

1 Research Paper

2 Older adults' cognitive risk factors associated with listeriosis

3

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

6 **Ellen W. Evans^{1*} and Elizabeth C. Redmond¹**

7

8 ¹Zero2Five° Food Industry Centre, Cardiff Metropolitan University, Western Avenue, Llandaff,
9 Cardiff, Wales CF5 2YB

10

11

12

13

14

15

16 Keywords: Consumer food safety, domestic kitchen, listeriosis, older adults, storage practices,
17 knowledge, attitudes, self-reported practices

* Author for correspondence. Tel: +44 (0)29 2020 5836; Fax: +44 (0)29 2041 6982; E-mail: elevans@cardiffmet.ac.uk

ABSTRACT

1
2 Consumer implementation of recommended food safety practices, specifically relating to time and
3 temperature control of ready-to-eat (RTE) food products associated with listeriosis are crucial. This is
4 particularly the case for at-risk consumers such as older adults, given the increased listeriosis
5 incidence reported internationally among adults aged ≥ 60 years. However, data detailing older adults
6 cognitive risk factors associated with listeriosis are lacking. Combining knowledge, self-reported and
7 attitudinal data can achieve a cumulative multi-layered in-depth understanding of consumer food
8 safety behavior and cognition. This study aims to ascertain older adult's cognition and behavior in
9 relation to domestic food handling and storage practices that may increase the risks associated with *L.*
10 *monocytogenes*. Older adults (≥ 60 years) ($n=100$) participated in an interview and questionnaire to
11 determine knowledge, self-reported practices and attitudes towards recommended practices. Although
12 the majority (79%) had positive attitudes towards refrigeration, 84% were unaware of recommended
13 temperatures (5°C) and 65% self-reported to 'never' check their refrigerator temperature. Whilst most
14 (72%) were knowledgeable of 'use-by' dates indicating food safety and 62% reporting to 'always'
15 take note; conversely, neutral attitudes were held and 67% believed it safe to eat food beyond 'use-by'
16 dates and 57% reported to do so. Attitudes towards consuming foods within recommended two days of
17 opening were neutral, with 55% aware of recommendations, <84% reported consuming RTE foods
18 beyond recommendations. Although knowledgeable of some key practices, older adults self-report
19 potentially unsafe practices when storing RTE-foods at home, which may increase risks associated
20 with *L. monocytogenes*. This study has determined that older adults' food safety cognition may impact
21 on behaviors, understanding consumer food safety cognition is essential for developing targeted food
22 safety education.

1 Data from the United Kingdom indicate that listeriosis incidence has dramatically increased in
2 recent years (29) with the majority reported to be non-pregnancy associated cases (30) and associated
3 with older adults (34, 55). Given the increased incidence of illness associated with *Listeria*
4 *monocytogenes* among older adult consumers in the United Kingdom, research on the food handling,
5 storage and consumption practices of older adult consumers has been recommended to determine
6 contributory factors associated with listeriosis in the domestic kitchen (1). There is a need to establish
7 how food is stored and handled by this consumer group and also the reasons for this.

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

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

1 behavioral findings will give a more in-depth insight to why food safety practices are implemented
2 (17).

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

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

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

22 Combining knowledge, self-reported and attitudinal data can achieve a cumulative multi-layered
23 in-depth understanding to consumer food safety behaviors and cognition. Such findings can inform the
24 development of targeted food safety educational initiatives.

1 Pty Ltd; Australia) was utilized for the analysis of qualitative data. Descriptive and inferential
2 statistics were conducted using SPSS Statistics 20 (IBM® Software Group; Chicago, IL, USA).
3 Validity and reliability of the methods were determined to ensure reproducibility. The internal
4 reliability of the Likert-type scales and a variation of a visual analogue scale used in the CAPI was
5 determined using a Cronbach's alpha test for coefficient of reliability. A reliability coefficient (α
6 <0.86) indicating good internal consistency was determined.

7 **RESULTS**

8 **Respondent demographic.** A total of one hundred older adults' from South Wales, UK
9 participated in the study. Eighty percent were female and reported being responsible for the majority
10 of food preparation and storage practices in the home, 44% reported to live in single person
11 households whereas 56% lived with others (spouse or family). The majority (86%) of participants
12 were 'retired' and reported being from socioeconomic groups ABC1 (UK upper - lower middle class
13 social status) (85%). The majority (65%) were aged between 60 and 69 years, 28% were aged between
14 70 and 79 years and 7% were over the age of 80 years.

15 **Older adult consumers' awareness of listeriosis and associated food products.** The majority
16 (88%) of older adults were able to name at least one pathogen associated with foodborne illness, the
17 most frequently named pathogens when unprompted were *Salmonella* (62%) and *E. coli* (49%); only
18 20% named *L. monocytogenes* or listeriosis. Similarly, when prompted, the majority reported
19 awareness of *Salmonella* (99%) and *E. coli* (100%) however, a greater proportion reported awareness
20 of *L. monocytogenes* (87%) than when unprompted. Awareness of food products associated with *L.*
21 *monocytogenes* was lacking, with 55% unable to identify any food products associated with *L.*
22 *monocytogenes*, 9% of sample only identified one food product, 16% identifying two, 8% identifying
23 three, one person correctly identified six associated food products. Soft cheese and unpasteurized milk
24 were the food products most frequently believed to be associated with *L. monocytogenes* by older
25 adults in this study (see Table 1). A lack of awareness of the association of RTE meat and fish
26 products was determined. When prompted, 44% perceived the risk of listeriosis to be greatest for

1 'pregnant women', no participants perceived 'themselves' to be at risk from *L. monocytogenes*, and
2 less than a third (30%) perceived the 'vulnerable elderly' to be at an increased risk of becoming ill
3 with *L. monocytogenes*. Data indicated limited awareness of behaviors required to control the risks
4 associated with *L. monocytogenes* whereby 18% perceived food avoidance to be a control behavior,
5 6% ensuring dairy produce are pasteurized and adherence to 'use-by' dates by 3%.

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

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

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

25 **Attitudes towards risk factors associated with listeriosis.** Overall, the majority (73%) of older
26 adults were found to have a neutral attitude towards food safety. Attitudinal scores of participants that

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

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

15 Attitudes towards domestic refrigerator safe operating temperatures determined that the majority
16 (88%) indicated a concern about the length of time the refrigerator door is open for. Although 79%
17 had a positive attitude towards ensuring a refrigerator runs at 5°C or less is essential for maintaining
18 the safety of foods, only 25% had a positive attitude towards the need to check the actual temperature
19 of the refrigerator (see Table 2).

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

23 *“Checking the fridge temperature? I know it’s somewhat important, although I don’t do it.”*
24 (Participant 95. Male aged 60 – 69 years.)

1 *“Well if it’s not too far past the use-by date, I’ve got to think about that one, ’cos, you know, well*
2 *if it smells OK, I think then that it is wasteful to throw it, I would be concerned that that is wasteful.”*
3 (Participant 100. Female aged 60 – 69 years.)

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

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

14 Data in Table 4 indicate that older adults do not adhere to recommendations for consumption of
15 RTE foods associated with *L. monocytogenes* within two days of purchase/opening. Although the
16 majority (89 – 94%) reported that RTE cooked fish or shellfish would be stored and consumed within
17 two days of either purchase from the deli counter or after opening, a large number of participants
18 indicated that after purchase/opening, they would store soft cheese (70 – 83%), cooked sliced meats
19 (67 – 70%), sliced cured meats (47 – 78%) and pâté (62 – 38%) for durations beyond the
20 recommended two days.

21 Self-reported temperature monitoring of domestic refrigerators determined that 99% of older
22 adults in this study reported they believed their domestic refrigerator to be ‘cold enough’, however,
23 72% reported that they do not know the temperature of their home refrigerator. Of the 28% that
24 reported they knew the temperature, it was determined that only 18% (5% of all older adults) stated a
25 temperature in degrees (Celsius or Fahrenheit). Considerable confusion between the actual
26 temperature of the refrigerator and the number displayed on the dial of the refrigerator was identified.

1 The reported frequency of checking refrigerator temperature is illustrated in Figure 2. It can be seen
2 that the majority of participants (55%) reported ‘never’ checking their refrigerator operating
3 temperature. The most reported frequency of checking refrigerator operating temperature was ‘every
4 week’ (16%).

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

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

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

- 1 consumed within two days of opening, and those with a positive attitude were significantly more likely
- 2 ($p < 0.05$) 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

1 expiry date (41). Previous data on consumer attitudes towards adherence of ‘use-by’ dates indicated
2 that 73 - 75% considered it was very important to avoid the consumption of foods that have expired
3 dates (57). Although the majority (72%) of older adults in this study indicated awareness that the ‘use-
4 by’ date was the best indicator for food safety, 66% failed to express a positive attitude towards
5 avoiding the consumption of food beyond the ‘use-by’ date; only 39% believed that it was essential to
6 ‘always’ eat food by the ‘use-by’ date to ensure the safety of food. Some older adults expressed
7 concerns regarding the potential wastefulness caused by adhering to ‘use-by’ dates, indeed, the
8 perception of wastefulness may increase the risk of foodborne listeriosis due to the prolonged storage
9 of RTE foods that may allow for critical limits of *L. monocytogenes* to be exceeded prior to
10 consumption.

11 Contradictions were determined regarding ‘use-by’ dates. Even though 62% reported to ‘always’
12 take note of the ‘use-by’ date of food labels, only 42 - 43% reported that they were unlikely to
13 consume soft cheese three days beyond and cooked meat from a sealed pack two days beyond the
14 ‘use-by’ date. In addition to this, 57% of older adults self-reported that they do consume food that
15 have expired ‘use-by’ dates. Previous data indicate that 18 – 40% of consumers report never eating
16 food products beyond the expiration date (17). Older adults in this study, RTE food products
17 commonly associated with *L. monocytogenes* were frequently reported to be consumed beyond the
18 expiry of the ‘use-by’ date, including; sliced cured meat (60%), sliced cooked meat (50%), pâté
19 (40%), pre-pared salad bags (65%). A significantly greater ($p < 0.01$) percentage of female participants
20 (79%) reported to ‘always’ check the ‘use-by’ date on food products than male participants (45%),
21 such demographic differences in self-reported practices may be utilized to inform the development of
22 targeted consumer food safety education.

23 Although knowledge of ‘use-by’ dates was determined to be greater among the older adult
24 consumers of this study than among consumers from the general population (27, 45), self-reported
25 consumption of food products beyond the ‘use-by’ date was reported by a larger proportion of older
26 adults (41). Unsurprisingly, negative attitudes towards the importance of ‘use-by’ were significantly
27 associated ($p < 0.001$) with self-reported consumption of food beyond the ‘use-by’ date. Such findings

1 have implications for the development of food safety education whereby influencing attitudinal change
2 may be of benefit among older adults rather than solely raising awareness and increasing knowledge.

3 **Ensuring refrigerator operating temperature is $\leq 5.0^{\circ}\text{C}$.** Given the ability of *L. monocytogenes*
4 to survive and grow at refrigeration temperatures (2), refrigeration temperatures are critical in
5 controlling *L. monocytogenes* (35), therefore refrigeration temperatures $\leq 5.0^{\circ}\text{C}$ are recommended to
6 safeguard consumers from the risks associated with listeriosis (15, 20). Previous food safety research
7 involving consumers from the general population has determined that large proportions of consumers
8 lack knowledge of safe refrigeration temperatures. Indeed, 93% of Irish consumers (25), 79 - 84% of
9 UK consumers (22, 52), 68% Australian consumers (36) and 44% Slovenian consumers (37),
10 reportedly lacked knowledge of recommended refrigeration temperatures. Previous studies indicate
11 positive consumer attitudes towards refrigeration, with 97% of consumers believing it to be important
12 to keep a refrigerator at the correct temperature (25). However, self-report data have determined that
13 65% consumers in Trinidad (5); 71% UK consumers (60); 75% Australian consumers (36), reportedly
14 do not or have never checked/measure the operating temperature of their refrigerator. Failure to ensure
15 safe refrigeration temperatures may have implications for food safety.

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

24 Although older adult knowledge of safe refrigeration temperatures concur with previous research
25 that indicate the majority of consumers from the general population are also unaware of recommended
26 temperatures (22, 25, 52); attitudes towards the importance of refrigeration and checking refrigeration

1 temperatures were less positive among older adults' than the general population (25). Self-reported
2 checking of refrigerator operating temperature among older adults' corresponded to that of the general
3 population (5, 60). Significant associations ($p<0.001$) were determined between knowledge and
4 positive attitudes towards recommended refrigeration temperatures and self-reported frequency of
5 checking refrigerator operating temperatures. Consequently, such findings have implications for food
6 safety educators as older adults lack awareness of refrigeration temperatures, failure to check
7 operating temperature may result in older adults unintendedly storing RTE food products at potentially
8 unsafe temperatures that can increase the risk of listeriosis.

9 **Consuming RTE food products within two days of opening.** Modified atmosphere packaging
10 (MAP) is commonly used to extend the shelf life of RTE food products (6, 53), however post-opening
11 of such packaging will result in increased levels of *L. monocytogenes* (54). It is reported that the risk
12 of listeriosis can be decreased by reducing the storage length of delicatessen meat (21, 35).
13 Consequently, recommendations indicate that RTE food products should be consumed within two
14 days of purchase or opening (15). A lack of consumer food safety data relating to the adherence of
15 storage duration guidelines has been identified, particularly in relation to consumer attitudes (17).
16 However, previous data indicate that that the majority of consumers (96%) were aware that the
17 improper storage of food may represented a health hazard (3) and 40 - 69% reported to
18 'always/usually' follow manufacturer's instructions for storage of food products (25, 45); furthermore
19 the majority of consumers have reported consumption of foods within two days of purchase/opening
20 (41).

21 This study has undertaken an in-depth cognitive analysis of food storage practices post-opening
22 packaging of RTE foods. Findings indicate that the majority (68%) of older adults had positive
23 attitudes towards the importance of consuming RTE food within two days of preparing, opening or
24 purchase, but knowledge of recommended safe storage length after opening RTE food was lacking,
25 with 56 – 84% believing that RTE foods associated with *L. monocytogenes* could be stored beyond the
26 recommended two days after purchase or opening. Furthermore, many older adults reported prolonged
27 storage of RTE food beyond the recommended two days in the home; with only 28% reporting that

1 RTE food would be consumed within the two days. In addition, older adults reported that RTE food
2 products from the delicatessen counter (70% soft cheese and 47% sliced cured meat) would be stored
3 and intended for consumption beyond the recommended two days after purchase and pre-packed RTE
4 foods were reported to be stored for durations exceeding recommendations (83% soft cheese, 78%
5 sliced cured meat, 70% sliced cooked meats and 62% pâté). Findings suggest that older adults
6 frequently consume RTE food products associated with *L. monocytogenes* subjected to prolonged
7 storage which may increase the risk of listeriosis.

8 A comparison of the results from this study specific to findings relating to storage of opened RTE
9 food products was limited due to the lack of previous data. Although positive attitudes towards the
10 importance of storage and consumption of opened RTE food were expressed by the majority of older
11 adults, self-reported data did not concur with recommended practices. Storage of RTE food products
12 for prolonged times was reportedly wide-spread among older adults which does not compare with
13 previous research where the majority of consumers from the general population are reported to
14 consume RTE food products within two days (40). Older adult knowledge and positive attitudes
15 towards consuming food within two days of opening/purchasing were significantly associated with the
16 self-reported frequency of consuming food within recommendations, such findings can be utilized to
17 design and develop food safety education to increase awareness and improve attitudes to enable
18 behavioral change when storing RTE food products in the home after opening.

1 **Conclusions.** Although the majority of older adults reported to be aware of listeriosis, only around
2 a third were aware of associated food products. Cumulatively, older adult consumers' knowledge of
3 key practices required to reduce the risks associated with listeriosis were comparable to consumers of
4 the general population. However, self-reported practices relating to 'use-by' date adherence and
5 storage of opened RTE food were determined to be lower among older adults than data suggest for the
6 general population. Furthermore, older adults' attitudes towards the three key risk-reducing storage
7 practices were more negative than those of general population consumers. Such findings can have
8 implications for the safety of food in older adult domestic kitchens.

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

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

21 However, given that it has been determined in this research study that no significant associations
22 existed between older adults' knowledge and attitudes towards the key food safety practices required
23 to reduce the risks associated with *L. monocytogenes*. Furthermore, attitudes were significantly
24 associated with self-reported practices. Consideration is given to the impact of attitudes on the
25 implementation of food safety practices as consumer attitudes have been determined to be significant
26 determinants of consumer behaviors (50).

1 Given that attitudes have been reported to be a determinant of behavior, findings from this study
2 regarding older adults' attitudes towards 'use-by' dates, post-opening storage durations and refrigerator
3 operating temperatures were significantly associated with self-reported practices. Therefore an
4 initiative to approach attitudes may help to increase implementation of risk reducing food storage
5 behaviors. Consequently, to enable the development of targeted consumer food safety education that
6 aims to reduce the risks of listeriosis among the older adult age group by improving the
7 implementation of food safety practices, there is a need to direct educational efforts to change older
8 adult consumers' attitudes and not only increase knowledge.

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

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

22 There is a need to combine the findings of this research study with 'in home' observed domestic
23 kitchen behaviors associated with listeriosis. Such data would provide a more detailed understanding
24 of how older adults' cognition of listeriosis risk factors impact upon handling practices of RTE food
25 products and implementation of food safety behaviors in the domestic kitchen. Such findings would
26 give a greater understanding of the cognitive and behavioral associations of listeriosis risk factors in

1 the domestic kitchen that would inform food safety educators to facilitate the design and development
2 of targeted food safety education for older adults to reduce incidence of listeriosis.

3

1

ACKNOWLEDGEMENTS

2 This study was supported by research funds from the Vice Chancellor's Doctoral Award from
3 Cardiff Metropolitan University. The authors wish to acknowledge Prof. Louise Fielding (1968 –
4 2013) for her support throughout the project.

5

REFERENCES

- 1
2 1. ACMSF. 2008. Advisory Committee on The Microbiological Safety of Food. Ad hoc group
3 on vulnerable groups. Report on the increased incidence of listeriosis in the UK.
- 4 2. Adams, M., and M. Moss. 2006. Food Microbiology. The Royal Society of Chemistry,
5 Cambridge.
- 6 3. Angelillo, I. F., M. R. Foresta, C. Scozzafava, and M. Pavia. 2001. Consumers and foodborne
7 diseases: knowledge, attitudes and reported behavior in one region of Italy. *Int J Food Microbiol.*
8 64:161-166.
- 9 4. Awaisheh, S. S. 2009. Survey of *Listeria monocytogenes* and other *Listeria* spp.
10 contamination in different common ready-to-eat food products in Jordan. *Pak. J. Biol. Sci.* 12:1491-
11 1497.
- 12 5. Badrie, N., A. Gobin, S. Dookeran, and R. Duncan. 2006. Consumer awareness and
13 perception to food safety hazards in Trinidad, West Indies. *Food Control.* 17:370-377.
- 14 6. Ballantyne, A., R. Stark, and J. D. Selman. 1988. Modified atmosphere packaging of shredded
15 lettuce. *Int. J. Food Sci. Technol.* . 23:267-274.
- 16 7. Bannister, B. A. 1987. *Listeria monocytogenes* meningitis associated with eating soft cheese.
17 *J. Infect.* 15:165-168.
- 18 8. Barker, C., N. Pistrang, and R. Elliott. 2002. Self-report methods. In N.P. Chris Barker, Robert
19 Elliott (ed.), Research methods in clinical psychology - an introduction for students and practitioners
20 John Wiley & Sons, England.
- 21 9. Beckers, H., P. Soentoro, and E. Delfgou-van Asch. 1987. The occurrence of *Listeria*
22 *monocytogenes* in soft cheese and raw milk and its resistance to heat. *Int. J. Food Microbiol.* 4:249 -
23 256.
- 24 10. BRC, CFA, and FSA. 2010. Shelf life of ready to eat food in relation to *L. monocytogenes* -
25 Guidance for food business operators. First Edition. British Retail Consortium, Chilled Food
26 Association, Food Standards Agency, .
- 27 11. Cates, S. C., R. A. Morales, S. A. Karns, L.-A. Jaykus, K. M. Kosa, T. Teneyck, C. M. Moore,
28 and P. Cowen. 2006. Consumer knowledge, storage, and handling practices regarding *Listeria* in
29 frankfurters and deli meats: Results of a web-based survey. *J. Food Prot.* 69:1630-1639.

- 1 12. Clayton, D. A., C. J. Griffith, and P. Price. 2003. An investigation of the factors underlying
2 consumers' implementation of specific food safety practices. *Brit. Food J.* 105:434-453.
- 3 13. Clayton, D. A., C. J. Griffith, P. Price, and A. Peters. 2002. Food handlers' beliefs and self-
4 reported practices. *Int J Environ Heal R.* 12:25-39.
- 5 14. Cook, P., and M. Bellis. 2001. Knowing the risk: relationships between risk behaviour and
6 health knowledge. *Public Health.* 115:54 - 61.
- 7 15. Department of Health, and Food Standards Agency. Date, 2008, Listeria - Keeping food safe.
8 Available at: <http://food.gov.uk/multimedia/pdfs/publication/listeriafactsheet0708.pdf>. Accessed 8th
9 November 2014.
- 10 16. Dharod, J. M., R. Perez-Escamilla, S. Paciello, Berm, M. dez, A. n, K. Venkitanarayanan, and
11 G. Damio. 2007. Comparison between self-reported and observed food handling behaviors among
12 Latinas. *J. Food Prot.* 70:1927-1932.
- 13 17. Evans, E. W., and E. C. Redmond. 2014. Behavioural risk factors associated with listeriosis in
14 the home: A review of consumer food safety studies. *J. Food Prot.* 77:510 - 521.
- 15 18. Evans, E. W., and E. C. Redmond. 2015. Analysis of Older Adults' Domestic Kitchen Storage
16 Practices in the United Kingdom: Identification of Risk Factors Associated with Listeriosis. *Journal of*
17 *Food Protection.* 78:738-745.
- 18 19. FAO, and WHO. 2004. Risk assessment of *Listeria monocytogenes* in ready-to-eat foods -
19 Interpretative summary. *Microbiological Risk Assessment Series.* 4.
- 20 20. FDA. Date, 2003, *Listeria monocytogenes* risk assessment: Interpretive summary, research
21 assessment/safety assessment,. Available at:
22 [http://www.fda.gov/Food/ScienceResearch/ResearchAreas/RiskAssessmentSafetyAssessment/ucm185](http://www.fda.gov/Food/ScienceResearch/ResearchAreas/RiskAssessmentSafetyAssessment/ucm185291.htm)
23 [291.htm](http://www.fda.gov/Food/ScienceResearch/ResearchAreas/RiskAssessmentSafetyAssessment/ucm185291.htm). Accessed 24th October 2013.
- 24 21. FDA. Date, 2003, Quantitative assessment of relative risk to public health from foodborne
25 *Listeria monocytogenes* among selected categories of ready-to-eat foods. Risk assessment /safety
26 assessment. Available at:
27 [http://www.fda.gov/Food/ScienceResearch/ResearchAreas/RiskAssessmentSafetyAssessment/ucm183](http://www.fda.gov/Food/ScienceResearch/ResearchAreas/RiskAssessmentSafetyAssessment/ucm183966.htm)
28 [966.htm](http://www.fda.gov/Food/ScienceResearch/ResearchAreas/RiskAssessmentSafetyAssessment/ucm183966.htm). Accessed 24th October 2013.
- 29 22. FDF, and IEHO. 1994. FOODLINK: National food survey. Food and Drink Federation and
30 the Institution of Environmental Health Officers.

- 1 23. Fischer, A., A. D. Jong, E. V. Asselt, R. D. Jonge, L. Frewer, and M. Nauta. 2007. Food safety
2 in the domestic environment: An interdisciplinary investigation of microbial hazards during food
3 preparation. *Risk Analysis*. 27:1065-1082.
- 4 24. FSA. 2008. Retail survey of *Listeria monocytogenes* in smoked fish. Food Survey Information
5 Sheet 05/08.
- 6 25. FSAI. 1998. Public knowledge and attitudes to food safety in Ireland.
- 7 26. Garrido, V., A. I. Vitas, and I. García-Jalón. 2009. Survey of *Listeria monocytogenes* in ready-
8 to-eat products: Prevalence by brands and retail establishments for exposure assessment of listeriosis
9 in Northern Spain. *Food Control*. 20:986-991.
- 10 27. GfK, and FSA. Date, 2009, Public attitudes to food issues. Food Standards Agency, London.
11 Available at: <http://www.food.gov.uk/multimedia/pdfs/publicattitudestofood.pdf>. Accessed 18th
12 September 2010.
- 13 28. Gianfranceschi, M., A. Gattuso, S. Tartaro, and P. Aureli. 2003. Incidence of *Listeria*
14 *monocytogenes* in food and environmental samples in Italy between 1990 and 1999: Serotype
15 distribution in food, environmental and clinical samples. *Euro. J. Epidemiol.* 18:1001 - 1006.
- 16 29. Gillespie, I. A., J. McLauchlin, C. L. Little, C. Penman, P. Mook, K. Grant, and S. J. O'Brien.
17 2009. Disease presentation in relation to infection foci for non-pregnancy-associated human listeriosis
18 in England and Wales, 2001 to 2007. *J. Clin. Microbiol.* 47:3301-3307.
- 19 30. Gillespie, I. A., P. Mook, C. L. Little, K. A. Grant, and J. McLauchlin. 2010. Human
20 listeriosis in England, 2001–2007: association with neighbourhood deprivation. *Euro Surveill.* 15.
- 21 31. Gross, R. 2005. Attitudes and attitude change. In R. Gross (ed.), *Psychology, the science of*
22 *mind and behaviour* Hodder and Stoughton Educational, London.
- 23 32. Hebert, J. R., L. Clemow, L. Pbert, I. S. Ockene, and J. K. Ockene. 1995. Social desirability
24 bias in dietary self-report may compromise the validity of dietary intake measures. *Int. J. Epidemiol.*
25 24:389-398.
- 26 33. Hoffman, A. D., K. L. Gall, D. M. Norton, and M. Wiedmann. 2003. *Listeria monocytogenes*
27 contamination patterns for the smoked fish processing environment and for raw fish. *J. Food Prot.*
28 66:52-60.
- 29 34. HPA. 2011. Decrease in listeriosis incidence in England and Wales in 2010. *Health Protection*
30 *Report*. 5.

- 1 35. ILSI Research Foundation, and Risk Science Institute. 2005. Achieving continuous
2 improvement in reductions in foodborne listeriosis – A risk-based approach. *J. Food Prot.* 68:1932-
3 1994.
- 4 36. Jay, S. L., D. Comar, and L. D. Govenlock. 1999. A national Australian food safety telephone
5 survey. *J. Food Prot.* 62:921-928.
- 6 37. Jevsnik, M., V. Hlebec, and P. Raspor. 2008. Consumers' awareness of food safety from
7 shopping to eating. *Food Control.* 19:737-745.
- 8 38. Kennedy, J., V. Jackson, I. Blair, D. McDowell, C. Cowan, and D. Bolton. 2005. Food safety
9 knowledge of consumers and the microbiological and Temperature Status of their Refrigerators. *J.*
10 *Food Prot.* 68:1421 - 1430.
- 11 39. Kosa, K., S. Cates, S. Godwin, and A. Draughon. 2008. Older adults' food safety attitudes and
12 knowledge: findings from a national survey. *J Am Diet Assoc.* 108:A118-A118.
- 13 40. Langer, A., T. Ayers, J. Grass, M. Lynch, F. Angulo, and B. Mahon. 2012. Nonpasteurized
14 dairy products, disease outbreaks, and state laws—United States, 1993–2006. *Emerg. Infect. Dis.* 18.
- 15 41. Marklinder, I. M., M. Lindblad, L. M. Eriksson, A. M. Finnson, and R. Lindqvist. 2004. Home
16 storage temperatures and consumer handling of refrigerated foods in Sweden. *J. Food Prot.* 67:2570-
17 2577.
- 18 42. Mena, C., G. Almeida, L. Carneiro, P. Teixeira, T. Hogg, and P. Gibbs. 2004. Incidence of
19 *Listeria monocygoenes* in different food products commercialized in Portugal. *Food Microbiol.*
20 21:213 - 216.
- 21 43. Mullan, B. A., C. Wong, and E. J. Kothe. 2013. Predicting adolescents' safe food handling
22 using an extended theory of planned behavior. *Food Control.* 31:454-460.
- 23 44. Pouillot, R., K. Hoelzer, K. A. Jackson, O. L. Henao, and B. J. Silk. 2012. Relative Risk of
24 Listeriosis in Foodborne Diseases Active Surveillance Network (FoodNet) Sites According to Age,
25 Pregnancy, and Ethnicity. *Clin. Infect. Dis.* 54:S405-S410.
- 26 45. Prior, G., L. Hall, S. Morris, and A. Draper. 2011. Exploring food attitudes and behaviours in
27 the UK: Findings from the Food and You Survey 2010. p. 92. *In*, vol. Unit Report 13. London.
- 28 46. Redmond, E. C., and C. J. Griffith. 2003. A comparison and evaluation of research methods
29 used in consumer food safety studies. *Int. J. Consum Stud.* 27:17-33.

- 1 47. Redmond, E. C., and C. J. Griffith. 2003. Consumer food handling in the home: A review of
2 food safety studies. *J. Food Prot.* 66:130-161.
- 3 48. Redmond, E. C., and C. J. Griffith. 2004. Consumer attitudes and perceptions towards
4 microbial food safety in the domestic kitchen. *J. Food Safety.* 24:169-194.
- 5 49. Redmond, E. C., and C. J. Griffith. 2005. Factors influencing the efficacy of consumer food
6 safety communication. *Brit. Food J.* 107:484-499.
- 7 50. Roberts, K., and K. Marvin. 2011. Knowledge and attitudes towards healthy eating and
8 physical activity: What the data tell us. *In* National Obesity Observatory, Oxford.
- 9 51. Scott, E. 2003. Food safety and foodborne disease in 21st century homes. *Can. J. Infect. Dis.*
10 14:277 - 280.
- 11 52. Spriegel, G. 1991. Food Safety in the Home. *J. Nutr. Food Sci.* 91:14 - 15.
- 12 53. Stollewerk, K., A. Jofré, J. Comaposada, G. Ferrini, and M. Garriga. 2011. Ensuring food
13 safety by an innovative fermented sausage manufacturing system. *Food Control.* 22:1984 -1991.
- 14 54. Taormina, P. 2010. Storage considerations for opened packages of ready-to-eat meats. p. 12 -
15 13. *In*, Food Safety Magazine, vol. August/September 2010. The Target Group Inc., California.
- 16 55. The OzFoodNet Working Group. 2010. Monitoring the incidence and causes of diseases
17 potentially transmitted by food in Australia: Annual report of the OzFoodNet network, 2009.
18 *Commun. Dis. Intell.* 34.
- 19 56. Uyttendaele, M., P. De Troy, and J. Debevere. 1999. Incidence of *Listeria monocytogenes* in
20 different types of meat products on the Belgian retail market. *Int. J. Food Microbiol.* 53:75-80.
- 21 57. Walker, A. 1996. Food safety in the home: A survey of public awareness.
- 22 58. Wilbey, R. A. 1997. Estimating shelf-life. *Internat. J. Dairy Technol.* 50:64-67.
- 23 59. Woodburn, M. J., and C. A. Raab. 1997. Household food preparers' food-safety knowledge
24 and practices following widely publicized outbreaks of foodborne illness. *J. Food Prot.* 60:1105-1109.
- 25 60. Worsfold, D. 1994. An evaluation of domestic food hygiene and food preparation practices.
26 *In*, University of Wales., vol. PhD thesis.
- 27 61. Zeedyk, M., L. Wallace, B. Carcary, K. Jones, and K. Larter. 2001. Children and road safety:
28 increasing knowledge does not improve behaviour. *Br J Educ Psychol.* 71:573 - 594.

1 **Figure legends**

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

4 FIGURE 2. Reported frequency of checking refrigerator operating temperature ($n = 100$)

1 Table 1 Awareness of food products associated with *L. monocytogenes* among older adults

Food products	<i>n</i>	Aware of the association with <i>L. monocytogenes</i> (%)
Soft cheese	100	36
Unpasteurized milk	100	33
Pâté	100	13
Smoked salmon	100	4
Pre-packed sandwiches	89	3
Pre-packed salads	89	3
Sliced cured meat	100	1
Cooked sliced meat	100	0

2

3

1 Table 2 Older adult attitudes towards recommended food safety practices

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

2

3

1 Table 3 Reported consumption of food products after expired 'use-by' date

Food products	<i>n</i>	Same day / Never after 'use by date' (%)	After the 'use-by' date (%)
Smoked fish and shellfish	79	81	19
Tub/pre-packed refrigerated pâté	74	60	40
Refrigerated packets of cooked sliced meats	82	50	50
Container of soft cheese/spread	84	40	60
Refrigerated packets of sliced cured meats	74	40	60
Pre-packed mixed salad bags	80	36	64
Packs of pre-cut fruits	52	59	41

2

1 Table 4 Self-reported storage of food products associated with *L. monocytogenes* after purchase/opening

Food products associated with <i>L. monocytogenes</i>	<i>n</i>	Reported storage after purchase/opening	
		≤2days (%)	>2days (%)
Cooked fish or shellfish from the deli counter	71	94	6
Cut fresh pâté from the deli counter	60	77	23
Cooked sliced meat from the deli counter	84	67	33
Items from the salad counter	80	59	41
Sliced cured meats from the deli counter	73	53	47
Soft cheeses from the deli counter	77	30	70
Refrigerated packet of RTE cooked fish and shellfish	78	89	12
Refrigerated packs of pre-cut fruits	41	56	44
Refrigerated packet of smoked fish	80	53	48
Pre-packed mixed salad bags	80	41	59
Refrigerated packet of pâté	73	38	62
Refrigerated packet of cooked sliced meats	83	30	70
Refrigerated packet of sliced cured meats	74	22	78
Refrigerated pack/container of soft cheese	77	17	83

2

1 Table 5 Cumulative comparison of older adults' knowledge, attitudes and self-reported practices relating to the three key
 2 practices associated with the risk of listeriosis in the domestic kitchen

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

3

4

1 Table 6 Statistical associations determined between cognitive findings relating to listeriosis risk factors

Three key practices associated with the risk of listeriosis	Statistical associations		
		Attitudes	Self-reported practices
Following 'use-by' dates on unopened pre-packed RTE food products	Knowledge	$p > 0.05$	$p > 0.05$
	Attitudes	-	$X^2(2, n = 100) = 30.214, p = 0.000,$ Cramer's V = 0.550
Ensure refrigerator is operating at $\leq 5^\circ\text{C}$	Knowledge	$p > 0.05$	$X^2(2, n = 100) = 19.191, p = 0.000,$ Cramer's V = 0.438
	Attitudes	-	$X^2(8, n = 100) = 27.276, p = 0.001,$ Cramer's V = 0.373
Consuming RTE food products within two days of opening	Knowledge	$p > 0.05$	$X^2(2, n = 80) = 7.738, p = 0.021,$ Cramer's V = 0.319
	Attitudes	-	$X^2(8, n = 99) = 23.829, p = 0.002,$ Cramer's V = 0.347

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

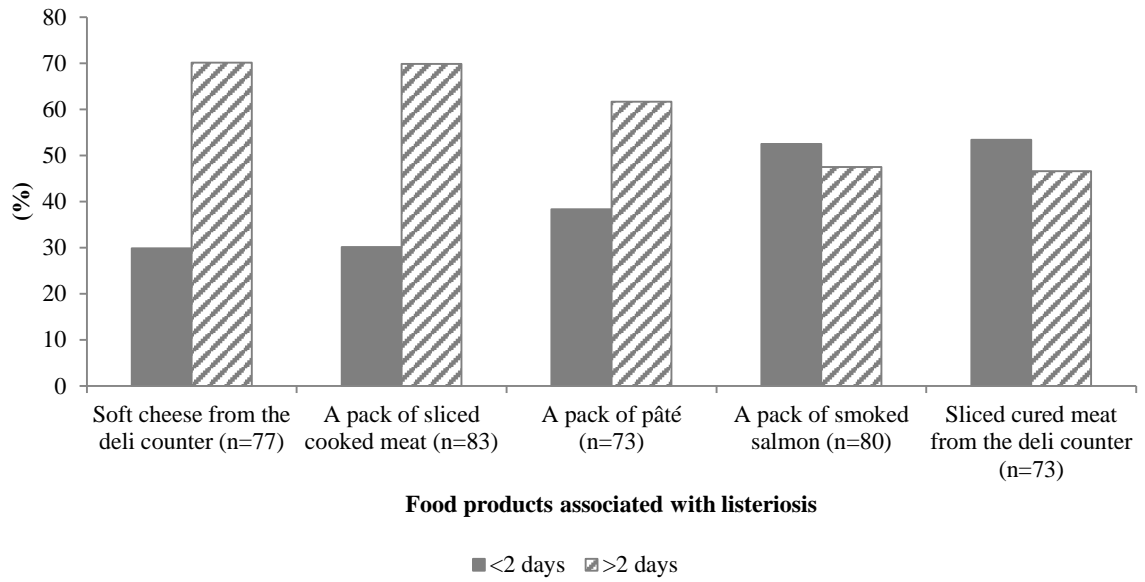
2

3

1

Figure 1.

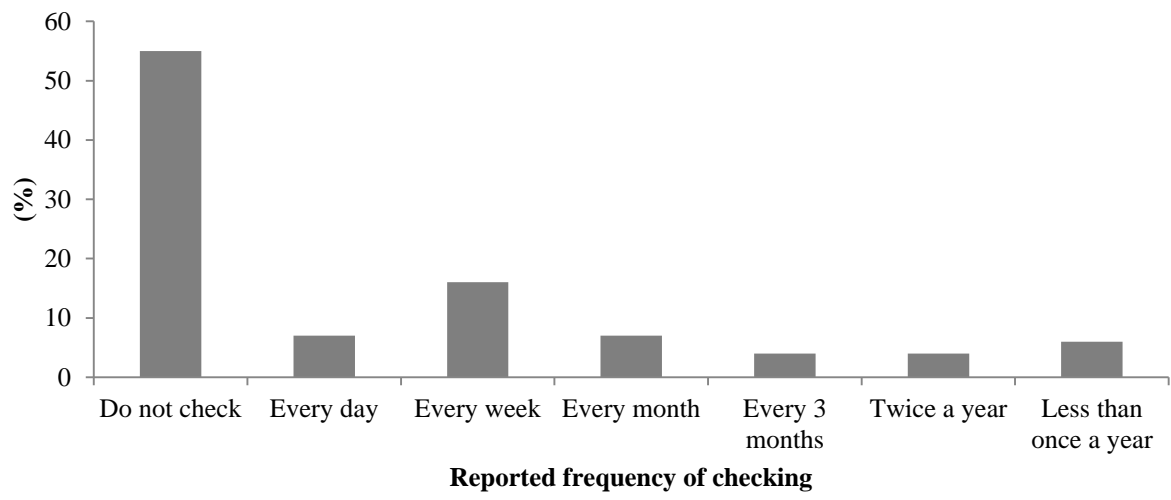
2



3

1

Figure 2.



2

3