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

MILLMAN, Caroline <http://orcid.org/0000-0003-4935-0477>, RIGBY, D, EDWARD-JONES, G, LIGHTON, L and JONES, D

Published version

MILLMAN, Caroline, RIGBY, D, EDWARD-JONES, G, LIGHTON, L and JONES, D (2014). Perceptions, behaviours and kitchen hygiene of people who have and have not suffered campylobacteriosis: A case control study. Food Control, 41, 82-90.

Copyright and re-use policy

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

Authors

Caroline Millman[1]*, Dan Rigby[1], Gareth Edward-Jones[2], Lorraine Lighton[3] and Davey Jones[2]

[1] School of Social Sciences, University of Manchester, Manchester, M13 9PL, UK

[2] School of Environment, Natural Resources & Geography, College of Natural Sciences, Bangor University, Bangor, Gwynedd, LL57 2UW, UK

[3] Greater Manchester Public Health England Centre Health Protection Team, Sentinel House, Eccles, M30 0NJ, UK

*Corresponding author: Caroline Millman

Email: caroline.millman@manchester.ac.uk

Abstract

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

Keywords

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

1. Introduction

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

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

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

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

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

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

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

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

In summary, the research questions that we asked are:

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

2. Materials and methods

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

2.1. Case and control recruitment

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

2.2. Data collection

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

2.2.1. Survey

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

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

- How much risk do you think there is to you personally from food poisoning in the home?
- How much risk do you think there is to the average person from food poisoning in the home?
- How much control do you think you personally have over getting food poisoning in the home?
- How much control do you think the average person has over getting food poisoning in the home?
- How much knowledge do you think you personally have about the risk of getting food poisoning in the home?
- How much knowledge do you think the average person has over the risk of getting food poisoning in the home?

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

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

2.2.2. Kitchen sampling

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

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

The following sample points were targeted to ensure consistency in sampling across respondents' kitchens: chopping boards, kitchen sink surround and the bottom shelf of the refrigerator. Surfaces were sampled aseptically using alginate tipped swabs (Medical Wire & Equipment Co.) pre-moistened in 10 ml MRS Neutralising Broth containing Peptone (vegetable origin), Disodium Phosphate, Lecithin, Tween 80 and Sodium Thiosulphate, to mitigate effects of chlorine, quaternary ammonium compounds and phenolics, based household cleaning agents. The sampling method was controlled by ensuring that no more than a 5 x 5 cm^2 area was swabbed and that the swab tip was rolled and turned across the selected area.

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

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

2.3. Data analysis

2.3.1. Laboratory analysis

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

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

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

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

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

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

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

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

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

2.3.2. Statistical analysis

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

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

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

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

3.2. Kitchen behaviours

The mean Likert response for the kitchen behaviours was calculated for both cases and controls to highlight any areas of interest. Significant differences between the responses of cases and controls was evident in answer to: the use of chopping boards, eating runny eggs, eating cooked meat a day 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.

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

3.3. Kitchen sampling

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

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

4. Discussion

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

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

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

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

445 *Acknowledgements*

446 This research was undertaken as part of an ESRC studentship (ES/G030782/1) funded by the
447 Economics Social Research Council, linked to 'Reducing *E. coli* O157 Risk in Rural Communities' (RES-
448 229-31-0003) funded under the UK Research Councils' Rural Economy and Land Use Programme. The
449 authors thank all those who participated in the study, the team at the Greater Manchester Public
450 Health England Centre Health Protection Team for making the recruitment a success, Dave Brandon
451 and Dave Mitchell for helping with the microbiological analysis and to Professor Sarah O'Brien and
452 Kathryn Jackson for their valuable help with the ethics process and recruitment design.

453 *References*

454
455
456 Abbot, J. M., Byrd-Bredbenner, C., Schaffner, D., Bruhn, C. M., & Blalock, L. (2007). Comparison of
457 food safety cognitions and self-reported food-handling behaviors with observed food safety
458 behaviors of young adults. *European Journal Clinical Nutrition, 63*, 572-579.

459 ACMSF. (2008). Fresh produce: Agency advice on re-washing ready to eat leafy salads. In. London:
460 Advisory Committee on the Microbiological Safety of Food.

461 Adak, G. K., Cowden, J. M., Nicholas, S., & Evan, H. S. (1995). The public-health laboratory service
462 national case-control study of primary indigenous sporadic cases of *Campylobacter* infection.
463 *Epidemiology and Infection, 115*(1), 15-22.

464 Anderson, J. B., Shuster, T. A., Hansen, K. E., Levy, A. S., & Volk, A. (2004). A Camera's view of
465 consumer food-handling behaviors. *Journal of the American Dietetic Association, 104*(2), 186-
466 191.

467 Cogan, T. A., Slader, J., Bloomfield, S. F., & Humphrey, T. J. (2002). Achieving hygiene in the domestic
468 kitchen: the effectiveness of commonly used cleaning procedures. *Journal of Applied*
469 *Microbiology, 92*(5), 885-892.

470 Doorduyn, Y., Van. Den. Brandhof, W. E., Van. Duynhoven, Y. T. H. P., Breukink, B. J., Wagenaar, J. A.,
471 & Van Pelt, W. (2010). Risk factors for indigenous *Campylobacter jejuni* and *Campylobacter*
472 *coli* infections in The Netherlands: a case-control study. *Epidemiology and Infection, 138*,
473 1391-1404.

474 Fischer, A. R. H., De Jong, A. E. I., Van Asselt, E. D., De Jonge, R., Frewer, L. J., & Nauta, M. J. (2007).
475 Food safety in the domestic environment: An interdisciplinary investigation of microbial
476 hazards during food preparation. *Risk Analysis, 27*(4), 1065-1082.

477 Fischer, A. R. H., Frewer, L. J., & Nauta, M. J. (2006). Toward improving food safety in the domestic
478 environment: A multi-item rasch scale for the measurement of the safety efficacy of
479 domestic food-handling practices. *Risk Analysis, 26*(5), 1323-1338.

480 Frewer, L. J., Shepherd, R., & Sparks, P. (1994). The interrelationship between perceived knowledge,
481 control and risk associated with a range of food-related hazards targeted at the individual,
482 other people and society. *Journal of Food Safety, 14*(1), 19-40.

483 FSA. (2001). Foodborne Disease Strategy - revised. In (Vol. 2012).

484 FSA. (2010). Food and You 2010. In (Vol. 2012).

485 FSA. (2010/2011). Annual Report of the Chief Scientist. In (Vol. 2012).

486 Gauci, C., & Gauci, A. A. (2005). What does the food handler in the home know about salmonellosis
487 and food safety? *Journal of the Royal Society for the Promotion of Health, 125*(3), 136-142.

488 Gettings, M. A., & Kiernan, N. E. (2001). Practices and perceptions of food safety among seniors who
489 prepare meals at home. *Journal of Nutrition Education, 33*(3), 148-154.

490 Gilbert, S. E., Whyte, R., Bayne, G., Paulin, S. M., Lake, R. J., & van der Logt, P. (2007). Survey of
491 domestic food handling practices in New Zealand. *International Journal of Food Microbiology,*
492 *117*(3), 306-311.

493 Gillespie, I. A., O'Brien, S., & Bolton, F. J. (2009). Age patterns of persons with campylobacteriosis,
494 England and Wales, 1990-2007. *Emerging Infectious Diseases, 15*(12), 2046-2048.

495 Gorman, R., Bloomfield, S., & Adley, C. C. (2002). A study of cross-contamination of food-borne
496 pathogens in the domestic kitchen in the Republic of Ireland. *International Journal of Food*
497 *Microbiology, 76*(1-2), 143-150.

498 Haysom, I. W., & Sharp, A. K. (2005). Bacterial contamination of domestic kitchens over a 24-hour
499 period. *British Food Journal, 107*(7), 453-466.

500 Hilton, A. C., & Austin, E. (2000). The kitchen dishcloth as a source of and vehicle for foodborne
501 pathogens in a domestic setting. *International Journal of Environmental Health Research,*
502 *10*(3), 257-261.

HPA. (2011). Food-borne outbreaks of *Campylobacter* (associated with poultry liver dishes) in England. *Health Protection Report, 49*.

Kapperud, G., Espeland, G., Wahl, E., Walde, A., Herikstad, H., Gustavsen, S., Tveit, I., Natås, O., Bevanger, L., & Digranes, A. (2003). Factors Associated with Increased and Decreased Risk of *Campylobacter* Infection: A Prospective Case-Control Study in Norway. *American Journal of Epidemiology, 158*(3), 234-242.

Little, C. L., Gormley, F. J., Rawal, N., & Richardson, J. F. (2010). A recipe for disaster: outbreaks of campylobacteriosis associated with poultry liver pâté in England and Wales. *Epidemiology and Infection, 138*, 1691-1694

Mattick, K., Durham, K., Domingue, G., Jorgensen, F., Sen, M., Schaffner, D. W., & Humphrey, T. (2003). The survival of foodborne pathogens during domestic washing-up and subsequent transfer onto washing-up sponges, kitchen surfaces and food. *International Journal of Food Microbiology, 85*(3), 213-226.

Mattick, K., Durham, K., Hendrix, M., Slader, J., Griffith, C., Sen, M., & Humphrey, T. (2003). The microbiological quality of washing-up water and the environment in domestic and commercial kitchens. *Journal of Applied Microbiology, 94*(5), 842-848.

Miles, S., Braxton, D. S., & Frewer, L. J. (1999). Public perceptions about microbiological hazards in food. *British Food Journal, 101*(10), 744-762.

Miles, S., & Scaife, V. (2003). Optimistic bias and food. *Nutrition Research Reviews, 16*, 3-19.

Mylius, S. D., Nauta, M. J., & Havelaar, A. H. (2007). Cross-Contamination During Food Preparation: A Mechanistic Model Applied to Chicken-Borne *Campylobacter*. *Risk Analysis, 27*(4), 803-813.

Neimann, J., Engberg, J., Molbak, K., & Wegener, H. C. (2003). A case-control study of risk factors for sporadic *Campylobacter* infections in Denmark. *Epidemiology and Infection, 130*(3), 353-366.

Palumbo, M. S., Gorny, J. R., Gombas, D. E., Beuchat, L. y. R., Bruhn, C. M., Cassens, B., Delaquis, P., Farber, J. M., Harris, L. J., Ito, K., Osterholm, M. T., Smith, M., & Swanson, K. M. J. (2007). Recommendations for Handling Fresh-cut Leafy Green Salads by Consumers and Retail Foodservice Operators. *Food Protection Trends, 27*(11), 892-898.

Parry, S. M., Miles, S., Tridente, A., Palmer, S. R., & Group, S. a. E. W. I. D. (2004). Differences in perception of risk between people who have and have not experienced *Salmonella* food poisoning. *Risk Analysis, 24*(1), 289-299.

Parry, S. M., Slader, J., Humphrey, T., Holmes, B., Guildea, Z., & Palmer, S. R. (2005). A case-control study of domestic kitchen microbiology and sporadic *Salmonella* infection. . *Epidemiology and Infection, 133*, 829-835.

Redmond, E., Griffith, C., J., Slader, J., & Humphrey, T. (2001) *The Evaluation and Application of Information on Consumer Hazard and Risk to Food Safety Education B2 - The Evaluation and Application of Information on Consumer Hazard and Risk to Food Safety Education*. London: Food Standards Agency.

Redmond, E. C., & Griffith, C. J. (2003). A comparison and evaluation of research methods used in consumer food safety studies. *International Journal of Consumer Studies, 27*(1), 17-33.

Redmond, E. C., & Griffith, C. J. (2004a). Consumer attitudes and perceptions towards microbial food safety in the domestic kitchen. *Journal of Food Safety, 24*(3), 169-194.

544 Redmond, E. C., & Griffith, C. J. (2004b). Consumer perceptions of food safety risk, control and
545 responsibility. *Appetite, 43*(3), 309-313.

546 Rodrigues, L. C., Cowden, J. M., Wheeler, J. G., Sethi, D., Wall, P. G., Cumberland, P., Tompkins, D. S.,
547 Hudson, M. J., Roberts, J. A., & Roderick, P. J. (2001). The study of infectious intestinal
548 disease in England: risk factors for cases of infectious intestinal disease with *Campylobacter*
549 *jejuni* infection. *Epidemiology and Infection, 127*(2), 185-193.

550 Rollins, D. M., & Colwell, R. R. (1986). Viable but nonculturable stage of *Campylobacter jejuni* and its
551 role in survival in the natural aquatic environment. *Applied and Environmental Microbiology,*
552 *52*(3), 531-538.

553 Sargeant, J. M., Majowicz, S. E., Sheth, U., & Edge, V. L. (2010). Perceptions of Risk and Optimistic
554 Bias for Acute Gastrointestinal Illness: A Population Survey. *Zoonoses and Public Health,*
555 *57*(7-8), e177-e183.

556 Sharot, T. (2011). *The optimism bias : a tour of the irrationally positive brain*. New York: Pantheon
557 Books.

558 Strachan, N. J. C., MacRae, M., Thomson, A., Rotariu, O., Ogden, I. D., & Forbes, K. J. (2012). Source
559 attribution, prevalence and enumeration of *Campylobacter spp*. from retail liver.
560 *International Journal of Food Microbiology, 153*(1–2), 234-236.

561 Sudershan, R. V., Rao, G. M. S., Rao, P., Rao, M. V. V., & Polasa, K. (2008). Food safety related
562 perceptions and practices of mothers - A case study in Hyderabad, India. *Food Control, 19*(5),
563 506-513.

564 Tam, C. C., Rodrigues, L. C., Viviani, L., Dodds, J. P., Evans, M. R., Hunter, P. R., Gray, J. J., Letley, L. H.,
565 Rait, G., Tompkins, D. S., & O'Brien, S. J. (2012). Longitudinal study of infectious intestinal
566 disease in the UK (IID2 study): incidence in the community and presenting to general
567 practice. *Gut, 61*(1), 69-77.

568 Trepka, M. J., Murunga, V., Cherry, S., Huffman, F. G., & Dixon, Z. (2006). Food Safety Beliefs and
569 Barriers to Safe Food Handling among WIC Program Clients, Miami, Florida. *Journal of*
570 *Nutrition Education and Behavior, 38*(6), 371-377.

571 Verrill, L., Lando, A. M., & O'Connell, K. M. (2012). Consumer Vegetable and Fruit Washing Practices
572 in the United States, 2006 and 2010. *Food Protection Trends, 32*(4), 164-172.

573 Weinstein, N. D. (1987). Unrealistic optimism about susceptibility to health problems: Conclusions
574 from a community-wide sample. *Journal of Behavioral Medicine, 10*(5), 481-500.

575

576