

Time Temperature Study of UK Consumers' Domestic Refrigerators



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Introduction

Consumer demand for convenient, fresh foods with minimal preservatives and low thermal processing has led to increased sales of refrigerated ready-to-eat RTE foods worldwide¹

However, such foods are commonly associated with listeriosis due to the ability of *Listeria monocytogenes* to survive and grow at refrigeration temperatures².

Consequently, effective temperature control of RTE-foods by consumers in the domestic kitchen is critical for food safety as inadequate refrigeration practices are believed to increase the risk of foodborne illness³.

UK recommendations for domestic refrigeration are $\leq 5.0^{\circ}\text{C}$ ⁴. Although data suggest that many refrigerators in home kitchens operate at temperatures exceeding recommendations, such data is often determined by means of a single one-off temperature and is not indicative of usual function or temperature fluctuation⁵.

Consequently there is a need to determine actual domestic refrigerator operating temperature over a prolonged period to gain an understanding of typical usage on function.

Aim

This study aimed to assess actual domestic refrigerator operating temperature profiles and establish self-reported food storage practices of UK consumers

Methods

Time-temperature profiles of refrigerators ($n=43$) in domestic kitchens were determined using three Signatrol SL52T self-contained button dataloggers (Range: -40°C – $+85^{\circ}\text{C}$; accuracy: $\pm 0.5^{\circ}\text{C}$; frequency: every minute) over 136 hours placed in a central storage area, a door storage area and outside of the refrigerator.

Households ($n=43$) documented self-reported refrigerator usage during profiling.

Statistical analysis was conducted using IBM SPSS Statistics to determine significant differences or relationships between refrigeration temperatures and self-reported practices.

References

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Results

Refrigerator profiles

Forty-three domestic refrigerators in consumer home kitchens were included in the study. The age of domestic refrigerators in kitchens ranged from 4 months up to 30 years, the majority (70%) of refrigerators were free-standing non-integrated. As indicated in Table 1, refrigerator operating temperatures ranged from -0.15°C to 17.9°C , an average difference of 1.94°C was determined between refrigerator doors and central storage locations operating temperatures. Statistical analyses determined:

Table 1. Domestic refrigerator temperature ranges ($^{\circ}\text{C}$)

	Door operating temperature	Central operating temperature	Door/central temperature difference	Temperature fluctuations
Min	-0.15	-1.72	0.02	1.51
Max	17.90	16.91	4.51	6.03
Mean	7.84	5.88	1.94	3.47

- No statistical differences ($p>0.05$) were determined in operating temperature according to refrigerator age.
- No significant differences ($p>0.05$) were determined in refrigerator operating temperatures according to refrigerator type.
- Those reporting to check their refrigerator temperature 'every day' and 'every week' were significantly more likely ($p<0.05$) to have mean refrigerator temperatures in-line with recommendations ($\leq 5^{\circ}\text{C}$), than those reporting 'every three months' and 'less than once a year'.

Time-temperature profiling

Figure 2 illustrates the average operating temperature of refrigerators; although 21% of refrigerators had mean operating temperatures adhering to recommended safe operating temperatures.

The time-temperature profiling determined that:

- 40% central storage locations were operating at unsafe ($>5^{\circ}\text{C}$) temperatures for the duration of the datalogger study (136 hours).
- 67% refrigerator doors storage locations were operating at unsafe ($>5^{\circ}\text{C}$) temperatures for the duration of the datalogger study (136 hours).
- No refrigerator doors or central storage locations were discovered to operate at $\leq 5^{\circ}\text{C}$ for the duration of the study.
- 9% had a door and central temperature that were $\leq 5^{\circ}\text{C}$ for 75% of the study.

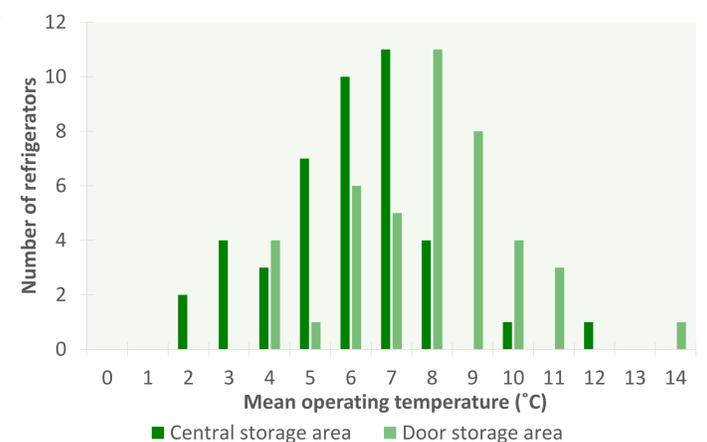


Figure 2. Domestic refrigerators mean operating temperatures ($n = 100$)

Impact of self-reported practices and external factors on operating temperature fluctuation

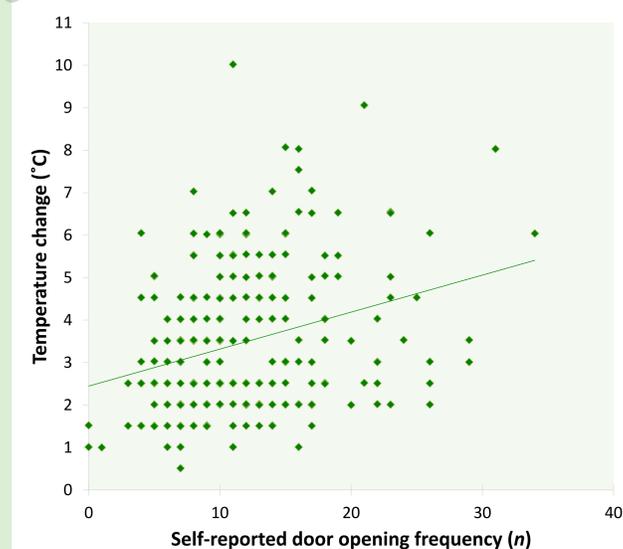


Figure 3. Daily door opening frequency and temperature change ($n = 258$)

Temperature fluctuations as indicated in Table 1. were determined to be on average 3.47°C each day. Temperature changes correlated with self-reported usage:

- A positive correlation between the ambient temperature of the kitchen and the temperature of the refrigerator was determined ($r = 0.786$, $n = 8192$, $p < 0.005$).
- Average temperature change of 1.92°C was noted when food shopping was reported to be placed in the refrigerator, (range 7.05°C increase - 2.01°C decrease).
- A positive correlation between temperature change and door opening frequency ($r = 0.29$, $n = 258$, $p < 0.005$), as illustrated in Figure 3, a greater temperature change was observed when a greater number of door opening frequencies was reported.
- No significant differences ($p>0.05$) were determined in temperature fluctuations according to reported method of putting food shopping away after returning home, 'continuously re-opened', 'opened and left open' or 'organise all chilled items and place in refrigerator all at once'.

Significance of the study

- Temperature profiles indicate that majority of the sample may store RTE-foods at unsafe temperatures which may increase risk of foodborne illness such as listeriosis given the pathogens ability to proliferate at increased refrigeration temperatures.
- Findings highlight the need for improvement of domestic kitchen refrigeration practices among UK consumers.
- Data may be used to inform development of targeted food-safety strategies.