

Growth of *Listeria monocytogenes* in Ready-to-Eat Foods: Re-enactment of Observed Domestic Storage Practices Implemented 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%)¹ and mortality rates (<41%)² of foodborne pathogens. In Europe, incidence of listeriosis has increased three-fold among older adults (≥60 years) since the 1990s³.

Given *L. monocytogenes* is a psychrotrophic mesophile and a facultative anaerobe⁴, 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) foods³. Furthermore incidence of listeriosis is predominantly believed to be sporadic, which may be associated with food prepared in the domestic kitchen⁵.

Subsequently, it is important that consumers implement adequate temperature control (≤ 5°C/41°F) and avoiding prolonged storage to safeguard RTE foods from *L. monocytogenes* growth⁶.

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 adults³.

Research aim

This study aimed to determine older adults' actual refrigeration storage practices 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 as result of older adults' domestic storage practices.

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.

Data was entered into a specifically designed Microsoft Access 2007 database, Microsoft Excel 2010, 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 (12.5g) were inoculated with ~3.71 log₁₀ CFU/g *L. monocytogenes*.
- Inoculated food products were stored at temperature ranges as determined in older adults' domestic kitchens (≤ 5°C/41°F, > 5°C/41°F and ambient temperature).
- 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 and enable calculation of CFU's and growth rates.

References

1. Centers for Disease Control and Prevention. 2013. Incidence and Trends of Infection with Pathogens Transmitted Commonly Through Food – Foodborne Diseases Active Surveillance Network, 10 U.S. Sites, 1996–2012. *Morbidity and Mortality Weekly Report (MMWR)*, 62:283 – 287.
2. Mook, P., Patel, B. and Gillespie, I. (2012). Risk factors for mortality in non-pregnancy-related listeriosis. *Epidemiology and Infection*, 140 (04): p. 706–715.
3. ACMSF (2008). Increased incidence of Listeriosis in the UK, Ad Hoc Group on Vulnerable Groups, Advisory Committee on The Microbiological Safety of Food, Food Standards Agency: London
4. Adams M & Moss M (2006) *Food Microbiology*, Second Edition, The Royal Society of Chemistry.
5. FSA (2000) Foodborne Disease: Developing a strategy to deliver the agency's targets. Paper FSA 00/05/02.
6. FSA and DoH (2008). Listeria – keeping food safe, *Department of Health*, Food Standards Agency, London
7. Mintel (2012). Cheese, Market Report, Mintel International: London
8. Mintel (2011). Over-55s' Eating Habits - Executive Summary, Market Report, Mintel International: London
9. HPA (2009) Detection and Enumeration of *Listeria monocytogenes* and other *Listeria* Species. *National Standard Method* [Standards Unit Evaluations and Standards Laboratory]

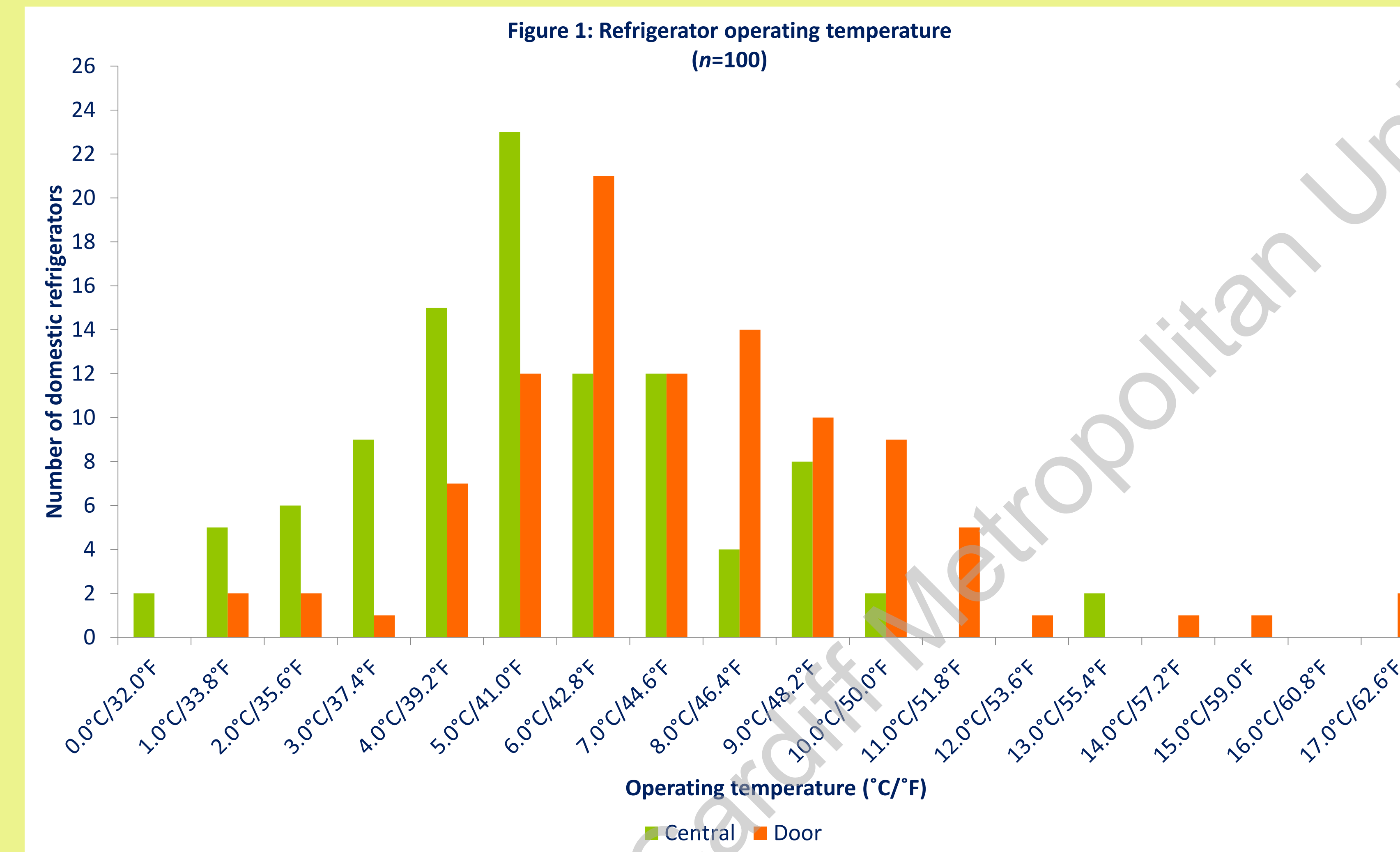
Results

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 0.5°C/32.9°F and up to 17.4°C/63.3°F (Mean: 6.2°C/43.2°F) (Figure 1).



Storage of RTE foods

RTE foods associated with *L. monocytogenes* were stored in the majority (68%) of older adults' domestic kitchens of which:

- 35% had been reportedly stored by older adults for longer than the recommended 2 days after opening (some up to 21 days).
- 66% would reportedly be stored beyond the recommended two days after opening and remain intended for consumption.

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 associations existed between older adults refrigerators 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 participant demographic and food storage malpractices and temperatures ($p>0.05$).

In-home Survey

The majority of older adults were observed (51%) or self-reported (70%) to store RTE foods beyond the recommended two days after opening; furthermore, the majority (72%) of older adults had refrigeration temperatures exceeding recommendations (> 5°C/41°F).

Laboratory Re-enactment

The laboratory re-enactment trial 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 and ambient) than at recommended temperatures (≤ 5°C/41°F).

Laboratory Re-enactment

Figure 2 & Figure 3 indicate that the growth of *L. monocytogenes* was found to be slower at ≤ 5°C/41°F (recommended) than > 5°C/41°F and ambient temperature (abuse) in both soft cheese and RTE ham.

Figure 2: Mean *L. monocytogenes* growth in soft cheese at three different domestic storage temperatures (log cfu/g)

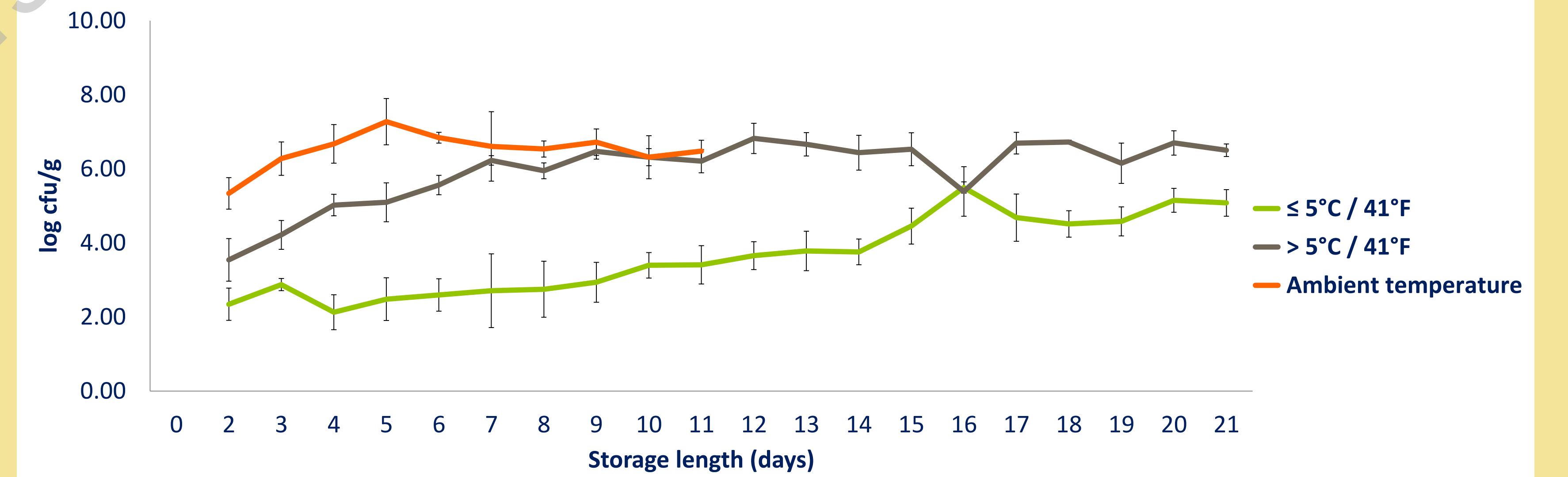
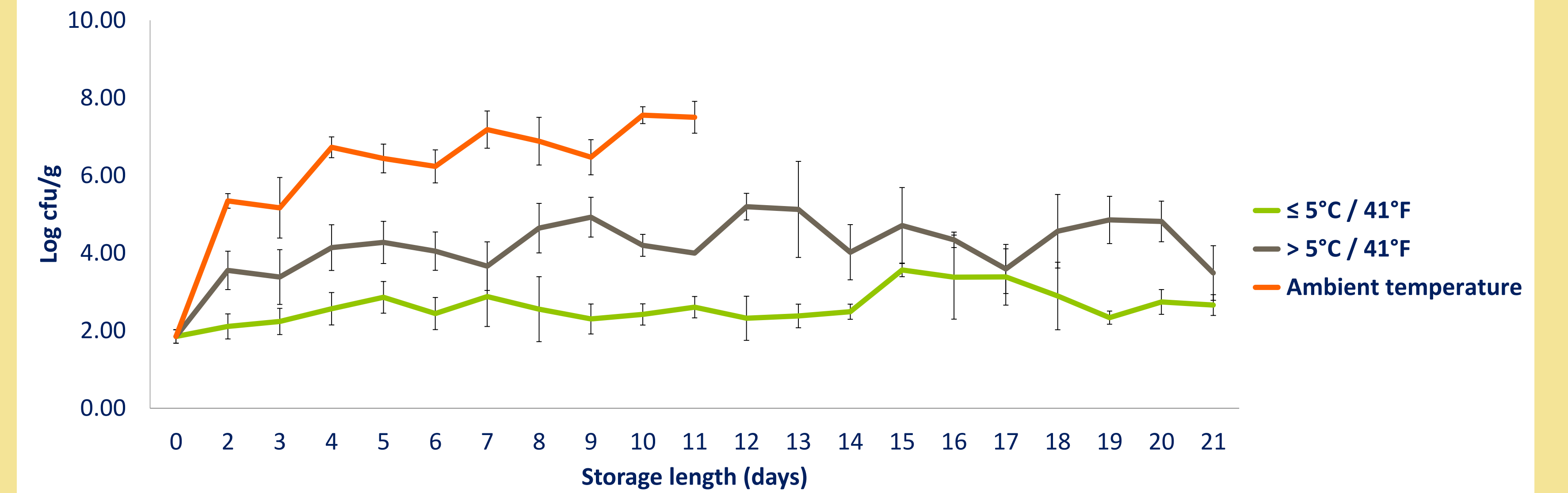


Figure 3: Mean *L. monocytogenes* growth in RTE ham at three different domestic storage temperatures (log cfu/g)



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⁻¹) was significantly greater ($F(2, 45) = 8.12, p < 0.001$) than at recommended temperatures ≤ 5°C/41°F (94 hours t⁻¹).

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⁻¹) and ambient (11 hours t⁻¹) ($p > 0.05$).

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.



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