

Perceptions, behaviours and kitchen hygiene of people who have and have not suffered campylobacteriosis: A case control study

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20 ***Abstract***

21 Whilst the scale of food poisoning in the home is not fully understood, the increase in sporadic
22 cases of *Campylobacter* continues to place focus on home hygiene and domestic food safety
23 practices. Domestic hygiene has rarely been identified as a risk factor for the incidence of
24 campylobacteriosis but due to the high levels of sporadic cases of *Campylobacter*, cross
25 contamination from kitchen practices remains of significant interest. Due to the complexities of
26 human nature, finding the true risk perceptions and practices that take place in the kitchen is
27 challenging, with social desirability bias affecting the results of surveys and optimistic bias influencing
28 risk perceptions. This study looks at self-reported kitchen behaviours and perceptions of people who
29 have had campylobacteriosis in comparison to people who have not had food poisoning. It also
30 investigates microbiological kitchen hygiene within a smaller sample. The survey crucially includes a
31 longitudinal element to investigate any change that may take place after a period of six months has
32 elapsed. Optimistic bias was evident in both groups and no significant difference in perception was
33 noted in the baseline study. However, the longitudinal study showed that individuals who had not
34 had food poisoning increased their optimism, introducing a significant difference in optimistic bias
35 between the two groups after six months had elapsed. Self-reported kitchen behaviours also
36 exhibited a difference between the two groups, with the individuals who had campylobacteriosis
37 responding more favourably with the exception of washing chicken and washing salad leaves sold in
38 a bag. No evidence of kitchen hygiene differences could be found between the people who had
39 suffered campylobacteriosis in comparison to people who had not had food poisoning. The results of
40 the survey demonstrate that more effective food safety communication is required. Important
41 messages such as 'not washing chicken' seem not to have been absorbed and the good practices
42 become routine. These messages need particularly to be aimed towards people who may not
43 perceive themselves as being at risk of getting food poisoning, such as the young, although the
44 challenge of changing the practice of those who perceive themselves to be at low risk remains.

45

46 ***Keywords***

47 Optimistic bias; *Campylobacter*; Domestic kitchen; Case control study; Risk perception.

48

49 **1. Introduction**

50 Each year, 11 million working days are lost in the UK due to infectious intestinal disease which is
51 estimated to cost the UK approximately £2 billion annually (FSA, 2010/2011). *Campylobacter* is the
52 most commonly reported bacterial pathogen (9.3 cases per 1000 person-years), with an estimated
53 500,000 cases occurring annually in the UK (Tam, et al., 2012).

54 Despite the high recorded and estimated incidence of *Campylobacter*, outbreaks are rarely
55 identified, with much of the incidence being attributed to sporadic infection. More recently it has
56 been reported that this pattern has started to change, with an increasing number of outbreaks
57 associated with undercooked chicken and chicken livers (HPA, 2011; Little, Gormley, Rawal, &
58 Richardson, 2010; Strachan, et al., 2012). Studies of campylobacteriosis have highlighted risk factors
59 that include travel abroad, raw meat, milk, untreated water and handling pets with diarrhoea (Adak,
60 Cowden, Nicholas, & Evan, 1995; Doorduyn, et al., 2010; Kapperud, et al., 2003; Neimann, Engberg,
61 Molbak, & Wegener, 2003; Rodrigues, et al., 2001). The consumption of poultry (particularly chicken)
62 is the most frequently identified source of infection, with Neimann et al. (2003) listing 11 studies in a
63 20 year period (1979-1998). However, Rodrigues et al. (2001) suggest that consumption of chicken
64 may be less important as a source for sporadic *Campylobacter* cases than cross contamination from
65 raw poultry (Kapperud, et al., 2003), indicating that poor domestic hygiene practices may be a
66 significant risk factor.

67 Studies of kitchen practices generally take the form of self-reported surveys, which focus on
68 specific questions of practice or attitudes and perceptions towards food safety (Gilbert, et al., 2007;
69 E. C. Redmond & Griffith, 2004a). Focus groups have been used to investigate practices in sub-groups
70 of the population (Gauci & Gauci, 2005; Gettings & Kiernan, 2001; Sudershan, Rao, Rao, Rao, &
71 Polasa, 2008; Trepka, Murunga, Cherry, Huffman, & Dixon, 2006). However, observational studies
72 (Abbot, Byrd-Bredbenner, Schaffner, Bruhn, & Blalock, 2007; Anderson, Shuster, Hansen, Levy, &
73 Volk, 2004) have been key in revealing kitchen practices (E. C. Redmond & Griffith, 2003).

74 Microbiological studies often include observational elements in addition to sampling (Fischer, et al.,
75 2007; Gorman, Bloomfield, & Adley, 2002; Haysom & Sharp, 2005; Mylius, Nauta, & Havelaar, 2007)
76 and in many cases laboratory analysis has been based on re-enactments of behavioural studies
77 (Mylius, et al., 2007; E. Redmond, Griffith, Slader, & Humphrey, 2001). Only Parry et al. have
78 investigated the perceptions and practices of people who have had confirmed food poisoning (S. M.
79 Parry, Miles, Tridente, Palmer, & Group, 2004; S. M. Parry, et al., 2005).

80 Although it is not known what proportion of cases of *Campylobacter* can be attributed to food
81 prepared or eaten at home, the UK Food Standards Agency (FSA) has identified improved domestic
82 food safety as critical in reducing the burden of illness (FSA, 2001). Consumer behaviour is not
83 regulated and in this regard the prevention of food safety hazards depends on good food safety and
84 hygienic practices being adopted and becoming 'second nature' in the home. In other words, food
85 safety practices have to become an ingrained habit to ensure that they are repeatable on each
86 occasion that food preparation is undertaken. In order to make progress in this unregulated area it is
87 essential that consumer behaviour is better understood and that education and food safety
88 communication strategies are developed appropriately, in order to try to direct the consumer
89 towards making the safe preparation of food a habit (Fischer, Frewer, & Nauta, 2006; E. C. Redmond
90 & Griffith, 2004b).

91 Whilst a more detailed understanding of food risk perceptions are necessary to establish what
92 people do or don't do in order to address poor practices, it is widely reported that risk perceptions
93 are influenced by optimistic bias (OB), so analysis of personal risk has also focussed on the presence,
94 extent and causes of OB (Fischer, et al., 2006; Miles, Braxton, & Frewer, 1999; Miles & Scaife, 2003;
95 S. M. Parry, et al., 2004; Sargeant, Majowicz, Sheth, & Edge, 2010; Sharot, 2011; Weinstein, 1987).
96 Optimistic bias is "the inclination to overestimate the likelihood of encountering positive events in
97 the future and to underestimate the likelihood of experiencing negative events" (Sharot, 2011: pg
98 xv). OB is evident in many situations. With respect to food safety, OB occurs where individuals who

99 believe that they are less likely to be affected by food safety hazards also believe that their risk of
100 food poisoning is less than the average person. OB is also evident in the finding that people believe
101 that they are in control of microbiological hazards when they prepare food themselves (Miles, et al.,
102 1999), but food prepared by others is much more hazardous to them (Frewer, Shepherd, & Sparks,
103 1994; Miles, et al., 1999). It is believed that individuals who see themselves at lower risk of food
104 poisoning (because of optimistic bias) are less likely to be sensitive to food safety awareness
105 campaigns, believing that the messages are not for them (E. C. Redmond & Griffith, 2004b). It is
106 thought that this can make educational initiatives to reduce risk more challenging. However, more
107 research is required to assess if people do become more impervious to food safety messages the
108 lower the risk they believe they are exposed to.

109 Explanations of OB are categorised into either motivational or cognitive, with motivational
110 explanations based on the theory that “assume that individuals are motivated to make risk
111 judgements that will not induce negative affect or threaten self-esteem, and so will maintain or
112 promote psychological wellbeing” (Miles & Scaife, 2003: pg 15). Cognitive explanations for optimistic
113 bias are centred on the failure of the individual to adopt the perspective of others. Individuals may
114 conclude incorrectly that their chances differ from those of others, be influenced by any past
115 experience (or absence of experience) or by comparison of themselves with a stereotype and
116 incorrectly conclude that the hazard will not apply to them as they do not fit the stereotype (Miles &
117 Scaife, 2003).

118 This study uses the principles of research undertaken by Parry et al to investigate the food safety
119 perceptions and extent of OB, in addition to assessing kitchen hygiene (S. M. Parry, et al., 2004; S. M.
120 Parry, et al., 2005). Whilst the work of Parry focussed on people who had *Salmonella*, in comparison
121 to people who have not had salmonellosis, we compare individuals who have had laboratory
122 confirmed campylobacteriosis, with individuals who have not had laboratory confirmed food

123 poisoning. We further extend this research by introducing a longitudinal element, revisiting food
124 safety perceptions six months later.

125 Whilst the main survey elicited information regarding the existence and levels of OB, the use of
126 questionnaires to elicit attitudes, awareness and behaviours suffers from certain limitations due to
127 discrepancies between self reported practices and those in reality. This was partly addressed by
128 environmental microbiological sampling in the kitchens of a small group, drawing on past research by
129 Redmond et al. (2001), Fischer et al. (2007) and Parry et al. (2004; 2005).

130 In summary, the research questions that we asked are:

- 131 a) What is the level of optimistic bias and perception of food hygiene and food safety of
132 individuals in the home and does having had campylobacteriosis promote any difference
133 in optimistic bias in comparison to an individual that has not had food poisoning?
- 134 b) Does behaviour and optimistic bias change with time lapse following
135 campylobacteriosis?
- 136 c) Is microbiological kitchen hygiene different between people who have, and have not,
137 recently had campylobacteriosis?

138 ***2. Materials and methods***

139 The case control study was conducted using a survey of self reported kitchen behaviours and
140 food safety perceptions, in addition to a kitchen sampling programme for a sub group of the main
141 study. A longitudinal study surveyed kitchen behaviours and food safety perceptions six months later
142 in the same cohort. Cases were defined as people aged 18 or over, who have had laboratory
143 confirmed campylobacteriosis in Greater Manchester, England, whilst controls were matched
144 (gender, age and general geographic location) individuals with no laboratory confirmation of food
145 related illness in the previous five years.

146 **2.1. Case and control recruitment**

147 Participants in the study were recruited via two routes: via the Greater Manchester Health
148 Protection Unit (HPU) and by snowball sampling for the recruitment of controls. The HPU receives
149 laboratory reports on all isolates of *Campylobacter* from people resident in Greater Manchester and
150 at the time of the study routinely sent enhanced surveillance questionnaires to all cases of
151 *Campylobacter*. For this study, cases were initially contacted by the HPU with a letter of invitation,
152 information sheet, consent form and paper-based questionnaire (with an online option provided).
153 Informed consent was established by the individual returning their consent form to the HPU
154 permitting direct contact by the researcher. The recruitment and research design was approved by
155 an NHS Research Ethics Committee. It was intended that controls be recruited by the use of a referral
156 system whereby postcards were provided for cases to pass onto friends to apply for involvement in
157 the study. In fact this method yielded few controls and supplementary methods of recruitment were
158 necessary including: the use of social media to advertise on local group sites, snowball sampling using
159 contacts in Greater Manchester, and visiting societies and groups in the region. The controls also
160 completed the same consent form to take part in the study.

161 **2.2. Data collection**

162 As part of the informed consent process for both cases and controls, the participant was asked if
163 they wished to take part in a home study involving a kitchen visit, a further questionnaire in 6
164 months' time or simply complete the initial questionnaire.

165 **2.2.1. Survey**

166 The questionnaire was designed to investigate self-reported behaviours and perceptions of
167 individuals with regard to food safety in the home. The questions used by Parry et al. (2004) with
168 regard to risk, control and knowledge were presented to elicit perceptions and the existence and
169 level of optimistic bias, with a seven-point Likert scale. These comprised a series of three pairs of
170 questions to measure respondents' perceived levels of risk, control and knowledge regarding food

171 poisoning in the home, in comparison to their perception of that of the average person. The
172 questions were:

- 173 - How much risk do you think there is to you personally from food poisoning in the home?
- 174 - How much risk do you think there is to the average person from food poisoning in the home?
- 175 - How much control do you think you personally have over getting food poisoning in the
176 home?
- 177 - How much control do you think the average person has over getting food poisoning in the
178 home?
- 179 - How much knowledge do you think you personally have about the risk of getting food
180 poisoning in the home?
- 181 - How much knowledge do you think the average person has over the risk of getting food
182 poisoning in the home?

183 Participants were asked how involved they were in the preparation of food in the home.
184 Questions relating to more specific behaviours in the domestic kitchen were also included in the
185 survey (Figure 1). Additionally, cases were asked about their recent illness and their perception of its
186 origin, including recent travel abroad.

187 To establish if there was any change in behaviour and any change in OB through time following
188 the food poisoning incident, research with consenting individuals was repeated six months later,
189 repeating the risk, control, knowledge and kitchen behaviour questions.

190 ***2.2.2. Kitchen sampling***

191 A review of kitchen hygiene was undertaken for a subgroup of recruits who had consented to a
192 home visit. Visits were pre-arranged in the same manner for both controls and cases. Environmental

193 swabs were taken for analysis of hygiene indicator organisms and the dishcloth in use was exchanged
194 for a new one and analysed for the pathogens, *Salmonella* and *Campylobacter* as well as hygiene
195 indicator organisms.

196 The following sample points were targeted to ensure consistency in sampling across
197 respondents' kitchens: chopping boards, kitchen sink surround and the bottom shelf of the
198 refrigerator. Surfaces were sampled aseptically using alginate tipped swabs (Medical Wire &
199 Equipment Co.) pre-moistened in 10 ml MRS Neutralising Broth containing Peptone (vegetable
200 origin), Disodium Phosphate, Lecithin, Tween 80 and Sodium Thiosulphate, to mitigate effects of
201 chlorine, quaternary ammonium compounds and phenolics, based household cleaning agents. The
202 sampling method was controlled by ensuring that no more than a 5 x 5 cm² area was swabbed and
203 that the swab tip was rolled and turned across the selected area.

204 If the household had a dishcloth or sponge, this was removed for analysis by inverting a sterile
205 Stomacher bag (Seward UK), re-inverting and sealing with an identifying label. Where the dishcloth
206 or sponge was found to be soaking in household bleach or was new and unused, it was not sampled.
207 For each dishcloth removed, the participant was given a replacement.

208 Samples were transported under chilled conditions ($4 \pm 2^{\circ}\text{C}$) until testing at a UKAS accredited
209 microbiology laboratory. Wherever practicable, samples were transported and prepared for analysis
210 within 10 hours of sampling, with all samples prepared within 24 hours of sampling. Samples were
211 labelled with a code number to prevent the laboratory knowing the origin of the samples and to
212 ensure that there was no indication of their case/control status.

213 ***2.3.Data analysis***

214 ***2.3.1. Laboratory analysis***

215 Swabs were vortexed (VWR) for 30 seconds to elute bacteria into solution. 0.5 ml was then
216 transferred to 4.5 ml of Maximum Recovery Diluent MRD (Oxoid CM0733), vortexed for 30 seconds
217 to disperse the sample and further serial dilutions were prepared as required.

218 Dishcloths and sponges were weighed and an equivalent volume of MRD added to the
219 Stomacher bag. This was then massaged by hand for 30 seconds and 0.5 ml removed and transferred
220 to 4.5 ml of MRD, vortexed for 30 seconds to ensure consistency of mixing and serial dilutions
221 prepared as required. 25 ml aliquots were transferred to 225 ml Buffered Peptone Water BPW
222 (Oxoid CM0509) and Bolton Broth (Oxoid CM983) for *Salmonella* and *Campylobacter* isolation
223 respectively.

224 Counts were prepared from serial dilutions for both swab and dishcloth/sponge samples as
225 above and 0.5 ml aliquots removed for each test:

226 Enumeration of Aerobic Colony Count (ACC) was based on ISO 4833 (Microbiological examination
227 of food and feeding stuffs: enumeration of micro-organisms colony count technique) at 30°C using
228 Plate Count Agar (Oxoid CM325) incubated aerobically at 30°C for 48 hours.

229 Enumeration of *Enterobacteriaceae* was based on ISO2158-2 4833 (Microbiological examination
230 of food and feeding stuffs: Enumeration of *Enterobacteriaceae*. 2004) using Violet Red Bile Glucose
231 Agar (VRBGA) (Oxoid CM485) incubated aerobically at 37°C for 24 hours.

232 Enumeration of *Escherichia coli* was based on BS ISO 16449 (Microbiology of food and animal
233 feedstuffs – horizontal. Method for the enumeration of B-gluconronidase positive *E.coli* Part 2:
234 colony count at 44°C,2001) by plating on Tryptone Glucoronidase X Agar (Oxoid CM945) at 44°C for
235 24 hours.

236 *Salmonella* isolation followed ISO 6579 (Microbiological examination of food and animal
237 feedstuffs. Detection of *Salmonella* part 4 2002) using a pre-incubation step in BPW for 20 hours at

238 37°C, 0.1 ml transferred to 10 ml Rappaport Vassiliadis Soya Peptone Broth (RVS) (Oxoid CM0866)
239 incubated at 41.5°C ± 1°C for 18-24 hours and 1 ml transferred to 9 ml of Muller Kaufmann
240 Tetrathionate Broth (MK-TTn) (Oxoid CM0029) incubated at 37°C for 21-27 hours. 5 µl was then
241 removed and streaked onto both Brilliant Green Agar (BGA) (Oxoid CM0263) and Xylose Lysine
242 Decarboxylase Agar (XLD) (Oxoid CM0469) from both selective broths. Typical colonies were purified
243 and identified using physiological, morphological, biochemical and serological profiles.

244 *Campylobacter* isolation followed BS EN ISO10272-1:2006 (Microbiological examination of food
245 and animal feeding stuff. Detection of thermotolerant *Campylobacter*). The samples were incubated
246 in micro-aerophilically in Bolton Broth (Oxoid CM983) at 37±1°C for 3-5 hours, transferred to
247 41.5±1°C up to 48 hours, 5 µl was streaked onto *Campylobacter* Blood-Free Selective Medium
248 (Modified CCDA - Preston (Oxoid CM0739) with selective supplement (Oxoid SR0155) and incubated
249 micro-aerophilically for 48 hours at 41.5±1°C. Typical colonies were purified and identified using
250 physiological, morphological, biochemical and serological profiles.

251 **2.3.2. Statistical analysis**

252 The microbiological results were tested for case/control differences by swab area (sink, chopping
253 board and fridge) and microorganism using the Wilcoxon Mann-Whitney test. In order to measure
254 optimistic bias from the survey data, a difference or bias score was calculated between a
255 respondent's answers to the questions about themselves and those about the average person.
256 Typically, OB has been tested using a one-sample t-test (S. M. Parry, et al., 2004; Sargeant, et al.,
257 2010; Weinstein, 1987). However, as the difference scores are ordinal not interval we used the
258 Wilcoxon Mann-Whitney test to test the hypothesis that the sample median is equal to zero and
259 therefore shows no bias. Any difference between cases and controls in optimistic bias was then
260 analysed, in addition to any change apparent through the longitudinal study. The kitchen behaviours
261 were analysed in the same manner to identify differences between cases and controls and
262 longitudinally. Chi-square was utilised to test for association with case/control status, gender,

263 responsibility in the kitchen and age. Age bands were chosen to compare with the findings of
264 Gillespie et al. (2009), which demonstrates age-related changes in *Campylobacter* incidence (1990-
265 2007) with greatest increasing risk of infection in 60+ year olds.

266 **3. Results**

267 Questionnaires were mailed out to 836 cases over a five month period. 202 were returned but 3
268 were excluded because they were completed by people who did not fit the case definition i.e. were
269 under the age of 18. In addition, 17 people who had travelled abroad within 7 days prior to their
270 illness were removed from the sample. A total of 182 case questionnaires were therefore analysed.
271 185 controls were recruited. For the longitudinal study, 118 cases and 96 controls consented to
272 complete the survey 6 months later, yielding 77 case and 44 control useable questionnaires with a
273 completion rate of 65% and 46% respectively. Twenty five cases were visited after agreeing to take
274 part in the home study. The same number of age and sex matched controls was identified and
275 visited.

276 **3.1. Perceptions and optimistic bias**

277 The questions relating to risk, designed to elicit the existence of OB, were completed by 355
278 individuals. Of this sample, 42.5% believed themselves to be at greater or about the same risk of
279 getting food poisoning in the home as the average person. In contrast, 57.5% of participants believed
280 that they were at a lower risk of getting food poisoning in the home than the average person.

281 Testing the difference scores for risk, control and knowledge, the three scores are significantly
282 different from zero and demonstrate OB. The participants have indicated that the average person is
283 at a significantly greater risk of getting food poisoning than himself or herself ($z=13.031$, $p<0.001$),
284 has significantly less knowledge ($z=-13.701$, $p<0.001$) and significantly less control ($z=-7.461$, $p<0.001$)
285 over food poisoning in the home. This bias score was converted into a simple rating (Figure 2) to
286 show the existence of OB. No significant difference was found between cases and controls.

287 For the longitudinal study the same analysis was repeated, again demonstrating the existence of
288 OB, with 25.21% believing themselves to be at greater or about the same risk of getting food
289 poisoning in the home as the average person in comparison to 74.79% who believed themselves to
290 be at lesser risk. The participants continued in their beliefs that the average person was at a
291 significantly greater risk of getting food poisoning than himself or herself ($z=8.612$, $p<0.001$), had
292 significantly less knowledge ($z=-3.498$, $p<0.0005$) and significantly less control ($z=-9.095$, $p<0.001$)
293 over food poisoning in the home. A simple rating was calculated as before (Figure 3). On this
294 occasion a significant difference between cases and controls was identified for the risk questions ($z=-$
295 2.314 , $p=0.021$) but not for the control ($z=0.182$, $p=0.856$) or knowledge ($z=-1.929$, $p=0.054$)
296 questions.

297 Due to the change in sample numbers between the initial and longitudinal survey it was
298 necessary to calculate a score change to identify the actual movement in bias between the two
299 survey occasions. Individuals with an increased level of OB were defined as those who developed OB
300 during the study, or who were previously pessimistic and developed no bias. Increased bias for
301 controls was found to be 36.36% in contrast to 19.18% for cases. 13.7% of cases reduced bias (to no
302 or pessimistic bias) in contrast to 2.27% of controls. This is displayed in Figure 4.

303 Chi-square testing of risk scores and risk ratings for the initial and longitudinal survey against age,
304 gender and responsibilities in the kitchen showed no significance with the exception of the risk rating
305 from the longitudinal survey against decreasing age band ($\chi^2(1)=6.693$, $p=0.010$), decreasing age
306 band for controls ($\chi^2(1)=4.728$, $p=0.030$) and gender ($\chi^2(1)=5.716$, $p=0.017$), favouring females.

307 ***3.2. Kitchen behaviours***

308 The mean Likert response for the kitchen behaviours was calculated for both cases and controls
309 to highlight any areas of interest. Significant differences between the responses of cases and controls
310 was evident in answer to: the use of chopping boards, eating runny eggs, eating cooked meat a day
311 after its “use by” date, following manufacturers’ instructions for cooking, using antibacterial spray

312 and eating pink beef burgers. In all of these instances, the cases answered more favourably than the
313 controls. The mean Likert scores are shown in Table 1, along with the p value indicating significant
314 differences between cases and controls.

315 Cases were significantly more likely than controls to wash poultry and 'ready to eat' salad leaves.
316 The advice from the FSA is that raw poultry and other meat should not be washed in order to avoid
317 cross contamination. In the case of raw vegetables and salad ingredients, whilst the general advice is
318 to wash vegetables and salad ingredients, items sold 'ready to eat' in a bag do not require further
319 washing before consumption. For these products, washing has been carried out by the manufacturer
320 to a more satisfactory standard than can be achieved in the home (ACMSF, 2008; Palumbo, et al.,
321 2007; Verrill, Lando, & O'Connell, 2012) and further preparation in the kitchen may increase the risk
322 of cross-contamination. 69.63% of respondents reported that they washed raw chicken before
323 cooking, compared with the FSA 'Food and You survey' in 2010 which reported that 63% of people
324 wash poultry and red meat some of the time, with 41% of people always carrying out this practice
325 (FSA, 2010). It was found that there was no significant association with gender ($\chi^2(4)=1.031$, ns) but
326 there was a significant association with responsibility for food preparation or responsibilities in the
327 kitchen ($\chi^2(8)=16.618$, $p=0.034$). 72.9% of people who were responsible for food preparation stated
328 that they wash chicken in comparison to 61.66% who have no responsibilities in the kitchen.
329 Significance was also found for case control status ($\chi^2(4)=12.097$, $p=0.017$), with 65.32% of controls
330 stating that they wash chicken in comparison to 73.86% of cases. Age was also found to affect the
331 responses ($\chi^2(12)=28.799$, $p=0.004$). 69.63% stated that they washed chicken with 62.9% for 20-59
332 year olds in comparison to 80.45% for people aged 60+. With regard to salad leaf washing there was
333 no significant relationship with responsibility in the kitchen ($\chi^2(8)=4.632$, ns), or case control status
334 ($\chi^2(4)=6.593$, ns). However, significance was found with gender ($\chi^2(4)=15.244$, $p=0.004$) and age
335 ($\chi^2(12)=12.994$, $p=0.015$). Whilst overall, 79.67% stated that they washed salad leaves sold in a bag,
336 85.93% of people aged 60+ wash leaves in comparison to 75.45% for 20-59 year olds.

337 When the questions were repeated six months later, the responses changed marginally. For
338 example, washing of chicken for the cases (mean=3.74, SD 1.59) showed a marginal increase whilst
339 controls exhibited a decrease (mean=2.88, SD 1.66) with a significant difference between the two
340 groups ($p=0.0045$). With regard to the washing of salad leaves, cases remained similar after 6 months
341 (mean=3.47, SD 1.52) but the controls reduced (mean=2.75, SD 1.62), increasing the statistical
342 significance ($p=0.0167$).

343 **3.3. Kitchen sampling**

344 Microbiological analysis of the swab locations (fridge, chopping board and sink) in the 25 case
345 and 25 control kitchens indicated no difference between the two groups of people, thereby
346 indicating no significant difference in kitchen hygiene between people who have had
347 campylobacteriosis and people who have not. Table 2 illustrates the swab results tested for Aerobic
348 Colony Counts, *Enterobacteriaceae* and *E. coli* and the Wilcoxon Mann-Whitney p-value. A footnote
349 to the Table gives the mean values corresponding to the minimum detectable differences (at power
350 of 80%) for Aerobic colony count and *Enterobacteriaceae*.

351 *E. coli* was found on a chopping board and a sink surround in one case kitchen but in both
352 instances this was at a level of less than 100 cfu/ml. Higher counts of *Enterobacteriaceae* and Aerobic
353 Colony Counts were found in the sink areas as expected, with marginal differences between
354 chopping boards and the fridge. Dishcloths were taken from 17 cases and 20 controls. Neither
355 *Salmonella* nor *Campylobacter* were detected in any of the dishcloths, so confirmatory pathogen
356 testing was not required. *E. coli* was identified on one dishcloth, but with a low count of 150 cfu/ml.

357 **4. Discussion**

358 Whilst the impact of home food preparation on the scale of food poisoning is not fully
359 understood, efforts to stem the increase in campylobacteriosis include a focus on home hygiene and
360 domestic food safety practices. This study looks at kitchen hygiene amongst people who have had
361 campylobacteriosis in comparison to people who have not had food poisoning. It also looks at self-

362 reported kitchen behaviours and perceptions to establish any difference between a larger sample of
363 cases and controls and any change that may take place after a period of six months has elapsed.

364 Pathogens (*Salmonella* and *Campylobacter*) were not found from the sampling of dishcloths from
365 control and case kitchens, and no difference was noted between cases and controls for the swab
366 results taken from the fridge, chopping board and sink areas. Whilst there was some difference
367 between cases and controls with regard to the dishcloth for indicator organisms, these differences
368 were not evident among the pathogens. The indicator organisms were helpful in demonstrating that
369 soiling was present and to indicate that improved microbiological hygiene was required in both
370 settings. Whilst the results of Parry et al. (2005) could not be replicated in this study in terms of
371 pathogen isolation (they found that even when *Salmonella* was isolated from 10% of the case
372 dishcloths in comparison to 5% of the control dishcloths, this difference was not statistically
373 significant) they also concluded that there was no evidence of differing hygiene practices between
374 the case and control samples . Although *Salmonella* was isolated from the kitchens, there was
375 insufficient evidence to suggest that this was a cause of infection.

376 Dishcloths have been used in several studies (Gorman, et al., 2002; Hilton & Austin, 2000;
377 Mattick, Durham, Domingue, et al., 2003; Mattick, Durham, Hendrix, et al., 2003) as an indicator of
378 kitchen hygiene. They are often used to wipe all the surfaces in the kitchen and therefore provide an
379 ideal opportunity to pick up contamination. It was therefore disappointing to find no pathogens on
380 the dishcloths but this should perhaps be considered with the knowledge that the isolation of
381 *Campylobacter* is notoriously challenging to isolate due to its viable nonculturable stage (Rollins &
382 Colwell, 1986), requirement for microaerophilic conditions and its rapid decline on surfaces after the
383 initial contamination in comparison to *Salmonella* (Cogan, Slader, Bloomfield, & Humphrey, 2002).
384 This may support the view that sporadic campylobacteriosis is more likely to be caused by cross
385 contamination during preparation and transient, rather than residual contamination on surfaces. This

386 may include behaviours that could cause direct cross contamination risk, for example inappropriate
387 hand or packaging contact, in addition to undercooking.

388

389 In order to ensure that we adopted ethical practices during the sampling section of the study it
390 was necessary for announced kitchen sampling visits to be conducted. Whilst it is understood that by
391 being announced, this visit would have permitted an element of “tidying”, the participant was
392 unaware of the sampling sites and the possibility of dishcloth removal. It should be noted that the
393 cases and controls were provided with equal notice of the kitchen visits to avoid any one group
394 having more or less notice and therefore minimising any bias. Unfortunately, the sample size for the
395 kitchen hygiene section was restricted due to low recruitment levels, the challenges of ethical
396 approval and consent and general reluctance to allow a researcher into the house.

397 With respect to the responses to questions about kitchen behaviours, the significant difference
398 exhibited between cases and controls may be explained in one of two ways. Either the difference is
399 an actual representation of kitchen behaviour or social desirability bias may have influenced the
400 cases to a greater degree. Respondents can seek to appear to be “good” leading to a social
401 desirability bias (Oppenheim, 1998) and perhaps the cases did not want to reflect that their case of
402 food poisoning may have originated from their own practices, creating the difference in response.
403 This however does not fully explain the two behaviours of washing chicken and washing salad leaves
404 sold in a bag. Either respondents adopted incorrect practices, or they claimed to practice incorrect
405 behaviours in the mistaken belief that they were giving the correct answers. The FSA ran food safety
406 campaigns advising against the practice of washing poultry and raw meat on TV and radio, including
407 one run prior to Christmas 2007 and again pre-Christmas 2009. The cohort effect reported here
408 suggests that the younger generation may have been influenced by such food safety campaigns, or
409 washing poultry may have become a habit that was adopted for the older participants, before the
410 public health message was made explicit. With respect to washing salad leaves there may have been

411 some misinterpretation of the FSA advice to wash vegetables, given during 2011 following a
412 vegetable related *E. coli* O157 outbreak. This advice excluded ready-to-eat salad leaves sold in a bag.
413 With respect to both washing chicken and salad leaves, it would appear that the kitchen preparation
414 behaviours of the individuals aged 60+ are not changing in line with the introduction of pre-washed
415 products onto the market, which negate the need for washing in the home.

416 The results of the perception and subsequent OB analysis, whilst demonstrating no difference
417 between cases and controls, diverged during the longitudinal study with controls exhibiting an
418 increased bias which was not replicated by the cases. Whilst at first, this result appears
419 counterintuitive, one of two explanations may be considered for this increased bias; an effect of
420 campylobacteriosis with cases causing their perceptions to be tempered or controls exhibiting
421 increased OB because they have continued to not experience food poisoning. Miles et al. (2003)
422 highlight that OB may be influenced by any past experience (or absence of experience) and that
423 “Optimistic bias is linked with the belief that lack of experience with a hazard in the past is protective
424 against experience in the future”(Miles & Scaife, 2003: pg 17). In this situation, the controls have
425 continued to not experience food poisoning and therefore may have increased their OB as a result.
426 This highlights the importance of a longitudinal element for an insight into the influence of food
427 poisoning or, possibly more importantly, the lack of food poisoning. This lack of a negative
428 experience and creation of OB increases the likelihood that food safety messages, such as those
429 highlighted by the kitchen behaviours (washing chicken and salad leaves sold in a bag), do not alter
430 behaviour (Miles & Scaife, 2003). With these results in mind, an understanding of food safety
431 behaviours in the home would benefit from further research of optimistic bias in relation to age and
432 level of experience of food preparation in the home.

433 In conclusion, no evidence of kitchen hygiene differences could be found between the people
434 who had suffered campylobacteriosis in comparison to people who had not had food poisoning.
435 Optimistic bias was evident in both groups but again no significant difference was noted in the initial

436 study. However, the longitudinal study showed that individuals who had not had food poisoning
437 increased their optimism, introducing a significant difference in optimistic bias between the two
438 groups after six months had elapsed. Self-reported kitchen behaviours also exhibited a difference
439 between the two groups, with the individuals who had *Campylobacter* responding more favourably,
440 with the exception of washing chicken and washing salad leaves sold in a bag. The survey
441 demonstrated that effective food safety communication continues to be required, particularly
442 targeting people who may not perceive themselves as being at risk of getting food poisoning -
443 Important messages such as 'not washing chicken' are not yet second nature.

444

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453 ***References***

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