Laboratory re-enactment of observed food-storage practices in domestic kitchens of older adults (≥60years): potential for *Listeria monocytogenes* growth in ready-to-eat foods

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Introduction

The foodborne pathogen *Listeria monocytogenes,* is responsible for human listeriosis which is associated with the highest hospitalisation (<95%) (1) and mortality rates (<41%) (2) of foodborne pathogens. In the UK, incidence of Listeriosis has increased three-fold among older adults (≥60 years) since the 1990s (3).

Given *L. monocytogenes* is a psychrotrophic mesophile and a facultative anaerobe (4) the pathogen has the ability to survive and grow in vacuum packed food products during refrigeration; consequently the majority of incidence is predominantly associated with ready-to-eat (RTE) foods (3); furthermore the majority of incidence is believed to be sporadic, which may be associated with food prepared in the domestic kitchen (5).

Subsequently, it is important that consumers implement adequate temperature control (≤5.0˚C) and avoiding prolonged storage to safeguard RTE foods from *L. monocytogenes* growth (6).

Older adults are reported to frequently consume RTE foods associated with *L. monocytogenes* (7,8); 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 (3).

Research aim

This study aimed to determine older adults' actual refrigeration of RTE foods associated with *L. monocytogenes* in the domestic kitchen and conduct laboratory re-enactments of such practices to assess the potential impact on *L. monocytogenes* growth.

Methods

'In home' Survey

Participants were recruited according to predetermined criteria; older adults' (≥60 years) domestic kitchens (*n* = 100) 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 (ITS P 300W Temp) from a central food storage location and from the refrigerator door.

Laboratory Re-enactment

Survey findings informed development of laboratory re-enactment experimental design:

- Samples of soft cheese (10g) and sliced RTE ham (12.5g) were inoculated with ~3.71 $\log_{10}$ CFU/g *L. monocytogenes.*
- Inoculated food products were stored at temperature ranges as determined in older adults' domestic kitchens (≤5.0˚C and >5.0˚C).
- Food products were analysed following national standard methods for enumeration of *L. monocytogenes* (9) every 24 hours for up to 21 days to determine growth.

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

Results and Discussion

'In home' Survey

Refrigerator operating temperatures

The majority of refrigerators 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 5.0°C.
- Temperatures ranged from 0.5 °C to 17.4 °C (Mean: 6.2°C) (Figure 1).

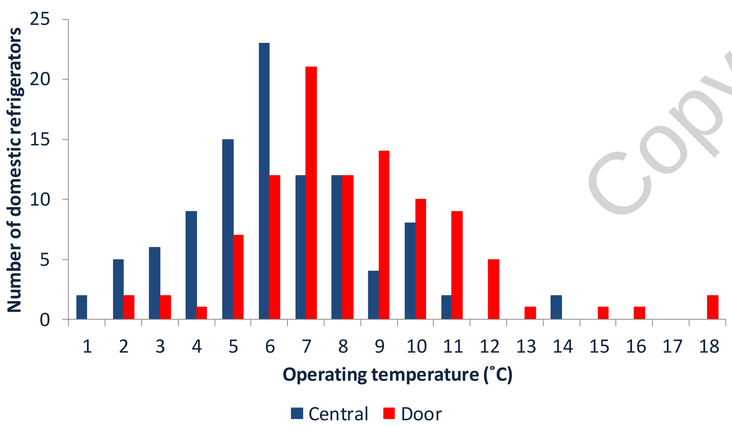
Storage of RTE foods

RTE foods associated with *L. monocytogenes* were stored in the majority (70%) of older adults' homes of which:

- 54% of which had been reportedly stored by older adults for longer than the recommended 2 days after opening (some up to 21 days).

77% of older adults stored RTE foods beyond the recommended two days after opening.

Figure 1: Refrigerator operating temperature (n = 100)



Laboratory Re-enactment

Growth rate

Figure 2 & Figure 3 indicate the growth of *L. monocytogenes* at ≤5.0˚C and >5.0˚C. Growth of *L. monocytogenes* was found to be slower at ≤5˚C (recommended) than >5˚C (abuse).

Figure 2: Mean *L. monocytogenes* growth in soft cheese ($\log_{10}$ cfu/g)

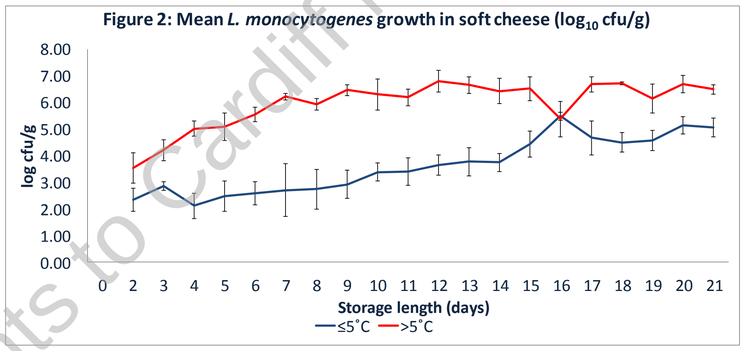
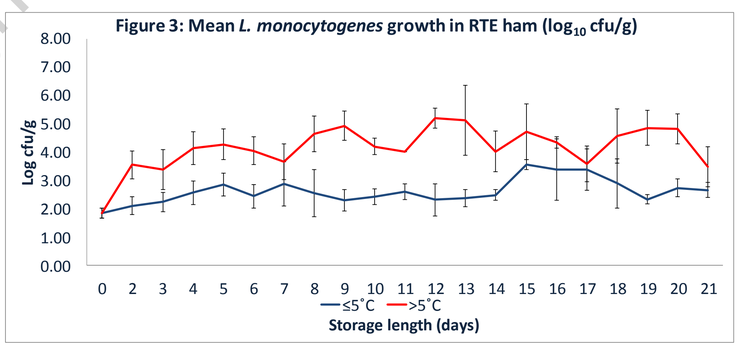


Figure 3: Mean *L. monocytogenes* growth in RTE ham ($\log_{10}$ cfu/g)



Generation times

The average generation time for *L. monocytogenes* in RTE food products at 'abuse' temperatures of >5°C (21.5 hours t^{-1}) was significantly greater ($F(2, 45) = 8.12$, $p < 0.001$) than at recommended temperatures ≤5˚C (94 hours t^{-1}).

Conclusion

⇒The 'in home' survey observation suggests that the majority of older adults (77%) store RTE foods beyond the recommended two days after opening; furthermore, the majority (72%) of older adults had refrigeration temperatures exceeding recommendations (≤5°C).

⇒No significant statistical associations were determined between older adults with refrigerators operating at recommended / abuse temperature and having food opening for longer than the recommended two days after opening ($p > 0.05$)

⇒The laboratory re-enactment trial of observed storage practices has determined that levels of *L. monocytogenes* increased during prolonged storage; in addition to this it was determined that growth was significantly different at abuse temperatures (>5°C) than at recommended temperatures (≤5°C).

⇒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.

⇒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 consumer group.

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