Food handlers and Norovirus transmission: Social science insights

Report

Ipsos MORI

Social Science Research Unit
Food Standards Agency

June 2017

Social Science in Government

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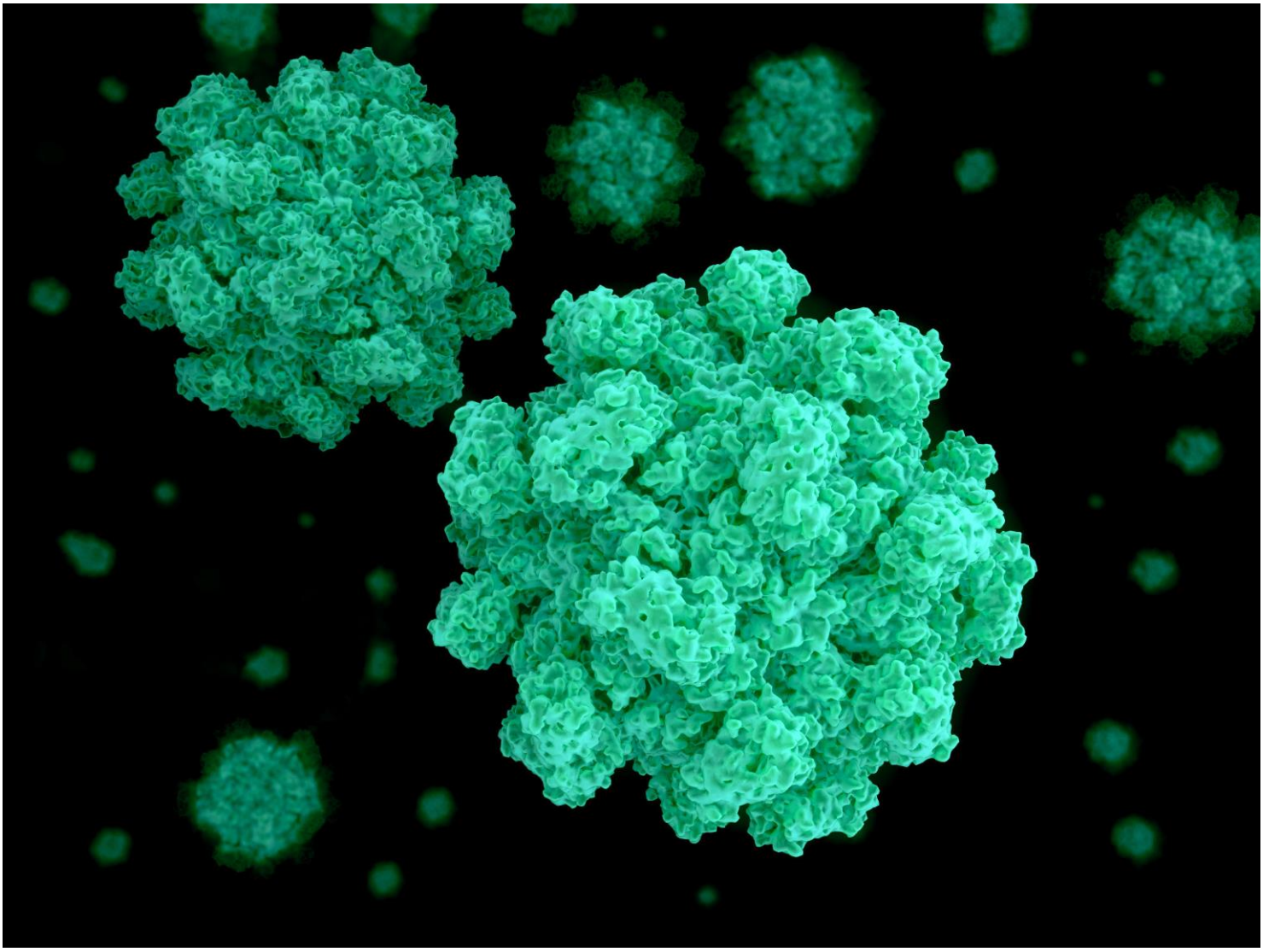

June 2017

Food Handlers and Norovirus transmission (FS101143)

Report prepared for the Food Standards Agency

Acknowledgements

This project was funded by the Food Standards Agency (FSA). The authors would like to thank the FSA and Dr. Lou Atkins at University College London for their support and advice in delivering this research. They would also like to thank the FSA's appointed external reviewers for their input during the reporting stage.

We would also like to thank all the Food Business Operators (FBOs) and food handlers who agreed to accommodate our researchers and were willing to discuss their views and behaviours related to food hygiene and norovirus.

Finally, the authors would like to thank Dr Sinead Watson, Queens, University Belfast, and Dr Yun Yun Gong, University of Leeds for their help with the scoping review; as well as the Ipsos MORI project team for their help with fieldwork and analysis.

Contents

Glossary

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APEASE	A criteria for making context-based decisions on intervention content and mode of delivery (See appendix 9).
Behaviour Change Interventions (BCIs)	Behaviour change interventions are coordinated sets of activities designed to change specified behaviour patterns.
Behaviour Change Techniques (BCTs)[i]	Are an active component of an intervention designed to change behaviour.
COM-B	COM-B (Michie et al 2011, Michie et al 2014) is an overarching framework for modelling behaviour and behaviour change. It sets out that behaviour occurs from an interaction of 'capability' to perform the behaviour and 'opportunity' and 'motivation' to carry out the behaviour. New behaviour or behaviour change requires a change in one or more of these.
Food Business Operator (FBO)	The Food Business Operator (FBO) is defined in EU law as 'the natural or legal person/s responsible for ensuring that the requirements of food law are met within the food business under their control'.[ii] Throughout this report, the FBO refers to the person who self-defined as such during this study. In the absence of the FBO, the research team spoke with the person who stated they had management / supervisory responsibilities over staff.
Food Handler	FSA guidance on food handler health[iii], uses the term 'food handler' mainly to refer to people who directly touch open food as part of their work. For the purposes of this research, a food handler constituted a person in a dedicated role with responsibility for food preparation, handling, cooking and storage. Across the food establishments in this study this was typically the head chef / cook or an assistant chef / cook.
Food Standards Agency (FSA)	The FSA was created in 2000 as a non-Ministerial government department, governed by a board, and tasked with protecting consumers in relation to food. The FSA uses its expertise so that people can trust the food they buy is safe to eat and honestly labelled.
Food Hygiene Rating Scheme (FHRS)	The FHRS provides consumers with information about hygiene standards in food business establishments. The purpose of the FHRS is to allow consumers to make informed choices about the places where they eat out or shop for food and, through these choices, encourage businesses to improve their hygiene standards.
Hazard Analysis and Critical Control Point (HACCP)	HACCP is an internationally recognised way of managing food safety and protecting consumers. All FBOs except farmers and growers are required by EU food hygiene legislation, to implement and maintain hygiene procedures based on HACCP principles, including identifying any hazards that need to be eliminated and implementing appropriate controls.
Habit	Generically, *something that you do often and regularly, sometimes without knowing that you are doing it*[iv] or *a settled or regular tendency or practice, especially one that is hard to give up.* More specifically, from a psychological perspective, habit may be understood as a "*non-volitional mechanism involved in motivation*"[v] and has been defined as *'a process by which a stimulus automatically generates an impulse towards action, based on learned stimulus-response associations.'*[vi]

Theoretical Domain Framework (TDF)	The Theoretical Domains Framework (TDF) is an integrative framework developed from a synthesis of psychological theories as a vehicle to help apply theoretical approaches to interventions aimed at behaviour change.
Symptomatic / asymptomatic	Norovirus is highly infectious; this means the organism is likely to be easily spread by food handlers who: • have been symptomatic (have had diarrhoea and/or vomiting) and return to work while still shedding virus particles and fail to follow the relevant hygiene requirements • are asymptomatic (who are infected but show no symptoms), but are nonetheless shedding virus and fail to follow the relevant hygiene requirements

Executive Summary

Executive Summary

Introduction

Norovirus is the most common cause of infectious gastrointestinal disease in the community.[vii] In 2014, the Food Standards Agency (FSA) estimated approximately 74,000 cases of foodborne norovirus infection in the UK[viii]. Reducing this incidence is a key priority of the FSA.

Norovirus has frequently been associated with outbreaks of illness linked to raw or lightly cooked shellfish, principally from oysters, as well as fresh produce, particularly soft fruit. However, the introduction of norovirus into food by infected food handlers[ix] is thought to be a significant contributor to human infection but evidence of this in the formal literature is limited.

In November 2015, FSA funded this study to enhance their understanding of norovirus transmission in the catering sector, in order to better understand the role of food handlers in this context. The objective of the research was to:

- Explore influences on norovirus transmission among food handlers working in the catering sector, and
- Propose potential ways to mitigate and reduce norovirus transmission in this context.

Method

A scoping stage informed by a desk based review of literature evidence and five expert interviews identified five "control strategies" ("Personal hygiene"; "Food handling", "Washing and cooking food", "Surface and uniform cleaning", and "Fitness to work"), each consisting of a number of "practices and behaviours" with potential to reduce or mitigate norovirus transmission. The scoping review informed a mixed-method, case study design, during which, thirty-two food establishments were visited.

As part of each visit, in-depth interviews were conducted with a food handler and an individual with responsibility for food handlers, structured environmental and behavioural observations were undertaken and a small number of food handlers (not including the interviewed food handler) were surveyed. Data collection and analysis were informed by COM-B, the Theoretical Domains Framework and the Integrated Behavioural Model for Water Sanitation and Hygiene (IBM-WASH). Future intervention strategies and Behaviour Change Techniques were identified using the Behaviour Change Wheel and the Behaviour Change Technique Taxonomy v1. What these models are and why they were chosen is covered in appendix 3 (published separately).

Key findings

Participants often reported recognition or awareness of the term norovirus but knowledge about norovirus was typically very low. There was often either a lack of knowledge or confusion about what norovirus is, and how it is contracted and transmitted. At best, participants had some awareness of norovirus symptoms and how to mitigate norovirus transmission but there was little evidence that norovirus was a particularly salient concern. Lack of knowledge of norovirus, and awareness of the relevance and implications of norovirus to food handling might have been anticipated. What was more surprising was the *Knowledge* and *Skills* gap in terms of the

awareness, and application of, recommended behaviours comprising more generic hygiene practice such as what constitutes effective hand-washing.

Environmental barriers were often identified both in terms of: characteristics of the setting (time scarcity, busyness, workload, and in the case of returning to work, money and pay); and the physical design and infrastructure of food handling environments. Both frequent micro-behaviours (e.g. hand washing, glove use, surface cleaning) and less frequent behaviours (e.g. uniform cleaning and exclusion from work) were environmentally influenced. *Social influences* were notable by their absence. For example, there was a lack of social pressure or expectation to engage in recommended behaviours (which may also be related to not knowing what is appropriate), as well as the assumption that recommended practice is already happening.

There was clear evidence of *Motivation*-related barriers, something that had not been identified in the scoping review. There was an absence of negative *Beliefs about Consequences* in relation to the non-performance of recommended behaviours, and certain behaviours (most obviously hand hygiene and surface cleaning) had become routinised and habitual but were typically not aligned with recommended practice.

There was clear and frequent evidence that seven "practices and behaviours" from four overarching 'control strategies' presented a norovirus transmission risk. These were:

- 'Inadequate hand washing and drying' and 'Not washing hands prior to gloving' from the Personal Hygiene control strategy;
- 'Using bare hands when preparing food' and 'Not changing gloves regularly' from the 'Handling food' control strategy;
- 'Food handlers cleaning the area where an episode of vomiting occurred instead of trained personnel';
- 'Not washing uniform or not washing uniform correctly' from the 'Surface and uniform cleaning' control strategy; and
- 'Returning to work too early' from the 'Fitness to work' control strategy.

Proposed behaviour change intervention strategy

In line with recommended practice in behaviour change intervention development 'Inadequate hand washing and drying' and 'Returning to work too early' were selected as target behaviours for the purposes of intervention development based on an assessment of likely impact, and ease of, behaviour change. A potentially feasible four part, complementary intervention strategy was developed after consideration of intervention function[x] and policy category[xi]. Seventeen behaviour change techniques[xii] (See Section 2.9) were identified as promising 'active ingredients' of the intervention strategy.

Intervention strategy component	Intervention function(s)	Policy category
Training: Principally targeted at the Kitchen Manager and ideally one to one and face to face with an Environmental Health Officer or equivalent. Videos are another option.	Education; Persuasion; Training; Modelling; Enablement	N/A
E-Learning: To support the training and as a stand-alone resource.		Guidelines

Resource provision: Suitably designed guidance, training materials, posters etc. to complement training and e-learning and targeted at both individual food handlers and FBOs.	Education; Persuasion; Training; Environmental restructuring; Modelling; Enablement	Guidelines
Awareness: Days or weeks with a specific norovirus focus to raise awareness at appropriate times of year.	Education; Persuasion	Communication / marketing

This study provides a foundation for meaningful intervention design work, but we suggest that more careful intervention planning and development work is required to ensure optimal development, design and eventual implementation of interventions in this context.

Introduction

1 Introduction

1.1. Background

Norovirus is the most common cause of infectious gastrointestinal disease in the UK.[xiii] In 2014, the FSA estimated approximately 74,0 00 cases of foodborne norovirus infection in the UK.[xiv] Reducing this incidence is a key priority of the FSA

Noroviruses are transmitted primarily through the faecal-oral route, either by direct person-to-person transmission or faecal contaminated food or water.[xv] Norovirus has frequently been associated with outbreaks of illness linked to raw or lightly cooked shellfish, principally from oysters, as well as fresh produce, particularly soft fruit. However, the contamination of food by norovirus infected food handlers[xvi] is thought to be a contributor to human norovirus infection but evidence of this in the formal literature is limited.

In 2015, the FSA funded the norovirus attribution study (NoVAS)[xvii], which is aiming to assess the proportion of norovirus infection in the UK that is foodborne. A specific work package (WP5)[xviii] in the NoVAS project is examined the prevalence of norovirus contamination in catering premises.

In November 2015, Food Standards Agency (FSA) funded our study to enhance their understanding of norovirus transmission in the catering sector and specifically to better understand the role of food handlers in this context.

The purpose of this research study was to identify barriers to reducing norovirus transmission among food handlers working in the catering sector, and subsequently develop a series of behavioural intervention options for consideration by the FSA.

1.2. Methods

The study used a staged approach, each one is described below:

1.2.1 Scoping stage

The scoping stage had two components.

1) desk research literature review (see Appendix 1) conducted by the University of Leeds and Queens University Belfast; and
2) five telephone interviews with subject matter experts, including policy specialists from the FSA, and academics from the NOVAs study;

A scoping stage informed by a desk based review of literature evidence and five expert interviews identified five "control strategies" ("Personal hygiene"; "Food handling", "Washing and cooking food", "Surface and uniform cleaning", and "Fitness to work"). The telephone interviews further confirmed these findings. Each identified control strategy consisted of a number of constituent 'practices and behaviours' e.g. personal hygiene, comprised 'inadequate hand washing and drying' and some suggestion of the key barriers to those

behaviours e.g. no access to hand washing facilities. The five control strategies relate to Norovirus transmission within a food preparation and handling context that researchers in this study sought to investigate

1.2.2 Behavioural research visits to 32 food establishments

Sampling and recruitment

Qualitative sampling is by nature purposive, seeking to reflect the breadth of circumstances and experience, rather than attempting to be strictly representative of a population. The sampling approach was designed to ensure good coverage across different types of food establishments, focusing on those variables which are likely to influence food handlers' behaviours: the Food Hygiene Rating Scheme (FHRS) score was the primary sampling criteria as we and the FSA considered this to be a useful proxy for food and hygiene related behaviours.

FSA also wanted this research to reflect WP5 in NoVAS project and focus on the catering sector, while also reflecting the diversity within the sector[xix]. Therefore, both the London and the North-West locations were chosen given they are the areas where the norovirus prevalence survey was conducted.[xx] Within these large areas, we purposively selected food establishments across urban, suburban and rural locations. As agreed with the FSA the sample was skewed towards smaller premises as it was assumed such businesses are less equipped to control Norovirus transmission due to resource and cost constraints.

A total of 32 food establishments were recruited in the aforementioned locations. Despite the use of monetary incentives, the reality of recruitment meant that the sample had elements of convenience (e.g. exceeding min quota for café/canteens) and self-selection bias i.e. the decision to participate in the study may reflect some inherent bias (e.g. self-selection bias) in the characteristics or traits of the participants. Appendix 11 sets out the characteristics of the food establishments included in the study.

Once the appointment was assigned to a member of the project team, they called the business a few days before the visit to reiterate the purpose of the research, explaining what we would like to do while on site, and we negotiated how this would happen in practice. The call was also crucial to building rapport with the FBO and ensured that he/she was comfortable with the visit.

The execution of this study complied with the MRS Code of Conduct. Participation was voluntary but both the recruiter and the research team encouraged participation and helped people understand the benefits to them of sharing their views and experiences. To thank participants for their time we offered each business establishment £150 in cash[xxi].

Preparatory work

Before the start of the fieldwork, the study approach was piloted in two food establishments. As a result, we realised the danger of selection bias i.e. the FBO selecting a food handler with the most experience and the norovirus priming issue i.e. participants having prior notification of the research topic. A refined approach was subsequently agreed with the FSA whereby the research team would select the member of staff to speak with and the study was explained as research into food safety practices. In preparation for the main stage of fieldwork, all researchers participated in an extended fieldwork briefing and were provided with a fieldwork briefing booklet designed to increase consistency of approach.

Primary data collection method

The primary research techniques used during the research visits was interviewing.

Interviewing

In each food business, a researcher first interviewed the FBO / person with management responsibility for the food handler to collect data on restaurant characteristics, food preparation training and policies, staff certification, food preparation processes, and influences affecting the control strategies. Development of the discussion guide for the food handler and manager interview ensured coverage of behavioural (TDF model) influences in the form of suitable questions for each of the target behaviours identified at the scoping stage. In light of the pilot, the audience (often English as a second language) and practicalities of the research process (limited time and attention) - we pursued an 'adaptive interviewing approach[xxii] asking questions about COM-B model components and following up with questions about TDF domains for applicable components.

We visited during a busy period e.g. lunchtime / evening so we could observe practice. As food businesses are busy environments some participants found it difficult to make time for us and in some cases, and, in some cases, it was necessary for the researcher to wait for up to half an hour between observation of food handler and their interview if the food handler was unable to get away from kitchen area.

Data triangulation

For the purpose of data triangulation and to establish the existence of components of the five control strategies, we also carried out an observation of practice and the food establishment environment, and research participants completed an anonymised questionnaire.

Environmental and behavioural observation

The research team conducted a 10 to 15 min observation of the premise to collect information on relevant aspects of the food establishment environment such as the availability of hand washing facilities. Then, using an observation method similar to the one designed by Green et al (2007)[xxiii] to mitigate desirability and performance bias the researcher conducted a 45 to 50 min observation of one worker who was preparing food.

Templates were developed that enabled researchers to record observed practices and behaviours of food handlers and also the environment in which food was prepared and sold / consumed, looking at relevant points of interest such as cleanliness of customer toilets.

Workers were chosen on the basis of the researcher's ability to observe them relatively unobtrusively (e.g. without interfering with their work). To limit the influence of the researcher's presence on food handler behaviour, the researcher observed the food handler for 10 to 15 min before beginning the 45 to 50 min data collection period to allow the food handler time to adjust to the researcher's presence. Additionally, food handlers were not made aware of precisely which aspects of their behaviour were being recorded during the observations. Following this, the researcher interviewed the food handler, covering the behavioural domains in each of the control strategies whilst also probing on issues of interest identified in observation.

Questionnaire

As with qualitative work there is a substantial literature on the application of TDF to quantitative, survey based work with numerous questionnaire studies which provide guidance in terms of questionnaire development.[xxiv] The questionnaire (see appendix 10), like the discussion guide, was not entirely devoted to TDF informed questions but we ensured coverage of TDF influences in the form of suitable questions.

1.2.3 Data analysis

Given the exploratory nature of the study, we spent the early stages of analysis in the development of an analytic framework. The framework was directly informed by the behavioural model that addressed the lines of enquiry. For each visit, data collected through the different methods (e.g. observations, in-depth interviews) was entered into the framework where it was mapped against specific behaviours within each control strategy. Researchers prioritised domains in terms of "saliency" in terms of recurrence and importance[xxv].

The data were analysed using saliency analysis[xxvi], an "enhancement" of thematic analysis that does not ignore codes (in this case 'domains') that do not recur. The application of the behavioural models in data collection and analysis allowed us to systematically assess the salience of the factors, which influence this.

1.3. Interpreting the findings

In reporting and discussing the results from this study, we use some semi-quantified language. In using this language with reference to verbal qualitative data we simply wish to draw attention to patterns in the data and enhance meaning. Given the design of this study we also refer to more explicitly quantitative data derived from observation and survey work. However, we stress that no inferences can be drawn about prevalence or distribution of phenomena beyond this sample whether derived from qualitative or quantitative data.[xxvii] When reporting qualitative data we refer to 'participants', and when reporting quantitative data we refer to 'respondents'.

We describe the findings in detail illustrated by verbatim quotations from participants. In brackets there is a reference to who the quote is attributed to: 'FBO', food handler' and, in so far as possible, the food hygiene rating of the respective food establishment.

Section 2: Findings

2 Findings

2.1 Overview

The evidence review *Norovirus transmission in food handlers and its prevention* (see Appendix 1) identified five 'Control Strategies' for the mitigation of norovirus transmission amongst food handlers, which consisted of a number of 'key practices and behaviours'.

We present findings in three ways for each of the five identified 'Control Strategies'[xxviii]: **firstly**, we present a 'Behavioural Summary' which lists 'key practices and behaviours' identified in the review, which can mitigate transmission and are colour coded (see Table 1); **secondly**, we present the most 'salient' barriers influencing a given control strategy using the Theoretical Domains Framework; **thirdly,** we present a brief comparison of the evidence of barriers from this study and those already identified in the evidence review. Prior to discussion of Control Strategies and by way of context we include a short section considering awareness of norovirus in the target population.

Table 1: Evidence for practice and behaviours

Factors increasing risk of norovirus transmission	RED indicates clear and frequent evidence that this was a transmission risk factor
	ORANGE indicates some evidence that this was a transmission risk factor
	GREEN indicates little, if any, evidence that this was a transmission risk factor

2.2 Participant awareness of Norovirus

Participants often reported recognition or awareness of the term norovirus, but knowledge about norovirus was typically very low. There was often a lack of knowledge or confusion about what norovirus is, how it is contracted and transmitted. At best, participants had some awareness of norovirus symptoms and how to mitigate norovirus transmission. However, in the case of the latter this tended to be indistinguishable from generic good food hygiene and safety practice.

"I know, but I don't know." [ID43]

"Is it something from Africa?" [ID704]

The one participant that reported working in an establishment that had experienced a norovirus outbreak still had very limited knowledge of norovirus or how to deal with it. Only one participant – a manager - identified norovirus as posing a serious potential business risk. However, the food handler interviewed at the same establishment had never heard of norovirus.

There was little evidence that norovirus was a particularly salient concern for managers or staff. There was some suggestion that other potential sources of illness – *E. coli* and Salmonella, for example - had greater recognition and salience. Other responses suggested that norovirus was not something typically associated with or relevant to the catering industry.

"I think it's a problem for hospitals." [ID 450]

2.3 Control Strategy 1: *Personal Hygiene*

- Behavioural summary

Table 2: Evidence for practices and behaviours identified in *norovirus transmission in food handlers and its prevention*

Factors increasing risk of norovirus transmission	Inadequate hand washing and drying
	Not washing hands prior to gloving
	Not washing hands prior to preparing food
	Not washing hands regularly
	Not using soap
	Relying on sanitary hand gels
	Not washing hands after attending the toilet

The most effective method for reducing norovirus contamination on the hands is washing them for 20 seconds with soap and running water, and drying them for a further 20 seconds with disposable paper towels (EFSA, 2011). There was very little evidence that this recommended practice took place in the food establishments included in the research. The regularity and frequency of handwashing was highly variable. Even in instances where food handlers regularly washed their hands they tended to do so inadequately. Typical features of inadequate handwashing were not washing hands prior to food preparation, not washing hands for long enough, not drying hands for long enough, as well as inconsistent use of soap and disposable paper towels. Where alcohol based gels were present, they were regularly used as an equivalent substitute for soap.

- Barriers influencing *Personal Hygiene*

Despite the fact that almost all (34/37) respondents *suggested* they had familiarity with handwashing guidance, there was a clear knowledge gap around effective handwashing practice. This was particularly pronounced when it came to knowledge of the length of time required for washing and drying hands; and to a lesser extent around use of liquid soap and disposable towels. Food handlers that used alcohol based hand gels considered them equivalent substitutes or superior to soap.

The qualitative data was supported by the survey data with about half (18/37) respondents able to identify recommended handwashing practice but a little over half (22/37) stating they use alcohol based gels. There was some evidence of differentiation of handwashing practice depending on task e.g. handling raw meat required a 'thorough wash' that more closely resembled recommended EFSA practice, as opposed to a more cursory wash after handling greasy food.

"There's washing your hands and then there's washing your hands." [ID43]

In addition to a knowledge gap around effective handwashing practice, there was evidence of a skills gap. Even where participants demonstrated knowledge of effective handwashing, this did not necessarily translate into recommended practice. Many participants said they had not received training externally and/or a demonstration of handwashing whether online or face to face. FBOs often provided their own food hygiene training. However, this did not necessarily include coverage, or demonstration, of handwashing. Further, there was no guarantee that internal training was in line with recommended handwashing practice.

Memory, attention and decision process played a role in handwashing. Participants variously described handwashing as automatic, "routine" or "reflex", but also stated that there were situations in which one might forget to hand wash either completely or in – what was perceived to be – the recommended way.

"I wash my hands lots of times. To be honest, I don't know how many times. It's like a routine now. Basically if I am doing something, after I am washing my hands, even if it's not necessary." [ID888]

Typically, forgetting handwashing was associated with being busy or under pressure in some way. Participants also reported using visual cues or heuristics as prompts to handwashing. For some, handwashing decision rules were based on type of task – as mentioned above, handling raw meat was perceived to require a more 'thorough wash' than other types of food. Others stated that they washed their hands when they "felt" or looked dirty.

Social influences were notable by their absence, in the sense that there was little evidence of expectation of recommended handwashing practice from colleagues or more senior staff. In some cases, there was clear evidence of implicit support for non-recommended practices from senior staff, most obviously in supporting the use of alcohol gels as an alternative to soap and water.

"We don't have a boy scout culture or culture of professionalism although it would be great if we did." [IDP1]

In addition to this, there was a notable absence of handwashing role models. The closest thing to a role model was typically the head chef. However, there was little evidence that they provided anything beyond information and reading material as part of induction and occasional, ad hoc surveillance. Typically, expectations of food handlers in more senior roles were often that handwashing is common sense, staff know what they're doing and can be trusted.

Environmental context and resource constraints to handwashing were stated and observed. Necessary materials were often either unavailable or inaccessible, including: the absence of a designated handwashing sink; an inaccessible handwashing sink; not enough handwashing sinks; the absence of liquid soap or the presence of an inadequate substitute like a bar of soap, washing up liquid or alcohol gel; and the absence, or inaccessibility, of disposable paper towels. In addition, handwashing was perceived as time consuming and was thought to be less likely to happen if food handlers were busy or short of time. Survey responses support this perspective with almost a quarter (8/37) of respondents reporting that when it is busy it is difficult to carry out hand hygiene and slightly fewer (6/37) reporting that kitchen layout, equipment and procedures make hand hygiene difficult. One response to a perceived and actual scarcity of time or physical environmental constraint was the adoption of shortcuts that typically departed further from recommended hand washing practice.

"I'm not sure. I am not taking my time. I'm just washing them. It depends. If I am in a rush, I will just wash them quickly, but if I have time, I will wash my hands properly." [ID 888]

"I am washing my hands [with washing up liquid] while I wash the dishes – I am saving time." [ID969]

There was no obvious shortcoming in beliefs about capabilities reported by participants. Handwashing was often considered straightforward, easy and common sense not just by senior staff and managers – as

suggested above – but by food handlers too. As a result, participants stated that handwashing was not something that necessarily required much guidance or training. The main perceived difficulty associated with handwashing was not the quality, but the frequency of the behaviour.

"It is not rocket science how to wash your hands." [ID969]

"I wash my hands not as much as I should do, but as much as I can do. More or less as much as you need to do." [ID703]

In terms of participants' beliefs about consequences, there was a general recognition that handwashing helps reduce cross contamination and the potential for customer illness; as well as the possibility of reputational risk to the establishment This general belief in negative outcomes tended to become more salient and pronounced in the context of handling raw meat or fish. However, there was no obvious relationship between the expression of greater levels of concern around outcomes and more effective handwashing practice.

"I like to wash my hands after everything, but especially after you prep meat, fish or eggs because it is very dangerous. I even wash my hands after preparing veggies like cucumber." [ID1068]

"[You should wash hands] after you touch any food. When I touch raw meat, I am paranoid." [ID233]

Habit – understood via the Reinforcement domain in the TDF – appeared to be an important barrier to effective handwashing practice. There was a common discrepancy between participants' accounts of their handwashing practice and observed practice. Furthermore, while participants stated that handwashing practice was automatic or routine, observational evidence suggested that automatic or routinised handwashing responses typically departed from recommended practice to varying degrees.

- Comparison with existing evidence

There is clear overlap between the barriers suggested by existing evidence and this study but there is also some discrepancy (see Table 3). First, we found no evidence of hand soap being considered an irritant by food handlers; and second, our study identified a number of additional possible barriers related to *Capability, Opportunity* and *Motivation*.

Table 3: Comparison of barriers suggested by existing evidence and this study

Barriers suggested by existing evidence	Barriers suggested by this study
Lack of knowledge/training	Clearly, lack of Knowledge and Skills that might be derived from training acted as barriers
No time during shift to wash hands	Both features of Environmental context and Resources acting as barriers
No access to hand washing facilities	
Hand soap causes skin irritation	We found no evidence of this
Sanitary hand gels don't kill the virus	Where sanitary hand gels were available, they were used as a substitute to hand washing

2.4 Control Strategy 2: *Handling food*

- Behavioural summary

Table 4: Evidence for practices and behaviours identified in *norovirus transmission in food handlers and its prevention*

Factors increasing risk of norovirus transmission	Using bare hands when preparing food
	Not changing gloves regularly

Norovirus transmission in food handlers and its prevention points outs that *"most food service companies require their employees to wear gloves when handling food, especially RTE foods" (see Appendix 1).* However, we found that glove use was not the norm when handling and preparing food. There was mixed practice in terms of glove use when preparing salads and/or sandwiches. Most food handlers stated it was relatively common for them to use bare hands except when handling raw meat and fish or "messy" foods, or if the food handler had a cut. However, there was clear evidence that food handlers did not necessarily use gloves even when handling raw meat. Given the relatively limited incidence of glove use, there was subsequently little evidence of regular changing of gloves and very few cases of concurrent handwashing and glove use; practices which are linked to a reduction in norovirus transmission. Further, even in those cases where some concurrent handwashing and glove use was evident, handwashing practice was often imperfect.

- Barriers influencing *Handling food*

Knowledge of what constitutes effective glove use appeared to be relatively limited. Typically, glove use was not understood as a necessary requirement / part of food handling and preparation except when handling raw meat, fish or if / when a food handler has a cut on their hand. Even food handlers who used gloves more frequently / regularly did so not because they had an appreciation of the benefits of glove use but instead because they had a general rule of thumb that they should use gloves as much as possible as part of their practice. Survey evidence supports the idea of a knowledge gap specifically in relation to glove use and norovirus, with only a third (13/37) of respondents agreeing that avoiding touching food with bare hands helped to mitigate transmission. As with handwashing, there was evidence of a skills gap accompanying the knowledge gap with little evidence that participants had been trained in effective glove use or that they engaged in key aspects of glove use such as washing hands prior to gloving and concurrent handwashing and gloving.

There was little evidence of colleagues – peer or senior / manager – expectation of glove use as part of food preparation or of the presence of role models for glove use. Social influences – in terms of expectations – ranged from weak expectations of glove use i.e. staff were told that glove use was a good idea as part of an induction process but there was no implementation of that weak recommendation to a complete lack of precedent for glove use i.e. glove use was not recognised as being part of the food handling and preparation process.

Environmental factors were both reported and observed barriers to glove use. Like handwashing, glove use was perceived to be time consuming, but particularly inconvenient when participants were busy. Furthermore, gloves were often in scarce supply, relatively inaccessible or simply not available; there was even some suggestion that regular glove use is wasteful in the context of the time constraints and workload.

"I don't wear gloves every second, as there is no time." [ID 685]

"You have to do different tasks, and change all the time. It is not practical wearing gloves." [ID381]

One of the related beliefs about consequences of glove use was that it was impractical to wear gloves. Participants also suggested that it could be dangerous and potentially unhygienic to wear gloves unless they were changed regularly. There was also the suggestion that if handwashing was already taking place then glove use did not offer any further, marginal hygiene-related benefit. A related point was that participants appeared to consider hand washing and glove use as substitutes rather than complements.

"You are washing your hands anyway. You keep on touching [food], the gloves get dirty too, unless you constantly change them. The amount of bacteria that plastic can hold can be more than in your hands." [ID1067]

"...If you do wear gloves you don't need to wash your hands." [ID226]

In terms of goals and priorities, glove use was something that participants generally preferred to avoid. Further, in comparison to glove use, hand washing was more obviously considered something that participants wanted to do and even something that was "more important".

"I would rather not use them [gloves]." [ID233]

Participants also expressed a more emotional reaction to wearing gloves - in addition to their perceived impracticality - that might be understood as a form of disgust. Conversely, one of the few instances in which food handlers wanted to wear gloves was to prevent mess or contact with food that smelled or stained e.g. chicken livers or beetroot or to prevent contact with an allergen.

"They are not practical really... putting them on, putting them off, getting so many gloves... they're so tight on your hands, sweaty. They are horrible."[ID235]

- Comparison with existing evidence

Again, there is clear overlap between the barriers suggested by existing evidence and this study. However, once again, this study significantly extends the number and type of potential barriers particularly in terms of *Opportunity* and *Motivation* (see Table 5).

Table 5: Comparison of barriers suggested by existing evidence and this study

Barriers suggested by existing evidence	Barriers suggested by this study
Lack of knowledge/training	Clearly, lack of Knowledge and Skills that might be derived from training acted as barriers
No gloves available	Gloves were often in limited supply and/or relatively inaccessible

2.5 Control Strategy 3: *Washing and cooking food*

- Behavioural summary

Table 6: Evidence for practices and behaviours identified in *norovirus transmission in food handlers and its prevention*

Factors increasing risk of norovirus transmission	Not cooking foods (shellfish) thoroughly to inactivate the virus
	Not washing fruit and vegetables during processing/preparation

Food handlers reported and were, to a lesser extent, observed washing fruit and vegetables as part of food preparation. Fruit and vegetables were often washed either pre-shift or as one of the shift's first activities as part of a shift and sometimes in an ad hoc way during the shift. One establishment had fruit and vegetables pre-washed by their supplier although food handlers washed fruit and vegetables again prior to serving. There was no evidence that food handlers used chlorinated water to wash fruit and vegetables. Food handlers reported that they cooked (or heated) foods thoroughly – typically meat rather than shellfish - and stated temperatures within the range recommended for virus and bacterial inactivation. Food handlers typically acknowledged that use of thermometers or probes to check food temperatures was recommended; but some admitted that this did not always happen.

- Barriers influencing *Washing and cooking food*

Barriers to *Washing and cooking food* were much less pronounced in comparison to other control strategies. Knowledge barriers existed in the sense that the exact range of temperatures recommended for virus inactivation was not known but food handlers typically had a temperature in mind which they – rightly - believed would ensure food was safe to eat. A potential barrier to the appropriate cooking of food was beliefs about capabilities and specifically over-confidence. Despite typical acknowledgement of the need to cook or heat food thoroughly not all food handlers used a thermometer or probe to test food temperature typically relying on an experience or practice-based assumption or behavioural rule of thumb.

"I have spent 32 years cooking a lot of meat – I know when it is ready." [ID703]

"You are meant to use a probe – as we have a breast. That's how you are meant to do it. But… You can do with touch – if it is firm is cooked. That is how I do it." [ID235, 4 FHRS]

Thorough cooking and heating of meat was a particularly salient concern for food handlers. Participants typically suggested an association between raw or undercooked meat and the potential for contamination and/or perceived risk either of customer complaint or of risk to customer safety. The participants in our sample did not prepare or serve shellfish but fewer than a third (11/37) of respondents suggested that 'cooking shellfish thoroughly' helped reduce the spread of norovirus. This may imply a Knowledge gap in terms of effective preparation of shellfish, as well as the relationship between shellfish and norovirus, and is likely to imply a lack of familiarity with shellfish preparation and therefore a Skills gap although this may be irrelevant if these are not skills that food handlers in smaller establishments require.

"Contamination for me is the biggest thing. It can be passed through anywhere but I don't use a lot of raw meat… so it is not so much of an issue for me." [ID233]

Washing and cooking food and specifically *washing fruit and vegetables during processing/preparation* also provided evidence of a relatively scarce facilitator of desirable behaviour. Environmental context and resources in terms of resources and time available often supported recommended practice in washing fruit and vegetables and to some extent in temperature checking. FBOs explicitly set aside time for washing fruit and vegetables that made this practice both routine and expected.

"You have a time in the day that is scheduled to prep." [ID381]

- Comparison with existing evidence

This study is in agreement with the existing evidence both in terms of the type of barrier and that this Control Strategy likely faces the fewest barriers to realisation (See Table 7).

Table 7: Comparison on barriers suggested by existing evidence and this study

Barriers suggested by existing evidence	Barriers suggested by this study
Lack of knowledge/training	Some evidence that lack of Knowledge and/or Skills may be a barrier

2.6 Control Strategy 4: *Surface and uniform cleaning*

- Behavioural summary

Table 8. Evidence for "practices and behaviours" identified in norovirus transmission in food handlers and its prevention

Factors increasing risk of norovirus transmission	Food handlers cleaning the area where an episode of vomiting occurred instead of trained personnel
	Not washing uniform or not washing uniform correctly
	Not cleaning and disinfecting food preparation equipment and surfaces
	Not cleaning and disinfecting surfaces and utensils contaminated by vomiting or diarrhoea

Practice in terms of cleaning and disinfecting food preparation equipment and surfaces was variable. Typically, surfaces were wiped down with a wet cloth or paper towel and antibacterial spray or disinfectant were used in only a few cases. Colour coded boards were used for food preparation but not always cleaned or disinfected even when they had been used for raw meat or fish. Utensils were rinsed with water and/or left next to or in a designated washing sink to be cleaned at a later time or put into a dishwasher.

There was no evidence that FBOs had experience in dealing with cleaning or disinfection after vomiting. Proposed responses recognised the importance of cleaning and disinfection but there was no evidence of awareness of the need for or availability of specifically trained personnel. Typically, responsibility would fall to whoever was working at the time which implied food handlers. Food handlers were largely responsible for washing their own uniforms. A minority of FBOs had uniforms cleaned by an external cleaner (5/ 37) - but this was a function of convenience or circumstance rather than design.

- Barriers influencing *Surface and uniform cleaning*

Knowledge, and to a lesser extent, skills were important barriers to effective cleaning and disinfecting. There was a clear lack of awareness of the need for specifically trained staff to deal with vomiting and/or diarrhoea and a lack of awareness about the potential shortcomings of domestic washing machines. There was a demonstrated skills gap in terms of effective cleaning and disinfection of food preparation equipment and surfaces and it seems likely there is a potential skills gap in the effective cleaning and disinfecting of vomiting or diarrhoea given the lack of specifically trained personnel or staff experienced in dealing with such situations.

The environment (context and resources) presented barriers to effective cleaning and disinfecting of equipment and surfaces in terms of the availability of appropriate resources e.g. disinfectant and in terms of the time available. One participant cleaned surfaces and equipment with a wet cloth when busy during service but did so with disinfectant at the end of a shift. This practice resembles the distinction between "thorough" and more regular handwashing but was more a function of time and routine than preceding task i.e. handling meat or not. However, there was also evidence that the cleaning of surfaces and equipment with only water and a cloth or paper towel took place in settings that were relatively quiet which might suggest that cleaning and disinfecting practices were to some extent routinised – whether effectively or not - in a similar way to handwashing behaviours.

The **environment (context and resources)** may also have acted as a barrier to effective uniform washing. In the absence of any understanding around why it might not be appropriate it was simply more convenient to have staff clean their own uniforms unless there were cleaning facilities on site or an existing arrangement with an external cleaner.

"We are a franchise company. If you work in another branch there is laundry service." (ID235, FHRS4)

Overall, **knowledge** would appear to be the principal barrier to effective uniform washing. There was very little awareness that it might not be desirable for staff to be responsible for washing their own uniforms. Related to this, there was typically an expectation – **social influence** - that staff would be responsible for washing their own uniform but this appeared to be primarily a function of a lack of knowledge. Survey data supported the idea of a knowledge gap in relation to uniform washing and norovirus with only around a third (13/37) respondents suggesting that 'professional cleaning of uniform" helped to mitigate transmission.

- Comparison with existing evidence

There is considerable overlap between existing evidence and the evidence from this study. However, the role of social influence in shaping some aspects of cleaning behaviour may be somewhat novel (see Table 9).

Table 9. Comparison of barriers suggested by existing evidence and this study

Barriers suggested by existing evidence	Barriers suggested by this study
Lack of knowledge/training	Clear evidence of Knowledge and Skills as barriers
Poor access to cleaning facilities and materials	Some evidence of this Environmental context barrier
Domestic washing machines may not kill the virus effectively	A clear potential risk related to Knowledge, Environment and Social Influence
No trained cleaning personnel	As per lack of Knowledge / Training

2.7 Control Strategy 5: *Fitness to work*

- Behavioural summary

Table 10. Evidence for "practices and behaviours" identified in norovirus transmission in food handlers and its prevention

Factors increasing risk of norovirus transmission	Returning to work too early
	Asymptomatic food handlers
	Continuing to work while experiencing symptoms
	Not reporting episode of vomiting/diarrhoea

Participants typically stated they would report symptoms of norovirus (vomiting and/or diarrhoea). This practice was intentional, often due to resource constraints such as staff shortage, and unintentional, due to staff not knowing the recommended period of absence. Only one participant explicitly recognised the potential problem of asymptomatic food handlers (i.e. not exhibiting symptoms of norovirus but potentially still carrying and transmitting the virus). There was little evidence to suggest that the potential for norovirus transmission from asymptomatic food handlers was recognised or that effective attempts were, or would be, made to mitigate this potential problem.

- Barriers influencing *Fitness to work*

There was a clear knowledge gap around appropriate exclusion from work practice. Participants were often unaware of official guidance and there was even more limited awareness of the recommendation that food handlers should not return to their workplace until at least 48 hours after norovirus symptoms (vomiting and/or diarrhoea) stop[xxix] The survey supported this finding with only a handful (5/37) of respondents correctly identifying recommended practice. Participant knowledge typically approximated recommended practice but was rarely completely accurate. Participants suggested various courses of action in the event of exhibiting symptoms including staying off work until GP says it is OK to return; staying off work for 48h; staying off work for 3 days.

There was very little evidence that managers or food handlers were aware of the potential for asymptomatic transmission of norovirus and no recognition of any need to report exposure to someone else with a norovirus diagnosis or symptoms. Again, survey evidence is supportive here with around a third (12/37) suggesting they would return to work once symptoms stopped. There was also limited awareness of the need for additional hygiene precautions when returning to work after illness.

"People don't care and don't understand that they don't have to be sick for their actions to matter…they don't understand that they can carry [norovirus] without being sick." [P1]

"if you don't have symptoms, it is OK to go to work." [ID969]

In the few cases where awareness was present it was unclear either what these precautions would consist of or whether the suggested precautions were appropriate or effective. For example, in one case where this was recognised as a problem in need of mitigation, the additional precaution was greater and more frequent use of

alcohol-based sanitary gel. This knowledge gap implies a skills gap, consistent with the fact that while some food handlers reported having received training around exclusion from work this was typically internal training that they may not remember clearly and/or may not align with recommended practice.

Social influences and environmental (context and resources) influences acted as complementary barriers to effective *Fitness to Work* practice. In terms of social influences there was evidence that food handlers look to more senior staff – typically the head chef – for guidance in the event of illness.

"If I was on a shift then I would talk to the chef and ask them what to do. She knows better than me what to do." [ID1068]

However, this was problematic not only because more senior staff may not be fully aware of FSA's *Fitness to Work* guidance but also because of the expectations placed on food handlers. In one case it was considered "irresponsible" to stay at home if a member of staff was only "a bit sick' and a small number of survey respondents (2/5) stated that they had worked whilst experiencing vomiting and/or diarrhoea in the past year because they were scared of the reaction of their boss. Expectations of staff varied according to establishment need most obviously in terms of staff availability. Consistent with this perspective, staff shortage was mentioned by a small number of survey respondents (4/5) as a reason for working in the past year despite experiencing vomiting and diarrhoea.

"The reality is if we're short staffed then this just doesn't happen…typically, we say stay away a day."
realistically an employee is not going to stay away for two days." [IDP1]

Environmental context and resources and beliefs about consequences also interacted as important barriers to effective *Fitness to Work* practice. Food handlers tended either not to be paid for sick days or they had to take sick days as holiday and consequently absence from work as a result of illness led to a loss of earnings.
A small number (3/5) respondents also reported that concern about losing their job was a reason for working despite experiencing vomiting and/or diarrhoea in the last year. Another salient barrier was professional identity and a sense of responsibility, loyalty and fairness to colleagues. Again, the survey data supported this with a small number of respondents (3/5) stating that not working despite experiencing vomiting and/or diarrhoea was not fair on colleagues.

"Does money enter into consideration when deciding whether or not going to work? ' It depends – if I was ill I would come in so not to lose the money from my shift, and not to leave my colleagues [in a bad situation]." (ID235 FHRS 4)

"[I] need to balance having a wage and customers' safety." (ID233)

Decision-making and resultant behaviour related to fitness to work is clearly a dynamic, complex process. In addition to the barriers mentioned above, there was also evidence of an emotional component in terms of worry about potential job loss and reactions of more senior colleagues. What does seem clear is that whilst there is recognition of some risk to customer safety – albeit without any real recognition of the possible role of norovirus – the barriers to effective *Fitness to Work* practice are significant.

Comparison with existing evidence

Again, there is clear overlap between the barriers suggested by existing evidence and this study. However, this study may help extend our appreciation of barriers to this Control Strategy. While existing evidence suggests salient Capability and Opportunity-related barriers this study suggests that Motivational barriers (Beliefs about Consequences and Social/Professional Identity) may be important as well as identifying a role for Social Influences (see Table 11).

Table 11. Comparison of barriers suggested by existing evidence and this study

Barriers suggested by existing evidence	Barriers suggested by this study
Lack of knowledge/training	Clearly, lack of Knowledge and Skills acted as barriers
No one to cover shift	All features of Environmental context and Resources acting as prominent barriers
Fear of losing job	
Loss of earnings	
Asymptomatic food handlers are unaware they have been infected	Another important potential barrier primarily Knowledge related i.e. what constitutes being infected

2.8 Summarising influences by *Control Strategy*

A simple summary of influences on - 'salient' 'domains' acting as barriers – each control strategy indicates that all but *Washing and cooking food* have numerous potential barriers (see Table 12). The *Capability* related domains – *Knowledge* and *Skills* – and *Opportunity* related domains – *Environmental context and resources* and *Social Influences* – are common to all of the control strategies other than *Washing and cooking food*.

Table 12. Identifying barriers – 'domains' – by Control Strategy[xxx]

'Domain'	'Control Strategy'				
	1.Personal Hygiene	2.Handling Food	5.Fitness to work	4.Surface & uniform cleaning	3.Washing & cooking food
Knowledge	X	X	X	X	X
Skills	X	X	X	X	
Environmental context & resources	X	X	X	X	
Social influences	X	X	X	X	
Belief about consequences	X	X	X		
Reinforcement	X			X	
Beliefs about capabilities	X				
Goals		X			
Memory, attention & decision-making	X				
Emotion		X			
Social / professional identity			X		
Number of 'salient' barriers	8	7	6	5	1

2.8.1 Prioritising by *Control Strategy*

A structured assessment of number and type of influence allow us to make an informed judgement about i) the likely impact and ii) ease of realisation of a given *Control Strategy*. Using this approach, we suggest that *Washing and cooking food* may be considered a low priority because there are so few barriers to its realisation and relatively little evidence of risk of transmission. Perhaps more contentiously, we suggest that *Handling Food* be considered a lower priority *Control Strategy*. Although *Handling Food* - mainly improving glove use - may help mitigate norovirus transmission it is unlikely that this *Control Strategy* will be easy to realise given the variety of barrier faced. Perhaps more importantly changing hand washing behaviour is likely to have a greater impact and be easier to achieve. As discussed above – Section 2.5 – hand washing and glove use are typically considered substitutes for one another rather than complements. Hand washing tends to be prioritised over glove use, and glove use is likely to be considered more impractical and participants were less likely to be motivated to use gloves than wash their hands. Overall, we suggest focussing on three control strategies: Personal Hygiene, Fitness to Work and Surface & uniform cleaning.

2.8.2 Prioritising *Control Strategy* components

Given a *Control Strategy* is a collection of components - 'practices and behaviours' – and best practice in terms of intervention design recommends focussing on "one or a few behaviours in the first instance" it is helpful to further prioritise in terms of *Control Strategy* components. There are a number of Control Strategy components that the study suggested presented a clear and frequent transmission risk factor. Using the same prioritisation logic applied to Control Strategies we suggest that the two most promising components in terms of likely impact and ease of realisation are i) Inadequate hand washing and drying and ii) Returning to work too early.[xxxi]

All 'domains' identified as barriers to each respective Control Strategy apply for each prioritised Control Strategy component. However, certain manifestations of Environmental Context and Resources barriers for the 'Returning to work too early' (pay, staff shortage) are not barriers which would easily be addressed by any likely feasible intervention.

2.9 Towards future Behaviour Change Interventions (BCI's) and Behaviour Change Techniques (BCT's) to support behaviour change

Using the links (see Appendix 7) between the Theoretical Domains Framework and the Behaviour Change Wheel's *Intervention Functions*[xxxii] we identified eight functions (Education, Persuasion, Training, Environmental Restructuring, Enablement, Modelling, Incentivisation and Coercion) that could be used to address the barriers to the prioritised *Control Strategy* components. In making this assessment we drew on APEASE[xxxiii] (see Appendix 9) - a criteria for making context-based decisions on intervention content and mode of delivery - to rule out the 'Restriction' intervention function given it is less likely to be acceptable and/or feasible in this context.

Guided by the links (see Appendix 6) between intervention functions and Behaviour Change Techniques (BCT's)[xxxiv] and expert consensus linking BCT's to TDF Domains[xxxv] we have generated a shortlist of potential BCT's to help respond to i) *Inadequate hand washing and drying* and ii) *Returning to work too early*. We are aware of the limitations of this approach – that ""effectiveness" is not part of the definition of BCT's."[xxxvi]

However, by using ii) we hope to begin to address the first of Kok et al's three conditions for effectiveness, "For a behaviour change method to be effective: (1) it must target a determinant that predicts behaviour."[xxxvii] These shortlists are presented as a starting point to support further work to satisfy Kok et al's third conditions for effectiveness, that any BCT[xxxviii] "must be translated into a practical application in a way that preserves the parameters for effectiveness and fits with the target population, culture and context."[xxxix]

Table 14. Linking 'Domains' to BCT's and 'Intervention functions' to examine 'Practical application'

Domain	BCT	Intervention Functions	Examples of possible 'practical application' of BCT	Relevance[xl]	
				TB1[xli]	TB2[xlii]
Knowledge	Information about health consequences	Education; Persuasion	An explanation of the consequences of not performing the recommended behaviour.	Y	Y
Skills	Behavioural practice / rehearsal	Training	Practice of recommended handwashing procedure at least once in relevant context.	Y	N
	Habit formation	Training	Repetition of recommended behaviour in context on a regular basis. This may not be as feasible as a one off practice but is likely to be important.	Y	N
Environmental Context & Resources	Restructuring the physical environment	Environmental restructuring; Enablement	The importance of a 'supporting environment' for hand hygiene is well documented.[xliii] It is unlikely to actually change FBO physical environments but it may be possible to provide advice and support to optimise environmental facilitation of target behaviours. An easy way to communicate this would be through education and/or training – face to face or video – and/or using "Prompts / Cues" (see below). This might be through visually appealing posters that communicate what a domestic environment to support healthy eating looks like[xliv] and/or a supporting checklist[xlvxlvi] might be used by food handlers prior to food preparation e.g. checking for presence of soap, water, separate paper towels and absence of hand sanitiser.[xlvii]	Y	N
	Prompts / Cues	Education' Environmental restructuring	Provision of stimuli to prompt or cue[xlviii] recommended behaviours at the time or place of the target behaviour. Prompts might take the form of posters that demonstrate recommended behaviour as simply as possible i.e. fewer steps is better without sacrificing sufficient detail.[xlix]There are many resources of this type[l] but it's not clear that there are any such resources that focus on norovirus and/or recommended behaviours to mitigate norovirus transmission. There may also be potential in developing prompts – most obviously posters – that communicate the relationship between a behaviour – or non-performance of a behaviour – and a consequence (c.f. Information about health, social or environmental consequences – that also targets automatic processes[li] using "aversive images"[lii] e.g. related to disgust.[liii] Cues – whether visual or olfactory (the latter likely less feasible – have been demonstrated to influence hand hygiene compliance.[liv] However, given the difficulties with the 'Priming' literature[lv] especially around the use of "surveillance cues"[lvi]we might want to be cautious in our expectation of impact on behaviour. In addition, implementing a cue will not address the more fundamental barrier of food handlers not having sufficient capability to engage in the recommended behaviour. One potentially promising direction for the design of more effective cues is to tie them to goals[lvii] and/or plans[lviii] which may in turn support habit formation.	Y	M

Social Influences	Information about others' approval	Education; Persuasion	Telling food handlers that the recommended behaviours are approved of by more senior staff, Local Authorities, FSA and/or any other 'Credible Source'.	Y	Y
	Modelling or demonstrating the behaviour	Training; Modelling	Demonstration to food handlers of effective handwashing or explanation of recommended 'return to work' behaviour using a realistic or familiar scenario. Handwashing demonstrations – whether face to face or via video - could benefit from the use of products which simulate and show the presence of germs on hands such as GloGerm[lix], GermJuice[lx] or GlitterBug[lxi]. Another, potentially less feasible form of handwashing demonstration might be provided by Surewash[lxii] or a similar technology.	Y	Y
	Identification of self as role model	Persuasion; Enablement	Informing food handlers that if they perform the recommended behaviours they are setting a good example for colleagues.	Y	Y
	Social support or encouragement	N/A	Provision of advice and/or support and/or praise and/or reward (c.f. Social Reward) for performance of a recommended behaviour. This could be delivered by external (EHO, Local Authority, FSA) or internal (Kitchen Manager) parties. Potentially important for returning to work behaviour that performing the recommended behaviour is valid and acceptable given the various barriers identified.	Y	Y
	Social reward	Incentivisation	Congratulate food handlers performing recommended behaviour e.g. suffering from norovirus symptoms but not coming back to work until 48h after symptoms have stopped.	Y	Y
Beliefs about consequences	Salience of consequences	Persuasion; Enablement	Visual stimuli (that target automatic, emotional processes) indicating undesirable consequences from not engaging in recommended behaviours. See the discussion in Prompts / Cues.	Y	Y
	Anticipated regret	Coercion; Enablement	Raising awareness of future likely regret as a result of not performing hand washing in the recommended way and/or returning to work early.	Y	Y
	Information about Social / environmental consequences	Education; Persuasion	Informing food handlers of the wider impact of norovirus outbreaks both in terms of illness, days off work and societal cost.	Y	Y

In addition to BCT's that target relevant 'domains' we propose consideration of a small number of other BCT's. The rationale for this is that i) there may be some precedent in the literature for their application and/or ii) the BCT may act as a facilitator of behaviour change rather than addressing a barrier. For example, developing an 'Action Plan' as a 'Behavioural Contract' and then making a 'Commitment' to that plan could help realise the typical good intention to engage in hand hygiene. There is further coverage of facilitators of behaviour change in the Section 3: discussion.

Table 15: Linking Behavioural domain, the intervention function and the possible application of BCT

Domain	BCT	Intervention Functions	Possible 'practical application' of BCT	Relevance [lxiii]	
				TB1	TB2
Goals	Action planning	Enablement	Prompt and/or develop a detailed, specific plan for performance of recommended behaviour. There is evidence to suggest that developing plans can support hand hygiene[lxivlxv] and – see Prompts / Cues – that planning can support habit formation and behaviour change.[lxvi] It is worth noting that the BCT satisfies the key 'parameter of effectiveness' (a pre-existing intention to perform the behaviour, particularly in the case of hand hygiene), the absence of which may greatly reduce or eliminate the effectiveness of the technique.[lxvii]	Y	Y
Intention	Behavioural contract	Enablement	A contract signed by food handler and kitchen manager (and ideally witnessed by another) or equivalent to perform the recommended behaviours as per 'Action Planning' BCT.	Y	Y
	Commitment	Enablement	Ask food handlers to reaffirm commitment to perform recommended behaviours whether starting, continuing or restarting them. This would likely overlap with the Action Planning and Behavioural contract BCT's. 'Commitment' might also be combined with Restructuring the Physical Environment' and / or "Prompts / Cues" to make the commitment to the recommended behaviour visible to the public e.g. using a signed poster.[lxviii]	Y	Y
N/A	Credible source	Persuasion	Presentation of any pertinent Intervention Function (Education, Training etc.) or BCT by a respected, high status individual emphasising the importance of performing recommended behaviours. This might be a Kitchen Manager, EHO, Local Authority representative, Microbiologist, senior FSA official etc.		

2.10 Participant's perspective on interventions

Participant responses indicated some demand for three broad 'Intervention Functions' – *Training*, *Education* and *Enablement*. This demand clearly overlaps with the findings from this study and the mapping of 'Intervention Functions' to 'Domains' outlined above.

2.10.1 Training

Type and quality of training received by food handlers was highly variable. Survey responses suggest that 7 out of 37 had no food hygiene qualifications while 13 out of 37 had Level 2 or above. Food handlers tended either to have completed online training at level 1 or 2 or to have received one-off in-house training as part of their induction that consisted of being provided with reading material put together by the head chef. [226 / 434].

"I make them go through food hygiene notes that I have done, which covers washing hands and chopping boards and I test them now and again." [ID1068]

There was no guarantee that the head chef or individual responsible for provision of information, induction or training had appropriate qualifications or skills or was able to train others effectively. Furthermore, food handlers did not necessarily have food safety qualifications when hired although some FBOs – typically those with higher FHRS ratings – did make some effort to recruit staff with existing qualifications.

Regularity and implementation of training were typically inadequate. A few businesses offered training on a regular basis, but of these two provided an in-house, voluntary refresher training every two or 'few' years [262 + 299] and only one offered training more regularly and with an external provider. [1005] There was some evidence of businesses using spot checks as way to implement and reinforce good practice but these tended to be ad hoc and irregular - 'keeping an eye out for things' [ID617] - when carried out internally and also tended to be considered the responsibility of one person / the manager or head chef.

"You need a pair of eyes which are open, that see how things are done… The staff training teaches how to do things but it is up to the manager's knowledge and ability to make sure that things are done correctly." [ID262]

There were two salient barriers to engagement with training. Firstly, environmental context and resources barriers such as money, time, staff turnover as well as logistical considerations like being in a position to deliver in-house training or send employees on external training. FBOs do not always have the 'bandwidth' [IDP1] to organise and deliver training not least because this is often, at least as far as internal training is concerned, the responsibility of one person (typically the head chef) who is already very busy.

"Money and time. and staff turnover…Ideally you would have a full induction before you even start to work but the reality is that sometimes you need people to start as soon as possible." (235, FHRS 4)

"We do send them on courses, but it's just about getting ourselves organised to send them…which is why I make them work through my food hygiene notes. A lot of it is a labour thing. If you're sending people on courses, then you're down one member of staff and you'd have to find cover." [ID1068]

Where training is deemed useful it is not necessarily in the interests of an FBO to invest in external employee training immediately. The decision to train a member of staff is based primarily on whether that individual is likely to stay or not and is therefore worth investing in. One FBO stated a clear preference for face to face training over online training despite it costing £100 per person, substantially more than online training.

Language difficulties - whether or not the individual in question is able to speak English and/or a language in which training is provided were also reported as a potential barrier to training. Some FBO managers believed that training would not be available in the right languages (e.g. Hindi) but didn't actually know and some made a decision to train based on whether or not they considered a staff member's language skills sufficiently good to make training worthwhile.

"The learning environment in a classroom is much more conducive to the information sinking in. If they are doing it online in their own language, which they can do, it's easy enough to pass and for it to go in one ear and out the other." [ID888]

In addition to these various environmental influences, participant *beliefs about capabilities* acted as a barrier to engagement with training. Participants perceived themselves to already have the necessary capabilities for effective food preparation and because they saw training to be an exercise in common sense. This view was sometimes associated with the idea that any training beyond an in house induction and provision of guidance made further training unnecessary.

"I have been in the industry whole my life, so I knew a lot [about food preparation before taking the training] …you go over a lot of stuff that is common sense." (ID703, FHRS 4]

"[Is training necessary to ensure good food hygiene?] No, as long as each chef reads the guidance and implements it." [ID226, FHRS 5]

Participants were asked how they might be better supported in ensuring appropriate practice in food preparation and production and there were several suggestions to improve training and engagement with training. They recommended that: available training could be streamlined and irrelevant information removed; training could be made more available and accessible (i.e. shorter, online); there should be demonstrations of relevant behaviours as part of all training (effectively a 'Modelling' intervention); and training should be available in a greater variety of languages.

"Time [is a challenge]. online trainings are good. They should be in small segments. I did the food safety training online. They should look at smaller segments. For instance, this part has to do with cross contamination… then you can do that part of training, stop and start again another segment. You should do the bit that is relevant to you, not all in one go. Time is a barrier; it is always an issue." (233, 5 FHRS)

There may also be a broader issue about the usefulness of training, related to mode of delivery. One FBO suggested that online training may not be effective because it may be more difficult for participants to retain and implement relevant information. This may be a pertinent concern given that one FBO stated that although

they had a Level 2 Food Hygiene qualification they had taken the online test and guessed all the answers. Finally, FBOs also suggested that some assistance with cost – whether through subsidy – or by making training freely available would be desirable.

2.10.2 Education

Participants identified a need for education and information both in terms of the most up to date information around food safety and hygiene but also more specific information in relation to norovirus. One FBO stated that there was little understanding of how food safety and hygiene practices and ratings related to microbiological reports and that it would be helpful to understand the relationship between these two things, for both an FBO and a food handler. This lack of norovirus-specific information and the lack of any link between hygiene behaviours and practices and norovirus is also a shortcoming of the general training that food handlers tend to receive.

2.10.3 Enablement

Enablement – "Increasing means / reducing barriers to increase capability…or opportunity" – includes forms of 'social support', both general and practical. One suggested way to address the education and information gap was through more regular and constructive visits and inspection implying a different role for and relationship with Environmental Health Officers (EHOs). Currently, visits from EHOs are thought to be critical without being particularly constructive and 'scary' or frightening'. However, EHOs are thought to not only inspect but "to provide advice and updates" and give establishments the means to improve rather than just telling them what they are doing wrong.

> *"They should come in regularly to check you are doing OK. now they come in every 18 months / 2 years […] They should keep you updated you, tell you about the new legislation…" (703, 4 FHRS)*

> *"It would be nice if the Environmental Health Officer had a 1-2-page newsletter, offering a few tips on our work, and relevant information. EHO should not be frightening you, they should be working with you." (233, 5 FRHS)*

> *"When the council sends the inspector, it is very scary… They pick on points, this is not good, this is not good either…. It would work if first they come in and tell how you could improve; and then they come and assess you." (ID 1067, 3FHRS)*

2.11 Towards intervention strategies to support behaviour change

Using the links between intervention functions and policy categories (see Appendix 8) the most likely relevant and applicable policies to support the delivery of intervention functions in this context are: 'communication/marketing', 'guidelines', 'environmental/social planning' and 'service provision.' With this in mind we outline a four part, complementary intervention strategy that may be feasible in this context. This strategy is offered as one way to address this behaviour change challenge that could usefully target all the 'Domains' and integrate all the 'BCT's' identified above. However, this strategy has not been subjected to any

scrutiny in terms of viability using APEASE or any other systematic criteria for designing and evaluating interventions.

Table 16: Proposed intervention strategy

Intervention strategy component	Outline
Training	One to one training of the Kitchen Manager (KM) – or equivalent – that focusses on i) the target behaviours and prepares the KM to train others. The training of the KM to be delivered by a 'credible source', perhaps an EHO as part of an inspection. One of the most important factors influencing sustained adoption of safe water, hygiene and sanitation technologies, albeit in a different setting, is personal contact with a "health promoter" over a period of time.[lxix] Personal follow-up in conjunction with on-going communications and other forms of support may contribute further to sustained adoption. It is conceivable that EHOs or similar, could play a role analogous to the 'health promoter.'
E-Learning	Provision of a video and/or internet package to support the training of the KM and to support the KM's training of food handlers (and ideally to allow food handlers to rain other food handlers). This mode of delivery could, for example, easily support demonstrations of hand washing practice that it may not always be feasible to provide face to face.
Resources	A range of complementary resources – 'guidelines', training materials that allow for effective delivery of BCT's e.g. Action Planning templates, posters etc. – that can be used as part of an individual training pack as a take away and/or at the FBO level.
Awareness	Designated day(s) or even week periods immediately prior to seasonal peak periods for norovirus outbreaks[lxxlxxi] designed to focus attention on norovirus, increasing the salience of the challenge and associated consequences. This could, for example, be communicated at a Local Authority level perhaps synchronised with the Training component. As suggested above – Training – personal follow-up in conjunction with on-going communications. *Awareness* of some sort – may contribute to sustained behaviour change. Although the focus here is on norovirus it may offer a way to ensure repeated focus on key behaviours common to different pathogens, using different awareness periods at different time of year. The way in which this period of 'Awareness' would be communicated is an open question but could be anything from a simple, appropriately designed letter to a more substantive communications campaign.

Section 3: discussion

3 Discussion

This study suggests that there are multiple barriers to both broad *Control Strategies* and specific target behaviours: i) inadequate hand washing and drying (a component part of the *Personal Hygiene* control strategy) and ii) returning to work too early (a component part of the *Fitness to work* control strategy).

Knowledge and *Skills* - were key barriers to mitigating norovirus transmission across all control strategies and target behaviours. Lack of knowledge of norovirus, and awareness of the relevance and implications of norovirus to food handling might have been anticipated. What was more surprising was the knowledge and skills gap in terms of the awareness, and application of, recommended behaviours that comprise more generic hygiene practice but are also components of norovirus control strategies; particularly hand washing and drying.

While Knowledge and Skills acted as barriers to both target behaviours it was also clear, particularly in the case of inadequate hand washing and drying, that having relevant Knowledge and Skills were insufficient to ensure performance of the target behaviour. Knowledge (and Skills) are likely important conditions for behaviour change[lxxii] and there is some evidence of a link between improved knowledge and improved hygiene practices.[lxxiii] However, while *Capability*-related domains may act as facilitators for the target behaviours they are likely necessary rather than sufficient conditions for behaviour change.

Environmental Context and Resources and *Social Influences* – were key barriers to both target behaviours and all but one of the control strategies. Environmental barriers were typically present both in terms of characteristics of the setting (time scarcity, busyness, workload and in the case of returning to work, money and pay) and the physical design and infrastructure of food handling environments. Both frequent micro-behaviours – hand washing, glove use, surface cleaning – and more infrequent behaviours – uniform cleaning and exclusion from work – were environmentally influenced in different ways.

A potential environmental facilitator of desirable behaviour is the integration of target behaviours into existing workplace processes. It was noticeable that in the case of the Control Strategy "Washing and cooking food" (specifically "Not washing fruit and vegetables during processing/preparation") that the reason this did not appear to be a norovirus transmission risk was that the practice had been made part of an existing food preparation routine. Although one-off behaviours are easier to routinize in this way it may be worth considering the possibility of routinizing hand washing practice as part of a regular, repeated preparation process enabling the *Habit Formation* BCT.

Social Influences – both injunctive and descriptive norms – and social desirability are commonly acknowledged to influence hygiene related practices.[lxxiv] However, in this setting, social norms are barriers in the sense that there was the lack of social pressure or expectation to engage in recommended behaviours. This may in turn be partly a result of knowledge gaps, not knowing what is appropriate or not, as well as the assumption that recommended practice is already happening.

Social Influence offers a potentially very important facilitator of behaviour change in this setting both for Control Strategies and target behaviours. Role models have been shown to be influential in changing

healthcare professional behaviour and specifically in improving hand hygiene compliance.[lxxv] Further, identity – and the degree to which a behaviour is believed to align with, strengthen or undermine a person's social or professional role and identity – is a potentially important influence on behaviour[lxxvi][lxxvii] even though there are no BCT's directly associated with this domain.[lxxviii][lxxix] One specific intervention with demonstrated success in norovirus outbreak prevention is the training and certification of Kitchen Managers in appropriate food safety practices.[lxxx] This study supports the idea that Kitchen Managers are influential in terms of food handling practice and are typically responsible for training food handlers. However, Kitchen Managers do not always have the capability or opportunity to train staff effectively even when motivated to do so.

There was also clear evidence of motivation-related barriers, which had not been highlighted in the existing evidence. Perceived threat – either in terms of susceptibility to, severity of illness and/or perceived outcomes – has been identified as an influence on sustained adoption of hygiene behaviours.[lxxxi] However, one very clear finding – related to *Knowledge* - was that there was little understanding of the potential consequences of norovirus and consequently no beliefs about the negative consequences of not engaging in hygiene behaviours specifically related to norovirus. *Beliefs about Capabilities* was a salient barrier especially regarding inadequate handwashing because it was common for food handlers to express confidence, and perceive that they were competent, in their behaviours even when that was clearly not the case. Related to this, it was not uncommon for food handlers to express an intention to do what they perceived to be the right thing but either they did not know what that was or they did not act on their intention. Therefore, *Intention* is a potential facilitator of behaviour change but it relies on having sufficient capability and being able to close the gap between intention and behaviour, hence the suggestion of using the *Action Planning* BCT.

Finally, it is important to recognise the role of the *Reinforcement* domain and the 'Habitual Level.'[lxxxii] The environment may facilitate or hinder more automatic (hand washing) or more routine (uniform cleaning, washing of fruit and vegetables and possibly surface cleaning[lxxxiii]) behaviours. Clearly, food handling environments support both 'good' and 'bad habits'[lxxxiv] and it is important to consider how environments can be influenced to support more good habits, hence the focus on BCT's like *Restructuring the physical environment* and *Habit Formation* BCT's.

We have suggested a variety of BCT's that might be part of behaviour change interventions but certain BCT's may be worth particular consideration. Evidence from the wider literature suggests that more effective combinations of BCT's for changing health behaviour[lxxxv] include providing information about the behaviour and health link or consequence and prompting intention formation or use of follow up prompts.[lxxxvi] This might suggest that "Information about Health Consequences", 'Salience of Consequences', "Action Planning" and appropriate "Prompts / Cues" may be effective when used in combination. These BCT's might be relevant to both target behaviours and all components of the suggested intervention strategy with the possible exception of Action Planning' in the case of Awareness days or weeks. The BCT 'Modelling or demonstrating the behaviour' seems important for both target behaviours given that it targets the *Social Influence* domain but also indicates what the recommended behaviour actually is. In addition to the above BCT's, in the case of frequent behaviours such as handwashing, Behavioural practice / rehearsal', and ideally 'Habit Formation' (although this may be less feasible) are likely important. In the case of the less frequent 'returning to work too early', 'Social support or encouragement' and/or 'Social reward' are likely important because it is important for the recommended behaviour to be perceived as acceptable and legitimate by managers and staff. Finally,

'Restructuring the physical environment' as far as possible in this context is likely to be important especially in supporting hand washing and drying. Memory, Attention and Decision-Making was identified as a barrier to effective hand washing and although there are no BCT's linked to this domain, 'Restructuring…' and 'Prompts / cues' may have a role in targeting attention. This study has focussed on behavioural influences and BCT's, the *why* and *what* of intervention development. Despite the suggestion of broad intervention strategies there has not been any comprehensive, structured, consideration of the equally important question of *how* interventions should be delivered. This question is outside the scope of this work but we would stress the likely importance of the Kitchen Manager, or equivalent, as a recipient, and provider of relevant interventions.

In order to provide a focus to this study we selected i) inadequate hand washing and drying and ii) returning to work too early. This was undertaken on the basis of recommended practice in behaviour change intervention development in making an assessment of likely impact, and ease of, behaviour change.[lxxxvii] This position is not only supported by this study but also the wider literature which suggests that improper hand washing is very common and a significant proportion of all outbreaks of norovirus infection are linked to ill food service workers.[lxxxviii] While we recommend focussing on these two behaviours we also recognise that neither of these behaviours are necessarily easy to change. This may be particularly true in the case of returning to work too early especially when that behaviour is intentional as opposed to unintentional. Although one individual may exhibit both types of behaviour it may be more feasible to change unintentional early return to work (given that behaviour is more likely driven by a Knowledge deficit) than intentional early return to work (given that behaviour is more likely driven by Environmental factors, specifically, wages).[lxxxix]

It may also be worth considering other target behaviour candidates. For example, while 'not cleaning and disinfecting food preparation equipment and surfaces' might not have the likely impact of either of the two suggested target behaviours it may be easier to change. A future intervention strategy might incorporate this as an additional target behaviour especially as this behaviour shares many of the same barriers as inadequate hand washing and drying and is similarly routinized or automatic. We also acknowledge the likely importance of bare hand contact with food as a means of norovirus transmission[xc] but as discussed above it was judged as less of a priority for intervention because of the difficulty of associated behaviour change.

3.1 Strengths and weaknesses

This study has several strengths including, eliciting the perspectives of more than one type of participant i.e. FBO and food handler, using a complementary mixed methods approach to mitigate the shortcomings of either verbal reports or observational data; and use the TDF ensured as comprehensive assessment of behavioural influence as well as an applied perspective in that we were able to credibly link assessment of influence with both intervention function and BCT. This study has also contributed to the existing evidence base by identifying a greater number of possible barriers to norovirus transmission control strategies while nuancing some of the barriers already known about. Finally, this study has also made an informed prioritisation of the components of Control Strategies to support the targeted development of behaviour change interventions.

The principal limitations of this study include the clear potential for reactivity and social desirability bias despite attempts to mitigate this both in research design and data collection; challenges with the audience especially

language barriers which may have reduced data quality and depth; selection bias, in the sense that those businesses that chose to participate may have been systematically different to those that did not despite having a range of business types and food hygiene rating (FHRS);; and the early lack of focus in terms of behaviour in the sense that consideration of broad control strategies did not allow pursuing recommended practice to focus on just one or two behaviours at the beginning of the study[xci]; and finally, these findings, while broadly consistent with analogous studies[xcii][xciii], are not generalizable and therefore barriers, interventions and BCT's may differ by, and need to be adjusted for, local context.

3.2 Conclusion

In conclusion, we suggest developing multifaceted interventions that use some combination of the recommended BCT's that target salient behavioural drivers. However, interventions are exercises in the "art of the possible"[xciv] and must be translated into a "practical application" that fits with "target population, culture and context."[xcv] On the basis of workshop discussion with FSA stakeholders we suggest the proposed intervention strategy as a plausible way forward but recognise that there has been no substantive consideration of what is "possible" or what "practical application" looks like. We recommend that this study provides a foundation for "meaningful intervention design work"[xcvi] in supporting a program of "needs assessment co-creation" with relevant stakeholders (FBOs, food handlers, Local Authorities, EHOs). This would help respond to the question of what is possible and what applications may be most practical, feasible and effective in this setting.

Chris Perry
Associate Director
Chris.Perry@ipsos.com

Graham Bukowski
Associate Director
Graham.Bukowski@ipsos.com

Elena Di Antonio
Research Manager
Elena.Diantonio@ipsos.com

Eleanor Thompson
Research Manager
Eleanor.Thompson@ipsos.com

Connor Leckey
Research Executive
Connor.Leckey@ipsos.com

For more information

3 Thomas More Square
London
E1W 1YW

t: +44 (0)20 3059 5000

www.ipsos-mori.com
http://twitter.com/IpsosMORI

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4 End notes

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[ii] The General Food Law Regulation (EC) 178/2002 is directly applicable EU legislation and provides the general principles of food safety which include the requirement on food businesses to place safe food on the market, for traceability of food, for presentation of food, for the withdrawal or recall of unsafe food placed on the market and that food and feed imported into, and exported from, the EU shall comply with food law. Available at: https://www.food.gov.uk/enforcement/regulation/foodlaw

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[iv] Cambridge Dictionary. Available at: http://dictionary.cambridge.org/dictionary/english/habit

[v] Michie, S., Van Stralen, M.M., West, R. (2011) The behaviour change wheel: A new method for characterising and designing behaviour change interventions, Implement Sci. 2011; 6: 42. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3096582/

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[viii] O'Brien, S., et al (2014) Costed extension to the Second Study of Infectious Intestinal Disease in the Community: Identifying the proportion of foodborne disease in the UK and attributing foodborne disease by food commodity, Food Standards Agency. Available at: https://www.food.gov.uk/sites/default/files/IID2%20extension%20report%20-%20FINAL%2025%20March%202014_0.pdf

[ix] University of Liverpool (report pending) Assessing the contribution made by the food chain to the burden of UK-acquired norovirus infection, Food Standards Agency. Available at: https://www.food.gov.uk/science/research/foodborneillness/b14programme/b14projlist/fs101040

[x] Michie, S., Van Stralen, M.M., West, R. (2011) The behaviour change wheel: A new method for characterising and designing behaviour change interventions, Implement Sci. 2011; 6: 42. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3096582/

[xi] Ibid.

[xii] Michie, S. et al (2013) The behaviour change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behaviour change interventions, Ann Behav Med. 2013 Aug;46(1):81-95. Available at: https://www.ncbi.nlm.nih.gov/pubmed/23512568

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[xvii] Accessing the contribution made by the food chain to the burden of UK-acquired norovirus infection (NoVAS Attribution Study) http://www.novas.org.uk/

[xviii] Prevalence of norovirus in the catering environment in outbreak and non-outbreak premises http://www.novas.org.uk/the-project/work-package-5/

[xix] FSA defined catering premises as a commercial or voluntary organisation that prepares and serves food to the final consumer. This includes restaurants, public houses, cafes, takeaways, hotels, guesthouses, and caterers. It does not include passenger carrying ships that travel outside the UK, the private supply of food, retailers selling packaged and prepared foods and which do not handle and prepare food, manufacturers and suppliers.

[xx] The list of establishments visited as part of the norovirus prevalence survey was provided to Ipsos MORI as sample for recruitment but all declined to participate in our study on the basis they were not able to fulfil the research commitment.

[xxi] This was handed over by the researcher to the gatekeeper / owner / manager of the businesses at the start of the visit. It was up to them how this money was distributed amongst participating staff although we recommended this was done in the following way: the employee interviewed (i.e. food handler) receives £20, and each staff member to complete the survey receives £10 each. For any money left over, it was up to the gatekeeper / owner / manager to decide how this should be distributed.

[xxii] Atkins, L. et al. (2014) An adaptive interviewing approach using the Theoretical Domains Framework to identify influences on variation in adenoma detection rates

[xxiii] Green, L. R., et al. (2006) Factors related to Food Work Hand Hygiene Practices, Journal of Food Protection, Vol. 70, No. 3, 2007, Pages 661–666. Available at: https://www.cdc.gov/nceh/ehs/ehsnet/Docs/JFP_Food_Worker_Hand_Hygiene.pdf

[xxv] Buetow, S. (2010) Thematic analysis and its reconceptualization as 'saliency analysis', J Health Serv Res Policy. 2010 Apr;15(2):123-5. Available at: http://www.ncbi.nlm.nih.gov/pubmed/19762883

[xxvi] Ibid.

[xxvii] Neale, J., Miller, P., West, R. (2014) Reporting quantitative information in qualitative research: guidance for authors and reviewers, Society for the Study of Addiction, Vol 109, Issue 2, pages 175-176. Available at: http://onlinelibrary.wiley.com/doi/10.1111/add.12408/full#references

[xxviii] The five control strategies are "Personal hygiene"; "Food handling", "Washing and cooking food", "Surface and uniform cleaning", and "Fitness to work".

[xxix] The law requires food handlers to be excluded from work if they have an infection that can be passed on through food and there is any likelihood of them contaminating food directly or indirectly (this would normally be diarrhoea or vomiting). The exclusion period is normally 48 hours from when symptoms stop naturally. Different action is required in special cases. (From the FSA's *Fitness to Work* guidance): https://www.food.gov.uk/sites/default/files/multimedia/pdfs/publication/fitnesstoworkguide09v3.pdf

[xxx] Yellow shading indicates which 'Domains' acted as salient barriers to each *Control Strategy*.

[xxxi] 'Asymptomatic food handlers' – a component of the 'Fitness to work' control strategy is not strictly a 'practice' or 'behaviour' but is related to and may help explain why, some food handlers return to work too early and it is likely sensible to consider these components together when it comes to intervention development.

[xxxii] Michie, S., Van Stralen, M.M., West, R. (2011) The behaviour change wheel: A new method for characterising and designing behaviour change interventions, page 113. Available at: http://www.behaviourchangewheel.com/online-book#113

[xxxiii] Ibid. page 22. Available at: http://www.behaviourchangewheel.com/online-book#22

[xxxiv] Ibid. page 150. Available at: http://www.behaviourchangewheel.com/online-book#150

[xxxv] Cane, J. (2015) From lists of behaviour change techniques (BCTs) to structured hierarchies: comparison of two methods of developing a hierarchy of BCTs, Br J Health Psychol. 2015 Feb;20(1):130-50. Available at: https://www.ncbi.nlm.nih.gov/pubmed/24815766

[xxxvi] Kok, J. et al (2015) A taxonomy of behaviour change methods: an Intervention Mapping approach, Health Psychology Review, Volume 10, 2016, Issue 3, pages 297-312. Available at: http://www.tandfonline.com/doi/full/10.1080/17437199.2015.1077155

[xxxvii] Ibid.

[xxxviii] Kok, J. et al. refer to Behaviour Change Methods rather than Techniques

[xxxix] Kok, J. et al (2015) A taxonomy of behaviour change methods: an Intervention Mapping approach, Health Psychology Review, Volume 10, 2016, Issue 3, pages 297-312. Available at: http://www.tandfonline.com/doi/full/10.1080/17437199.2015.1077155

[xl] Indicates whether the BCT is relevant (Y) might be relevant (M) or is not relevant (N) to the specified Control Strategy component.

[xli] TB1 refers to 'Inadequate hand washing and drying'

[xlii] TB2 refers to 'Returning to work too early'

[xliii] Neal, D. et al (2015) The Science of Habit: Creating Disruptive and Sticky Behavior Change in Handwashing Behavior, Catalyst Behavioural Sciences. Available at: http://www.washplus.org/sites/default/files/resource_files/habits-neal2015.pdf

[xliv] Weller, C. (2016) This checklist will tell you whether your home is designed for healthy eating. Business Insider UK. Available at: http://uk.businessinsider.com/healthy-eating-checklist-fat-proofs-your-kitchen-2016-6?r=US&IR=T

[xlv] Slim By Design (2014) Help Your Kitchen Make You Slim. Available at: http://www.slimbydesign.com/wp-content/home-resources/092114-sbd-home-scorecard.pdf

[xlvi] We are aware of the significant and serous criticism of Brian Wansink's work, for example: http://andrewgelman.com/2017/02/03/pizzagate-curious-incident-researcher-response-people-pointing-150-errors-four-papers-2/ - however, we offer the examples in the previous two footnotes as a principle for the sort of intervention that might have behaviour change potential in this context. In addition, the recent criticism of Wansink's work i) does not refer to the kinds of intervention principles we have indicated and ii) as Gelman points out it is conceivable that Wansink's research may do more harm than good despite methodological and statistical problems and errors - http://andrewgelman.com/2017/01/31/criticism-bad-research-harm-good/.

[xlvii] These examples overlap with other BCT's including "Avoidance/reducing exposure to cues for the behaviour' and 'Adding objects to the environment'

[xlviii] We make a distinction between prompts and cues based on the distinction made by Hollands et al between prompting – "use non-personalised information to promote or raise awareness of a behaviour" - and priming –

"place incidental cues in the environment to influence a non-conscious behavioural response". https://www.biomedcentral.com/content/supplementary/1471-2458-13-1218-S2.pdf
[xlix] Hollands, J. G. et al (2013) Altering choice architecture to change population health behaviour: a large-scale conceptual and empirical scoping review of interventions within micro-environments, Behaviour and Health Research Unit, University of Cambridge. Available at: http://whconference.unc.edu/files/2014/11/neal.pdf
[l] Centers for Disease Control and Prevention (2017) Handwashing: Clean Hands Saves Lives, Health Promotion Materials. Available at: https://www.cdc.gov/handwashing/posters.html
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[lix] http://www.glogerm.com/
[lx] http://www.germjuice.com/
[lxi] https://www.brevis.com/
[lxii] http://www.surewash.com/
[lxiii] Indicates whether the BCT is relevant (Y) might be relevant (M) or is not relevant (N) to the specified Control Strategy component.
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already been proposed as promising for translation into practical applications but it may be that others are worth considering, specifically in terms of targeting *Social/Professional Role and Identity,* most obviously *Incompatible beliefs* and *Identity associated with changed behaviour*.

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