Growth of *Listeria monocytogenes* in Ready-to-Eat Foods: Re-enactment of Observed Domestic Storage PracticesImplemented by Older Adults

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## Introduction

The foodborne pathogen *Listeria monocytogenes* is responsible for human listeriosis which is associated with the highest hospitalisation (95%) and mortality rates (43%) of foodborne pathogens. In Europe, incidence of listeriosis has increased three-fold among older adults (>60 years) since the 1990s.

*Listeria monocytogenes* is a psychrotrophic mesophile and a facultative anaerobe, the pathogen has the ability to survive and grow in vacuum packed food products during refrigeration; consequently the majority of incidence is predominately associated with ready-to-eat (RTE) foods. Furthermore incidence of listeriosis is predominately believed to be anticipated, which may be associated with food prepared in the domestic kitchen.

Subsequently, it is important that consumers implement adequate temperature control (<5°C/41°F) and avoid prolonged storage to safeguard RTE foods from *L. monocytogenes* growth.

Older adults are reported to frequently consume RTE foods associated with *L. monocytogenes* in the domestic kitchen. However, data relating to older adults' actual domestic food safety practices is lacking. The Advisory Committee on the Microbiological Safety of Food reported that there is a need to determine the actual food storage practices of this "at-risk" consumer group to ascertain factors that may contribute to the risk of listeriosis in the domestic kitchens of older adults.

## Methods

### In-home Survey

Participants were recruited according to predefined criteria, older adults (>60 years) domestic kitchens (n=18) were visited to conduct the in-home survey which included:

- Direct observation of older adults' storage practices of RTE foods in the domestic kitchen.
- Standardised interview techniques to determine self-reported lengths of storage times and intention for further storage and consumption of foods found in older adults' refrigerators.
- Recording of actual refrigerator operating temperatures using calibrated probes (ITE P 300W Temp) from a central food storage location and from the refrigerator door.
- Data was entered into a specifically designed Microsoft Access 2007 database, Microsoft Excel 2010, and from the refrigerator door.

Data was entered into a specifically designed Microsoft Access 2007 database, Microsoft Excel 2010, and statistical analysis was conducted using IBM SPSS Statistics.

### Laboratory Re-enactment

In-home survey findings informed the development of laboratory re-enactment experimental design:

- **Samples of soft cheese (10g) and sliced RTE ham (12g) were inoculated with~3.71 log CFU/g**. Inoculated food products were stored at refrigeration temperatures: 10.00°C/50°F (Recommended), >5°C/41°F (>5°C/41°F). Storage of RTE foods

The majority of refrigerators in the domestic kitchens of older adults in this study operated at temperatures in excess of recommended safe refrigeration temperatures:

- 72% of older adults’ domestic refrigerators operated at temperatures exceeding the recommended 5°C/41°F. Temperatures ranged from 5°C/41°F and up to 17.4°C/63.3°F (Figure 1).

The majority of older adults (70%) self-reported that they would store RTE foods for longer than recommendations and 2% of older adults were observed storing RTE foods at ambient temperature.

The majority of older adults (70%) self-reported that they would store RTE foods for longer than recommendations and 2% of older adults were observed storing RTE foods at ambient temperature. Statistical analysis determined no significant statistical association existed between older adults refrigerating operating temperature and storage of RTE food beyond the recommended two days after opening / purchasing (p>0.05). Furthermore no statistical differences were determined between participants demographic and food storage malpractices and temperatures (p>0.05).

Significance of the study

- This study has determined that the majority of older adults fail to implement recommended practices and ensure safe refrigeration temperatures to reduce the risks associated with listeriosis when storing RTE food products in the domestic kitchen.
- Consequently, this study has determined that older adults domestic kitchen refrigeration practices increase risk of microbial growth of *L. monocytogenes*, potentially making RTE foods unsafe for consumption, thus increasing the potential risk of listeriosis.
- Findings based on actual consumer behaviour may be used to inform risk-based targeted food safety education for older adults to increase implementation of safe refrigeration practices in the home to reduce the risk of listeriosis associated with this "at-risk" consumer group.

## Results

### In-home Survey

**Refrigerator operating temperatures**

- The majority of refrigerators in the domestic kitchens of older adults in this study operated at temperatures in excess of recommended safe refrigeration temperatures:
  - 72% of older adults’ domestic refrigerators operated at temperatures exceeding the recommended 5°C/41°F. Temperatures ranged from 5°C/41°F and up to 17.4°C/63.3°F (Figure 1).
  - Temperatures >5°C/41°F were found to be significantly (p=0.00) greater than the recommended 2°C/36°F after opening (p=0.0001) and 24 hours (p=0.0001). Growth rates of *L. monocytogenes* were confirmed using standard methods for enumeration of *L. monocytogenes*.

**In-home Storage of RTE foods**

- RTE foods associated with *L. monocytogenes* were stored in the majority (80%) of older adults’ domestic kitchens of which:
  - 30% had been repeatedly stored by older adults for longer than the recommended 2 days after opening (p<0.001). 40% would repeatedly be stored beyond this recommended two days after opening and remain inviolated for consumption.
  - Generation times of >5°C/41°F (>5°C/41°F) and ambient (11 hours t<0.001) were significantly greater (F (2, 45) = 8.12, p<0.001) than at recommended temperatures (<5°C/41°F). No significant differences were determined between the generation times of *L. monocytogenes* in RTE food products at the two ‘abuse’ temperatures of >5°C/41°F (21.5 hours t<0.001) and ambient (11 hours t<0.001).

**Laboratory Re-enactment**

- Laboratories re-enactment of observed storage practices has determined that levels of *L. monocytogenes* increased during prolonged storage and that growth was significantly different at abuse temperatures (<5°C/41°F) compared to recommended temperatures (<5°C/41°F).

**generation times**

- The average generation time for *L. monocytogenes* in RTE food products at ‘abuse’ temperatures of >5°C/41°F (21.5 hours t<0.001) was significantly greater (F (2, 45) = 8.12, p<0.001) than at recommended temperatures <5°C/41°F (0.04 hours t<0.001).

**In-home Survey**

- The majority of older adults were observed (51%) or self-reported (50%) to store RTE foods beyond the recommended two days after opening.

**Laboratory Re-enactment**

- The laboratory re-enactment of observed storage practices has determined that levels of *L. monocytogenes* increased during prolonged storage and that growth was significantly different at abuse temperatures (<5°C/41°F) compared to recommended temperatures (<5°C/41°F).