Identifying the Prevalence of Food Risk Increasing Behaviours in UK Kitchens

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Abstract

Foodborne disease poses a serious threat to public health. In the UK, half a million cases are linked to known pathogens and more than half of all outbreaks are associated with catering establishments. The UK Food Standards Agency (FSA) has initiated the UK Food Hygiene Rating Scheme in which commercial food establishments are inspected and scored with the results made public. In this study we investigate the prevalence of food risk increasing behaviours among chefs, catering students and the public. Given the incentive for respondents to misreport when asked about illegal or illicit behaviours we employed a Randomised Response Technique designed to elicit more accurate prevalence rates of such behaviours. We found 14% of the public not always hand-washing immediately after handling raw meat, poultry or fish; 32% of chefs and catering students had worked within 48 hours of suffering from diarrhoea or vomiting. 22% of the public admitted having served meat “on the turn” and 33% of chefs and catering students admitted working in kitchens where such meat was served; 12% of the public and 16% of chefs and catering students admitted having served chicken at a barbeque when not totally sure it was fully cooked. Chefs in fine-dining establishments were less likely to wash their hands after handling meat and fish and those who worked in award winning restaurants were more likely to have returned to work within 48 hours of suffering from diarrhoea and vomiting. We found no correlation between the price of a meal in an establishment, nor its Food Hygiene Rating Score, and the likelihood of any of the food malpractices occurring.
1. Introduction

There are an estimated 500,000 cases of foodborne disease linked to known pathogens in the UK annually [1], and 9.4 million in the US [2]. Associated with these illnesses are medical, financial and welfare costs, totalling £1.8 and $14 billion respectively [3, 4].

A large proportion of foodborne illness in the UK is considered avoidable [5]. While much investment and research is focused on making foods safer in early stages of the food chain, for example by vaccination (e.g. Salmonella in eggs), the role of food handlers/preparers is still a critical control point [6]. Practices can render previously uncontaminated foods unsafe to eat e.g. through cross-contamination; and contaminated foods safe to eat e.g. through thorough cooking [6, 7]. The latter is particularly important when handling food products that have high contamination rates at the point of retail e.g. the 70% of UK supermarket chickens that are Campylobacter positive [8].

Approximately 60% of foodborne disease outbreaks are linked to eating establishments and commercial caterers [9]. Multiple risk factors for foodborne illness are commonly implicated in outbreaks including inadequate heat treatment (50%), inappropriate storage (45%), cross-contamination (39%) and infected food handlers (12%) [10]. Domestic kitchens are also a significant source of sporadic foodborne disease cases [11].

The public have been targeted via information campaigns such as Food Safety Week [5, 12] and the catering industry through inspection and sanction, for example the Food Hygiene Rating Scheme (FHRS) implemented in 2013. A challenge for such campaigns is that knowledge does not always translate to behavioural change of domestic or commercial food handlers [13].

The FHRS inspection regime established by the UK FSA, is a composite score for food handling, physical structure, facilities and how the business manages and records its food safety processes. The score is available to consumers online (http://www.food.gov.uk/business-industry/caterers/hygieneratings) via a smartphone app (http://www.food.gov.uk/about-us/data-and-policies/app) and in establishments’ doors/windows. Display of the FHRS score at premises is mandatory in Wales and the extension of this mandatory regime is under consideration for England. The system differs geographically within the UK. For example, in England, Wales and Northern Ireland, a six-point scale is used, where values 0-2 are considered unacceptable, with 3-5 ranging from satisfactory to very good. The Scottish system is binary, indicating either ‘Pass’ or ‘Improvement Required’.

Such inspections are, by their nature, snapshots and determining the true prevalence of food malpractices is problematic. Research on food handling typically rely on self-reported behaviours, which may be subject to social desirability bias [11]. Misreporting may also be motivated by a desire to avoid embarrassment [14] and in commercial settings, admitting to food safety malpractice can be incriminating. Hence, direct questioning may prompt over-reporting of good, and underreporting of bad, food safety practices [13, 15, 16].
The risk of misreporting has led to the development (in other domains) of questioning techniques which induce greater truth telling and reveal more accurate estimates of the prevalence of sensitive behaviours. Methods such as the Randomised Response Technique (RRT) and the Item Count Technique \cite{14, 17} introduce randomisation or uncertainty into the question-answer process, protecting respondents by obscuring their answer. RRTs use a randomisation device (e.g. dice) to determine how respondents answer a sensitive question \cite{18, 19}. The researcher adjusts the results using the known probabilities of the dice outcomes that prompt a forced answer.

RRT studies in diverse disciplines have generated higher estimated prevalence rates than anonymous direct questioning \cite{20-22}. Validation studies, with access to true rates of the sensitive behaviour, have also shown the superiority of RRT techniques over direct questioning \cite{23, 24}. The forced response model is one of the most statistically efficient RRT designs \cite{19}, and is employed here for the first time in determining the prevalence of food handling malpractices.

This study focuses on poor food safety practices in kitchens. It is concerned with rates of Food Risk Increasing Behaviours (FRIBs). Given the importance of both commercial and domestic sectors in the food disease burden, we investigate such behaviours among the public and professional chefs. The Randomised Response Technique (RRT), designed to more accurately reveal rates of illicit behaviours, was implemented with the objectives of:

1. determining the prevalence of FRIBs amongst working chefs, catering students and the public;
2. investigating whether food malpractices are correlated with observable characteristics among the general public (gender, age, attitudes to risk, etc);
3. investigating whether food malpractices are more likely in certain types of commercial establishments (FHIRS, price band, awards won) and correlated with observable characteristics of chefs and catering students (gender, position etc);
4. exploring the implications of the prevalence of poor practices for food hygiene and human health.

2. Materials and Methods

2.1. Survey design: Selection of food risk increasing behaviours

We selected four Food Risk Increasing Behaviours (FRIBs) for investigation using RRT. The four behavioural statements presented to chefs and catering students were:

1) I always wash my hands immediately after handling raw meat, poultry or fish
2) I have worked in a kitchen within 48 hours of suffering from diarrhoea and/or vomiting
3) I have worked in a kitchen where meat that is ‘on the turn’ has been served
4) I have served chicken at a barbecue when I wasn’t totally sure that it was fully cooked
The four behavioural statements presented to the public were:

1) I always wash my hands immediately after handling raw meat, poultry or fish
2) I have cooked food for others within 48 hours of suffering from diarrhoea and/or vomiting
3) I have served meat that is ‘on the turn’
4) I have served chicken at a barbeque when I wasn’t totally sure that it was fully cooked

Behaviours 1 and 2 relate to food hygiene basics and should feature in the HACCP documentation of catering businesses. These behaviours have the potential to contaminate food with bacteria and represent two extremes of HACCP failing. The need for good hand hygiene is likely to be the most commonly communicated food hygiene message and should therefore be simple and accessible to respondents, whilst working within 48 hours of suffering from diarrhoea and/or vomiting contravenes UK regulations. For the public, washing hands is easily achievable, and well known good practice.

Behaviour 3 relates to serving meat that is spoiling, and is a previously unexplored behaviour suspected of being practised in some catering establishments (discussed later in the paper) with implications for foodborne illness.

Behaviours 2 and 3 were of interest because these are unlikely to be identified by direct observation kitchen behaviours or an inspection. Behaviour 2 was also selected as it was identified as a significant issue in one of the highest profile outbreaks of food poisoning in recent years in the UK, in which over 400 diners fell ill after eating at the Michelin-starred restaurant “The Fat Duck” (a case discussed later in the paper) and has been identified as a factor in other outbreaks (for example [25]).

Behaviour 4 was selected for investigation because undercooked chicken and barbecued meat are known risk factors for campylobacteriosis [26-28], the most common cause of foodborne disease in the UK [1]. Chicken is attributed as a risk factor in about 60-80% [29] of campylobacter cases. A notable feature of the profile of campylobacter cases is its seasonality, with a ‘spring peak’ identified consistently [30, 31]. Barbecuing might contribute to this seasonality [27, 32-34] and is increasingly widespread. In 2010 there were over 120 million barbecue events in the UK [35]. An additional motivation for including behaviour 4 was that barbecuing, and the cooking of chicken in general, has been the focus of repeated FSA campaigns aiming to reduce the number of chicken-related Campylobacter cases. These have included the 2014 “Don’t Wash Raw Chicken” campaign and 2015’s campaign entitled “the Chicken Challenge” (#ChickenChallenge) aimed at helping cut campylobacter food poisoning in half by the end of 2015.
2.2. Survey design: Randomised response protocol

Various RRT approaches have been employed in the literature. We used the forced response RRT (attributed to Boruch (36)) with respect to the four food behaviour statements listed above. Respondents were asked to roll two dice. They were then asked to answer the sensitive question following these instructions:

- Add up the numbers on the two dice
- If they add up to 2, 3 or 4, always answer Yes (regardless of your true answer)
- If they add up to 5, 6, 7, 8, 9 or 10 answer the question truthfully
- If they add up to 11 or 12, always answer No (regardless of your true answer)

Each statement was presented separately with “Yes” and “No” answer tick boxes, and respondents were reminded to roll the dice again and follow the instructions for each question. Only the interviewee knew the outcome of the dice roll. The interviewer was thus unable to distinguish an answer forced by the dice roll from an admission of the sensitive behaviour. This ensured both respondent privacy and protected the interviewer from being aware of potential malpractice.

Based on the probability of dice rolls, the proportion of respondents theoretically instructed to answer yes is known (1/6), as is the proportion instructed to answer truthfully (3/4). This technique allows the prevalence of true bad behaviours in the sample to be estimated but precludes determination of any individual’s behaviour.

To promote compliance with RRT instructions we followed the recommendations of Lensvelt-Mulders and Boeije (37) for successful RRT implementation including acknowledging to respondents that being “forced” to answer contrary to the truth is difficult but explaining that this is necessary for the technique to succeed, and explaining to the respondents how they were protected to increase the rate of compliance with the protocol.

2.3. Data collection

Four target groups were identified for sampling: chefs, catering students with restaurant experience, catering students without restaurant experience and the public. A questionnaire was designed for each sample, retaining as much commonality as possible but reflecting the differences between them. Each of the surveys featured four RRT behavioural statements, worded to suit the respondent group.

Each group was asked a set of additional questions on characteristics which may help to explain their food hygiene behaviours. For chefs and working students these included questions on: kitchen position, the type of restaurant they work in, average price of a main meal, food hygiene rating score and whether their kitchen had won awards or accolades. Members of the public were asked about their experience of food poisoning, their level of concern about food poisoning and their cooking
role at home. Demographic information (age, gender, education level etc.) was collected from all respondents.

The public sample (N=926) was recruited via an online market research panel (ResearchNow). The chef sample (N=132) was recruited through face-to-face convenience sampling at culinary shows and competitions and via online culinary forums. Catering students were recruited through pre-arranged college visits and at culinary shows and competitions, giving a sample of 61 students with commercial experience, and 45 without.

All face to face sampling required the interviewer to explain and demonstrate the RRT technique and rationale. The respondent rolled the dice in an opaque beaker to ensure privacy. Online surveys featured an embedded screencast explaining the RRT technique and rationale with a pair of virtual dice appearing in a pop-up window from a 3rd party website (to further reassure respondents that the die rolls were not being recorded by the researchers).

Data were collected in England, Wales and Scotland in 2014 and 2015. Informed consent was obtained from all participants and they were debriefed on the purpose of the survey after completion, and given the opportunity to withdraw their data. Ethical approval was obtained from the College of Natural Science Ethics Committee at Bangor University, reference number CNS/2014/AJ1.

2.4. Data analysis

To determine the prevalence rates of the FRIBs, the response data required adjustment, given the randomisation protocol. This employed the known probabilities of people giving ‘false’ yes and no answers.

Given the structure of the forced choice question, the probability that individual i gives a ‘yes’ response is given by:

\[
P(y_i) = \pi_1 + (1 - \pi_1 - \pi_2)P(Y)
\]

Where

\(y=\) reported behaviour, \(y=1\) for yes, \(0\) for no

\(Y=\) true behaviour, \(Y=1\) for yes, \(0\) for no

\(\pi_1 = \) probability that a respondent is instructed to answer ‘yes’

\(\pi_2 = \) probability that a respondent is instructed to answer ‘no’

From the sample it is possible to estimate the true proportion in the sample that has the behaviour from:
\[ \tilde{Y} = \frac{\hat{y} - \pi_1}{1 - \pi_1 - \pi_2} \]  

(2)

Where

\[ \hat{y} \] = the observed fraction reporting an answer of ‘yes’ [17].

The variance of the estimated prevalence rate is given by

\[ \text{var}(\tilde{Y}) = \frac{\hat{y}(1 - \hat{y})}{n \times (1 - \pi_1 - \pi_2)^2} \]  

(3)

Where:

\[ n = \text{total number of respondents} \]

This exposition is for the case where a ‘Yes’ answer indicates a FRIB. For Question 1, where a “No” implies a FRIB, the definition of \( y \) and the forcing probabilities are redefined appropriately. The standard error (SE) was taken to be the square root of the calculated variance and the 95% confidence intervals as the prevalence rate ± 1.96 SE [17].

It is possible to identify if individual specific characteristics influence the probability of FRIBs, even if responses are masked by the RRT technique, using an extension of the standard logit model. The probability that an individual response will be a ‘yes’ is given by:

\[ P(y_i) = \pi_1 + \frac{(1 - \pi_1 - \pi_2) \exp(\beta X_i)}{1 + \exp(\beta X_i)} \]  

(4)

Where \( X_i \) are a set of individual specific determinants that may influence the true underlying behaviour [38]. Estimation used the rrlogit command (v1.1.2) [39] in Stata 13.1.
3. Results

3.1. Sample characteristics

Tables 1 and 2 report the summary statistics for the samples.

Table 1. Summary statistics for chef sample

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Coding variable</th>
<th>Sample mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chefs</td>
<td>237</td>
<td>yes=1, no=0</td>
<td>0.55</td>
</tr>
<tr>
<td>Working Students</td>
<td>237</td>
<td>yes=1, no=0</td>
<td>0.26</td>
</tr>
<tr>
<td>Non-working students</td>
<td>237</td>
<td>yes=1, no=0</td>
<td>0.19</td>
</tr>
<tr>
<td>Time Worked</td>
<td>237</td>
<td>years</td>
<td>9.1</td>
</tr>
<tr>
<td>Age</td>
<td>235</td>
<td>years</td>
<td>31.4</td>
</tr>
<tr>
<td>Gender</td>
<td>236</td>
<td>male=1; female=0</td>
<td>0.75</td>
</tr>
<tr>
<td>Fine dining</td>
<td>193$</td>
<td>^5</td>
<td>yes=1; no=0</td>
</tr>
<tr>
<td>Award</td>
<td>193$</td>
<td>^5</td>
<td>yes=1; no=0</td>
</tr>
<tr>
<td>FHRS_pass</td>
<td>193$</td>
<td>^5</td>
<td>yes=1; no=0</td>
</tr>
<tr>
<td>Main Meal Cost</td>
<td>124$</td>
<td>^#</td>
<td>£</td>
</tr>
</tbody>
</table>

$^5$Chefs and working students only
$^#$Chefs only

Table 2. Summary statistics for public sample (n=905$)^1$)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coding variable</th>
<th>Sample mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adventurous$</td>
<td>^5</td>
<td>likert 1-5</td>
</tr>
<tr>
<td>Female</td>
<td>yes=1; no=0</td>
<td>0.56</td>
</tr>
<tr>
<td>University education</td>
<td>yes=1; no=0</td>
<td>0.34</td>
</tr>
<tr>
<td>Concern at home$</td>
<td>^6</td>
<td>likert 1-4</td>
</tr>
<tr>
<td>Risk$</td>
<td>^7</td>
<td>likert 1-5</td>
</tr>
<tr>
<td>A,B,C1 class</td>
<td>yes=1; no=0</td>
<td>0.60</td>
</tr>
<tr>
<td>Age</td>
<td>years</td>
<td>45.5</td>
</tr>
</tbody>
</table>

$^1$926 answered the RRT questions but not all of these answered the demographic / explanatory questions

To combine the data on establishment’s hygiene scores, where the scoring system differs by country, a binary variable (FHRS_pass) was constructed, combining scores of 3-5 in England and Wales with the Scottish Pass score to give an indication of satisfactory performance (FHRS_pass=1). The alternative category (FHRS_pass=0) combined those who held an unsatisfactory score (0-2 in E&W or Improvement Required in Scotland) (5%) and those who had no score or did not know it (16%).
3.2. Food risk increasing behaviours: Public

Table 3 reports the estimated prevalence rates of the four behaviours among the public, with associated standard deviations following Petroczi, Nepusz (17).

Table 3. Inferred prevalence rates of risk increasing behaviours among the public (n=926)

<table>
<thead>
<tr>
<th>Behaviour</th>
<th>Prevalence</th>
<th>sd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not washing hands</td>
<td>13.7</td>
<td>1.5</td>
</tr>
<tr>
<td>Served meat “on the turn”</td>
<td>22.0</td>
<td>1.8</td>
</tr>
<tr>
<td>Cooked for others within 48 hours of diarrhoea and vomiting</td>
<td>29.3</td>
<td>2.0</td>
</tr>
<tr>
<td>Served chicken at barbecue when not sure it was fully cooked</td>
<td>12.8</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Several personal characteristics were found to be significant in predicting FRIBs. These included whether the respondent considered themselves an “adventurous diner when eating out”, the level of concern they had about getting food poisoning at home, and their assessment of the likelihood of them suffering a food poisoning event compared to the general population. The results, reported in Table 4, are marginal effects (the change in the probability of the FRIB occurring given a marginal change in the characteristic, with all other characteristics at mean levels).

Those members of the public who were more concerned about food poisoning at home were also more likely to wash their hands (Table 4). Those who considered themselves adventurous when eating out were more likely to serve meat on the turn and serve undercooked chicken at a barbeque, while women were less likely to do the latter. Those who believed they were more at risk of food poisoning than the average person were more likely to have cooked food for others within 48 hours of diarrhoea and vomiting.

Table 4. Marginal effects of attributes on probability of bad behaviours: public sample

<table>
<thead>
<tr>
<th>Respondent characteristics</th>
<th>Not hand washing</th>
<th>Served meat on the turn</th>
<th>Working within 48 hours of diarrhoea and vomiting</th>
<th>Undercooked barbeque chicken</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adventurous</td>
<td>-0.5</td>
<td>3.7*</td>
<td>0.5</td>
<td>3.5**</td>
</tr>
<tr>
<td>Female</td>
<td>0.3</td>
<td>-4.1</td>
<td>3.7</td>
<td>-8.3**</td>
</tr>
<tr>
<td>University education</td>
<td>3.0</td>
<td>11.0**</td>
<td>9.1**</td>
<td>2.0</td>
</tr>
<tr>
<td>Concern at home</td>
<td>-4.5***</td>
<td>-1.0</td>
<td>-0.4</td>
<td>-2.3</td>
</tr>
<tr>
<td>Risk</td>
<td>0.6</td>
<td>0.9</td>
<td>8.9***</td>
<td>-0.8</td>
</tr>
<tr>
<td>Pseudo R²</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>n</td>
<td>905</td>
<td>905</td>
<td>905</td>
<td>905</td>
</tr>
</tbody>
</table>

*Indicate dummy variables *,**,*** indicate P>|z| <0.1,0.05,0.01 respectively
Although Table 4 reports the marginal effects and Table 3 mean prevalence scores, it is also possible to predict the probability that an individual will commit a FRIB, based on their personal characteristics. Such an analysis combines the estimates of the impact of attributes on behaviour with their prevalence in the sample and, in particular, their co-occurrence in the sample. The relatively low power of the models in predicting behaviour is manifest in the concentration of the values around the sample means, and the absence of groups with a particularly high predicted probability of performing the behaviour. However, these distributions do show the extent to which the model can differentiate between individuals on the basis of their characteristics.

**Fig 1. Histograms of the probability of committing the food risk increasing behaviours: Public sample.**

3.3. *Food risk increasing behaviours: Chefs and catering students*

Table 5 reports the estimated prevalence rates of the four behaviours among chefs and catering students, with associated standard deviations derived following Petroczi, Nepusz (17).

<table>
<thead>
<tr>
<th>Behaviour</th>
<th>Prevalence</th>
<th>sd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not hand washing (n=238)</td>
<td>7.4</td>
<td>2.2</td>
</tr>
<tr>
<td>Meat served on the turn (n=193)^5</td>
<td>33.0</td>
<td>4.7</td>
</tr>
<tr>
<td>Working within 48 hours of diarrhoea and vomiting (n=238)</td>
<td>31.6</td>
<td>4.1</td>
</tr>
<tr>
<td>Served barbeque chicken when not sure fully cooked (n=203)^6</td>
<td>15.9</td>
<td>3.4</td>
</tr>
</tbody>
</table>

^5 this question was not asked of non-working students
^6 this question was added to the survey after initial piloting, so the sample is reduced.

We found that:

- the proportion of chefs and catering students not hand-washing immediately after handling raw meat, poultry or fish was 7.4% (Table 5).
- almost one third of the sample (32%) reported working in a kitchen within 48 hours of suffering from diarrhoea and/or vomiting.
- serving meat on the turn was reported as having occurred in kitchens where they worked by 33% of the chefs and working students.
- 16% of the chefs and catering students reported having “served chicken at a barbeque when I wasn't totally sure it was fully cooked”.

Table 5. Prevalence rates of four typical bad behaviours amongst chefs and catering students
Approximately one third of the chefs and catering students reported returning to work within 48 hours of suffering from diarrhoea and vomiting whilst working in kitchens where meat on the turn was served. An understanding of the type of person and/or establishment in which such behaviour was most likely is of interest both from a regulatory point of view but also from the perspective of consumers wishing to reduce their risk of exposure to food prepared in such conditions. We considered a number of potential observable characteristics of the chef/working student (age, position, time in the job) and the establishment in which they worked (type, price bracket, Food Hygiene Rating Scheme (FHRS) scores, awards).

Table 6 reports the results for those variables found most likely to influence behaviour. The first model uses characteristics of the individuals: whether they were a chef or a trainee chef, whether they were a head chef, type of student and time in industry. The second model uses characteristics of the type of establishment they work in (whether it is ‘fine dining’ or has received awards and its FHRS score) and is limited to chefs and working students (since non-working trainees could not respond to such questions).
Table 6. Marginal effects of attributes on probability of bad behaviours: chef and catering student sample

<table>
<thead>
<tr>
<th>Chef characteristics:</th>
<th>Not hand washing</th>
<th>Served meat on the turn ( ^{&amp;} )</th>
<th>Working within 48 h of diarrhoea and vomiting</th>
<th>Undercooked barbeque chicken</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working student(^5)</td>
<td>-6.1</td>
<td>-15.1</td>
<td>-7.3</td>
<td>2.9</td>
</tr>
<tr>
<td>Non-Working Student(^5)</td>
<td>-3.8</td>
<td>-15.1</td>
<td>-6.0</td>
<td>-27.1(^{***})</td>
</tr>
<tr>
<td>Head chef(^5)</td>
<td>7.0</td>
<td>-25.6(^{**})</td>
<td>-8.0</td>
<td>-7.6</td>
</tr>
<tr>
<td>Time</td>
<td>-1.1</td>
<td>0.2</td>
<td>2.7</td>
<td>-0.7</td>
</tr>
<tr>
<td>Pseudo R(^2)</td>
<td>0.01</td>
<td>0.02</td>
<td>0.01</td>
<td>0.03</td>
</tr>
<tr>
<td>n</td>
<td>237</td>
<td>192</td>
<td>237</td>
<td>203</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Establishment characteristics:</th>
<th>Not hand washing</th>
<th>Served meat on the turn ( ^{&amp;} )</th>
<th>Working within 48 h of diarrhoea and vomiting</th>
<th>Undercooked barbeque chicken</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine dining(^5)</td>
<td>18.0(^*)</td>
<td>-14.7</td>
<td>1.3</td>
<td>-2.8</td>
</tr>
<tr>
<td>Award(^5)</td>
<td>1.4</td>
<td>-0.5</td>
<td>2.8(^{**})</td>
<td>6.6</td>
</tr>
<tr>
<td>FHRS_pass(^5)</td>
<td>0.3</td>
<td>4.7</td>
<td>-3.3</td>
<td>6.5</td>
</tr>
<tr>
<td>Pseudo R(^2)</td>
<td>0.05</td>
<td>0.01</td>
<td>0.03</td>
<td>0.01</td>
</tr>
<tr>
<td>n</td>
<td>193</td>
<td>193</td>
<td>193</td>
<td>177</td>
</tr>
</tbody>
</table>

\(^5\)Indicate dummy variables \(^*\), \(^{**}\), \(^{***}\) indicate P>|z| <0.1, 0.05, 0.01 respectively
\(^{\&}\) this question was not asked of non-working students

There were no systematic effects predicting the probability of all four risk-increasing behaviours, but there were individual effects. Working in a fine-dining establishment increased the probability of not washing hands after handling meat and fish. Chefs and students who worked in a restaurant that had received an accolade or award were more likely to have returned to work within 48 hours of suffering from diarrhoea and vomiting. We found no correlation between the price of a meal in an establishment and the likelihood of FRIBs occurring – despite over a third of the public sample (36%) agreeing that the more expensive a meal was the safer they would expect it to be. Furthermore there was no relationship between an establishment having an unsatisfactory FHRS score and rates of any of their FRIBs occurring. This suggests that chefs from establishments rated as ‘satisfactory’ are as likely to engage in bad behaviours as those rated ‘unsatisfactory’.

There is no evidence of a lower prevalence of risk-increasing behaviours in more expensive, award-winning or fine-dining establishments. Where significant effects occurred, they suggested the reverse: higher rates of poor hand-washing in fine-dining establishments and chefs in award winning kitchens more likely to return to work too soon after an episode of diarrhoea and/or vomiting.
Perhaps most notable of all is the absence of a relationship between the probability of FRIBs occurring and the chef’s establishment having an (un)satisfactory FHRS score.

4. Discussion

Food behaviours, in both domestic and commercial kitchens, are critical control points with respect to foodborne disease. The prevalence of illicit, food risk increasing behaviours are difficult to determine via direct questioning and observational studies, given their sensitive and often fleeting nature. In this study a forced response RRT technique, proven to improve estimates of illicit or embarrassing behaviours in other fields, was employed to estimate the prevalence of four FRIBs.

4.1. Methodological considerations

There is considerable evidence that RRT provides more accurate estimates of sensitive behaviours compared to direct questioning survey methods [18]. However, due to the inherent noise associated with forced response approaches, RRT requires larger samples compared to conventional techniques in order to obtain estimates with acceptable levels of error [40, 41]. Larger sample sizes require a contingent increase in research costs. However, it is suggested that increased costs are compensated for by the corresponding increase in data validity [19].

Whilst this method seeks to reduce the impact of social desirability bias it does not, however, account for the desire to reduce cognitive dissonance (the mental discomfort felt when knowledge and behaviour differs) and inaccurate memory formation and recall. These factors may partially account for the higher than expected rates of handwashing we report [42]. The similarity between the handwashing rates in this study and from comparable direct questioning studies suggest that these factors could be more important in the underreporting of poor hand hygiene behaviours than the social desirability bias controlled for by RRT. The RRT is therefore suggested as a useful means of determining the prevalence of sensitive, non-routine food behaviours, where social desirability bias is thought to be a primary reason for misreporting.
4.2. Prevalence of food risk increasing behaviours

The proportion of chefs and catering students identified as not hand-washing immediately after handling raw meat, poultry or fish was 7.4%. Rates of poor hand washing practice were higher among the public than the chef and student sample. Both estimates are comparable to rates obtained from direct questioning studies in the UK and Ireland e.g. 6% from face to face interviews with 200 Irish chefs [43] and 14% amongst the public from the Food Standards Agency’s large scale Food and You study [44]. Far higher rates have been reported in other studies e.g. 23% amongst chefs (based on telephone direct questioning) in a US study by Green and Selman [45] and 47% to 100% in observational studies in the UK, USA and Australia [11, 46-48].

It is of serious concern that almost one third of the surveyed chefs and students reported working in a kitchen within 48 hours of suffering from these illnesses. There is no comparative previous UK figure for this behaviour, however the rate is higher than those identified in US studies (using face to face or telephone questioning) where rates of between 5% and 20% were reported by Carpenter, Green [49], Sumner, Brown [50] and Green, Selman [16]. The lower rates recorded in the US may result from better hygiene practices, the acute sensitivity of admitting this behaviour in response to direct questioning, or a combination of the two. In the UK such behaviour contravenes Food Hygiene Regulations, which state that:

“No person suffering from, or being a carrier of a disease likely to be transmitted through food or afflicted, for example, with infected wounds, skin infections, sores or diarrhoea is to be permitted to handle food or enter any food-handling area in any capacity if there is any likelihood of direct or indirect contamination” [51]. Managers are required to exclude staff with symptoms such as diarrhoea and vomiting from working with or around open food, normally for 48 hours from when symptoms stop naturally.

Such risk increasing behaviour is not solely confined to “low-end” restaurants. Staff working too soon after illness, and hence still infectious, was a factor cited in the investigations of the outbreak of food poisoning at Michelin-starred chef Heston Blumenthal’s Fat Duck restaurant in 2009 [52]. The Health Protection Agency (HPA) criticised practices at the restaurant in its investigations after over 500 of the restaurant’s customers fell ill. The HPA later detected norovirus infection in six staff and reported that “Based on staff interviews, sickness records and samples taken, it is clear that staff worked while still infectious with norovirus,” [52]. Of the staff interviewed, 17 reported having had symptoms of gastrointestinal infection in the period under investigation of whom six reported working while unwell, including one who reported vomiting in the restaurant toilets. Nine staff reported returning to work before being asymptomatic for 48 hours.

The rates of serving of food within 48 hours of an episode of diarrhoea and vomiting are similar for the public at about 30%. However, the legal and wider food safety implications of such behaviour are different for chefs than for those at home. For the latter there may often be no feasible
alternative to them preparing food shortly after illness, particularly if there are children in the household.

The high proportion of chefs and students admitting to having worked in a kitchen where meat ‘on the turn’ has been served is also of concern for public health. There are no comparative rates of this behaviour in other studies, although the practice is a long-established means of reducing costs in restaurants and there are various means by which it is reported to be done. For instance, researchers for a UK television programme on ‘kitchen confessions’ spoke to several chefs who referred to the practice. One chef reported that:

"The first task we gave someone who came to us looking for a cheffing job was to make a meal with the chicken that was 'on the turn'. There's a way of treating the chicken with salt water that draws out the bad juices so that you can cook with it and it still tastes OK. That's important to a kitchen because it means you can get another day or two days out of your meat. If a chef could do this I knew he was experienced in restaurant kitchens" [53]. The use of rich, heavy sauces was cited by another who reported having "worked at a place where we served steak and chips on a Saturday a 'special value' steak on Sunday and a steak in a spicy pepper sauce on Monday. By that point the meat...was almost inedible but we'd mask it with a heavily flavoured sauce rather than bin it."

Interest in the rate of serving undercooked chicken at barbecues was motivated by the current UK policy focus on Campylobacter and the argument that barbecues may contribute to the annual ‘spring peak’ identified in campylobacter cases. These factors led the FSA to denote Campylobacter as their priority pathogen (alongside Listeria) in the 2010-2015 Foodborne Disease Strategy [5] and educational campaigns centred around safe barbecuing and the safe cooking of chicken in 2014 and 2015 respectively. The rate of serving chicken at barbecues when unsure it was fully cooked was higher among the chefs and catering students than the public (16% versus 13%) contrary to the expectation that the professionally trained would be less prone to this behaviour. The frequency with which barbecues are held, the popularity of serving chicken at them, the high rates of contaminated chicken sold in the UK (c.70% in 2015) and the role of undercooked chicken as a Campylobacter risk factor, means this behaviour represents a serious public health problem in the UK.

4.3. Implications of our findings

This study suggests that behaviours that may be important risk factors for foodborne disease are widely prevalent and likely to be missed by direct observation studies and restaurant inspections. There are likely to be varied and multiple causal factors behind the behaviours. A lack of time, staff and resources are consistently identified as barriers to compliance with safe food procedures such as handwashing [13, 45, 54]. There is a clear economic imperative to serve meat “on the turn” and existing behavioural norms within commercial kitchens will affect new members of staff employed
within them. The motives leading to workers opting to (return to) work whilst still posing risk of transmission after illness is multifaceted. Ignorance, the economic losses associated with not working, fear of losing one’s job and the desire not to let down colleagues (or the family business) are all possible causes of the behaviour [49].

Regardless of the causes, the prevalence of such behaviours is problematic for consumers. When dining out consumers use a variety of information sources and heuristics to make choices. They may believe that they are less vulnerable to food risk increasing behaviours when they opt to dine at a ‘fine dining’ restaurant, one with awards and where prices are higher and the FHRS score is good. For the FRIBs we considered, those assumptions and heuristics were unsupported. Where correlations were identified they were in the opposite direction: poor hand washing was more common among chefs working in “fine dining” establishments, working within 48 hours of diarrhoea and vomiting occurred more often in award winning restaurants. The price band of the establishment, and its FHRS score, were not correlated with all of the behaviours.

The FSA has established the FHRS as a means to help the public “choose where to eat out ...by telling you how seriously the business takes their food hygiene standards” [55]. The results presented here are not a systematic evaluation of the FHRS. However, the lack of correlation between an (un)satisfactory FHRS and the rate of FRIBs does sound a note of caution. When viewed together with the findings regarding higher rates of FRIBs among “fine dining” and award winning kitchens it suggests that the challenges for the public in finding outlets serving safer food continue to be considerable, with many of the cues they refer to and heuristics they employ being of limited help.
References


