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Risk it for a biscuit: Food safety behaviours and food insecurity of older adults

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ABSTRACT

Foodborne disease presents a significant public health issue, costing the UK economy £9 billion annually, with many incidences being due to food-related behaviours in the home. Adults aged 60 and over account for around a quarter of the population in England and Wales and are at a greater risk of foodborne disease and may suffer a much higher burden. Research into risky food behaviours has previously focused on larger cohorts and typically treats the over 60's as one homogenous group. The current paper aims to identify the characteristics associated with risky food-related practices related to cooking, cleaning, chilling, cross-contamination, and use-by date adherence. The current research analysed data from the Official Statistics survey, Food and You 2: Wave 6 (2022–23). A series of binary logistic regression models examined the characteristics associated with risky food-related practices. We demonstrate that the characteristics associated with risky behaviours are not uniform, with different factors being associated with specific behaviours. We suggest that risky behaviours cannot be targeted efficiently with a one size fits all approach. This research provides an evidence base for policy makers to target risky food behaviours in this understudied vulnerable group.

1. Introduction

The United Nations Sustainable Development Goal 2.1 aims to ensure all people have access to safe, nutritious, and sufficient food (United Nations, 2015). Foodborne disease is a global health issue, with contaminated food causing an estimated 420,000 deaths a year (World Health Organization, 2022), and a quarter of people in the UK suffering an incidence of infectious intestinal disease every year (Food Standards Agency, 2012). It is estimated that there are 2.4 million cases of foodborne disease in the UK every year, at a cost of £9 billion to the economy (Food Standards Agency, 2020b; Holland et al., 2020).

People are often confident in their own food handling and preparation behaviours - including cooking, cleaning, chilling, cross-contamination, and following use-by dates - and tend to underestimate the risk of contracting foodborne disease, especially in the home (Young & Waddell, 2016). On the contrary, people are more likely to contract foodborne disease in the home than other locations (European Food Safety Authority, 2018). It is estimated that 34% of foodborne disease outbreaks originate in the home, commonly due to factors such as inadequate food heating, chilling, storage, and cross-contamination (European Food Safety Authority, 2018). Moreover, whilst 72% of over-60s know that the use-by date shows whether a food is safe to eat or not,[1] 62% mistakenly believe that sensory assessments such as smell and taste can signal whether a food is safe to eat (Evans & Redmond, 2016), suggesting uneven knowledge of safe food practices that could result in risky behaviours that could result in illness.

Whilst everyone needs to exercise precaution over the foods they consume, some vulnerable groups of the population, such as older adults, are at an even greater risk of foodborne disease (Buzby, 2002) and may suffer more severe symptoms as a result (Food Standards Agency, 2020b). This is evidenced in the higher level of listeriosis seen in adults aged over sixty years old in the UK (Brennan, 2009). Research also highlights a lack of awareness of the dietary risks associated with ageing (Reimer et al., 2012) and the impact of one's own safety behaviours and foodborne disease (Wright, Canham, 2011). Older men perceive themselves as being at a lower risk of developing foodborne

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[1] It should be noted that while there are clear reasons to expect a greater risk of foodborne illness from eating food past its use-by date, the current evidence does not disaggregate incidences of foodborne illness in this way so these risks cannot be formally quantified (Food Standards Agency, 2000).

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disease than older women (Hanson & Benedict, 2002) and also exhibit riskier food safety behaviours (Evans & Redmond, 2016; Hanson & Benedict, 2002). However, being well-informed about food safety behaviours in the home is associated with safer food practices (Wright et al., 2011), which can reduce the risk of foodborne disease (Food Standards Agency, 2020a).

There are numerous contributing influences which could explain the increased likelihood of contracting foodborne disease in this age group. Firstly, from a physiological perspective, immune system functioning decreases with age, as does stomach acid production, which in turn can weaken older adults' resistance to foodborne pathogens (Buzby, 2002). In addition, eye-sight decline can have an impact as older adults have been shown to frequently keep foods for up to a month past the use-by date because they could not read the use-by dates (Hudson & Hartwell, 2002).

Secondly, modest incomes (Mangels, 2018), compounded by the increased cost of living (Broadbent et al., 2023; Office for National Statistics, 2023b) may contribute to risky food practices that can expose people to foodborne disease. In 2022–23, 1 in 10 older adults were food insecure (Food Standards Agency, 2023b) and food insecurity in older adults has been linked to reduced diet quality (Leung & Wolfson, 2021). Food insecurity and poor diet are associated with a higher prevalence of chronic disease, malnutrition, disability, poor health and decreased quality of life in older adults (Fernandes et al., 2018; Lee et al., 2022). The current cost-of-living crisis has increased the estimated costs of retirees to maintain minimum retirement living standards by 17.8% for single retirees and 19.0% for retired couples in 2021–2022 (Padley, 2022). This increase in costs is likely to reduce living standards among many older adults and risks increasing the prevalence of food insecurity and consequent health inequalities among older adults (Broadbent et al., 2023; Leung & Wolfson, 2021). In the general population, food insecurity is associated with specific risky food behaviours, for example, those who are food insecure are more likely to report eating food past the use-by date compared to those who are food secure (Food Standards Agency, 2023d). However, no research has explored the impact of food insecurity on the food safety behaviours of older adults and the constraints of adhering to food safety recommendations in the home. Improved understandings here have potential to inform targeted interventions to promote food safety behaviours among older adults and thereby reduce the incidence of preventable foodborne illness in this vulnerable group.

Third, there are psychological, environmental and social factors associated with behaviours in older age that may interrupt conformity to food safety recommendations in older people (Whitelock & Ensaff, 2018; Young & Waddell, 2016) and thereby increase their risk of foodborne disease. For example, evidence suggests that cognitive decline is associated with reduced adherence to medication instructions (Park et al., 1994); similar patterns may be evident with regard to following food safety recommendations. In addition, many older adults have grown up in conditions that fostered disapproval of food wastage (Walker-Clarke et al., 2022). As such, older adults may be reluctant to throw away spoiled food or food past the use-by date (Young & Waddell, 2016). This incentive to make food last can be exacerbated by practical constraints on their capacity to source fresh food such as reduced independence, long distances to grocery stores, lack of access to reliable transportation, and restricted mobility and strength to carry food shopping (Giles, 2009).

The objective of this research is therefore to identify the socio-demographic and economic factors associated with risky food-related behaviours in older adults (60+), providing an evidence base for policymakers to develop effective interventions to target those most at risk. Almost a quarter of the population in England and Wales are aged sixty years or over, yet older adults are often treated as a single group of the population (Office for National Statistics, 2023d). The Social Science Research Committee report on Listeria Monocytogenes and the food storage and handling practices of the over 60's in the home also acknowledged that research did not explore the diversity within the 'over 60s' age group, highlighting this as important future research (Brennan, 2009). This research will identify the diversity of food-related behaviours in this group to gain detailed insights into the practices of differently-aged over-60s. We therefore explore the following research questions:

Research question 1: Which individual characteristics are associated with a range of risky food safety behaviours in older adults aged 60 and over?
Research question 2: Is food insecurity associated with a range of risky food safety behaviours in older adults aged 60 and over?
Research question 3: What is the relationship between knowledge of use-by dates and adherence to use-by dates?

2. Methods

2.1. Data and sample

We used data from Food and You 2: Wave 6 (2022–23). This dataset is the Food Standards Agency official statistical survey which measures consumers' knowledge, attitudes, and behaviours relating to food safety and other food-related behaviours. The survey uses a sequential mixed-method 'push-to-web' which means participants received a postal invitation to complete the survey online. A postal version of the survey is later sent with a reminder letter to non-respondents. The fieldwork for Food and You 2: Wave 6 was conducted between October 12, 2022 and January 10, 2023. A nationally representative sample of 5991 adults (aged 16 years+) were recruited across England, Wales, and Northern Ireland. Up to two adults per household could complete the survey. We excluded data from respondents aged 59 years or under, and those who did not declare their numerical age (n = 3593), resulting in a final analytical sample size of n = 2398. Food security status was measured using the USDA Adult Food Security module.Particpants were classified as 'food secure' or 'food insecure' in line with USDA Adult Food Security module guidance (USDA, 2012). For further details about the dataset, see Food Standards Agency, 2023c.

2.2. Outcome variables

The Food and You 2: Wave 6 survey included questions about socio-demographics and knowledge and behaviours relating to food safety. We selected as outcome variables eleven key indicators of food safety behaviour representing the key areas of food safety behaviour; cooking,

Table 1
Summary of outcome variables of risky food safety behaviours.

Variable	Measurement level
Cooking:	
Eats chicken or turkey when the meat is pink or has pink or red juices	Individual
Does not always cook food until it is steaming hot and cooked all the way through	Individual
Cleaning:	
Does not always wash hands before starting to prepare or cook food	Individual
Chilling:	
No or don't know whether they check fridge temperature	Household
Would consume leftovers stored in the fridge after more than two days	Individual
Use-by dates:	
Does not always check use-by date before eating or preparing food	Individual
Would eat meat/smoked fish/bagged salad/yogurt after the use-by date	Individual
Cross-contamination:	
Washes raw chicken at least occasionally	Individual

Table 2
Summary of predictor variables and thematic block for model building (unweighted).

Sociodemographic characteristic	Frequency (n)	Percentage (%)	Thematic block
Age group			
60–64	576	24.0	Block 1: Demographics
65–69	588	24.5	
70–74	535	22.3	
75–79	363	15.1	
80–84	336	14.0	
Gender			
Male	1111	46.6	
Female	1273	53.4	
Has a long-term health condition			
Yes	938	41.2	
No	1341	58.8	
Household size			
1	565	24.6	
2	1447	63.0	
3+	285	12.4	
Annual Household income			
Less than £19,000	647	37.4	Block 2: Finances
£19,000 - £31,999	553	32.0	
£32,000 - £63,999	413	23.9	
More than £64,000	116	6.7	
Food security classification			
Secure	2065	89.2	
Insecure	251	10.8	
Responsible for cooking			
Yes	1969	82.6	Block 3: Food agency
No	414	17.4	
Responsible for food shopping			
Yes	1998	84.1	
No	377	15.9	
Country			
England	1250	52.1	Block 4: Geographies
Wales	561	23.4	
Northern Ireland	587	24.5	
Urban rural status			
Urban	1545	64.4	
Rural	853	35.6	

cleaning, chilling, cross-contamination and use-by dates were selected as the outcome variables (see Table 1). Participants' responses were re-coded as binary variables, 'risky' or 'not risky', in line with Food Standards Agency consumer advice for food hygiene in the home (see Table 3 for classifications and Food Standards Agency, 2020a for further information). To identify the knowledge-behaviour gap related to use-by date adherence (Research Question 3), we included knowledge of use-by dates as a predictor in the models relating to the consumption of foods past the use-by date.

2.3. Predictor variables

For this exploratory analysis we selected key socio-demographic and socio-economic variables that we expected to be associated with food safety behaviours. We grouped the selected variables into four thematic blocks relating to demographics, finances, food agency, and geographical factors (see Table 2). Demographic variables were included to identify how food safety behaviours are distributed across older people with different characteristics, while financial variables were included to explore whether and how these behaviours vary according to households' material resources. Food agency was explored to provide insights into whether food safety behaviours vary according to whether respondents take responsibility for food shopping and/or cooking. Geographical factors were included to offer insights into the geographical distribution of food safety behaviours, where targeted policy interventions in the devolved administrations might be appropriate. We did not include ethnic group due to low numbers of ethnic minority participants in the sample. We likewise did not explore employment status due to collinearity with age group.

2.4. Data analysis

We first estimated a series of logistic regression models to examine the relationship between socio-demographic characteristics and food safety behaviours. We then estimated a series of logistic regression models to examine the relationship between socio-demographic characteristics, knowledge of use-by-dates, and behaviours relating to use-by-dates. Data were weighted to make them nationally representative (for further information on the weighting see Food Standards Agency, 2023c). Models were built in stages with each thematic block being added in turn to provide a detailed progressive exploration of the characteristics associated with food safety behaviours. We report the final model results here; full model building results are available in the Appendix. We conducted multicollinearity checks, where the highest VIF = 1.43 demonstrated a low correlation between variables, well below the critical threshold of 3 (James et al., 2013) (results available on request). The data were analysed using IBM SPSS version 25 (IBM Corp, 2017).

3. Results

3.1. Prevalence of risky food behaviours

Table 3 shows the prevalence of risky food-related behaviours by age group. Overall, the most common risky behaviours related to willingness to eat foods after the use-by date. Despite 63.1% reporting that they always check the use-by date on food before eating or preparing the food, most are willing to eat food after the use-by date. Further to this, adherence to use-by dates varies by food type, with more respondents reporting that they would be willing to eat bagged salad and yoghurt after the use-by date compared to smoked fish or meat.

3.2. Individual characteristics, food insecurity, and risky food safety behaviours in older adults

3.2.1. Washing chicken

Those who were food insecure (OR: 1.86, 95% CI 1.12–3.09) were more likely to wash raw chicken compared to those who were food secure. Women (OR: 0.67, 95% CI 0.50–0.90) were less likely to wash raw chicken compared to men. Age, long-term health condition status, household size, financial factors, food agency and geographical factors were not associated with chicken washing practices (see Table 4).

3.2.2. Eating leftovers after two days or more

Income was the strongest predictor of eating leftovers after more than two days, with those with a higher income being more likely to do this (£32,000-£63,999, OR: 2.09, 95% CI 1.38–3.16; >£64,000, OR: 2.70, 95% CI 1.50–4.86). Those living in rural areas were more likely to eat leftovers after more than two days compared to those in urban areas (OR: 1.56, 95% CI 1.12–2.16). Women (OR: 0.72, 95% CI 0.52–0.99) had lower odds of eating leftovers after more than two days compared to men. Long-term health condition status, household size, food security status, food agency and country were not associated with eating unsafe leftovers.

Table 3
Prevalence of risky behaviours by age group (weighted).

	Age group (n and %)					
	60–64	65–69	70–74	75–79	80+	Total
Ever checks fridge temperature						
Yes, or has an alarm (not risky)	223 (68.4)	193 (67.0)	199 (70.3)	152 (73.4)	154 (52.4)	921 (65.9)
No or don't know (risky)	103 (31.6)	95 (33.0)	84 (29.7)	55 (26.6)	140 (47.6)	477 (34.1)
Eats chicken or turkey when the meat is pink or has pink or red juices						
No (not risky)	288 (92.9)	247 (92.2)	255 (97.3)	186 (92.5)	257 (90.5)	1233 (93.1)
Yes (risky)	22 (7.1)	21 (7.8)	7 (2.7)	15 (7.5)	27 (9.5)	92 (6.9)
Latest respondent would consume any leftovers stored in the fridge						
Within two days (not risky)	182 (60.3)	178 (66.9)	190 (72.8)	138 (70.8)	180 (69.2)	868 (67.6)
Over two days (risky)	120 (39.7)	88 (33.1)	71 (27.2)	57 (29.2)	80 (30.8)	416 (32.4)
Cooks food until it is steaming hot and cooked all the way through						
Always (not risky)	252 (82.1)	223 (82.9)	232 (87.5)	156 (78.8)	202 (78.3)	1065 (82.1)
Not always (risky)	55 (17.9)	46 (17.1)	33 (12.5)	42 (21.2)	56 (21.7)	232 (17.9)
Would eat meat after the use-by date						
No (not risky)	117 (39.9)	113 (43.3)	114 (44.2)	60 (33.3)	82 (32.8)	486 (39.1)
Yes (risky)	176 (60.1)	148 (56.7)	144 (55.8)	120 (66.7)	168 (67.2)	756 (60.9)
Would eat smoked fish after the use-by date						
No (not risky)	91 (35.1)	82 (35.5)	87 (40.5)	44 (27.2)	63 (30.1)	367 (34.1)
Yes (risky)	168 (64.9)	149 (64.5)	128 (59.5)	118 (72.8)	146 (69.9)	709 (65.9)
Would eat bagged salad after the use-by date						
No (not risky)	61 (20.3)	64 (24.2)	57 (22.7)	32 (19.2)	46 (20.8)	260 (21.6)
Yes (risky)	239 (79.7)	200 (75.8)	194 (77.3)	135 (80.8)	175 (79.2)	943 (78.4)
Would eat yoghurt after the use-by date						
No (not risky)	79 (26.3)	66 (25.0)	58 (22.5)	34 (19.3)	54 (22.5)	291 (23.5)
Yes (risky)	221 (73.7)	198 (75.0)	200 (77.5)	142 (80.7)	186 (77.5)	947 (76.5)
Checks use-by date before eating or preparing food						
Always (not risky)	213 (68.9)	177 (65.8)	180 (67.7)	124 (61.7)	133 (50.2)	827 (63.1)
Not always (risky)	96 (31.1)	92 (34.2)	86 (32.3)	77 (38.3)	132 (49.8)	483 (36.9)
Washes hands before starting to prepare or cook food						
Always (not risky)	247 (80.2)	207 (77.2)	204 (76.7)	142 (71.4)	181 (68.3)	981 (75.1)
Not always (risky)	61 (19.8)	61 (22.8)	62 (23.3)	57 (28.6)	84 (31.7)	325 (24.9)
Washes chicken						
Never (not risky)	166 (54.2)	140 (52.8)	150 (58.4)	90 (48.1)	132 (54.1)	678 (53.9)
At least occasionally (risky)	140 (45.8)	125 (47.2)	107 (41.6)	97 (51.9)	112 (45.9)	581 (46.1)

3.2.3. Not checking the fridge temperature

Compared to those aged 60–64, respondents aged 65–69 years (OR: 1.55, 95% CI 1.02–2.37) had greater odds of not checking the temperature of their refrigerator. In comparison to those who cook, respondents who do not cook (OR: 1.99, 95% CI 1.25–3.17) had greater odds of not checking the temperature of their refrigerator. Those living in households of two people (OR: 0.53, 95% CI 0.36–0.77) or more (OR: 0.42, 95% CI 0.25–0.70), had lower odds of not checking the temperature of their refrigerator then respondents living alone. Those who were food insecure (OR: 0.57, 95% CI 0.33–0.98) had lower odds of not checking the temperature of their refrigerator than respondents who were food secure. Compared to those with an income of £19,000 or below, respondents with higher incomes (£32,000-£63,999 OR: 0.66, 95% CI 0.44–0.99; >£64,000 OR: 0.51, 95% CI 0.28–0.98) had increasingly lower odds of not checking the temperature of their refrigerator. Gender, long-term health condition status, responsibility for shopping and geographical factors were not associated with fridge temperature practices.

3.2.4. Not always washing hands before starting to prepare or cook food

Compared to those living alone, respondents living in two-person households (OR: 0.64, 95% CI 0.42–0.97) had lower odds of not always washing their hands before cooking or preparing food. Those who were food insecure (OR: 0.32, 95% CI 0.15–0.68) had lower odds of not always washing their hands compared to respondents who were food insecure. Age, gender, long-term health condition status, food agency and country were not associated with handwashing practices.

3.2.5. Eating chicken or Turkey when the meat is pink or has pink or red juices

Women (OR: 0.42, 95% CI 0.22–0.77) and those with a long-term health condition (OR: 0.49, 95% CI 0.26–0.90) had lower odds of eating pink chicken or turkey. Those who were food insecure (OR 2.84, 95% CI 1.22–6.61) higher odds of eating pink chicken or turkey compared to those who were food secure. Age, household size, income, food agency and geographical factors were not associated with eating pink chicken or turkey.

3.2.6. Not cooking food until it is steaming hot and cooked all the way through

The odds of not cooking food until its steaming hot and cooked all the way through progressively increases with income (£19,000-£31,999 OR: 1.63, 95% CI 1.01–2.65; £32,000-£63,999 OR: 1.95, 95% CI 1.16–3.27; >£64,000 OR: 2.20, 95% CI 1.10–4.43). Conversely, when compared to those living alone, the odds of not cooking food until steaming hot and cooked all the way through progressively decreases as household size increases (two-person OR: 0.50, 95% CI 0.31–0.80; 3+ person OR: 0.36, 95% CI 0.19–0.68). Respondents who were not responsible for cooking had higher odds of not cooking food until steaming hot and cooked all the way through compared to those who were responsible for cooking (OR: 2.63, 95% CI 1.50–4.60). Age, gender, long-term health condition status, food security, responsibility for shopping and geographical factors were not associated with food heating practices.

3.2.7. Does not always check use-by date before eating or preparing food

Knowledge of use-by dates was the strongest predictor of checking behaviour, with respondents who did not have knowledge of use-by dates (OR: 2.81, 95% CI 2.04–3.89) having higher odds of not checking use-by dates before they prepared or ate food. Apart from those aged 70–74 years, the odds of not checking use-by dates increased with age with those in the oldest age bracket (80+ years OR: 2.01, 95% CI 1.26–3.22) being twice is likely to not check use-by dates compared to those aged 60–64 years. Those who are not responsible for cooking in the household (OR: 1.77, 95% CI 1.04–3.00) have higher odds of not checking use-by dates than those who are responsible for cooking. Women (OR: 0.63, 95% CI 0.46–0.86) had lower odds of not checking use-by dates compared to men. Long-term health condition status, household size, financial factors, responsibility for shopping and

Table 4
Logistic regression models predicting risky food safety behaviours showing odds ratios and 95% confidence intervals (weighted).

Block	Predictors:		Washes raw chicken	Eats leftovers after two days or longer	Does not check fridge temperature	Does not always wash hands before preparing/cooking	Eats chicken or turkey when the meat is pink or has pink or red juices	Does not cook food until steaming hot and cooked all the way through
Block 1: demographics	Age group	60–64	1.0 [-]					
		65–69	0.90 [0.60–1.36]	0.79 [0.52–1.22]	**1.55 [1.02–2.37]** [a]	1.41 [0.87–2.30]	1.24 [0.57–2.71]	1.07 [0.63–1.79]
		70–74	0.85 [0.56–1.31]	0.81 [0.52–1.26]	0.98 [0.63–1.53]	1.34 [0.81–2.22]	0.36 [0.12–1.08]	0.60 [0.33–1.08]
		75–79	1.39 [0.86–2.24]	0.80 [0.48–1.33]	0.75 [0.45–1.25]	1.46 [0.84–2.52]	1.08 [0.43–2.74]	1.18 [0.66–2.12]
		80+	1.29 [0.83–2.01]	1.05 [0.65–1.68]	1.44 [0.92–2.25]	1.52 [0.91–2.52]	2.06 [0.92–4.64]	0.94 [0.54–1.65]
	Gender	Male	1.0 [-]					
		Female	**0.67 [0.50–0.90]** [a]	**0.72 [0.52–0.99]** [a]	1.07 [0.79–1.46]	0.75 [0.54–1.06]	**0.42 [0.22–0.77]** *	0.70 [0.47–1.02]
	Long term health condition	No	1.0 [-]					
		Yes	0.83 [0.62–1.11]	0.84 [0.61–1.15]	1.24 [0.92–1.67]	1.31 [0.94–1.82]	**0.49 [0.26–0.90]** [a]	1.20 [0.83–1.74]
	Number of people in household	1	1.0 [-]					
		2	0.95 [0.65–1.37]	1.10 [0.72–1.68]	**0.53 [0.36–0.77]** [b]	**0.64 [0.42–0.97]** *	0.86 [0.40–1.83]	**0.50 [0.31–0.80]** *
		3+	0.89 [0.55–1.45]	1.28 [0.75–2.19]	**0.42 [0.25–0.70]** [b]	0.83 [0.48–1.44]	1.11 [0.44–2.83]	**0.36 [0.19–0.68]** [a]
Block 2: finances	Banded annual income	<£19,000	1.0 [-]					
		£19,000-£31,999	1.21 [0.84–1.74]	1.29 [0.86–1.93]	0.87 [0.61–1.26]	1.16 [0.77–1.75]	1.85 [0.86–3.94]	**1.63 [1.01–2.65]** *
		£32,000-£63,999	0.85 [0.57–1.26]	**2.09 [1.38–3.16]** [b]	**0.66 [0.44–0.99]** [a]	0.95 [0.61–1.49]	1.99 [0.90–4.39]	**1.95 [1.16–3.27]** [a]
		>£64,000	1.38 [0.79–2.42]	**2.70 [1.50–4.86]** [b]	**0.51 [0.28–0.96]** [a]	1.03 [0.54–1.97]	1.11 [0.34–3.58]	**2.20 [1.10–4.43]** [a]
	Food security	Secure	1.0 [-]					
		Insecure	**1.86 [1.12–3.09]** *	0.65 [0.35–1.19]	**0.57 [0.33–0.98]** *	**0.32 [0.15–0.68]** *	**2.84 [1.22–6.61]** [a]	1.03 [0.52–2.04]
Block 3: food agency	Shopping responsibility	Yes	1.0 [-]					
		No	1.12 [0.69–1.82]	0.98 [0.62–1.57]	1.31 [0.83–2.07]	1.18 [0.70–2.01]	1.17 [0.52–2.60]	1.68 [0.98–2.88]
	Responsibility for cooking	Yes	1.0 [-]					
		No	0.77 [0.45–1.30]	1.21 [0.75–1.95]	**1.99 [1.25–3.17]** [a]	1.06 [0.60–1.89]	2.09 [0.96–4.58]	**2.63 [1.50–4.60]** [b]
Block 4: geographies	Country	England	1.0 [-]					
		Wales	1.28 [0.70–2.33]	0.73 [0.38–1.41]	0.99 [0.54–1.84]	1.10 [0.56–2.14]	0.70 [0.18–2.69]	1.07 [0.52–2.21]
		Northern Ireland	0.99 [0.43–2.29]	0.49 [0.19–1.28]	1.30 [0.57–2.93]	0.92 [0.34–2.44]	0.41 [0.04–4.65]	0.73 [0.22–2.42]
	Urban-rural	Urban	1.0 [-]					
		Rural	0.74 [0.53–1.02]	**1.56 [1.12–2.16]** [a]	1.05 [0.75–1.45]	0.92 [0.64–1.33]	0.78 [0.40–1.52]	1.19 [0.80–1.77]

[a] $p < .05$.
[b] $p < .001$.

Table 5
Logistic regression models predicting use-by date (UBD) behaviours showing odds ratios and 95% confidence intervals (weighed).

Block	Predictors:		Does not check UBD	Would eat food after the use-by date			
				Meat	Smoked fish	Bagged salad	Yogurt
Block 1: demographics	Age group	60–64	1.0 [-]				
		65-69 (1)	**1.56 [1.00–2.42]** [a]	0.81 [0.52–1.26]	0.97 [0.59–1.58]	0.64 [0.38–1.07]	0.94 [0.58–1.53]
		70-74(2)	1.56 [0.98–2.47]	1.02 [0.65–1.60]	1.01 [0.60–1.69]	0.74 [0.43–1.29]	1.70 [0.99–2.89]
		75-79(3)	**1.78 [1.07–2.95]** [a]	1.50 [0.89–2.54]	**1.98 [1.06–3.70]** [a]	1.32 [0.64–2.73]	1.60 [0.85–3.01]
		80+(4)	**2.01 [1.26–3.22]** [a]	1.39 [0.84–2.28]	0.86 [0.48–1.53]	**0.54 [0.29–0.99]** [a]	1.02 [0.58–1.76]
	Gender	Male	1.0 [-]				
		Female (1)	**0.63 [0.46–0.86]** [a]	0.90 [0.65–1.24]	0.87 [0.59–1.26]	1.02 [0.69–1.51]	1.16 [0.80–1.68]
	Long term health condition	No	1.0 [-]				
		Yes	0.97 [0.72–1.32]	0.89 [0.65–1.21]	1.12 [0.78–1.61]	1.09 [0.74–1.60]	0.83 [0.58–1.18]
	Number of people in household	1	1.0 [-]				
		2	0.82 [0.56–1.21]	1.03 [0.68–1.57]	0.65 [0.39–1.07]	1.01 [0.61–1.68]	0.82 [0.50–1.33]
		3+	0.88 [0.53–1.46]	1.03 [0.61–1.73]	0.79 [0.42–1.49]	0.73 [0.39–1.38]	0.63 [0.34–1.14]
Block 2: finances	Banded income	<£19,000	1.0 [-]				
		£19,000-£31,999	0.80 [0.55–1.18]	**0.65 [0.44–0.96]** [a]	0.96 [0.60–1.52]	0.78 [0.47–1.27]	1.01 [0.65–1.59]
		£32,000-£63,999	1.11 [0.74–1.68]	0.92 [0.60–1.41]	1.07 [0.66–1.75]	1.00 [0.59–1.70]	1.35 [0.83–2.19]
		>£64,000	0.78 [0.42–1.44]	0.71 [0.38–1.32]	1.12 [0.54–2.30]	**0.36 [0.18–0.72]** [a]	1.00 [0.51–1.97]
	Food security	Secure	1.0 [-]				
		Insecure	0.99 [0.58–1.70]	0.76 [0.45–1.31]	0.74 [0.40–1.36]	0.64 [0.34–1.20]	**0.44 [0.24–0.78]** [a]
Block 3: food agency	Shopping responsibility	Yes	1.0 [-]				
		No	1.39 [0.85–2.27]	0.71 [0.43–1.15]	1.50 [0.82–2.74]	1.85 [0.94–3.65]	1.36 [0.75–2.45]
	Responsibility for cooking	Yes	1.0 [-]				
		No	**1.77 [1.04–3.00]** [a]	1.53 [0.93–2.54]	1.10 [0.61–1.99]	1.15 [0.62–2.13]	0.73 [0.42–1.28]
	UBD knowledge	Yes	1.0 [-]				
		No	**2.81 [2.04–3.89]** [b]	**3.17 [2.18–4.62]** [b]	**4.88 [2.99–7.95]** [b]	**2.58 [1.58–4.20]** [b]	**2.61 [1.67–4.08]** [b]
Block 4: geographies	Country	England	1.0 [-]				
		Wales	0.95 [0.50–1.79]	0.77 [0.41–1.46]	0.60 [0.30–1.20]	0.67 [0.32–1.41]	0.71 [0.35–1.43]
		Northern Ireland	0.60 [0.24–1.52]	**0.37 [0.16–0.88]** [a]	**0.25 [0.09–0.68]** *	**0.34 [0.13–0.85]** [a]	**0.33 [0.13–0.81]** [a]
	Urban-rural	Urban	1.0 [-]				
		Rural	0.94 [0.67–1.32]	**1.52 [1.06–2.17]** [a]	1.80 [1.18–2.75] [a]	**1.78 [1.14–2.79]** [a]	**1.56 [1.03–2.36]** [a]

[a] $p < .05$.
[b] $p < .001$.

geographical factors were not associated with checking use-by dates (see Table 5).

3.2.8. *Willingness to eat food after the use-by date*

Across the selected foods, a lack of use-by date knowledge was consistently associated with higher odds of being willing to eat these foods past the use-by date (meat, OR: 3.17, 95% CI 2.18–4.62; smoked fish, OR: 4.88, 95% CI 2.99–7.95; bagged salad, OR: 2.58, 95% CI 1.58–4.20; yoghurt OR: 2.61, 95% CI 1.67–4.08). Similarly, living in a rural area was associated with higher odds of being willing to eat these foods past the use-by date when compared to those living in urban areas (meat, OR: 1.52, 95% CI 1.06–2.17; smoked fish, OR: 1.80, 95% CI 1.18–2.75; bagged salad, OR: 1.78, 95% CI 1.14–2.79; yoghurt OR: 1.56, 95% CI 1.03–2.36).

We observe that those living in Northern Ireland were consistently less likely to be willing to eat these foods after the use-by date (meat, OR: 0.37, 95% CI 0.16–0.88; smoked fish, OR: 0.25, 95% CI 0.09–0.68; bagged salad, OR: 0.34, 95% CI 0.13–0.85; yoghurt OR: 0.33, 95% CI 0.13–0.81) compared to those living in England. However, willingness to eat foods after the use-by date did not differ between those living in England and Wales.

Age was not associated with willingness to eat meat or yogurt after the use-by date. However, compared to those aged 60–64 years, respondents aged 75 to 75 years (OR: 1.98, 95% CI 1.06–3.70) were more willing to eat smoked fish after the use-by date, and those aged 80 years or over (OR: 0.54, 95% CI 0.29–0.99) were less willing to eat bagged salad after the use-by date. Household income was not associated with willingness to eat smoked fish or yogurt after the use-by date. However, compared to those with an income of £19,000 or below, those with an income of £19,00 to £31,999 (OR: 0.65, 95% CI 0.44–0.96) were less willing to eat meat after the use-by date and those with an income of £64,000 or above (OR: 0.36, 95% CI 0.18–0.72) were less willing to eat bagged salad after the use-by date. Food security was not associated with willingness to eat food after the use-by date except for yogurt. Those who were food insecure (OR: 0.44, 95% CI 0.24–0.78) were less willing to eat yogurt after the use-by date compared to those who were food secure. Gender, long term health condition status, household size, responsibility for food shopping and/or cooking are not associated with willingness to eat food after the use-by date (see Table 5).

4. Discussion

4.1. *This research makes an important contribution to understanding food safety behaviours of older adults*

The current research demonstrates the complex relationship between food safety behaviours and demographic, financial, food agency and geographical factors in older adults. We observe three key findings; first,

the individual characteristics associated with risky food-related behaviours are not uniform, with different individual characteristics being associated with different risky behaviours (RQ1); second, that food security status also has varied associations with a range of risky food safety practices (RQ2); third, knowledge of use-by dates is the strongest predictor of use-by date adherence (RQ3).

4.2. Individual characteristics, food insecurity, and risky food safety behaviours in older adults

The recent cost-of-living crisis has seen the highest rate of inflation since the 1970's (Office for National Statistics, 2023a). Consequently, the costs for retirees to maintain minimum retirement living standards increased by an estimated 17.8% for single retirees and 19.0% for retired couples in 2021–2022 (Padley, 2022). A single adult requires a weekly income of £715.55 to have a comfortable standard of living in retirement (Padley, 2022). This increase in costs risks reducing the standard of living of many older adults, potentially increasing the prevalence of food insecurity. These changes may reduce dietary quality and increase health inequalities in older adults (Broadbent et al., 2023; Leung & Wolfson, 2021).

We observe an inconsistent relationship between food security and household income with food safety behaviours. Those experiencing food insecurity are more likely to eat pink chicken or turkey, but are also more likely to check the fridge temperature and to wash their hands before preparing and cooking food. Food security status was not associated with eating leftovers after two days or more, or not cooking food until steaming hot and cooked all the way through, and not consistently associated with use-by-date behaviours. Similarly, those with higher incomes are progressively more willing to eat leftovers after more than two days and to not cook their food until steaming hot and cooked all the way through, but more likely to check their fridge temperature. Income was not associated with washing chicken, not washing hands before preparing and cooking food, and eating pink chicken or turkey, and was not consistently associated with use-by-date behaviours.

Considering our findings on handwashing, much of the research looking at handwashing behaviour with the general population was conducted during the COVID-19 pandemic (e.g., (Brown et al., 2022; Love et al., 2022). Research conducted during COVID-19 with UK citizens which used the COM-B framework indicated that motivation had the largest influence on handwashing behaviour, and that those with higher incomes were more likely to engage with hygiene behaviours (Gibson Miller et al., 2020). Considering this finding in light of our findings, we suggest that those who are food secure are likely to have capability (e.g., understanding of the purpose of handwashing), and opportunity (e.g., access to sink and soap) but may have reduced motivation (e.g., beliefs about consequences of not washing hands before preparing food) to engage with handwashing behaviour in the reduced risk of COVID-19. Further detailed research is needed to test this possibility directly and to explore why motivations for handwashing may be lower to inform effective strategies to improve handwashing behaviours. More broadly, our findings demonstrate that financial constraint in the form of lower income and food insecurity are not consistently associated with riskier food practices but do highlight some areas of concern that require further research attention.

4.3. The relationship between knowledge of use-by dates and adherence to use-by dates

Our findings demonstrate that respondents with knowledge of use-by dates are more likely to check the use-by date before eating or preparing food, and less likely to eat a range of foods after the use-by date. Consequently, we suggest that an information campaign to increase consumer understanding of use-by dates would potentially have positive impacts on people's behaviours around use-by-dates, with positive health impacts.

In line with previous research (Wright et al., 2011), the findings show that being well-informed about food safety is associated with safer food practice, with knowledge of use-by dates being significantly associated with the likelihood that a person will check the use-by date of food before preparing or cooking it. However, this is not always the case. Even after knowledge of use-by dates is adjusted for, we see that older adults, men and those who do not have responsibility for cooking in the household are significantly less likely to check the use-by dates of foods, indicating that knowledge alone is not sufficient to drive safer food behaviours. This could be due to a range of factors relating to capability, opportunity, and motivation (Michie et al., 2011). For example, older men perceive lower risks of developing foodborne disease than older women (Hanson & Benedict, 2002) and also exhibit riskier food safety behaviours (Evans & Redmond, 2016; Hanson & Benedict, 2002), a pattern we also see here, where men are significantly less likely to check use-by-dates. Men are however no more likely than women to eat food after these dates. Older adults may also be less likely to check use-by-dates due to eye-sight decline preventing this (Hudson & Hartwell, 2002), while older adults' reluctance to waste food (Walker-Clarke et al., 2022; Young & Waddell, 2016) may manifest as not checking use-by dates. Finally, we found that those who do not have responsibility for cooking are also less likely to check use-by dates, which may reflect a knowledge gap in this group. We also recognise that although these groups were less likely to *check* use-by dates, this did not consistently translate into higher risks of *eating* a range of foods after their use-by dates. Such an inconsistency needs to be interrogated further to better understand these food practices and help inform interventions to promote safe food practices, especially in these higher-risk groups.

The current research demonstrates that demographic and socioeconomic characteristics are associated with many food safety behaviours. Adherence to use-by dates was the only behaviour consistently associated with geographical factors. Living in Northern Ireland or a rural area is not associated with *checking* use-by dates but is associated with a likelihood of *consuming* foods past the use-by date, where people in rural areas are more likely to consume food after the use-by date and people in Northern Ireland are less likely to do so. In line with previous research (Giles, 2009) we suggest that the greater willingness of those living in rural areas to eat food after the use-by date may reflect barriers in accessing food due to longer journey time to shops (Department for Transport, 2015) and limited transport options compared to those living in urban areas. Accordingly, different food practices in rural areas are likely to reflect practical constraints, rather than differences in knowledge of or attitudes towards food safety behaviours. The lower likelihood of Northern Irish respondents consuming foods past the use-by date has a less obvious explanation. It may reflect perceived higher risks of developing foodborne disease in this group, a possibility that needs direct empirical exploration (Hanson & Benedict, 2002; Reimer et al., 2012; Wright et al., 2011).

Surprisingly, we did not observe that food insecurity or low income were consistently associated with either checking use-by dates, or a greater willingness to eat food after the use-by date. This is an encouraging finding which demonstrates that financial constraint does not translate into a higher likelihood of these specific health-damaging risky food practices, at least with respect to the foods featured in the current research. Our multivariate analyses contradict recent evidence linking food insecurity with eating food past the use-by date (Food Standards Agency, 2023d) and further demonstrate the value of detailed statistical analyses that are able to account for compositional differences between groups to offer more nuanced understandings of these practices. We explored four types of food (meat, smoked fish, bagged salad, yogurt), and it is alternatively possible that the relationship between food insecurity, low income and use-by date adherence could vary for different types of food. Further research is needed to explore this possibility to gain valuable insights into the possible links between financial constraint and risky food practices. In line with previous research (Evans & Redmond, 2016; Hanson & Benedict, 2002) we observed that men

exhibit riskier food safety behaviours relating to cooking, cross-contamination, and use-by dates. We suggest this is due to a lower perceived risk but also fewer cooking skills, and less cooking experience (Hughes et al., 2004; Johannesson et al., 2016).

4.4. Limitations

We identify three key limitations of the current research. First, using data from a household survey means that the study sample inevitably suffers from some undercoverage. Food and You 2 participants are recruited via the Royal Mail's Postcode Address File, which excludes individuals in multiple residence institutions, such as care homes and prisons, and those who are homeless. As 2.5% of over 65s in England and Wales live in a care home (Office for National Statistics, 2023c), 13% of the prison population are aged over 60 (Ministry of Justice, 2022), and 9–12% of the homeless population are aged over 55 years (Age UK, 2019) and our results are not applicable to a small but important (and varied) minority of older people. To gain valuable insights here, further research is needed to explore food insecurity and food safety behaviours of these groups. We do note, however, that food practices in these spaces are likely to be very different to those in the private households we explored here, so the current results have relevance to the majority of older people.

Second, as Food and You 2 is a self-report survey it is subject to the typical biases of self-report surveys (Brenner & DeLamater, 2016), particularly given the social desirability of some of the behaviours, such as handwashing. When combined with complementary research it can provide valuable insights into practices. For example, while research using Food and You 2 shows that three-quarters of older adults' report that they always wash their hands before they prepare or cook food observational research found that 91% of older adults do not adequately wash their hands (Evans & Redmond, 2018). It is therefore possible that the risky food practices explored here are more prevalent than reported in the data. More importantly, our findings may be challenged if certain groups are more likely to under-report risky food practices. While there is no obvious reason why this would be the case, this possibility is worth investigating further.

Finally, Food and You 2 provides a valuable source of data for policy makers, academics, and non-governmental organisations. By design, Food and You 2 explores and captures food-related practices at the population level. Therefore, Food and You 2 does not specifically focus upon the prevalence of practices and challenges which may be unique to, or more prevalent in the older adult population, such as visual issues presenting challenges in reading use-by dates. Previous research has demonstrated the benefits of working with understudied groups to identify practices relating to food insecurity and food safety, identifying practices and challenges which had not been identified in the general population (Food Standards Agency, 2023a). We support more specialised research into the specific dynamics of food provisioning among older people.

Despite the limitations, the current research provides an important insight into the food safety practices of older adults and how these vary according to key socioeconomic characteristics, including food insecurity.

4.5. Implications

The findings of the current research have several theoretical and practical implications. First, we demonstrate that people over the age of sixty should not be treated as a single cohort, given the demonstrated diversity of variables which are associated with food safety practices. By understanding the socio-demographic and economic situations associated with different practices, policy makers can target differently-aged older people more effectively.

Food handling behaviours may be difficult to change in those with established habits, with practices being influenced by routine, experiential knowledge, and unconscious actions (Young & Waddell, 2016). We suggest the use of passive interventions could be highly effective in targeting some risky behaviours. For example, built-in fridge thermometers with an alarm overcome several barriers in safe food refrigeration such as; the need for consumers to know the recommended refrigeration temperature (capability); the need to have a separate fridge thermometer (opportunity), and the need to check the thermometer (motivation) (Michie et al., 2011). Such interventions may be particularly beneficial to older people who may face specific barriers to safe food practices, especially in relation to their capabilities to undertake these practices due to age-related decline.

Based on the current research and existing findings which demonstrate the role of established behaviours (Young & Waddell, 2016) and perceived risk (Evans & Redmond, 2016; Hanson & Benedict, 2002) in food-related practices, we suggest that food safety communications could draw on the Health Belief Model (HBM) (Fishbein & Yzer, 2003) and Social Cognitive Theory (SCT) (Bandura, 2013). We suggest a two-pronged approach. First, we suggest that by increasing older adults' understanding that they are a high-risk group with a reduced resistance to foodborne pathogens (Buzby, 2002; Fishbein & Yzer, 2003) we could reduce active risky food-related behaviours, such as eating food after the use-by date. Second, we suggest that SCT may be used to increase proactive health behaviours, such as handwashing, by normalising recommended practices by observing others who exhibit the behaviour (Bandura, 2013).

4.6. Conclusions

This research makes an important contribution to the limited evidence which investigates the food safety behaviours of older adults. Filling a knowledge gap, the research provides novel insights into the relationship between food insecurity and food-related behaviours, at a time which has seen booming rates of inflation and food insecurity. The findings demonstrate that different risky behaviours are associated with different socio-demographic and economic factors and cannot be efficiently targeted with a one size fits all approach. They also found that knowledge of use-by dates is the strongest predictor of use-by date adherence, suggesting that improving older people's knowledge around these practices could be an effective way to encourage safe food practices in relation to use-by dates. Collectively, these findings provide a valuable evidence base for policy makers to develop effective interventions to target older adults most at risk of unsafe food practices and their consequences for people's health.

Ethical approval

Ethical approval was granted by University of Sheffield, Department of Geography ethics board: Reference Number 064369.

CRediT authorship contribution statement

Beth Armstrong: Writing – original draft, Resources, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Rachel Smith:** Writing – original draft, Methodology. **Elisabeth Garratt:** Writing – review & editing, Methodology.

Declaration of competing interest

Dr Smith and Dr Garrett have no declarations of interest to disclose. Dr Armstrong has received research funding from the Food Standards Agency (FSA) to find her current fellowship position. The views express in this paper are her own and do not reflect the position of the FSA.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2024.107650.

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