Older-adults' domestic kitchen practices associated with an increased risk of listeriosis.

Consumer groups with weakened immunity including older-adults, people with HIV/AIDS, pregnant women and patients receiving chemotherapy are known to be at an increased risk of foodborne disease, in particularly listeriosis. Listeriosis is reportedly associated with the highest hospitalisation (<95%) and mortality rates (<41%) of foodborne pathogens in the UK. Historical surveillance data (1980s–1990s) suggest that the majority of listeriosis incidence were predominantly associated with pregnant women and 30% of incidence was associated with adults ≥60 years. Whereas in recent years (since 2000) the majority of listeriosis incidence has predominantly been associated with adults ≥60 years with a three-fold increase in incidence (ACMSF, 2008). Indeed, most recent data indicate that 65% of reported listeriosis cases were among adults ≥60 years (Public Health Laboratory Service, 2015).

Due to the psychrotrophic characteristics of the causative pathogen, *Listeria monocytogenes* having the ability to grow at refrigeration temperatures, consumer implementation of food safety practices, specifically relating to time and temperature control of ready-to-eat (RTE) foods, have been recommended to reduce the risks associated with listeriosis in the home (ECDC, 2010; FSA & DoH, 2008), these are identified as:

- Adhering to 'use-by' dates on unopened pre-packed RTE food products
- Consuming RTE foods within two days of opening or purchase from a deli-counter
- Ensuring safe operating temperatures (≤5.0°C) of domestic refrigerators

As the reasons for the increase among older-adults remain unclear, the Food Standards Agency the Advisory Committee on the Microbiological Safety of Food (ACMSF, 2008; MSFFG, 2005) recommend that research is required to determine domestic food handling and storage behaviours of consumers ≥60 years, to better understand the behavioural risk factors that may be associated with listeriosis. Such research is needed as understanding the actual food safety practices of older-adults in addition to the underlying knowledge and attitudes may aid the development of effective food safety education strategies.

In light of such recommendations, recent consumer food safety research from the ZERO2FIVE Food Industry Centre at Cardiff Metropolitan University has focused upon the cognitive and behavioural risk factors of older-adults associated with listeriosis in the domestic kitchen. This article gives a cumulative overview of the mixed-methods research approach utilised at the Food Industry Centre to analyse knowledge, attitudes, self-reported practices, observed behaviour and microbiological data relating to older-adults domestic food safety practices.

Review of consumer food safety studies to identify listeriosis risk factors (Evans & Redmond, 2014).

An in-depth review of cognitive and behavioural data relating to the risk factors associated with listeriosis as reported in 165 consumer food safety studies was conducted. The review findings determined that less than half (41%) of studies included assessment of consumer cognitive or behavioural data associated with listeriosis risk factors; of these 59% included data on safe refrigeration, 54% included data on storage of RTE foods, and 49% included data on adherence to 'use-by' dates. In most studies (83%), survey-based data collection methods

(questionnaires/interviews) were used; thus, the majority of findings were based on self-report (74%) and knowledge (44%). Observation (31%) and focus groups (12%) were less commonly used, resulting in a lack of actual behavioural and attitudinal data relating to listeriosis risk factors. Only 7% of studies included food safety data for older-adults.

Completion of the review revealed a need for in-depth research to determine attitudes and actual behaviours of older-adults in conjunction with knowledge and self-report of practices associated with listeriosis. Combining cognitive and behavioural data can achieve a cumulative multi-layered in-depth understanding of consumer food safety behaviour and cognition.

Cognitive risk factors associated with listeriosis in the domestic kitchen (Evans & Redmond, 2016).

As a result of the review findings, a study was conducted to ascertain older-adult's cognition in relation to domestic food handling and storage practices that may increase the risks associated with *L. monocytogenes*. An interview and questionnaire was designed, developed and conducted with one hundred older-adults to determine knowledge, self-reported practices, and attitudes towards recommended practices to reduce the risks associated with listeriosis.

Although the majority of older-adults (79%) had positive attitudes toward refrigeration, 84% were unaware of recommended temperatures and 65% self-reported to ''never'' check the operating temperature of their refrigerator. Although most older-adults in the study (72%) knew that the 'use-by' date on food products indicate food safety and 62% reported ''always'' taking note of 'use-by' dates, neutral attitudes were held with 67% believing it was safe to eat food beyond 'use-by' dates and 57% reporting doing so. Attitudes toward consuming RTE foods within the recommended two days of opening were neutral, with 55% aware of recommendations and, 84% reporting that they consume RTE foods beyond recommendations.

Even though knowledgeable of some key practices, older-adult consumers self-reported potentially unsafe practices when storing RTE foods at home, which may increase risks associated with *L. monocytogenes*. The study determined the need to identify the actual behaviours of older-adults that may increase the risks associated with listeriosis in addition to the cognitive risk factors.

Behavioural risk factors associated with listeriosis in the domestic kitchen (Evans & Redmond, 2015).

Given that the home kitchen is recognised as a significant location where foodborne illnesses are acquired, it is important to gain insight on the actual behaviours of consumers in their own homes that can impact on the safety of food. Consequently, observation and microbiological analysis was utilised to determine actual food storage practices and identify potential behavioural risk factors.

A domestic kitchen survey was conducted in the domestic kitchens of older-adults (*n*=100). Forty-one percent of foods in home refrigerators were observed to be beyond the 'use-by' date, of which 11% were unopened RTE food products commonly associated with listeriosis. Sixty-six percent of opened RTE foods had been or were intended to be stored beyond the recommended two days after opening. It was also established that many older-adults failed to ensure safe refrigeration temperatures; 50% of central food storage areas and 85% of door storage areas were operating at temperatures exceeding recommendations. *L.*

monocytogenes was isolated in 2% of older-adult home kitchens, (a tap handle and a refrigerator door handle).

Consequently, these findings suggest that storage malpractices may have a greater effect on the potential risk of listeriosis than its presence alone in domestic kitchens. The study has determined that many older-adults fail to adhere to recommendations and subject RTE foods associated with *L. monocytogenes* to prolonged storage at unsafe temperatures which may render food unsafe for consumption.

Cumulative comparison of cognitive and behavioural risk factors associated with listeriosis (Evans & Redmond, 2014, 2015, 2016).

Food safety malpractices associated with listeriosis were determined to be greater among older-adults than literature suggests for the general population. Although some older-adults were knowledgeable of recommendations, failure to implement was widespread. Additionally, statistical analyses have determined that significant associations exist according to cognition and behaviour among older-adults. The expression of positive attitudes towards recommended practices were significantly associated (p<0.001) with the implementation of recommended practices. Furthermore, self-reported adequate refrigeration practices were associated (p<0.001) with safe refrigeration temperatures.

In conclusion.

As a result of the vast technological developments within the food industry, we must acknowledge that food safety risks have changed over the years. However, the ability of the consumer to control such food safety risks within the home have not developed in line with the industry. Indeed, many older adults referred to times prior to technological developments: *"I remember when we didn't have 'use by dates' on food, so I believe the smell of food means that you can tell it is safe to eat"* and *"well, forty years I didn't have a refrigerator"*.

The research conducted at the Food Industry Centre has taken a novel approach to address the identified lack of older-adult data relating to the risks associated with listeriosis. An innovative combination of data collection methods and measures, which allowed for a cumulative comparison of cognitive, behavioural and microbiological data, has determined potential listeriosis risk factors in older-adults' domestic kitchens. Findings provide an important insight on the domestic food safety practices of a susceptible consumer group, which may be utilised for the development of targeted food safety education.

Given that unsafe refrigeration temperatures and prolonged storage of RTE foods were identified, and that such storage malpractices were determined to be more widespread than the isolation of *L. monocytogenes,* findings suggest that storage malpractices may be a greater risk factor for listeriosis than presence and potential cross-contamination of the pathogen for older-adults.

Following completion of this consumer based research, a laboratory based re-enactment of identified storage malpractices, ascertained that such practices significantly increase the growth of *L. monocytogenes* in RTE food, thus increasing the relative risk of listeriosis, the findings of which are currently being prepared for publication.

Consequently, the research conducted at the Food Industry Centre has established that older-adult consumers' domestic kitchen food safety cognition and behaviour, may contribute to the increased incidence of listeriosis among older-adult consumers in the UK.

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