



Not reheating leftovers until steaming hot throughout

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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](#)
- [Storing chilled foods at incorrect temperatures](#)
- [Not checking use-by dates and consuming foods past use-by dates](#)
- [The creation of food waste](#)

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

Summary

It is important to reheat leftover food until it is steaming hot throughout to kill harmful bacteria that may have grown since the food was cooked¹.

Observations, surveys, and interviews were conducted during the Kitchen Life 2 study to understand behaviours related to reheating leftovers.

Reheating leftover foods was only occasionally observed for food business operators (FBOs), occurring on 7% (22) of meal occasions. As such, this chapter focuses on the behaviour in households only.

Reheating leftover foods was observed on 14% (144) of meal occasions in households. Over half of reheating occasions were observed to take place for less than 2 minutes (although there is no specific FSA consumer guidance for specific reheating times, the [FSA's advice](#) on reheating states that reheated foods, such as rice and meat, should be steaming hot throughout).

To check that food was reheated correctly, in the survey, the majority of households claimed to check if the middle was hot. Just under half of the sample reported that they check if steam is coming off the food (which is part of FSA recommended guidance²).

Overall, the factors affecting whether households reheated leftovers until steaming hot were:

- mixed levels of **understanding that leftover food contained bacteria** together with **low levels of awareness of advice to reheat leftover foods to be steaming hot throughout** generally discouraged participants to reheat food safely (Psychological capability).
- the **availability of hobs and microwaves** in the kitchen to reheat foods enabled participants to reheat food safely. However, for microwaves, the presence of the door and limited space inside the appliance acted as a

¹ <https://www.food.gov.uk/sites/default/files/media/document/sfbb-childminders-cooking-reheating.pdf>

² The FSA does not currently have any specific guidance for households on reheating leftovers. In their [cooking guidance](#), consumers are advised on safe cooking practices (for example, cooking foods in microwaves until steaming hot) and are advised in the '[Home food fact checker](#)' how to reheat specific foods such as rice and meat safely. Guidance on reheating food is available for businesses in the '[Safer food better business](#)' pack. Separate guidance is available to [FBOs in Northern Ireland](#)

barrier to stirring foods while reheating, which may mean foods are not reheated throughout (Physical opportunity).

These were reinforced by the following contextual factors³:

- beliefs about **how to judge whether food was sufficiently hot** and **beliefs about the consequences of eating partially reheated leftovers**, which acted as both a barrier and enabler of reheating leftovers until steaming hot (Reflective motivation).
- **routines around reheating foods**, especially in terms of duration and power settings used in a microwave, which could also act as a barrier or enabler (Automatic motivation).

Recommendations: strengthening consumer advice

In households, the desired practice (that is, the behaviour that households should do to improve food safety) is to **reheat leftovers until steaming hot throughout**.

The FSA should consider strengthening consumer advice on reheating practices, including how to reheat leftover foods throughout, in terms of frequency (only once), duration, temperature (until steaming) and completeness (by stirring). Moreover, advice should address consumer misconceptions about reheating practices; including that bacteria may persist on leftover foods, why leftovers should be reheated until steaming hot (or eaten cold) rather than 'warmed', and the risks of foodborne disease from leftovers.

Addressing FSA guidance in these areas would be the first step to identifying best practice as the foundation for behaviour, on which behavioural interventions research could be based.

³ These factors are not in a hierarchy of importance.

Background

Reheating leftover food is important to kill harmful bacteria that may have grown since the food was cooked. Leftovers can be eaten cold if they have been cooked properly and [cooled and put in the fridge within 2 hours](#)⁴. However, if leftovers are reheated, it is very important that food is steaming hot throughout before it is consumed. This temperature can be judged through visual cues such as steam rising from the food.

The [literature review](#) conducted as part of the Kitchen Life 2 (KL2) project explored consumer behaviours on leftover foods. However, most published research focuses on the storage and consumption of leftovers rather than reheating. In this context, 1 in 3 older adults did not know how long it was safe to leave cooked meat, seafood, eggs or poultry out of the refrigerator⁵. FSA's Food and You 2 survey revealed that over 8 in 10 of those surveyed claimed to place leftovers in the fridge or freezer within 2 hours, with 7 in 10 intending to eat the leftovers within 2 days⁶.

Limited previous research on practices around reheating leftovers made it an area of interest for the FSA. The behaviour 'not reheating leftovers until steaming hot throughout' was also identified as a priority and high risk by the FSA risk assessment team at the start of the study.

This chapter uses the KL2 data to understand reheating leftover food behaviours in the households, the factors affecting this and identifies behaviours that could be the focus of future interventions research.

Finally, it should be noted that reheating leftovers by FBOs was only observed on 7% of meal occasions (22 meals in total), therefore it was not possible to conduct a meaningful analysis. As such, this chapter only reviews the behaviour in households.

Related behaviours

The time taken to cool food down before refrigeration and the amount of time food is stored in the fridge also impacts the food safety aspect of consuming leftovers⁷. Due

⁴ Between 8°C and 63°C, any bacteria that is present in food may grow and make you ill (See FSA's guidance on [Chilling and "Danger Zone"](#)).

⁵ McWilliams RM, Hallman WK, Senger-Mersich A, Netterville L, Byrd-Bredbenner C, Cuite CL and Sastri N. 'Food safety practices of homebound seniors receiving home-delivered meals' Topics in Clinical Nutrition 2017: volume 32(4), pages 268–281

⁶ ['Food and You 2' report](#)

⁷ [Food Standards Scotland. Chilling.](#)

to the complexity of measuring these durations, these behaviours were not subject to a detailed analysis in the KL2 study.

FSA guidance on reheating leftover foods

While there is a range of detailed [FSA guidance for reheating foods in food businesses](#)⁸, general guidance for households on heating food is less comprehensive and concerns advice on specific foods and reheating methods in the [Home food fact checker](#). This highlights the need to:

- only reheat cooked meats once in a microwave and make sure that it is steaming hot all the way through before eating
- reheat only small pieces of meat, as large pieces may dry out in some places while not being thoroughly heated in others
- stir food while it is reheating in a microwave and read the manufacturer's instructions on standing and stirring
- never reheat rice more than once and make sure it is steaming hot all the way through
- take extra care with takeaway rice, which ideally should be eaten at the moment of purchase because some food businesses may pre-cook their rice and then re-heat it before it is given to the customers

The FSA also provides consumer advice on [cooking food safely](#). Although this does not specifically comment on reheating, it does advise consumers on heating food in the microwave. It advises consumers to stir food halfway through heating and ensure that food is steaming hot before eating.

⁸ Separate guidance is available to [FBOs in Northern Ireland](#)

Kitchen Life 2: Findings for households

Quantitative observations from filming

In the KL2 sample of 70 households, 62 used leftover foods for at least one meal during the fieldwork period. In total, leftovers were used on 178 meal occasions, which is just under 1 in 5 of all meal occasions.

Of these 178 meal occasions, 4 in 5 (144 meal occasions) also involved reheating leftover foods.

Of these 144 meal occasions 82 involved reheating on a hob. The average time leftover food was reheated on a hob was 2 minutes and 51 seconds, with 49 reheating occasions lasting less than 2 minutes.

83 occasions involved reheating in a microwave⁹. The average time leftover food was reheated in a microwave was 1 minute and 19 seconds, with 66 reheating occasions lasting less than 2 minutes. Stirring leftover foods while reheating in a microwave, which is recommended by the FSA, was not commonly observed.

Within our household sample, reheating leftovers was:

- most likely to occur from 6–8pm
- positively correlated with the disposal of food waste ($r=0.249$)^{10 11}

There were challenges observing how participants knew whether leftover foods were reheated to be steaming hot, and it was not possible to record the temperature of foods. To understand claimed behaviours in this context, in the survey, households were asked 'When reheating food, how do you know when it is ready to eat?' They were also asked to judge the effectiveness of the method. Findings are shown in figure 1.

Checking the middle was hot was the most claimed behaviour (by 52 households) and was seen as an effective method to judge when reheated food is ready to eat.

⁹ 21 meal occasions where leftovers were reheated involved the use of both, a hob and a microwave.

¹⁰ Pearson correlation, whether a behaviour was ever observed.

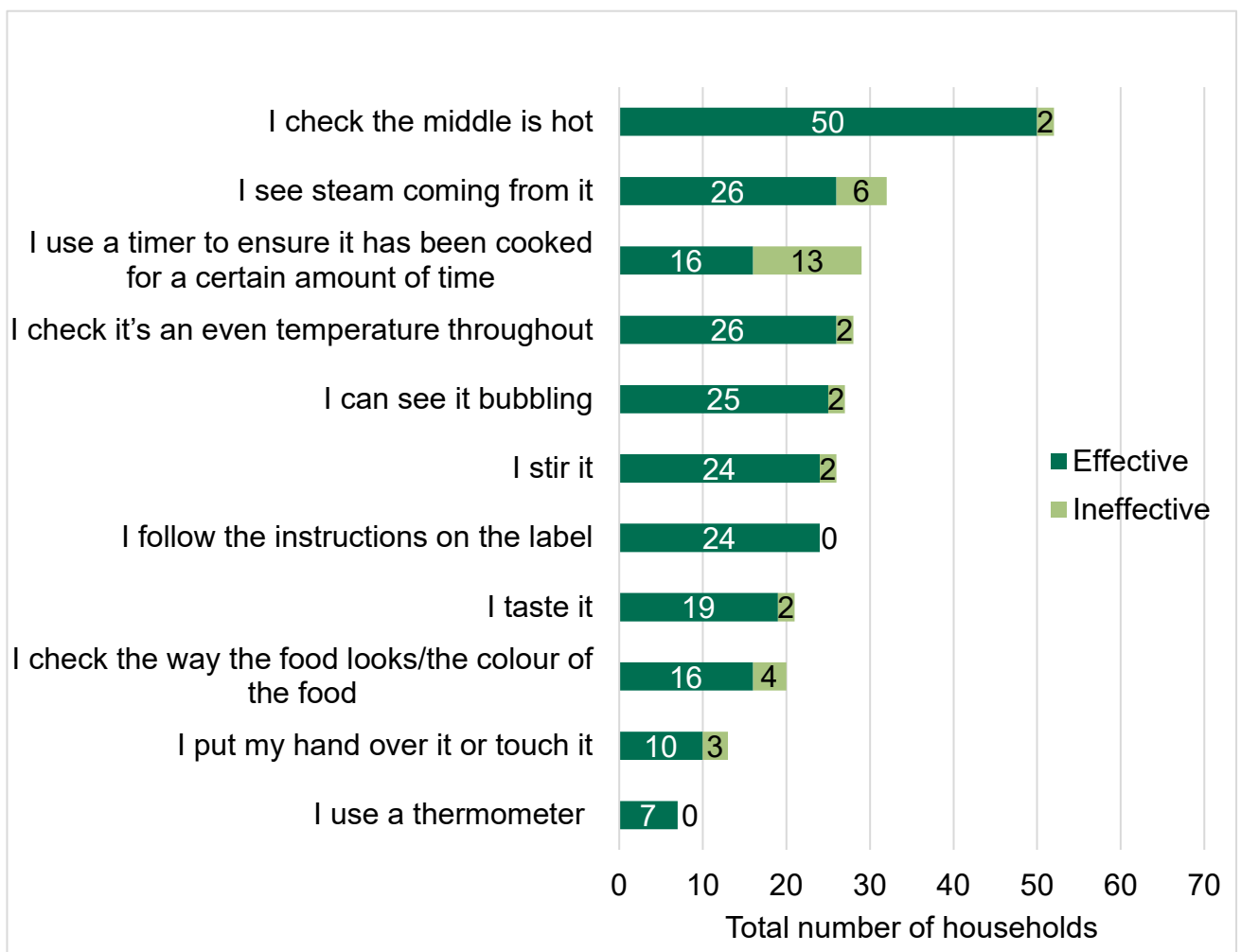
¹¹ The contribution of reheated leftover foods to food waste was not analysed in the KL2 study.

Seeing if steam was coming from it (which is part of the FSA recommended guidance) was claimed to be undertaken by less than half the households in the sample (32 households), of whom 6 did not see this method as effective. Out of the methods used, timing was seen as the least effective method to judge whether reheated food is ready to eat, relative to other methods.

No households stated that they did not use any of these methods, and most used a combination. While reported as a behaviour to judge when reheated food is ready to eat in 7 households, the use of a thermometer to check the temperature of reheated leftovers was not observed during filming.

Figure 1. Reported household behaviours on the use and effectiveness of different methods to judge when reheated food is ready to eat (base=70)

Survey question: “When reheating food, how do you know when it is ready to eat?”
Please select all that apply and rate in terms of effectiveness.



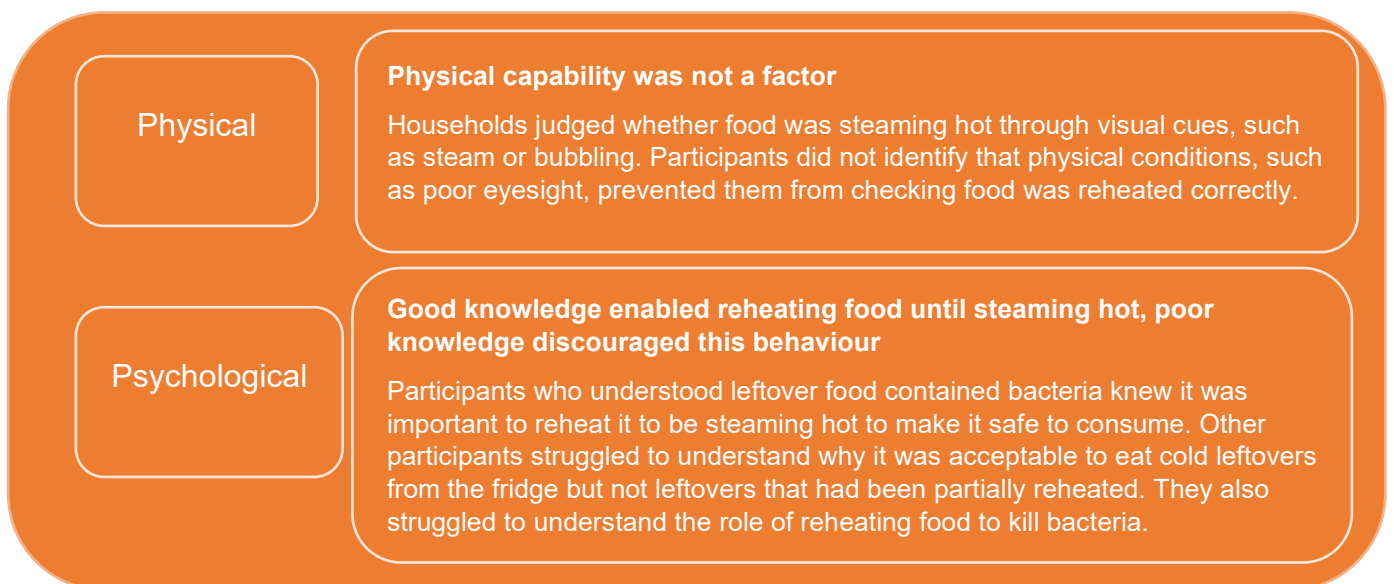
Factors influencing reheating leftover food until steaming hot throughout in households

Summary

Overall, the factors affecting whether households reheated leftover foods until steaming hot were different levels of understanding that leftover food contained bacteria and beliefs about the consequences of eating partially reheated foods. The physical design of a microwave was a barrier to stirring foods, which in turn discouraged reheating leftover food until steaming hot throughout. A summary of COM-B factors is given in figure 2.

Figure 2. Summary of COM-B factors influencing reheating leftovers until steaming hot throughout

Capability



Opportunity

Physical

The availability of appliances for reheating enabled the reheating until steaming hot

Households had hobs, cookers, microwaves, and utensils available to enable the reheating of leftovers until steaming hot throughout.

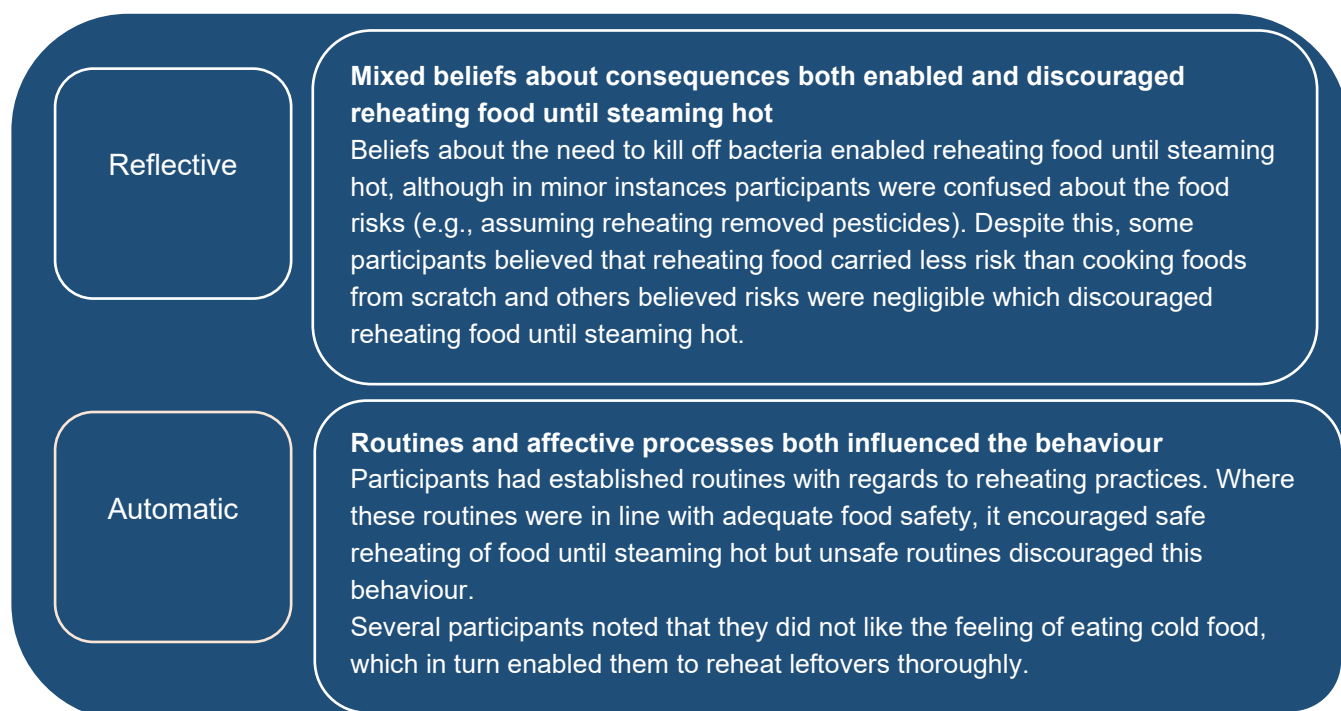
However, microwaves presented physical barriers to stirring food while it was being reheated (the door needed to be opened, and a low ceiling-height made stirring harder to perform).

Social

Social and culture norms were not a factor

The need to reheat leftovers until steaming hot throughout was not discussed in the household during observations. The presence of young children resulted in only minor differences in observed behaviours.

Motivation



Detailed findings

Physical capability

In the interviews, factors related to physical capability were not mentioned as factors that would discourage reheating leftovers until steaming hot throughout. However, a range of cues used to signal when food was steaming hot relied on visual capabilities, such as seeing steam or bubbles coming from the food or being able to read any reheating instructions on the label (these visual cues were mentioned by between a third and a fifth of participants in the survey as methods used to judge when reheated food is safe to eat – shown in figure 1).

Psychological capability

In the interviews, understanding the need to reheat leftovers until steaming hot was mixed among participants. For those with a good understanding, this was generally linked to advice about reheating foods from parents (see [social opportunity](#)). Across all participants in the sample, awareness of FSA advice around reheating leftover foods was low.

One significant area of confusion concerned the safety of eating cold foods versus the need to reheat foods until steaming hot. As noted in the [background section](#), leftovers can be eaten cold if they have been cooked and cooled properly, but if

reheated they need to be steaming hot before being consumed. In this context, it was relatively common for participants to misunderstand two things. First, that bacteria can still be present in cooked foods. Second the role and importance of reheating thoroughly because between 8°C and 63°C any bacteria that are present can grow quickly (according to [FSA's guidance related to the "Danger Zone"](#)).

'It is confusing that you can eat cooked chicken cold, so why does it have to be boiling hot when you heat it up? That does not make sense. That is why I would not be too concerned about it being steaming if I reheated.'

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

Even participants who did understand this distinction were uncertain about whether their knowledge was correct.

'To eat something cold isn't risky to me. I don't know, but I think that it's as long as it was cooled down properly. That's not a problem. But not reheating it properly can be quite dangerous. Is that right?'

Female, 26–40, White, socio-economic group C2DE, lives with partner

Consequently, poor understanding that leftover food contains bacteria, and that these multiply within a certain temperature range, was likely to influence not reheating leftovers until steaming hot throughout.

Physical opportunity

All household participants in our sample had easy access to a cooker, and other suitable utensils such as spoons to stir the food, to ensure food was reheated until steaming hot throughout. Almost 2 in 3 households had access to a microwave, which was routinely used for reheating food, and accounted for approximately half of reheating occasions, with reheating on a hob accounting for the other half. While not common, certain households also said (during interviews) that they used an air fryer to reheat foods.

Despite their availability, it was less easy to stir foods while reheating in microwaves, due to physical barriers such as needing to open the microwave door, and the low roof height of the appliance making the food harder to access and stir. Relative to a hob, stirring leftovers during the reheating process in a microwave was observed on

fewer occasions, which may influence whether leftover foods are reheated evenly throughout. Stirring was more common after the food had been removed from the microwave for serving.

Neither the time taken to reheat foods nor any associated costs were cited as barriers to reheating food until steaming hot.

Social opportunity

Social opportunity was not observed to play a notable role when participants were reheating leftovers, and the behaviour was not discussed directly with others in the household. However, for those with good understanding, this was generally discussed as a taught behaviour from childhood with participants describing the need to reheat food until it is 'scalding hot'.

In interviews, participants with young children said they were particularly mindful of the need to reheat foods properly. In observations, households with children and without children reheated food for approximately the same time, on average.

While cultural factors were mentioned in interviews in terms of whether food groups such as rice could be reheated more than once, there was no specific mention of culture influencing whether foods needed to be reheated until steaming hot (beyond the influence of parental advice when growing up).

Reflective motivation

Beliefs played a significant role influencing whether leftover food was reheated until steaming hot. Beliefs were centred around two areas – how to judge food was steaming hot and the food safety consequences of eating leftovers that were not reheated properly.

There were several beliefs mentioned by participants in interviews about the best way to judge when reheated food was hot enough. As supported by the survey findings, in interviews, participants generally believed that effective reheating required food to be steaming or bubbling; this belief enabled the effective reheating of foods. Tasting or touching food (including people placing fingers into dishes to test the temperature), the time the food had been reheated for (described variously as the 1-minute or 2-minute rule) and the colour of food were also mentioned by participants in interviews, as methods of judging whether reheating was effective. Generally, multiple cues were used to signal food was reheated thoroughly.

'How do I know if it's heated through? It's when you can't touch the bowl any longer! And the steam coming out and it's bubbling.'

Female, 41–60, Black, socio-economic group ABC1, lives with partner

In terms of food safety consequences, beliefs about the need to kill off bacteria was an enabler of reheating food until steaming hot. In interviews, there were several instances of participants citing the need to overheat foods to make them safe, either by ‘bubbling for ages in the pan’ or ‘absolutely nuking it in the microwave’.

Despite this, for most participants, the need to reheat leftovers until steaming hot was believed to be a lower risk than cooking foods from scratch, and for a few participants, risks were believed to be negligible, either because leftover food ‘is not raw’ or because their ‘immune system is strong’ and they were less concerned about the risk of food poisoning. Such beliefs about negligible risks acted as a barrier to reheating food until steaming hot.

There were also minor instances of people believing that the need to reheat leftovers was related to other food risks – including to get rid of pesticides and other residues in foods – though this acted to enable reheating.

Automatic motivation

While there were no common practices observed across households, routines within a household were frequently observed and mentioned, and concerned both duration of reheating (such as the 1-minute or 2-minute rule) and the microwave setting (for example on full power). As noted, routines to stir products in a microwave were not frequently observed, though this was more common for reheating on a hob.

While less notable, affective processes also appeared to influence the behaviour. Several participants noted that they did not like the feeling of eating cold food, which in turn prompted them to always reheat foods thoroughly.

Case study

Reheating leftover food to be steaming hot throughout in households

Name: Vic

Age group: 26–40 years

Household composition: Lives with family including children

Age of children: 2 children under 5 years

Vic lives with her partner Matt and their 2 young children. Vic works full-time and describes life as 'very busy, with Monday to Friday particularly bonkers'. Vic and Matt have a nanny to support with childcare, as Vic does not get in from work until after 6pm and her partner works away for most of the week.

The family are currently living in temporary accommodation while they buy a house. The kitchen is relatively long and thin. Although the countertop is relatively busy with various appliances, the kitchen is tidy, and Vic likes to keep the kitchen clean.

Vic tries to eat well and favours organic foods, as she is concerned about 'pesticides and other nasties'. She eats meat occasionally but increasingly eats plant-based foods. She is also very mindful of food hygiene risks. 'Cross-contamination terrifies me. If I pierced a package with meat in it, I would wash the knife or get a new one.'

Leftovers are quite often eaten in the household, and this is observed on 5 meal occasions during the week. At each meal occasion, when the food is reheated, it is done in a microwave. Vic uses a 1-minute rule to reheat food and it 'always seems to be fine'. On occasion, Vic is also observed visually checking the food for steam and tasting the food to check it is hot enough. However, she does not stir the food while it is reheating (though it is stirred afterwards).

During the interview, Vic says she is not particularly aware of the risks from not reheating leftover foods to be steaming hot. Rather, the need to reheat food thoroughly was something she learned from her parents growing up. Vic's general rationale to reheat food was because she doesn't like the taste of eating cold foods. However, she is particularly concerned about reheating rice to be steaming hot as she believes it will reduce high levels of arsenic that can be found in the crop. This belief comes from a news story she read online.

Analysis of Vic's behaviour

The influences on Vic behaviour mainly relate to psychological capability, physical opportunity, and reflective and automatic motivation. Vic does not understand that it is important to reheat foods to be steaming hot to kill harmful bacteria and this is a barrier to her reheating food until it is steaming hot throughout. Rather, Vic's reheating behaviours are motivated by preferring the taste of hot foods (automatic motivation) and from what she learnt from her parents (social opportunity). She also has confused toxicological concerns about arsenic in rice with microbiological risks (reflective motivation)

Vic has easy access to the stove and microwave, and she typically uses the microwave to reheat foods, which enable safe reheating practices. There are two

additional barriers to Vic reheating leftover food thoroughly. First, she does not stir leftover food during the reheating process, and rather waits to stir foods afterwards as it is more convenient to do this (physical opportunity). Second, her routines involve reheating in a microwave for 1 minute only (automatic motivation). On occasion, she will also use visual cues (such as steam) as well as taste to judge the temperature, which act to enable reheating until steaming hot throughout (reflective motivation) although tasting food is not in line with recommended practice.

Recommendations: strengthening consumer advice

In reviewing the KL2 findings, the main influences on whether leftovers were reheated to be steaming hot throughout concerned participants knowledge of why to perform the behaviour, beliefs about the consequences of not reheating food until steaming hot, and personal routines used to reheat foods.

After KL2 fieldwork was completed, a workshop was held with experts in food safety and the behavioural sciences to discuss the COM-B influences on each of the KL2 priority behaviours, including reheating leftovers. 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 should do to improve food safety. In this case, the desired practice is for households to **reheat leftovers until steaming hot throughout**.

For most other behaviours in KL2, the workshop attendees discussed specific behaviours to target within the desired practice, which could be the focus of future research for the development of behavioural interventions. In the case of reheating leftovers, workshop attendees did not focus on identifying specific behaviours. Instead, discussion focussed the FSA's guidance on this topic, as guidance for consumers about reheating foods is limited. Further advice could be more specific, for example, focussing on duration, temperature (until steaming), microwave power, completeness (by stirring) and if these differ for different food items. While not the subject of analysis in KL2, additional guidance around the frequency i.e., reheating leftovers only once is another potential area for advice. KL2 also found that consumers were misunderstood about the role of reheating food, so any guidance should also explain:

- that bacteria that may persist in leftover foods
- the danger of bacteria breeding in food when food is neither steaming hot throughout nor cold. This includes, for example, food that is only partially reheated or 'warmed' rather than thoroughly reheated.

- That reheating foods can carry risk of foodborne disease even if the food is not raw or being cooked from scratch

Addressing FSA guidance in these areas would be the first step to identifying best practice as the foundation for behaviour, on which behavioural interventions research could be based. Future interventions research should then focus on the COM-B analysis provided to develop suitable interventions based on the factors influencing the behaviour.

Conclusion

This chapter provided in-depth analysis on not reheating leftovers until steaming hot throughout 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 Wheel¹² can be used to identify effective interventions and behaviour change techniques.

¹² 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>