

# ARE DOMESTIC REFRIGERATORS SAFEGUARDING CONSUMERS FROM LISTERIOSIS?

## Findings from a food safety citizen science study

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### BACKGROUND AND APPROACH.

One of the World Health Organization five keys to food safety<sup>1</sup> is "keep food at safe temperatures" and refrigeration plays a crucial role in this. In the UK, Food Standards Agency<sup>2</sup> and Food Standards Scotland<sup>3</sup> guidelines recommend domestic refrigerators operate at 5°C or below. Refrigerators operating above this temperature can increase the growth rate of foodborne pathogens such as *Listeria monocytogenes*<sup>4</sup>, which can cause severe illness.

Previous research from the ZERO2FIVE Food and Drink Research Unit has established that although 79% of consumers believe refrigeration to be important, 84% were unaware of the temperature a refrigerator should operate at<sup>5</sup>. Furthermore, ownership of refrigerator thermometers is low<sup>6</sup>.

Given the lack of thermometer ownership, a Citizen Science project was developed to distribute thermometers to enable consumers to check the temperature of their refrigerator. "Citizen Science Research" is defined as the collection and/or analysis of data by the public, yet the approach is seldom used in a food safety context.

The aim was to develop a citizen science approach to distribute refrigerator thermometers to enable consumers to check domestic refrigeration temperatures and to establish the most appropriate method to undertake food safety citizen science research.

During spring/summer 2023, refrigerator thermometer packs (n=1,175) were distributed to the public at various events throughout Wales (figure 1). Participants were instructed how to use the refrigerator thermometer, how to upload a photograph of the thermometer in their refrigerator (figure 2) and record operating temperatures using a designated online tool (figure 3).



Figure 1. Distribution of thermometer packs.



Figure 2. Refrigerator thermometer pack.

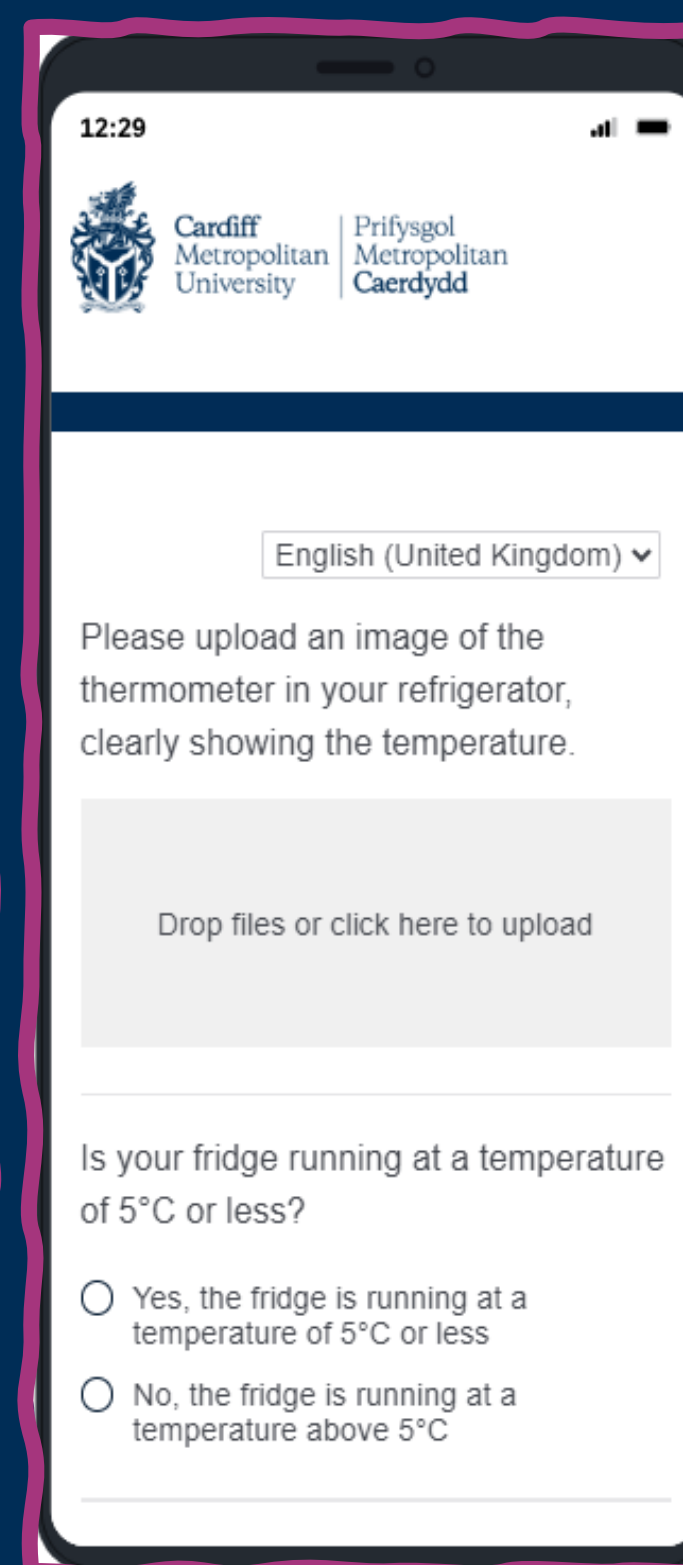


Figure 3. Online platform.

### RESPONSE RATES AND DEMOGRAPHIC CHARACTERISTICS.

Resulting from the five distribution methods employed, 1,175 refrigerator thermometers were distributed among the public.

In the three-months following the final distribution, 201 individuals had engaged in the citizen science project, giving an overall response rate of 17%.

The response rate for each method was calculated, as indicated in Table 1, the greatest response rate (39%) was achieved when the refrigerator thermometers were sent out in the post to individuals that had completed an online questionnaire regarding food safety in a previous research project (approach 1).

The lowest response rate (12%) was achieved at a cultural festival in the north of the country where thermometers were given away and an opportunity to win £100 was emphasized to each recipient (approach 2), but no emphasis was placed on it being a research project. Conversely, at a food festival in the south of the country, where people were recruited as volunteers for a research project, and no emphasis placed on the £100 prize was placed, a higher response rate was achieved (21%) (approach 3).

The majority of respondents identified as female (73%) and reported being from the younger age groups, with 22% in the 18-24 age category and 23% in the 25-34 age category. Only 9% were in the 65-74 age category, and no respondents were aged 75 years or older. While 89% of the respondents identified as belonging to the "White" ethnic group, the project included participants from Asian (3%), Black (3%), Mixed (1%) and Other (1%) ethnic groups. Eighty one percent reported living in Wales, 19% reported living in England (the majority of these were recruited via approach 1). Anecdotally, we are aware that women participate in research more frequently than men. Although age and gender were not reflective of the population of Wales/UK, the distribution among ethnicities in this project were similar to the population estimates for Wales<sup>7</sup>.

Table 1 response rates of different distribution methods.

Approach number, Location of distribution and dates	Distribution method	Target audience	Number distributed	Responses	Response rate
1. Participants of an online food safety questionnaire opted-in to participate. Thermometers posted to participants. (April 2023).	Volunteers needed for a research project.	Mothers of babies and toddlers	100	39	39%
2. National Eisteddfod (cultural festival) Boduan, Gwynedd, North Wales. (7 <sup>th</sup> August 2023).	Free thermometer with chance to win £100 voucher.	General population	500	58	12%
3. Welsh Food Festival, St. Fagans, Cardiff, South Wales. (9 <sup>th</sup> September 2023).	Volunteers needed for a research project.	General population	350	73	21%
4. Freshers Fayre/Welcome week activities at Cardiff Metropolitan University, South Wales. (20 <sup>th</sup> /21 <sup>st</sup> September 2023).	Free thermometer with chance to win £100 voucher.	Students in shared accommodation	200	25	13%
5. Foodbank in Cardiff, South Wales. (19 <sup>th</sup> September 2023)	Volunteers needed for a research project.	Food insecure population	25	6	25%
<b>Totals</b>			<b>1,175</b>	<b>201</b>	<b>17%</b>

### REFRIGERATOR OPERATING TEMPERATURES.

Refrigerator temperatures for 201 refrigerators were recorded as part of this citizen science project, this involved the submission of an image of the refrigerator thermometer indicating the operating temperature. Findings indicated that:

- The recorded temperatures ranged from 0°C to 20°C (figure 4).
- Only 29% of the refrigerators were reported to be operating at temperature of 5°C or less (figure 5).
- Seventy one percent were operating at temperatures exceeding the recommended safe temperature (5°C), it was of concern that 37% of refrigerators were operating at temperatures of 10°C or above (figure 6).

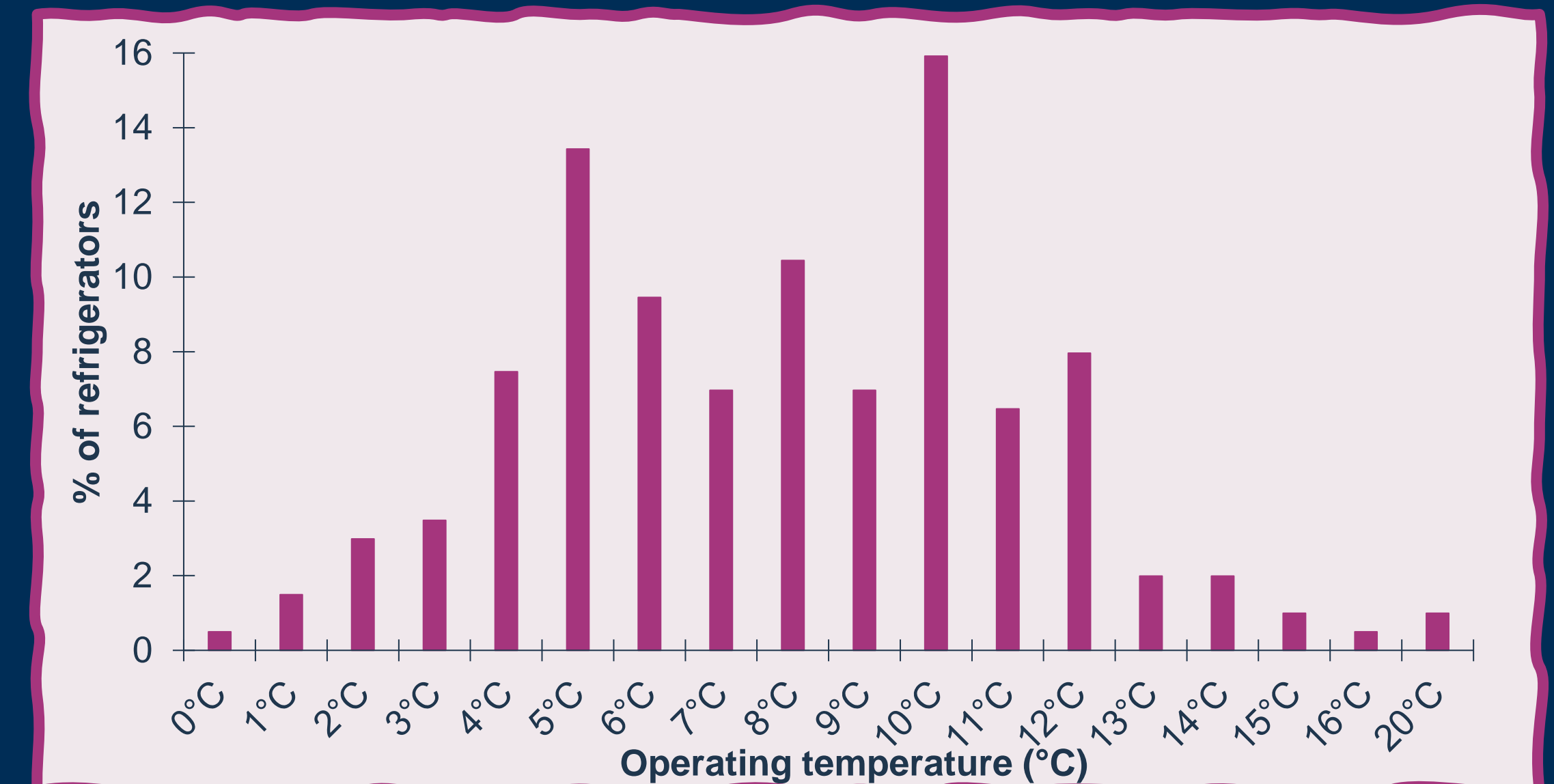


Figure 4. Operating temperature of refrigerators (n=201).

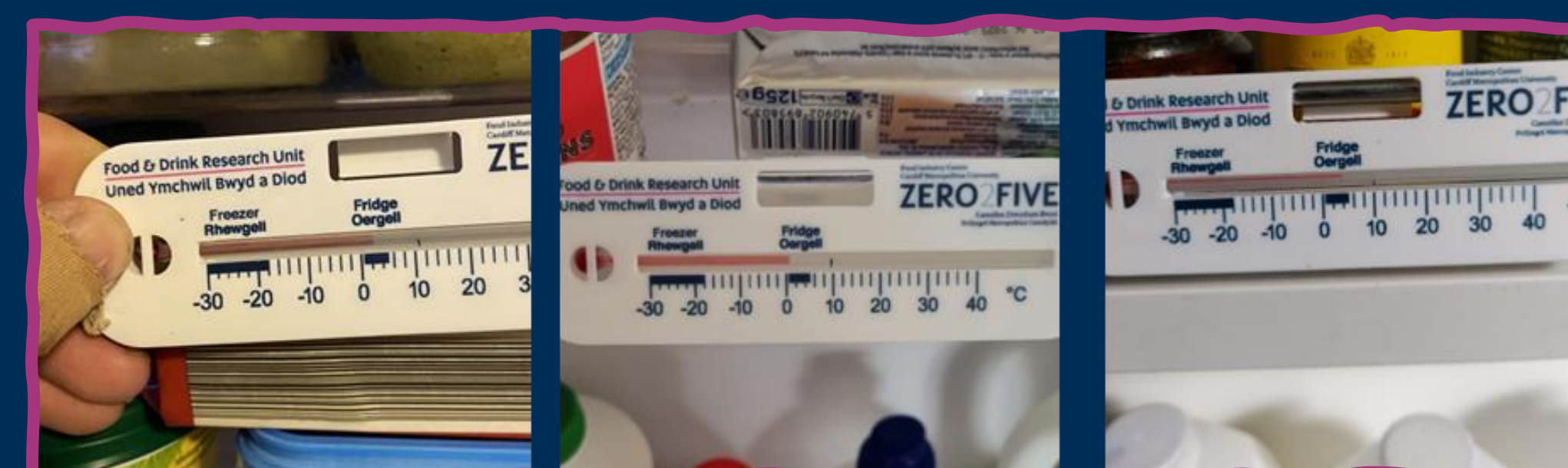


Figure 5. Examples of submitted images indicating safe temperatures (≤5°C).

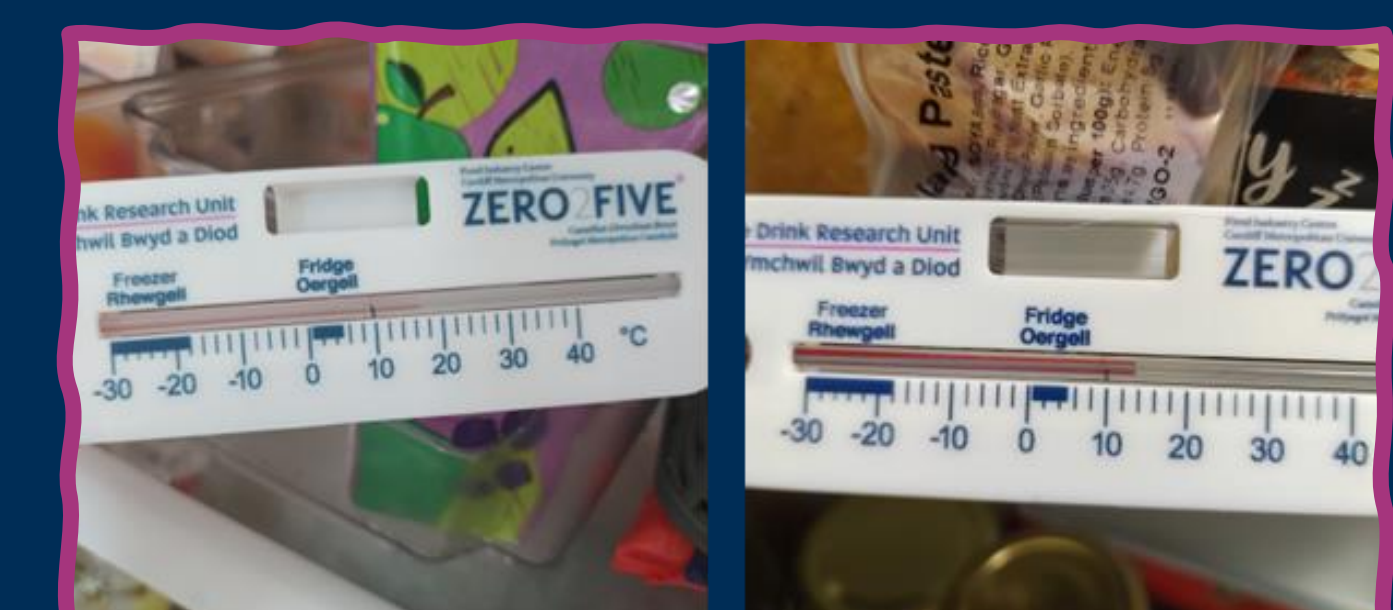


Figure 6. Examples of images indicating unsafe temperatures (≥5°C).

Data detailing the reported age of the refrigerators were captured, 39% of the refrigerators were <5 years old, 29% were 5 – 10 years old, additionally 14% of participants reported not knowing the age of their refrigerator. No significant associations were determined between reported age and operating temperatures (p>.05).

A quarter of participants (25%, n=39) reported that they lived in rented accommodation and did not own their refrigerator. A chi-square test for independence (with Yates Continuity Correction) indicated a significant association between type of accommodation and temperature  $\chi^2(1, n=153) = 4.303, p = .038, \phi = -.184$ , whereby 82% of those in rented accommodation had refrigerators at unsafe temperatures compared to 62% of those that lived in properties they owned.

As indicated in figure 7, the online portal prompted those with refrigerators operating above 5°C to adjust the temperature and provided an additional opportunity to win a £100 voucher.

Of those with temperatures above 5°C (n=127), 80% reported that they were concerned about the potential for food poisoning bacteria growth and indicated intentions to adjust the temperature. Another 18% considered adjusting, while 2% were not concerned and had no plans to adjust their refrigerator temperature.

Of those with potentially unsafe refrigeration temperatures (n=127), 28% (n=36) adjusted their refrigerator temperature and submitted a second image, of these seven remained at potentially unsafe temperatures.

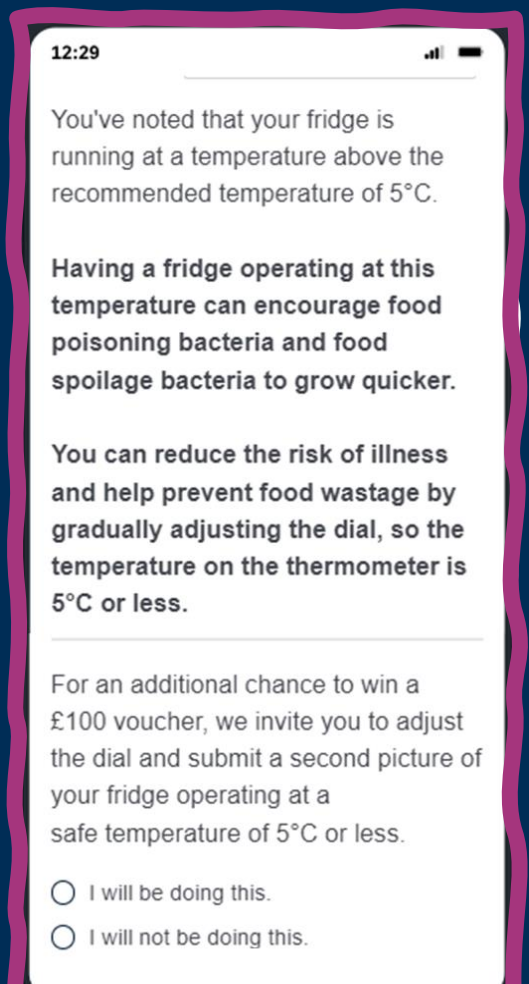


Figure 7. Online portal prompting temperature adjustment.

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### CONCLUSIONS AND RECOMMENDATIONS.

- Although there are limitations associated with capturing a one-time temperature from one location of a domestic refrigerator using a smartphone camera; this study demonstrates that citizen science research approaches can be beneficial for capturing food safety related data from the public, to communicate food safety messages, and prompting food safety practices among the public.
- We anticipated that the £100 voucher would motivate people to participate, however, findings indicate that recruiting people as volunteers to participate in research resulted in a higher response rate. We recommend that future research needs to capture what motivate individuals to participate.
- This study has established that the majority of domestic refrigerators operate at potentially unsafe temperatures. Providing a refrigerator thermometer has enabled consumers to check and adjust temperatures to help ensure food safety.
- Discussions with consumers have indicated disbelief that manufacturers sell refrigerators that are able to operate at unsafe temperatures. Future efforts are required to enhance domestic refrigerator design and functionality to assist consumers in ensuring safe food storage in the domestic setting.

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