



Storing chilled foods at incorrect temperatures

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Introduction

Kitchen Life 2 (KL2) is a study that used motion-sensitive cameras in household and business kitchens to observe real-life behaviour (preparing food, cooking, and cleaning). This observational data was supplemented with data from surveys, interviews, and food diaries. The COM-B behavioural framework was used to understand the influences on behaviour. The resulting analysis provides fresh insight for risk assessment, policy development, and behavioural intervention design in relation to food safety and food waste behaviours in household and business settings.

KL2, which was commissioned by the FSA in February 2021 and completed in June 2023, was delivered by Basis Social, with support from Leeds University Business School. This unique and innovative research project won the Analysis in Government 'Innovative Methods' award in 2022.

Aims and Objectives

The aims of the study were to identify:

- the key behaviours relating to food safety that occur in household and business kitchens
- where, when, how often, and with whom food safety behaviours occur, and the key factors that influence these behaviours

KL2 had two main objectives:

- to provide highly detailed, real-life data for risk assessment at the FSA
- to inform future behavioural interventions research

Method

Overall, 101 kitchens participated in KL2, with 70 households and 31 food business operators (FBOs) taking part across England, Wales, and Northern Ireland.

After a literature review and a pilot, the main fieldwork design involved installing motion sensitive cameras to film participants in their kitchen over 5-7 days, with 3 days of footage analysed from this period.

The footage was coded, with labels applied to describe the behaviour (e.g., washing hands with soap), person (e.g., chef), and context (e.g., sink, utensils). In addition, fridge and freezer thermometers were used to monitor the temperature of the appliances during the fieldwork period. Photographs were also taken of the interior of

a fridge and, for households only, a food diary and shopping receipts were kept, to verify ingredients cooked.

After the filming period, survey, interviews, and observational methods were used to understand influences on food safety behaviours. The fieldwork took place over 5 waves between June 2021 and October 2022.

Behaviours were analysed using the COM-B behavioural model. The model enabled the research team to systematically explore the barriers and enablers of various food safety behaviours in relation to capability, opportunity, and motivation.

Experts in food safety policy, behavioural sciences, and communications were then involved in a workshop to discuss findings and consider behaviours to target for future interventions.

Further methodological details about this study are available in the [Technical Report](#), and a raw dataset can be downloaded via the [FSA's Data Catalogue](#).

Research Reports

This is one of 7 chapters detailing the findings from this study. Each report focuses on a behaviour of interest to the FSA, exploring the behaviour in detail, using COM-B analysis to identify the factors influencing the behaviour, and discussing the behaviours that would need to change to achieve the desired practice. Each report also contains a case study, which explores a real scenario captured during the KL2 study, to illustrate the behaviour.

The other 6 chapters can be found here:

- [Not washing hands with soap after touching meat, fish and poultry](#)
- [Reusing a chopping board after preparing meat, fish and poultry](#)
- [Reusing a tea towel or cloth for multiple purposes](#)
- [Not reheating leftovers until steaming hot throughout](#)
- [Not checking use-by dates and consuming foods past use-by dates](#)
- [The creation of food waste](#)

Key insights across all 7 reports are available via the main [Kitchen Life 2 webpage](#).

Further details about why these behaviours were selected as the focus for KL2 reports is provided in the [Technical Report](#).

Summary

Storing chilled foods at an incorrect temperature is a food safety risk, as it promotes the growth of harmful bacteria. FSA guidance states that the fridge should be 5°C or below. Specifically, for FBOs in England, Wales and Northern Ireland it is a legal requirement to store cold foods below 8°C.

65 households¹ in the Kitchen Life 2 (KL2) study had a fridge/freezer thermometer installed during the fieldwork period. In 34 households, the average² fridge temperature measured was greater than the recommended maximum of 5°C. 8 households had an average fridge temperature above 8°C, where the potential for bacterial growth is significantly elevated.

29 food business operators³ (FBOs) in the KL2 study had a fridge thermometer installed (28 had a freezer thermometer) during the fieldwork period. In 8 FBOs, the average fridge temperature measured was greater than the recommended maximum of 5°C, and 1 FBO had an average temperature above the legal maximum of 8°C.

Overall, the influences on the storage of chilled foods at incorrect temperatures differed across households and FBOs.

In households, the key influences were:

- the **fridge design**, and specifically whether the fridge had a built-in thermometer and/or alarm or whether it only had a coldness dial⁴. (Physical opportunity).
- **participants not knowing or being uncertain** about the recommended operating temperature for a fridge. (Psychological capability).
- an **absence of any routines to check the fridge temperature** (Automatic motivation).

These were reinforced by the following contextual factors⁵:

- a **belief that the fridge was set to the correct operating temperature**

¹ 5 households did not install the fridge/freezer thermometer.

² Average taken across the filming period.

³ 2 FBOs did not install the fridge/freezer thermometer.

⁴ Many participants reported that they had alarms in their appliance, but this was not verified as part of the study. Most appliances did not sound an alarm during the duration of filming when the appliance was running too warm.

⁵ These factors are not in a hierarchy of importance.

(Reflective motivation).

In FBOs, the key influences were:

- the **lack of a 'compliance culture'** in certain FBOs (Social opportunity).
- **inconsistent routines** for temperature checks on appliances (Automatic motivation.)
- for a small number of FBOs, the use of **older fridges that did not have thermometers or alarms** built into them (Physical opportunity).

These were reinforced by the following contextual factors⁶:

- **beliefs about the consequences of fridges running at an incorrect temperature** – specifically that fluctuations in temperature (above the recommended threshold) were not of significant concern for a minority of FBOs (Reflective motivation).
- concerns about the **food safety risks to their customers**, as well as the **reputation of their business** (Reflective motivation).

Behaviours to target for potential interventions

In both households and FBOs, the desired practice (that is, the behaviour that households and FBOs should do to improve food safety is **to check the operating temperature of a fridge (daily for FBOs) and, as required, adjust the appliance settings to ensure foods are refrigerated within the recommended range of 0-5°C.**

Households need an easy way to monitor and change their fridge temperature, so interventions should focus on easy ways of doing this behaviour. For households with built-in fridge alarms, enabling consumers to set these alarms correctly (and check that they are working) could also be an area for future behavioural interventions research. Improving consumer awareness of the correct fridge temperature, and risks of running the appliance at the incorrect temperature, are also an important finding from this research. However, improving awareness alone is unlikely to improve the behaviour.

For FBOs, a focus on compliance is important, by emphasising or strengthening a requirement to undertake and record daily checks on fridge and freezer

⁶ These factors are not in a hierarchy of importance.

temperatures. Interventions could focus on the need to act if a fridge was above 5°C to ensure temperatures remain under 8°C.

Background

Chilling food correctly helps to stop the growth of harmful bacteria and helps food stay safe and fresh for longer⁷. The [literature review](#) conducted as part of the KL2 project highlights wide differences in household fridge operating temperatures⁸. A UK study showed fridge temperatures ranged from -1.72°C up to 17.98°C , with no fridge within the correct operating temperature throughout the entire study and only 5% of fridges within the temperature guidelines for 80% of the study duration⁹.

In a US study, 48% of homes had a fridge with operating temperatures above 5°C , with 11% having temperatures over 7.28°C . This research also showed that homes with fridges that tested positive for listeria and faecal coliforms had higher mean operating temperatures.¹⁰

FSA's [Food and You 2](#) survey found that 65% of UK consumers knew the correct temperature that a fridge should be, and 59% of respondents stated that they monitor fridge temperatures¹¹. However, fewer than one-third of households had a thermometer in their fridge, and there may be confusion between the temperature and the coldness dial inside the fridges¹². Storing chilled foods at incorrect temperatures was an area of interest for the FSA Risk Assessment team and was identified as high risk. The FSA was keen to gain insight into whether and how a

⁷ FSA (2020). 'Chilling'. <https://www.food.gov.uk/safety-hygiene/chilling>

⁸ Research on food business fridge temperatures was not covered in the literature review. However, keeping fridge temperatures below 8°C is a legal requirement and a key aspect of food hygiene inspections undertaken by local authorities. To show due diligence, businesses are encouraged to keep a temperature log of their fridge and freezer as part of their food safety management plan.

⁹ Evans EW and Redmond EC. 'Time-temperature profiling of United Kingdom consumers' domestic refrigerators' *Journal of Food Protection* 2016: volume 79(12), pages 2119–2127

¹⁰ Borrusso PA and Quinlan JJ. 'Prevalence of pathogens and indicator organisms in home kitchens and correlation with unsafe food handling practices and conditions' *Journal of Food Protection* 2017: volume 80(4), pages 590–597

¹¹ FSA (2021). <https://www.food.gov.uk/research/food-and-you-2/food-and-you-2-wave-1>

¹² Evans, E. W., & Redmond, E. C. Time-Temperature profiling of United Kingdom consumers' domestic refrigerators. *Journal of Food Protection* 2016: 79(12), 2119-2127.

fridge was checked to be cold enough and whether participants knew the safe operating temperatures for fridges.

Fridge and freezer temperature data were collected for households and FBOs involved in KL2. Participants were sent separate fridge and freezer thermometers during the fieldwork period and were asked to place them inside the respective appliances. For participants with more than one fridge or freezer, the main appliance used to chill raw foods was selected. The thermometers stored, on the device, a record of the appliance temperature every 15 minutes during the 5-day fieldwork period. This data was then downloaded from the device after it was returned to the research team. Three days of temperature data were analysed from each kitchen; corresponding to the three days that the filmed footage was analysed. For further information on the use of thermometers during the KL2 fieldwork, see [the technical report](#).

This chapter uses the KL2 data to understand the operating temperatures of fridges in the study, whether and how fridge temperatures were checked, the factors affecting this and identify behaviours that could be the focus of future interventions research.

Related behaviours

There are several behaviours that can influence whether chilled foods are stored at the correct temperature. This includes the temperature the fridge or freezer is set to, whether space is left inside the appliance for cold air to circulate, and whether the appliance door is frequently left open.

While not the focus of this report, data and insights were collected on the time a fridge door was left open, which has the potential to increase the operating temperature¹³.

Overall, leaving a fridge door open was:

- observed on 463 meal occasions (44% of all meal occasions) in households, with an average duration of 48 seconds and a maximum duration of 8 minutes and 26 seconds
- observed on 102 meal occasions (33% of all meal occasions) in FBOs, with an average duration of 43 seconds and a maximum duration of 4 minutes and

¹³ Evans and Redmond (2016, see note 3) found that leaving the fridge door open can impact the internal temperature, with the temperature rising 2.51°C on average 6 minutes after storage and taking 36 minutes to return.

50 seconds

Leaving a fridge door open was an unconscious and habitual behaviour that household and FBO participants were unaware of doing. When asked in interviews, participants did not believe they left fridge doors open for more than 30 seconds (which they believed was a safe period), despite frequently being observed to do so.

Being distracted when taking items from a fridge was a significant factor in leaving the fridge door open, especially for FBOs. Though not common, certain household participants also mentioned that the seal on the fridge door (especially on new fridges) made them hard to close and reopen, meaning they would purposefully leave the door ajar for a while when loading or unloading a fridge. This was not mentioned by FBOs.

FSA guidance on storing chilled foods at the correct temperature

[FSA guidance for households](#) on storing chilled food safely includes the following advice:

- store any food with a use-by date, as well as cooked dishes, salads and dairy products, in the fridge
- keep chilled foods out of the fridge for the shortest time possible during preparation
- cool cooked food quickly at room temperature and place it in the fridge within 1 to 2 hours
- check the fridge is cold enough using a fridge thermometer as the dials on fridges don't always show the right temperature – the fridge should be 5°C or below
- do not overfill the fridge, to leave space for air to circulate and maintain the set temperature

In terms of freezing, the same guidance highlights that households should freeze pre-packaged food until midnight on the 'use by' date, with leftovers and homemade goods frozen as soon as possible. It also highlights the need to cool any warm dishes before putting them in the freezer. The guidance also says the cold temperatures of a domestic freezer (-18°C) delay chemical reactions within foods and put any bacteria that may be present on pause.

[FSA guidance for FBOs](#) on chilling foods is similar to that for households. The guidance highlights that the following foods need to be chilled:

- food with a use-by date
- cooked dishes
- other ready-to-eat foods such as prepared salads and desserts

The FBO guidance also states the need to:

- follow storage instructions
- put food that needs to be chilled in the fridge straight away

- cool cooked food as quickly as possible and then put it in the fridge
- keep chilled foods out of the fridge for the shortest time possible during preparation
- check regularly that the fridge and display units are cold enough (5°C or below)

The FBO guidance includes the need to refrigerate or dispose of any cold foods that are left out for serving or display after 4 hours. It also cites recommended fridge temperatures of 5°C or below, and a legal requirement to store cold foods below 8°C.

For frozen foods, the guidance states that fresh foods must be frozen before midnight on the use-by date and re-labelled correctly. It also states that FBOs need to keep frozen foods at a temperature of -18°C.

Kitchen Life 2: Findings for households

Quantitative observations from filming

In the sample of 70 households, fridge and freezer temperature data were collected for 65 households (with the remainder failing to install the thermometer during the fieldwork period).

The FSA recommends a fridge temperature of 5°C or below. Data collected in KL2 shows that:

- the average¹⁴ fridge temperature of all households in the sample was 5.3°C (with minimum and maximum temperatures ranging from -3.8°C to 17.2°C).
- 34 households had an average fridge temperature greater than the 5°C recommended maximum during the fieldwork period.
- 8 households had an average fridge temperature greater than 8°C, which poses a significant risk for elevated bacteria growth.

The FSA recommends a freezer temperature of -18°C or below. KL2 data shows that:

- the average freezer temperature of all households in the sample was -19.6°C (with minimum and maximum temperatures ranging from -32.6°C to 14.4°C)
- 21 households had an average freezer temperature above -18°C during the fieldwork period.

KL2 data indicates that storing chilled foods at an incorrect fridge temperature was a potential safety issue for just under half the households in the sample. Additionally, the storage of frozen foods at an incorrect freezer temperature impacted just under a third of households. Whilst this is not necessarily a food safety risk (as pathogens can only grow above -2°C), freezers that fall outside of the recommended range

¹⁴ Averages are based on three days of thermometer data per household.

Temperature readings were recorded approximately four times per hour during this period. The three days of temperature data analysed correspond to the period when filmed footage was analysed in each household.

could compromise food quality and result in spoilage.. Factors influencing the storage of chilled foods at incorrect temperatures are now explored in more depth.

Factors influencing the storing of chilled foods at incorrect temperatures in households

Summary

Overall, the storing of chilled foods at incorrect temperatures in households was influenced by a reliance on fridges to work effectively and the belief that the fridge was operating at the correct temperature. A lack of routines to check fridge temperatures and (for some households) the lack of an easy means to measure the temperature, compounded by a poor understanding of the correct temperature range, also enabled the behaviour. A summary of the influences on behaviour by COM-B domain is given in figure 1.

Figure 1. Summary of COM-B factors influencing the storing of chilled foods at incorrect temperatures in households

Capability

Physical

Eye conditions were a minor influence on the storing of chilled foods at the incorrect temperature.

An inability to read the fridge temperature or coldness dial due to an eyesight condition was cited as a problem for only a few participants. Such conditions only had a minor role enabling the storing of chilled foods at incorrect temperatures.

Psychological

Limited knowledge of the recommended fridge operating temperature was a significant enabler of the storing of chilled foods at the incorrect temperature.

In interviews, participants commonly cited temperatures around 6°C as the safe operating temperature of a fridge (above the 5°C recommended maximum). Consequently, poor understanding of safe fridge temperatures was an enabler of storing chilled foods at incorrect temperatures.

Opportunity

Physical

Presence of a thermometer and/or alarm was a notable influence, and both encouraged and discouraged the storage of chilled foods at the incorrect temperature.

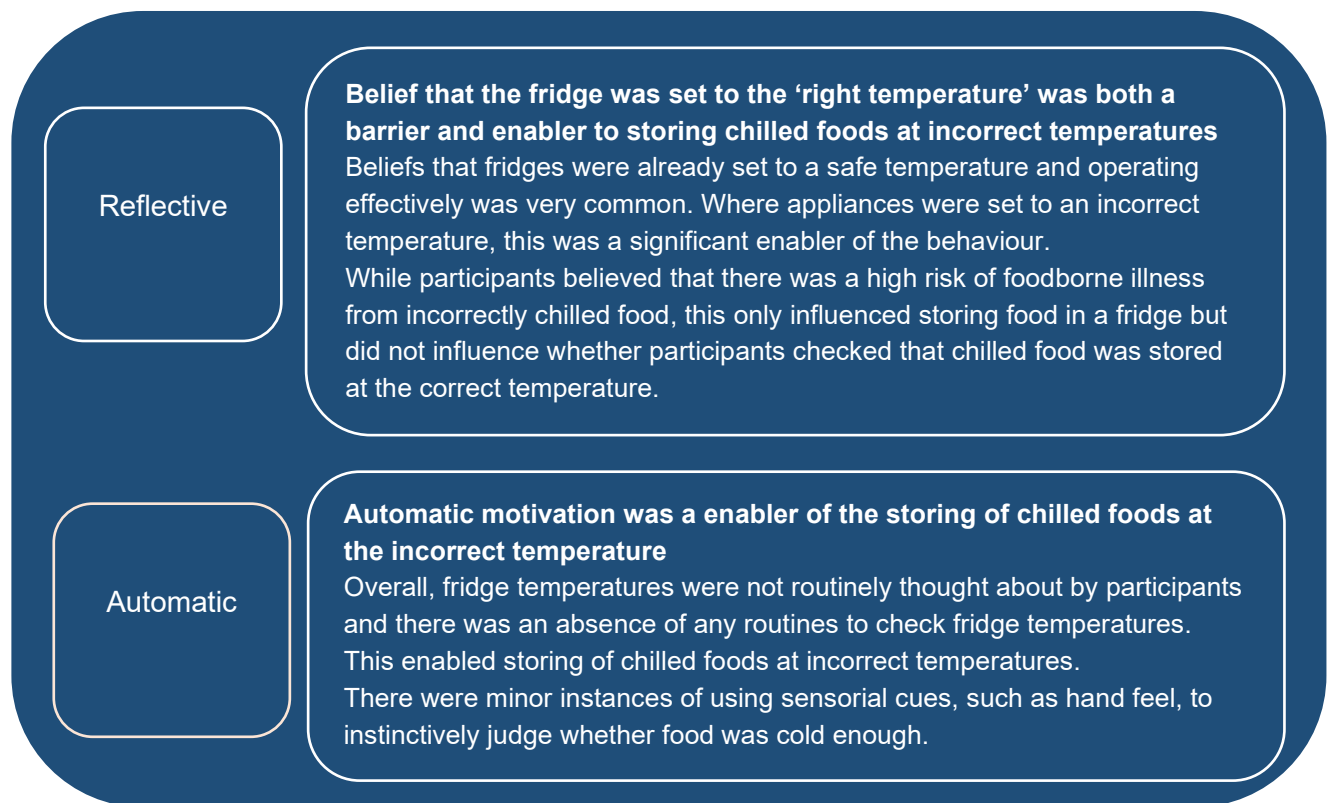
The presence of a built-in thermometer and alarm and whether these were set to the right temperature, encouraged the storage of foods at the correct temperature. However, the absence of these, and if they were working correctly, was an enabler of storing chilled foods at incorrect temperatures.

Social

Social norms were not a factor.

Discussions about fridge temperatures, or shared household behaviours concerning the monitoring of fridge temperatures, were not observed during fieldwork. Consequently, social norms were not an influence on the behaviour.

Motivation



Detailed findings

Physical capability

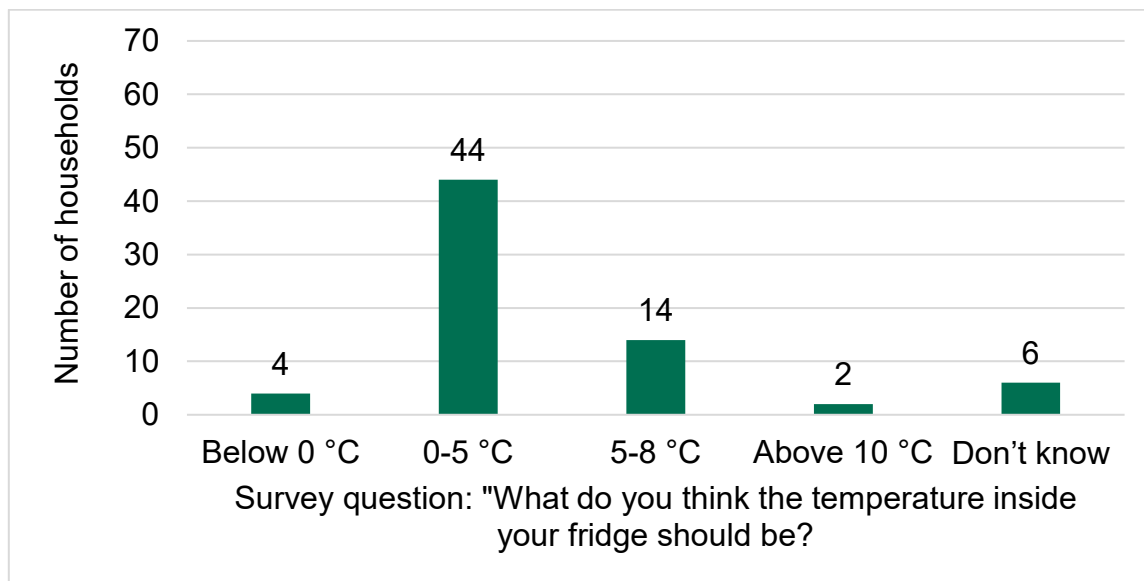
Physical capability was a minor factor influencing the storage of chilled foods at an incorrect temperature, and whether and how a fridge was checked to be cold. Specifically, the inability to read the fridge temperature or coldness dial settings due to an eyesight condition was cited as a problem for a few participants.

Psychological capability

Limited knowledge of the recommended fridge operating temperature was a significant enabler of storing chilled foods at incorrect temperatures.

While from the survey, 44 (out of 70) participants correctly identified the recommended operating temperature range for a fridge was between 0–5°C (see figure 2) there is strong evidence from the interviews to suggest this level of knowledge is overstated, and participants guessed, or were prompted by answers in the survey from a list of options.

Figure 2. Understanding of safe fridge operating temperature range among households (n=70)



In interviews, participants (including those who gave correct answers in the survey) were either unsure or struggled to recall the correct fridge operating temperature, with a temperature of 6°C often cited.

'I think it's between... I can't remember exactly, but I think it might be between 5 and 8 degrees. Okay, I might be wrong. But I think it's that. I think mine's set at 6 degrees.'

Female, 26–40, White, socio-economic group ABC1, lives with family

Overall, participants either did not know or were uncertain about the recommended operating temperature for a fridge.

Additionally, although not commonly mentioned, some participants with fridge coolness dials were not clear about the level to which the dial should be set.

Physical opportunity

The default temperature setting of the fridge played a notable role in influencing the storing of chilled foods at incorrect temperatures in households. In interviews, participants mentioned they would only very occasionally adjust the fridge settings.

'I've never really look about the limits. I definitely can set the temperature and have done it once.'

Female, 26–40, White, socio-economic group ABC1, lives with family

Consequently, if the default setting was too high, foods would be stored at the incorrect temperature, and not subsequently checked.

Related to this, in interviews for households that had fridge alarms¹⁵, these were reported as being relied upon to warn if the temperature went above a safe threshold.

‘There’s no risk that the fridge will go below a temperature because the fridge alarm will sound if this happens’

Male, 26–40, White, socio-economic group ABC1, lives with family

Several households claimed that alarms were present in their fridge, which would sound if the temperature of the fridge was too high. However, there were only a few observations of fridge alarms sounding during fieldwork, despite KL2 thermometers indicating that fridges ran at more than 5°C for at least one hour in 52 households. It is possible that the temperature threshold for the fridge alarm had been set too high in certain households, or that the alarm was not working correctly. It is also possible that participants misunderstood the purpose of the in-built alarm (as discussed in the reflective motivation section), or inaccurately reported there was a temperature alarm on the appliance. The presence of alarms in fridge/freezers was not corroborated.

For participants who reported that their appliance did not have an alarm or built-in thermometer, there was limited reliance on the coldness dial to manage fridge temperatures. Dials were not frequently mentioned in interviews, and settings were changed very occasionally. Such households did not have an easy way to check if the appliance was running at too high a temperature and were not observed to check.

Social opportunity

Social opportunity was not a factor that influenced the storing of chilled foods at incorrect temperatures in households, and whether and how refrigerated food was checked to be cold. There were no observations of fridge temperatures being discussed during filming, nor was it cited in the context of safety for children or others in the households in interviews. If done at all, checking the fridge temperature was a private behaviour.

¹⁵ Data was not collected on the total number of fridges with thermometers or alarms in the study.

Reflective motivation

Reflective motivation was both a barrier and enabler to storing chilled foods at incorrect temperatures in households and whether and how refrigerated food was checked to be cold. There were 3 influential beliefs.

First were beliefs about the consequences of storing foods at an incorrect temperature. Participants believed there was a strong likelihood of getting ill from foods that were not refrigerated correctly, especially raw foods such as meat and fish. While this view was very widespread, it was only an enabler of keeping chilled foods in a fridge, rather than checking whether the fridge was operating at a safe temperature.

Second, and related, a belief that the fridge was already set to the right temperature and was operating correctly was very common. This belief was one of the most significant factors enabling foods to be stored at an incorrect temperature. For households without a built-in fridge thermometer, participants believed the fridge was at a safe temperature as the dial was 'set to the coolest setting'. During interviews, there were no instances of participants saying they were concerned their fridge was too warm. The belief that the fridge was already set to the correct temperature was also perpetuated by the belief that an alarm would sound if the temperature was too warm. Despite this belief, most appliances that were running too warm during the KL2 study did not sound an alarm (this issue is also discussed in physical opportunity). The presence of alarms in fridge/freezers was not corroborated.

Third, while less common, there was a belief that when problems arose with fridges, they were commonly associated with the appliance being too cold rather than too warm. For example, the build-up of ice in the freezer compartment of smaller fridges was believed to mean that the fridge or freezer was running cold, rather than the appliance not working properly. This belief also enabled foods to be stored at an incorrect temperature.

Automatic motivation

Overall, fridge temperatures were not routinely thought about by participants and consequently there was little conscious motivation to check the temperatures. The default behaviour was not to check the appliance unless a problem had arisen. There was an absence of any routines to check fridge temperatures in households, with no observations of temperature checks being undertaken during filming or

stated during interviews¹⁶. In this context, automatic motivation had the potential to be a significant enabler of the storing of chilled foods at incorrect temperatures.

In one household where the participant worked in a food business and had to check fridge temperatures daily whilst at work, they did not consider the need to perform similar checks on the fridge at home.

‘At work, we have to record every day on the temperature of the fridge and the temperature of the freezer. But at home you would never think of it.’

Female, 41–50, White, socio-economic group C2DE, lives with family

There were minor instances of participants saying they would rely on sensorial cues, such as whether milk from the fridge felt warm to the hand, to instinctively perceive whether a fridge was operating at the incorrect temperature. While this was an enabler of checking refrigerated food was cold, the behaviour was reported in a household where the fridge was running on average above 5°C across the filming period, so this approach is unlikely to be effective.

Case study

Storing chilled foods at incorrect temperatures in households

Name: Jean

Age group: 26–40 years

Household composition: Lives alone

Jean is self-employed and lives in North East England. She describes herself as ‘quite spontaneous’. While Jean enjoys cooking from scratch and experimenting with new dishes, she is also just as happy to get a ready-to-eat meal from a supermarket. She used to eat out a few times a week but was very unwell during the COVID-19 pandemic and now spends more time at home.

Jean’s kitchen is small and clean, with an open-plan layout that leads into a sitting room. Jean has a large fridge-freezer, which looks to be relatively modern and well maintained. Jean does not report any physical barriers to using the appliance.

¹⁶ This observational finding contrasts with claimed data in the [Food and You 2 survey](#), where 59% of respondents say that they monitor fridge temperatures.

While Jean stated in the survey that the correct temperature of the fridge should be 0–5°C, she is uncertain in the interview and believes 6°C is a good temperature. She thinks (but is not sure) that this is the temperature her fridge is set at and believes an alarm would sound if the fridge was too warm. However, she is unsure whether the alarm had been disabled after there was a problem with the freezer a few weeks ago. She also believes that because her house is old and cold, food would not get too warm anyway. She says, 'technically you could forget to put your milk away, and your milk would be fine, because it's so cold in the house'.

Jean's fridge temperature data, captured by KL2 thermometers, show the appliance is consistently running too warm, with an average temperature of 6.6°C taken across 3 days (with a minimum of 3.4°C and maximum of 9.1°C). Jean is unaware of this and believes the fridge is fine as it is 'relatively new'.

Jean knows there is a risk related with running the fridge too warm, saying 'there would obviously be a risk from these things'. Nonetheless, she thinks the appliance is working well and, if anything, is running too cold after there was a build-up of ice in the freezer (Jean's freezer was running at an average temperature of -17.1°C).

Analysis of Jean's behaviour

The influences on Jean's behaviour is primarily related to psychological capability. Firstly, Jean has a lack of knowledge on the safe operating temperature of the fridge, and falsely assumes that the ice-build up in the freezer means that the fridge-freezer is cold enough to store food at (psychological capability). This is a barrier to operating her fridge at the recommended temperature. Further, Jean relies on the alarm in the fridge-freezer to sound if the temperature is too warm, however it is not certain if the alarm works. The alarm not working is a barrier to ensuring that Jean's fridge-freezer is operating at the recommended temperature (physical opportunity).

Identifying behaviours for interventions (households)

In reviewing the KL2 findings, a notable influence on storing chilled foods at incorrect temperatures in households was how infrequently participants considered the behaviour. One of the key observations was that participants believed once their fridge was set up, the appliance would keep foods at a safe temperature and there was limited need to check this. Where available, fridge alarms were seen to warn

participants in the event of temperatures becoming too high (although KL2 data indicates this did not happen in practice).

After KL2 fieldwork was completed, a workshop was held with experts in food hygiene and the behavioural sciences to discuss the COM-B influences on each of the KL2 priority behaviours, including the storing of foods at incorrect temperatures. In the workshop, experts discussed the findings from KL2 to explore the 'problem behaviours' that occurred in kitchens and then considered the 'desired practice'; that is, the behaviour that households and FBOs should do to improve food safety. In this case, the desired practice is for individuals in households to **check the operating temperature of a fridge and, as required, adjust the appliance settings to ensure foods were refrigerated within the recommended range of 0-5°C.**

Once the 'desired practice' was established, the workshop then explored the specific behaviours to target, to enable the desired practice. Each of these specific behaviours is explored in more detail below. It should be noted that the workshop was not designed to explore behavioural interventions, as this was outside of the scope of KL2. These specific target behaviours could be used in future research, for the development of behavioural interventions.

Specific behaviours to target to achieve the desired practice:

1) Checking the operating temperature of the fridge.

- Findings from the KL2 study indicate that most households do not routinely check fridge temperatures and that most participants believed that their fridge was running at a 'safe' temperature. Consequently, enabling people to check the fridge temperature was an important behaviour to enable.
- A barrier identified was that participants who owned fridges without in-built thermometers were not easily able to check the operating temperature of their appliance.
- Enabling participants to check the temperature of their fridge regularly and have a reliable method in place to do so, should be a high priority area of focus for any future interventions research. Interventions should consider ways that consumers can easily check the temperature of their fridge.

2) Enabling households to lower the fridge temperature if above 5°C.

- In addition to checking the fridge temperature, households need to lower the fridge temperature if it is above 5°C.
- While fridge coolness settings were found to be confusing by a few participants, the ability to adjust the fridge temperature settings was not cited

as an issue in most households in interviews.

- Both behaviours (checking fridge temperatures and changing the temperatures as required) would need to be considered for any intervention design to achieve the desired practice.

3) **Setting and checking fridge alarms**

- KL2 showed that many participants, who had an alarm in their fridge, relied on the sound of an alarm to alert them if the fridge temperature was too high. However, most fridges in the study did not sound an alarm, despite being too warm. Most participants assumed that the temperature of the fridge was correct if the alarm did not sound.
- Enabling participants to set these alarms correctly (and check that they are working) could also be an area for future behavioural interventions research. Interventions could also focus on the effect that alarms have in alerting participants to an issue with their fridge temperature.

Further recommendation: Improving awareness of the correct fridge temperature

A key part of the FSA's role is to provide guidance to businesses and consumers on food safety practices. KL2 has identified areas where the FSA's guidance could be improved, or where awareness of the guidance may be beneficial.

Findings from the KL2 study indicate that many participants do not know the recommended operating temperature for their fridge. Although the majority were able to identify the correct temperature in a survey setting (where multiple-choice answers were available), they could not accurately report the correct temperature in interviews, and often guessed at 'about 6°C'.

Improving consumer awareness of the correct fridge temperature, and risks of running the appliance at the incorrect temperature are also an important finding from this research. However, it should be noted that improving awareness alone is unlikely to improve the behaviour. For this reason, the FSA should consider improving awareness in addition to the behaviours outlined above.

Kitchen Life 2: Findings for FBOs

Quantitative observations from filming

In the sample of 31 FBOs, fridge temperature data was collected for 29 FBOs, and freezer temperature data was collected in 28 FBOs (with the remainder failing to install the thermometer during the fieldwork period or being omitted during data quality checks – see [the technical report](#) for further details). The data shows that:

- the average¹⁷ fridge temperature across the filming period was 4.3°C (with minimum and maximum temperatures ranging from -2°C to 15.6°C)
 - 8 FBOs had an average fridge temperature greater than the 5°C recommended maximum during the fieldwork period
 - 1 FBO had an average fridge temperature greater than 8°C during the fieldwork period (it is a legal requirement that cold foods must be kept at 8°C or below).
- for freezers, the average temperature was -18.6°C (with minimum and maximum temperatures ranging from -32.4°C to 3.2°C)¹⁸. The average temperature is in line with FSA recommended guidance of -18°C.
 - 8 FBOs had an average freezer temperature warmer than the recommended -18°C during the fieldwork period.

This indicates that the storing chilled foods at an incorrect fridge temperature was a potential safety issue for a quarter of the FBOs in the sample. Additionally, the storage of frozen foods at an incorrect freezer temperature impacted just under a third of FBOs. Whilst this is not necessarily a food safety risk (as pathogens can only grow above -2°C), freezers that fall outside of the recommended range could compromise food quality and result in spoilage. Factors influencing the storage of chilled are now explored in more depth.

¹⁷ Averages are based on three days of thermometer data per FBO. Temperature readings were recorded approximately four times per hour during this period. The three days of temperature data analysed correspond to the period when filmed footage was analysed in each FBO.

¹⁸ A temperature of 20°C was recorded, but this kitchen was omitted as this figure was deemed an anomaly and is likely to be the result of an error.

Factors influencing the storing of chilled foods at incorrect temperatures in FBOs

Summary

Most FBOs were diligent about storing foods at the correct temperatures. This was enabled by three factors:

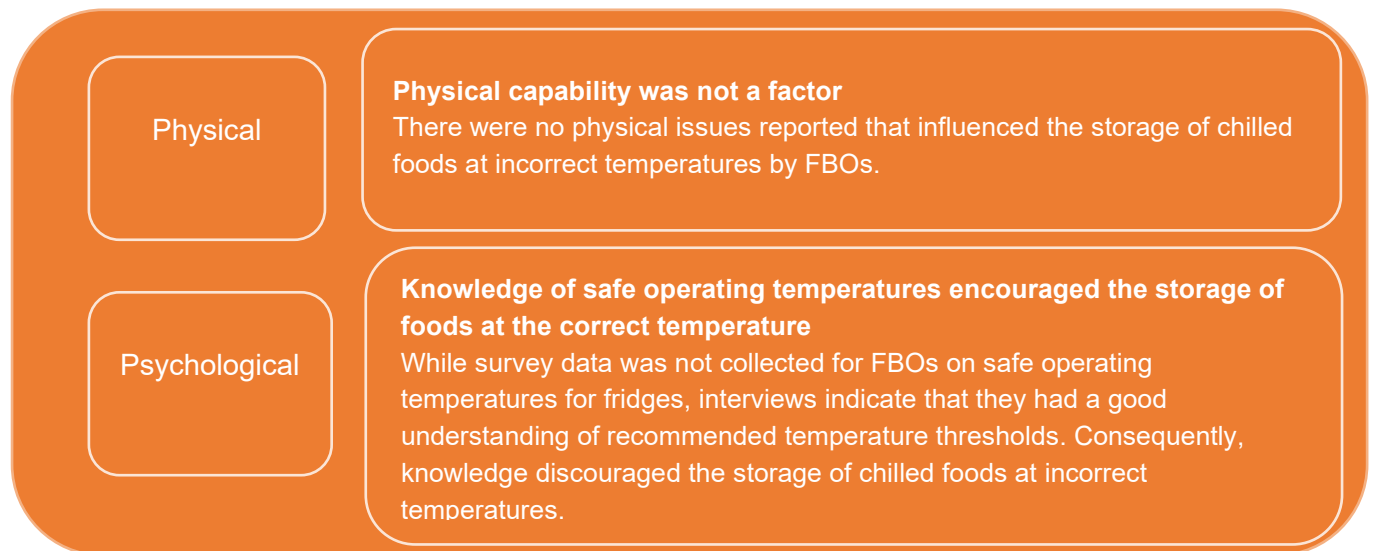
- a compliance culture, together with established routines to check fridge temperatures
- the use of modern fridge equipment with built-in thermometers
- beliefs that there were serious consequences for both consumers and the business from running appliances at too warm a temperature

Conversely, FBOs with a culture less focused on compliance, who had fewer set routines to check fridge and freezer temperatures, enabled the storing of chilled foods at incorrect temperatures. For this group, which was relatively small in the study, the behaviour was reinforced by beliefs that there were limited consequences of fridges running at an incorrect temperature, and specifically that fluctuations in temperature (above the recommended threshold) were not of significant concern. It was also enabled by using older fridges and freezers that did not have thermometers or alarms built into them.

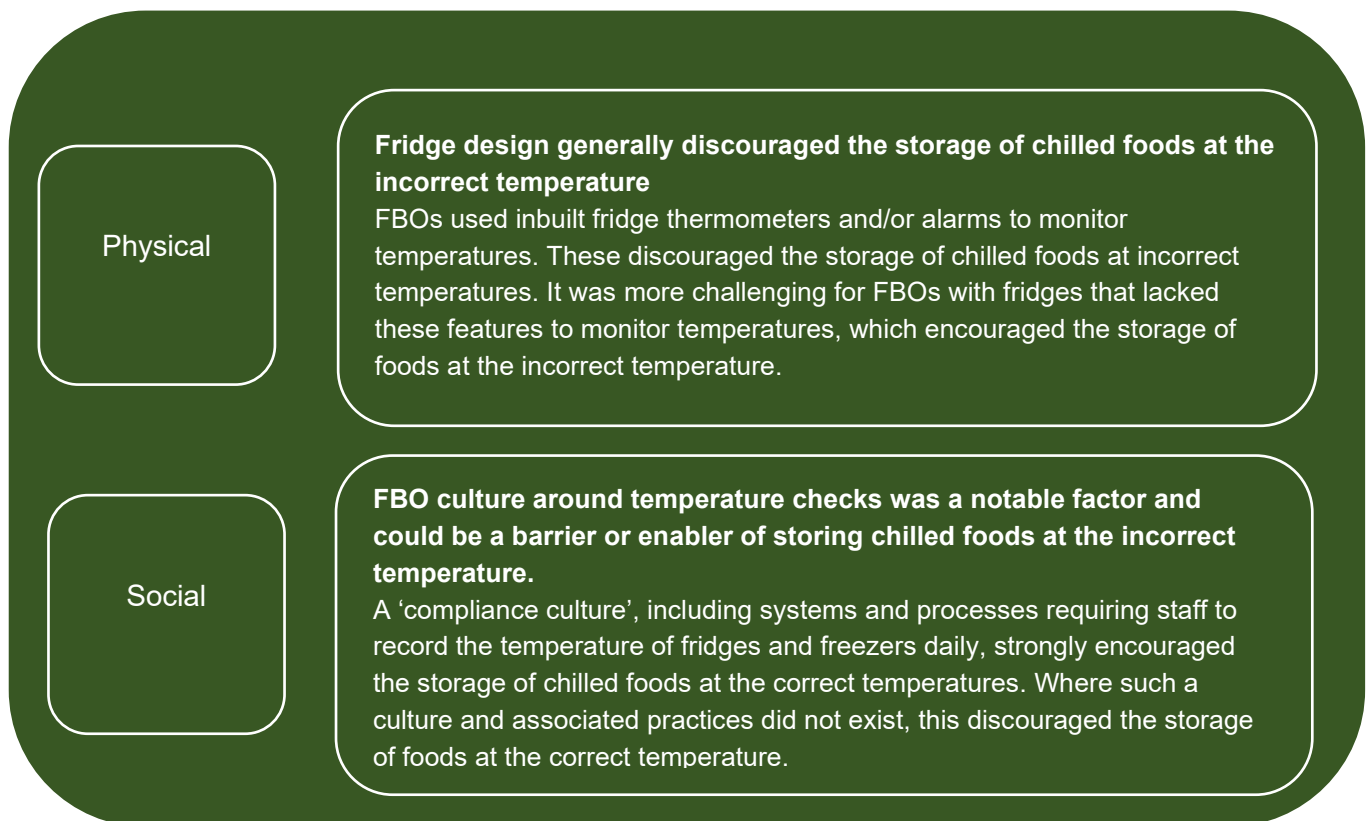
A summary of COM-B factors is given in figure 3.

Figure 3. Summary of COM-B factors influencing the storing of chilled foods at incorrect temperatures in FBOs

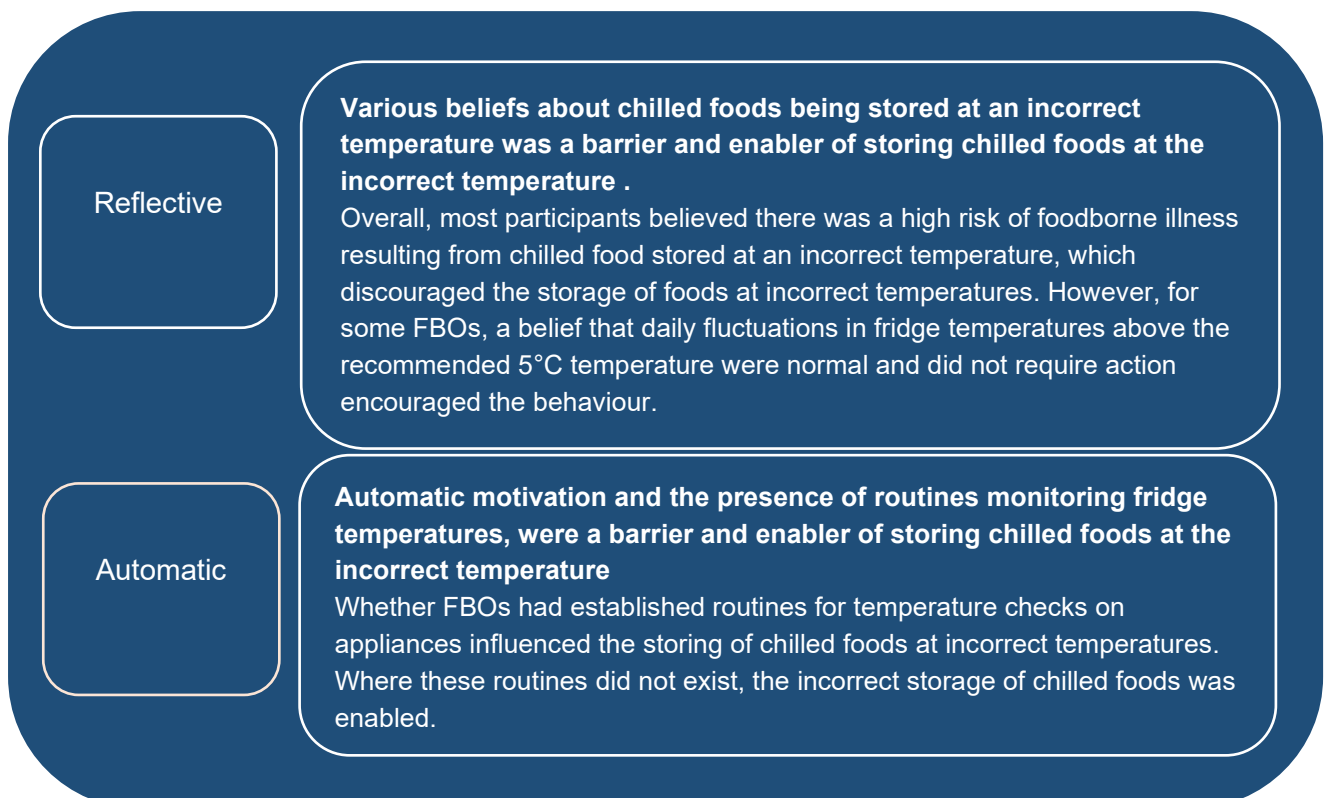
Capability



Opportunity



Motivation



Detailed findings

Physical capability

Physical capability was not cited or observed as a factor influencing the storage of chilled foods at an incorrect temperature, or whether and how a fridge was checked to be cold in FBOs.

Psychological capability

Accurate knowledge about fridge temperatures enabled the storage of chilled foods at the correct temperature. While no survey data were collected on whether FBO participants understood the correct operating temperature of a fridge or freezer, findings from interviews suggest a good understanding.

Specifically, in interviews, the 0–5°C recommended range was commonly mentioned in the context of safe operating temperatures for fridges, with a few instances of participants suggesting 6°C was acceptable. Similarly, temperatures of –18°C or below were cited as a safe operating temperature for freezers.

While running a fridge or freezer at too high a temperature was noted as a serious environmental health breach in interviews, the maximum threshold of 8°C for a fridge was not spontaneously mentioned.

Physical opportunity

The design of the appliance and time taken to record fridge temperature readings both influenced whether and how a fridge was checked to be at an incorrect temperature in FBOs.

In general, the monitoring of fridge temperatures by FBOs was generally enabled by the appliance. The majority of FBOs had modern fridges with thermometers built-in. This was observed from filming and from photographs taken of fridge storage. FBOs also said in interviews that fridges typically had temperature alarms. The triggering of a fridge or freezer alarm was not observed during the filming, despite 8 fridges running above the recommended temperature of 5°C throughout the duration of filming, on average. Additionally, though not common, temperature probes were claimed in interviews to be used by a small number of FBOs for fridges.

Several FBOs said they used devices (such as iPads) to record fridge temperatures, which made the process of record keeping easier and helped to reduce barriers to undertaking daily temperature checks on appliances.

A lack of resources, for example the time, money or expertise to replace faulty fridge components, was not stated as a factor that could influence keeping chilled foods at an incorrect temperature.

Social opportunity

The culture of an FBO influenced the storage of chilled foods at an incorrect temperature and could be a barrier or enabler to the behaviour. In interviews, several FBOs mentioned a 'compliance culture' which was enabled by systems and processes requiring staff to record the temperature of fridges and freezers. This generally involved 'opening checks'¹⁹, where the fridges and freezers were examined to check that they were working properly, and temperatures recorded. This was the responsibility of the manager to oversee, with different members of staff undertaking the checks depending on the size of the business, including the use of rotas for larger businesses. In two businesses, temperature checks were mentioned as being undertaken twice a day, but most businesses checked fridge/freezer temperatures once each day as part of 'opening checks'.

When monitoring fridge temperatures, the use of checklists was noted as important and, in the survey, a third of businesses said they used the 'Safer Food, Better Business' pack (separate guidance is available to [FBOs in Northern Ireland](#)), which provides guidance for the safe storage of chilled foods (including the need to conduct temperature checks at least once a day). A compliance culture within FBOs discouraged the storage of food at incorrect temperatures. While not observed to be explicitly discussed during filming, the need to ensure food was kept at the correct temperature was mentioned in interviews as a key part of the food safety culture in most FBOs.

There was a small but notable group of FBOs where the culture surrounding temperature checks was more relaxed. These businesses did not have daily routines for temperature checks, and rather claimed to check the appliances every few days. In interviews, descriptions of how these checks were carried out were vague, and generally, it did not involve the routine recording of fridge temperatures. The culture in these FBOs enabled the storing of chilled foods at incorrect temperatures.

Reflective motivation

Beliefs about the consequences of storing chilled foods at an incorrect temperature were a notable factor influencing behaviours and whether and how a fridge was

¹⁹ 'Opening checks' form part of the [FSA's business guidance](#) and refer to checks completed at the beginning of the day. This includes checking that fridges/freezers are working correctly.

checked to be cold. In general, FBOs believed there were significant health and safety risks from not keeping perishable foods chilled or frozen at the correct temperature. They were especially conscious of risks from meat, and this helped to enable temperature checks. In a few FBOs, monitoring fridge and freezer temperatures was cited as one of the most critical points to monitor to keep customers safe.

As well as impact on customers, the impact on the reputation of the business was also mentioned by several FBOs as a significant factor influencing behaviour.

‘You cannot have a fridge which is higher than 5, 6 degrees. You can’t have a freezer which is not working at the right temperature. It’s always -18, -19, -20 degrees. It’s important to look after your equipment. With fridges and freezers, if something goes wrong, the whole business goes down the drain.’

Italian restaurant, fewer than 5 staff, FHRS rating 4–5

While less common, certain FBOs believed the temperature of a fridge or freezer would commonly fluctuate, often for reasons that were outside of their control, such as during hot weather. For these FBOs, having temperature readings above the recommended range from time to time was viewed as less of a concern. Fridges that were sometimes too warm were seen as a ‘normal’ way of operating a fridge, and hence not likely to pose any food safety risks. This belief was reinforced by an absence of food poisoning incidents in the business.

Automatic motivation

Automatic motivation had a significant influence on storing of chilled foods at an incorrect temperature in FBOs, and whether and how a fridge temperature was checked.

Specifically, checking fridge temperatures was an important part of many FBO routines. While this was driven by the protocols and checklists (mentioned in the physical opportunity section), it was also an established practice in these businesses, being undertaken as part of ‘opening checks’²⁰. FBOs that were not in

²⁰ ‘Opening checks’ form part of the [FSA’s business guidance](#) and refer to checks completed at the beginning of the day. This includes checking that fridges/freezers are working correctly.

the habit of checking fridge temperatures daily (as part of a routine) were more likely to store chilled foods at incorrect temperatures.

Case study

Storing chilled foods at incorrect temperatures in FBOs

Name: Carlos

Role: Owner

Type of business: Café

Number of staff: Fewer than 5

FHRS rating: 4–5

Carlos has worked in restaurants all his working life but is now semi-retired. After the COVID-19 national lockdowns, he decided to set up a small café with his partner Sofia. He established the café as he is 'passionate about food' and to supplement the income from his pension. The café makes coffees, drinks, smoothies, milkshakes and sandwiches. He describes the café as a 'popular place to hang out'.

The café kitchen is very small and square in shape. On the far wall is the fridge, which is tall and thin. A separate freezer is housed in another room and not visible to the camera. To the near side and facing the serving area is a display unit for cakes and deli items, together with a coffee machine and a kettle.

Food hygiene is important to Carlos but, as the café does not use many raw foods, he believes risks are minimal. The café does have a deli counter and uses a range of cured meats. Carlos believes 'keeping the food temperature right' is very important for safety. In the interview, Carlos reports the correct temperature to be around 6°C for the fridge and -18°C for the freezer. Carlos does not mention any physical problems with being able to read the appliance thermometers or change fridge or freezer settings. The fridges do not have built-in alarms and Carlos is not observed to discuss the temperature of the fridges with Sofia.

From the temperature readings, the fridge runs at an average temperature of 7.2°C across the filming period (with a minimum of 6.1°C and a maximum of 8°C). Carlos says the fridge has a thermometer, which he claims to 'check from time to time, every couple of days' but this cannot be confirmed in observations. While formal records are not kept, he notes during his interview that the fridge temperature does fluctuate; Carlos puts this down to the hot summer. He is not

particularly concerned about this from a food safety perspective as it ‘is around the right temperature’. He does not alter the fridge settings in response to changes in weather.

Analysis of Carlos’ behaviour

The influences on Carlos’ behaviour relate to several factors, most notably psychological capability and automatic motivation, but also physical opportunity, and reflective motivation. Specifically, Carlos has a lack of knowledge on the safe operating temperature of the fridge, which he understands as 6°C (psychological capability). This enables the behaviour of storing chilled foods at the incorrect temperature. Carlos does not have set routines for monitoring fridge temperatures (automatic motivation) and, while he claims to check the fridge temperature ‘every couple of days’, this is not observed. This lack of routine, together with a lack of an alarm on the appliance (physical opportunity), is a significant enabler to the behaviour. While Carlos understands there is a risk from running the fridge too warm, he puts any fluctuations in the fridge temperature down to the warm summer weather (reflective motivation). This means that even when Carlos knows the fridge temperature is high, his motivation to act on this knowledge is limited.

Identifying behaviours for interventions (FBOs)

In reviewing the KL2 findings, a notable influence on storing chilled foods at incorrect temperatures in FBOs was routines around opening checks²¹ in the business, together with systems and processes to check and record temperature. Ensuring businesses acted when fridge temperatures were above the 5°C maximum was also an issue to be addressed.

After KL2 fieldwork was completed, a workshop was held with experts in food hygiene and the behavioural sciences to discuss the COM-B influences on each of the KL2 priority behaviours, including the storing of foods at incorrect temperatures. In the workshop, experts discussed the findings from KL2 to explore the ‘problem behaviours’ that occurred in kitchens and then considered the ‘desired practice’; that is, the behaviour that households and FBOs should do to improve food safety. In this case, the desired practice is for FBOs to **check the operating temperature of a fridge daily and, as required, adjust the appliance settings to ensure foods were refrigerated within the recommended range of 0-5°C.**

²¹ ‘Opening checks’ form part of the [FSA’s business guidance](#) and refer to checks completed at the beginning of the day. This includes checking that fridges/freezers are working correctly.

Once the 'desired practice' was established, the workshop then explored the specific behaviours to target, to enable the desired practice. Each of these specific behaviours is explored in more detail below. It should be noted that the workshop was not designed to explore behavioural interventions, as this was outside of the scope of KL2. These specific target behaviours could be used in future research, for the development of behavioural interventions.

Specific behaviours to target to achieve the desired practice:

1) Establishing daily routines to check food temperatures.

- Findings from the KL2 study indicate that where FBOs had established daily routines in place to monitor fridge temperatures they were more likely to check that fridges were operating at the recommended temperature range (0–5°C). The presence of a consistent routine acted as a reminder for FBO staff that fridge temperature is an important aspect of food safety. Conversely, an absence of routines, meant such monitoring was undertaken in an unsystematic way.
- There is already guidance provided from the FSA in the [Safer Food, Better Business pack](#) (separate guidance is available to [FBOs in Northern Ireland](#)) around the need to monitor the temperature of fridges daily, as part of the 'opening checks' to maintain basic food hygiene standards. Consequently, interventions to support compliance with the recommended practice would be important.
- The FSA may wish to consider ways to improve the existing food hygiene inspection process, which already involves assessments of fridge/freezer temperatures and the methods that FBOs use to record and assess temperatures of their appliances.
- For the reasons outlined, establishing daily routines to check food temperatures should be a key focus for any future intervention research.

2) Enabling FBO staff to turn down the fridge temperature settings, where temperatures are higher than 5°C

- Findings from the KL2 study indicate that even when fridges were running above the recommended maximum of 5°C, some FBOs failed to act on this knowledge.
- Reasons for this behaviour concerned beliefs that fluctuations in fridge temperatures above 5°C were 'normal' and did not present a significant food safety risk.
- Interventions could focus on the need to act if a fridge was above 5°C, to ensure temperatures remain under 8°C
- While not explored in KL2, one hypothesis discussed during the workshop was that the recommended (0–5°C) versus legal (8°C) thresholds on fridge temperatures also influenced whether FBOs acted to adjust temperature settings above 5°C. This was potentially an area to clarify in future communications.

Conclusion

This chapter provided in-depth analysis on storing chilled foods at incorrect temperatures and the factors that influence this behaviour, including illustrative case studies of these factors in practice. The findings presented in this report allow the FSA to better understand this behaviour, and the risks involved.

Understanding the specific influences on these behaviours enables future work on designing effective interventions to enable behaviour change. Future research should focus on designing interventions which can enable the positive target behaviours outlined in this report. Following on from the use of COM-B to understand behaviours, The Behaviour Change Wheel²² can be used to identify effective interventions and behaviour change techniques.

²² Michie, S., van Stralen, M.M. & West, R. The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Sci* 6, 42 (2011). <https://doi.org/10.1186/1748-5908-6-42>