62</td>
</tr>
<tr>
<td>Refrigerated packet of cooked sliced meats</td>
<td></td>
<td>83</td>
<td>30</td>
<td>70</td>
</tr>
<tr>
<td>Refrigerated packet of sliced cured meats</td>
<td></td>
<td>74</td>
<td>22</td>
<td>78</td>
</tr>
<tr>
<td>Refrigerated pack/container of soft cheese</td>
<td></td>
<td>77</td>
<td>17</td>
<td>83</td>
</tr>
</tbody>
</table>
Table 5 Cumulative comparison of older adults’ knowledge, attitudes and self-reported practices relating to the three key practices associated with the risk of listeriosis in the domestic kitchen

<table>
<thead>
<tr>
<th>Three key practices associated with the risk of listeriosis</th>
<th>Adequate refrigeration temperature (5°C)</th>
<th>Following ‘use-by’ dates on RTE foods</th>
<th>Consuming RTE food within two days of opening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>87% did not know the recommended refrigeration temperatures (5°C).</td>
<td>72% knew that the ‘use-by’ date was the best indicator of food safety.</td>
<td>56 – 84% thought that RTE food could be consumed beyond the recommended two days after opening.</td>
</tr>
<tr>
<td>Attitudes</td>
<td>52% had a positive attitude towards checking the operating temperature of the refrigerator.</td>
<td>66% had a negative attitude towards consuming food with expired ‘use-by’ dates.</td>
<td>68% had a positive attitude towards the importance of consuming RTE food within two days of opening.</td>
</tr>
<tr>
<td>Self-reported practice</td>
<td>65% reported to ‘never’ check refrigerator temperature.</td>
<td>57% reported keeping and consuming food beyond the ‘Use-by’ dates.</td>
<td>72% failed to report that RTE food would ‘always’ be consumed within two days of opening.</td>
</tr>
</tbody>
</table>
Table 6 Statistical associations determined between cognitive findings relating to listeriosis risk factors

<table>
<thead>
<tr>
<th>Three key practices associated with the risk of listeriosis</th>
<th>Statistical associations</th>
<th>Attitudes</th>
<th>Self-reported practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Following ‘use-by’ dates on unopened pre-packed RTE food products</td>
<td>Knowledge</td>
<td>$p &gt; 0.05$</td>
<td>$p &gt; 0.05$</td>
</tr>
<tr>
<td></td>
<td>Attitudes</td>
<td>-</td>
<td>$X^2(2, n=100) = 30.214, p = 0.000,$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cramer’s $V = 0.550$</td>
</tr>
<tr>
<td>Ensure refrigerator is operating at $\leq 5°C$</td>
<td>Knowledge</td>
<td>$p &gt; 0.05$</td>
<td>$X^2(2, n=100) = 19.191, p = 0.000,$</td>
</tr>
<tr>
<td></td>
<td>Attitudes</td>
<td>-</td>
<td>Cramer’s $V = 0.438$</td>
</tr>
<tr>
<td>Consuming RTE food products within two days of opening</td>
<td>Knowledge</td>
<td>$p &gt; 0.05$</td>
<td>$X^2(2, n=80) = 7.738, p = 0.021,$</td>
</tr>
<tr>
<td></td>
<td>Attitudes</td>
<td>-</td>
<td>Cramer’s $V = 0.319$</td>
</tr>
</tbody>
</table>

$X^2 = \text{Pearson Chi-Square test for independence with Cramer’s V indicating the effect size of the association}$
Figure 1.

Food products associated with listeriosis

- Soft cheese from the deli counter (n=77)
- A pack of sliced cooked meat (n=83)
- A pack of pâté (n=73)
- A pack of smoked salmon (n=80)
- Sliced cured meat from the deli counter (n=73)

<2 days  ≥2 days
Figure 2.

Reported frequency of checking

- Do not check
- Every day
- Every week
- Every month
- Every 3 months
- Twice a year
- Less than once a year

(%)