Covid at Work Study in the Food and Drink Processing Industry: Summary of Results

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The PROTECT COVID-19 National Core Study on transmission and environment is a UK-wide research programme improving our understanding of how SARS-CoV-2 (the virus that causes COVID-19) is transmitted from person to person, and how this varies in different settings and environments. This improved understanding is enabling more effective measures to reduce transmission – saving lives and getting society back towards 'normal'.

The Covid@Work Study (CAWS) was carried out with the aim of improving understanding of the impact of the COVID-19 pandemic on the Food and Drink Processing Industry (FDPI) sector, as well as the impact of mitigation measures on the sector. As an essential sector, the FDPI continued to operate throughout the pandemic as it had done prior, responding to and negotiating mitigating measures as they were introduced. This summary of results covers the findings of the study, which was broken down into three stages: an initial online survey, a secondary telephone survey, and finally stakeholder interviews from across the sector. The study was carried out by a team of researchers from the Institute of Occupational Medicine, the London School of Hygiene and Tropical Medicine, and the University of Manchester. The report identifies indicators of transmission risk, the challenges faced by companies in responding to mitigating measures and employee shortages and the efficacy of these measures within the sector.

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Covid at Work Study in the Food and Drink Processing Industry: Summary of Results

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Summary

The Food and drink processing industry (FDPI) represent an essential sector that maintained operations throughout the pandemic and periods of lockdown, and thus were considered at potential risk for work-related outbreaks of COVID-19. This part of the PROTECT Programme aimed to study the impacts of the pandemic on the FDPI and evaluate the barriers and enablers of mitigation measures in the sector.

The FDPI study, the 'Covid @ Work Study' (CAWS), engaged with the FDPI community primarily through various industry federations or associations and unions. This was a challenging time for the sector, due to both the pandemic and Britain's withdrawal from the European Union, both of which created uncertainties in the supply/demand chains as well as workforce availability.

The CAWS included an online baseline survey, a follow-up interview survey, and sector stakeholder qualitative interviews. In addition, a literature review was performed to examine other FDPI studies globally. To examine the risks in the FDPI in the context of other essential sectors which continued to operate throughout the pandemic, results from another PROTECT analysis were included in this report.

Key findings:

- In a sample of companies within subset of sectors (primarily beverage, grain milling, malting, distilling, prepared meals, and baked goods sub-sectors), infection rates appeared to be most influenced by deprivation in the surrounding community, with those with more remote workers at less risk and those with larger numbers of workers overall, to be at higher risk.

- Based on Office of National Statistics data, the FDPI sector as a whole was not necessarily at greater risk of infection than other essential sectors, but risks varied depending on location. However this is an aggregate analysis and does not include risks to individual FDPI sub-sectors.

- Environmental factors such as ventilation, temperature, humidity, and noise were identified by stakeholders and experts in the sector, as potential factors that raise transmission risks, but in some cases infrastructure limited companies' ability to implement controls such as improved ventilation (especially fresh air intake) and social distancing. There was desire for more information on the impacts of these factors and related controls.

- Infection risk was higher for companies with a larger number of workers on site, in particular where workers tend to work in closer proximity to each other.

- Socioeconomic factors are important with respect to communication and implementation of risk mitigation measures. The FDPI workforce tends to be of lower income levels and temporary or migrant workers often work in this sector. Language and financial barriers were among the challenges faced by companies. Companies acknowledged that providing more than statutory sick pay enabled their workers to take leave when ill, an important measure to prevent workplace transmission of illness.

- Inconsistencies rapid changes in government policies and guidance across the UK made the COVID-19 response challenging for the industry.

Background

Food and drink processing industry (FDPI) facilities represent an essential sector that maintained operations throughout the pandemic and periods of lockdown. There was some evidence early on in the pandemic which indicated that the FDPI may be at high risk for outbreaks and infection-related impacts in general. This was thought to be due to factors relating to the type of work done and work organization in FDP facilities, e.g. large number of workers in close proximity, cold temperatures, a workforce with a large percentage of migrants and low socioeconomic status workers. There is, however, a lack of information on COVID-19 in the FDP sector in the UK.

We developed a programme of work called the Covid@Work Study (CAWS), a subset of sector specific studies in Theme 3 of the PROTECT programme. CAWS included a literature review and a three-stage study which used both quantitative and qualitative methods to evaluate COVID-19 risks, mitigation measures, and enablers and barriers related to managing COVID-19 risks. A diagram of the study is shown in Figure 1.

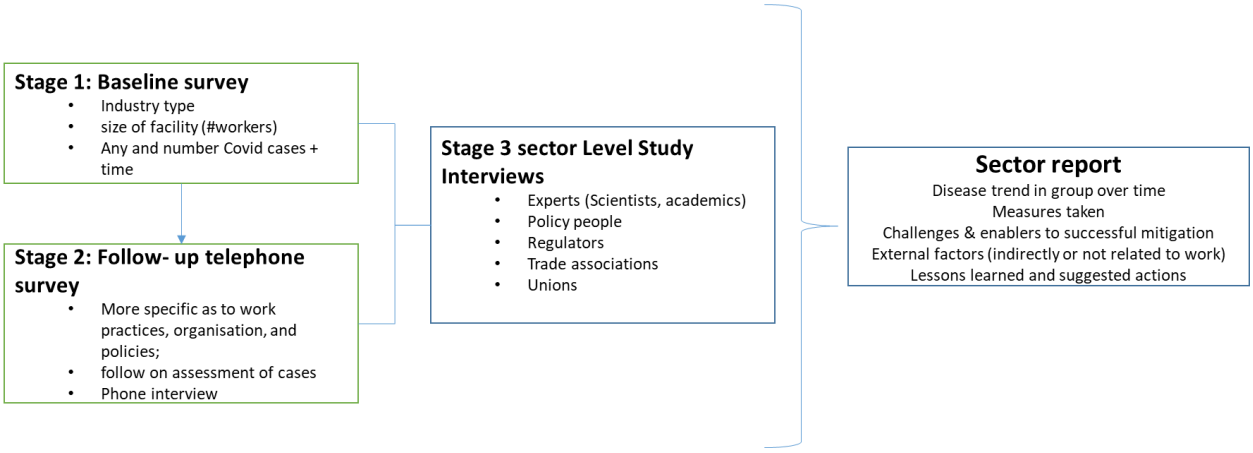

Figure 1: Stages of the COVID-19 @ Work Study

Stage 1 and Stage 2 of CAWS were designed to ascertain the number of COVID-19 cases and information about the worksites over time. These were designed as questionnaires to be completed by facility managers. Stage 1 provided the baseline population of companies for the study and was done as an online survey to reach as many companies as we could. Stage 2 primarily followed up the facilities from Stage 1 using an interviewer administered survey. Stage 2 focused on gathering updated information regarding number of COVID-19 cases and facility operations, with an expansion to include mitigation measures implemented at various times of the pandemic. Our recruitment strategy for Stages 1 and 2 relied on engaging with industry federations and unions. Stage 3 complemented the other two stages using qualitative methods. Semi-structured interviews were done with representatives from a range of stakeholders related to the FDP sector (see Figure 1).

Details of the CAWS and literature review are found in the appendices 1 to 4. Additionally, the CAWS was presented at a PROTECT public webinar on 3 March 2022, entitled ‘Food manufacturing: a high-risk environment for COVID-19 virus transmission? Slides for this are also found in the appendix 5.

Stage 1

METHODS

We developed an online CAWS survey to ascertain site-specific information for food and drink production facilities on workplace factors (e.g., site purpose, number of workers), characteristics potentially related to virus transmission (e.g., ventilation, temperature), and COVID-19 outcomes (e.g., testing, positive cases). To recruit companies, we held discussions with food federations and associations in the UK food and drink processing sector. We encouraged them to send their members information about the survey, including the survey website. The survey was administered via https://www.onlinesurveys.ac.uk/ from 15 January to 15 July 2021. The study was approved by The London School of Hygiene and Tropical Medicine Research Ethics Committee (ref: 22908).

We obtained cumulative COVID-19 case rates per 100,000 population for lower tier local authorities (LTLAs) from the UK government (coronavirus.data.gov.uk/details/download). As an indicator of area-level socioeconomic status (SES), we used the mean Index of Multiple Deprivation (IMD) decile in a 1 km area surrounding each facility. Monthly COVID-19 incidence rates per 1,000 employees at each site were calculated: the numerator was positive cases reported in a given time period and the denominator was total workers at the site; the ratio was then divided by the number of months in the period and multiplied by 1,000.

We performed negative binomial regression on a subset of reported characteristics due to the small sample size of our dataset. The main analysis used manufacture of beverages as the reference group, since it had the median COVID-19 incidence rate. We only included sites that had complete data for each covariate, ≥5 workers on site, and ≥5 sites within each industry subgroup; n=52 sites were included in analysis.

RESULTS

66 individual sites completed the survey. COVID-19 cases were reported from the start of the pandemic up to June 2021. Respondents represented a range of industry subgroups, including grain milling/storage (n=16), manufacture of malt (n=14), manufacture of prepared meals (n=12), manufacture of beverages (n=8), distilling (n=5), manufacture of baked goods (n=5), and other (n=6), with a total of 15,563 workers across all sites. Lowest case rates were reported from sites working in distilling with an average of 0.9 monthly COVID-19 cases per 1,000 workers; highest reported rates were in the sites working in grain milling/storage sector with an average of 6.1 monthly COVID-19 cases per 1,000 workers.

In fully adjusted models, all Incidence Rate Ratios (IRRs) included the null value except for grain milling/storage (IRR = 2.22 [95% CI: 1.13-4.34]). Several local and workplace factors were related to decreasing risks of COVID-19 cases, including deprivation (IRR = 0.77 [95% CI: 0.64-0.93]), proportion of remote workers (IRR = 0.76 [95% CI: 0.61-0.96]), and the proportion of workers in close proximity (IRR = 0.91 [95% CI: 0.83-0.99]); higher numbers of workers were associated with an increased risk (IRR = 1.52 [95% CI: 1.15-2.00]) (Figure 2).

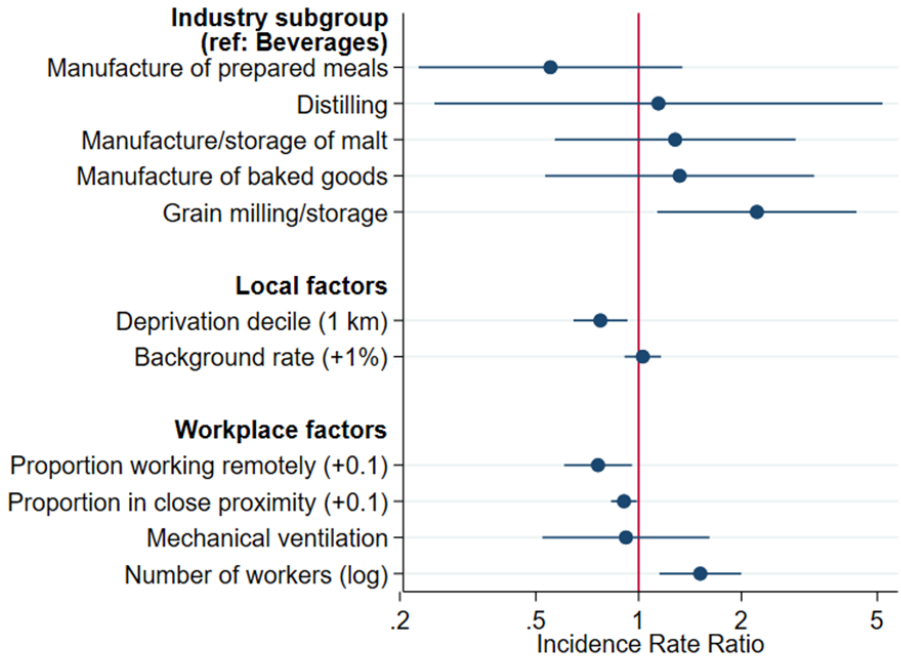

Figure 2. The Incidence Rate Ratios (IRR) for industry subgroups, local and workplace factors, adjusted for all covariates present (n=52 sites).

This survey was followed up by more in-depth structured interviews involving a subset of these same sites (i.e., stage 2), as well as informed by additional "deep dive" interviews of experts and stakeholders across the sector (i.e., Stage 3).

The Stage 1 CAWS results were submitted as a manuscript that is at present under review with the peer-reviewed journal, *Annals of Work Exposure and Health*. This manuscript and supplementary material are included in Appendix 1 of this report.

Stage 2

METHODS

The stage 2 CAWS questionnaire was developed to collect data on workplace changes since the Stage 1 survey, such as the number of workers, and also to collect additional information on experiences relating to the implementation and employee uptake of COVID-19 mitigation measures. We used a review (see Literature Review) we recently completed and information from government guidance to the FDPI to inform the selection of mitigation measures in the questionnaire. To elicit more detailed responses, we contracted a professional survey company to undertake telephone interviews of the survey respondents. As with the Stage 1 survey, we used the online platform, https://www.onlinesurveys.ac.uk/, to collect data, which the interviewers filled out.

We selected 49 sites from Stage 1 to invite by email for the stage 2 interviews. We calculated for each site monthly COVID-19 incidence rates per 1,000 employees since the date of the Stage 1 survey submission. Area-level socioeconomic status and local authority rates were calculated as was done in Stage 1.

RESULTS

Out of the 49 sites that were invited to participate in stage 2 interviews, 24 (49%) sites were represented in 13 completed interviews. Interviews were undertaken from 3 November to 22 December 2021. Nearly all (23/24, 96%) sites experienced at least 1 COVID-19 case since completion of the Stage 1 survey.

The interview questionnaire asked about the implementation of 30 different mitigation measures. Two thirds (20/30, 67%) of the measures were implemented at all sites. Most of the sites introduced measures during the initial phase of the pandemic in March-April 2020. However, some measures were implemented later in the pandemic, such as encouragement to get vaccinated and measures relating to visitors, possibly due to not allowing visitors on-site until later in the pandemic.

The median COVID-19 rate for the stage 2 period was 7.2 (minimum=0, maximum=23.4) monthly cases per 1,000 workers. The rates tended to be higher in stage 2 compared to Stage 1, as presented in Figure 3. The observed pattern of higher COVID-19 rates during stage 2 also reflects the trends in community rates, which were much higher during the stage 2 period. The lower tier rates during the Stage 1 and 2 periods were moderately positively correlated (r=0.43, p=.04).

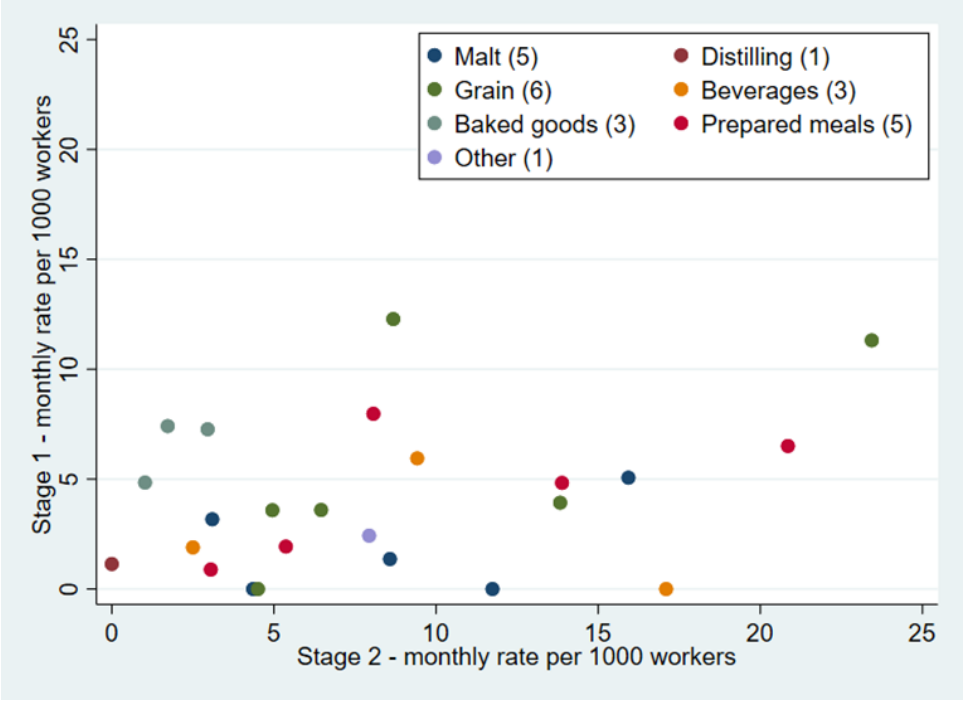

Figure 3. A scatterplot of the monthly COVID-19 rates per 1,000 workers reported in the Stage 1 and 2 surveys; colours refer to the product related to each site.

More details on results of the stage 2 CAWS survey are included in Appendix 2.

Stage 3

A series of qualitative semi structured ('deep dive') interviews were conducted with experts across the Food and Drink Processing Industry (FDPI) within the UK. The work formed part of the "Partnership for Research in Occupational, Transport, Environmental COVID-19 Transmission (PROTECT)" National Core Study programme[1]. The interviews sought to enhance understanding of COVID-19 virus transmission within the FDPI as well as challenges and enablers to the industry's response to the pandemic.

METHODS

A total of 21 semi structured ('deep dive') interviews were conducted remotely via video conferencing (e.g. Zoom or by phone) between August and November 2021. Written transcripts were generated and subject to independent quality checks before being subject to thematic analysis. This report presents the findings from across and within the different stakeholder groups consulted, namely: Government Agency representatives, Federations and trade associations, Unions and Academics in their respective fields deemed relevant to the study scope.

RESULTS

Supporting information exchange and engagement

- Unions, Government agencies and Federations used a variety of channels to communicate and engage with the FDPI. Amongst the most frequently cited were websites, emails/calls and webinars.
- Websites were considered the most effective channels across all stakeholder groups though stakeholders reported using them in different ways. E.g. Government agency respondents referred to websites used to signpost businesses to central sources of Government guidance, while Federations wrote quarterly newsletters which were accessible through their website for members.
- Additional communication channels cited included the use of industry forums, having "teams on the ground", magazine articles and feedback through meetings and groups.

Risk perceptions of the FDPI

- Specific risk factors identified for the transmission of COVID-19 within the FDPI included poor social distancing, size and age of buildings, temperature/humidity, noise and ventilation. Some respondents were however cautious not to attribute isolated risk factors for transmission of the COVID-19 virus.
- Wider transmission factors, including shared accommodation and transportation to and from the workplace were identified by Unions, Government agency and Federation respondents.
- Respondents acknowledged the difficulty of comparing food processing with wider industries, acknowledging the variation in production practices, products and facilities between different FDPI facilities and sub-sectors.
- FDPI sub-sectors believed to be at greatest risk for COVID-19 transmission were meat processing facilities, agricultural food picking/production and sandwich making.

Implementation of mitigation measures and protective practices

- COVID-19 mitigation measures believed to be effective within the FDPI included: effective testing, self-isolation, use of PPE, vaccination, physical distancing, cleaning/hand hygiene, good ventilation, risk assessments and limiting staff contact. Emphasis on these risk mitigation measures varied across different stakeholder groups.
- The importance of ensuring adequate risk assessments was emphasized as a key measure to mitigate COVID-19 transmission, as this should be specific to the workplace in question. Some respondents however felt that risk assessments had been too generic, based on Government guidelines, or focused too much on specific mitigation measures.
- Respondents generally acknowledged the importance of using a variety of mitigation measures together, rather than focusing or prioritizing one.

Compliance

- Government agency, Federation and Union respondents generally perceived good levels of compliance with COVID-19 measures within the FDPI. Challenges to securing industry compliance are discussed however, including frequent changes in Government guidelines.
- Many respondents cited FDPI businesses had implemented some form of compliance monitoring and support, e.g. car park spotters, COVID-19 marshals.
- Some respondents noted challenges in communication faced between workers and employers, particularly in settings where there were large numbers of agency workers and/or workers for whom English is not their first language.

Industry challenges in responding to COVID-19

- Balancing competing priorities and responding to changes in supply and demand was a challenge cited amongst Federations, Government Agencies and Union respondents.
- Workforce related challenges included labour shortages, self-isolation/ sickness absence and worker exhaustion.
- Financial challenges included costs associated with the implementation of COVID-19 control measures and staff sick pay.
- Federations, Unions and Government Agencies identified the fast pace of changing guidance as a challenge for the FDPI
- A number of challenges outside of the DFPI were also said to be impacting the industry alongside the COVID-19 pandemic, namely EU exit ('Brexit'), furlough and interwoven supply chains with other industries

Enablers to preventing COVID-19 transmission

- The introduction of financial support, either as sick pay from FDP businesses or through self-isolation payment support provided by the Government was the most prominent enabler cited.
- Other enablers cited by small numbers of interview respondents included the introduction of COVID-19 home testing, management buy-in within FDP businesses, introduction of the seasonal agricultural workers scheme within the agricultural sector, improved communication between workers and managers, mechanical ventilation and use of technology in general.

COVID-19 detection and response

- Means of identifying a COVID-19 outbreak varied between and within different stakeholder groups and encompassed notification from the FDP business themselves, contact with public health bodies, import bans introduced from other countries, Federation member surveys.
- Specific subsectors identified to have suffered large outbreaks included meat/poultry facilities, agricultural food picking/production and sandwich making.
- Some respondents were of the opinion that workplace outbreaks mirror rates of COVID-19 within the wider community, whilst others reflected on the significance of outbreaks within the FDPI when community rates were reportedly low.
- Some respondents expressed distrust in the accuracy of reported COVID-19 cases and outbreaks.

Looking forward

- It was anticipated that some COVID-19 measures would be retained within the FDPI, for reasons of maintaining good practice and in anticipating of needing to put them back in practice in future, though some anticipated challenges in trying to maintain practices within the workplace that will no longer be maintained within the wider community.
- Continued provision of financial support was considered to be important by some to ensure that people don't feel the need to come to work when they are unwell.
- Some respondents emphasised the importance of keeping good ventilation to prevent the spread of COVID-19 and other viruses.
- Lessons learned from the COVID-19 pandemic were considered relative to the design of future production facilities in order to allow more space for implementation of mitigation measures that may be needed and incorporating ventilation systems at the time of their construction.
- Respondents considered the potential use of technology in future to support management of the COVID-19 virus or similar, including automation of tasks, wearable technology to support social distancing; wastewater testing to support detection of COVID-19.

Gaps in knowledge

- Enhancing understanding of ventilation relative to transmission of the COVID-19 virus within the FDPI was identified as a gap in knowledge across three of the four stakeholder groups.
- Further gaps in knowledge identified by different stakeholder groups included: understanding transmission routes within the FDPI; understanding the FDPI workforce (in particular migrant workers); unknown future of the COVID-19 pandemic; the impact of temperature relative to transmission of the COVID-19 virus; and symptoms of the COVID-9 virus (said to change with different variants).

Industry concerns

- Respondents expressed various concerns related to future variants of the COVID-19 virus.
- Federations expressed concern for further lockdowns and the impact this may have on production, demand and staffing within the FDPI.

Literature Review

Further to the survey, a narrative literature review was conducted. This was due to reports at the beginning of the pandemic which suggested that a large number of outbreaks and clusters of COVID-19 were emerging within certain areas of the FDP sector. The essential nature of the FDP sector during the course of the pandemic also suggested that further understanding was required on the transmission and control of COVID-19 in these workplaces. In order to assess this potential risk, a review was conducted to provide an overview of the literature assessing the extent of transmission in the food processing sector along with the risk factors associated with COVID-19 infection/mortality rates in this setting, and the preventive measures used to reduce transmission.

Various research questions were generated for the review, including the following:

1. What is the evidence for an increased risk of infection, outbreaks and COVID-19 mortality in the food production sector compared to other sectors?
2. Which risk factors contribute to any elevated COVID-19 infection and mortality rates in the food production sector?
3. Which preventative measures/ risk mitigation strategies have been taken to reduce COVID-19 in the food production sector, and which have shown to be effective?

An electronic search was conducted using various scientific databases to gather the existing literature on this topic to date. The inclusion criteria included: 1) papers involving the level of transmission in the food production sector (including increased risk of infection, outbreaks and mortality), 2) papers with information on factors that are linked to an increased risk of COVID-19 infection in this sector, and 3) studies focusing on preventative measures or risk mitigation strategies in the food production sector. As there were a limited number of food-sector specific studies based in the UK, studies in other countries were also included.

The search strategy identified 26 papers that met the inclusion criteria, six of which were based in the UK, though the country with the most papers was the USA, with a total of nine papers. The review generated a mix of findings, with some papers suggesting that there was an increased risk of COVID-19 within the FDP sector, while others stating that risk of transmission, outbreaks or mortality were higher in other sectors (such as healthcare, public transport etc). Moreover, findings on transmission in the FDP sector varied by geographical location and sub-sector, with a higher level of information regarding risk of infection, outbreaks and COVID-19 found in meat/poultry facilities, also mainly based in the USA.

Findings from the literature suggested that the most significant risk factors associated with COVID-19 infection or mortality in the FDP sector included:

1) Ethnicity: ethnic minorities were more disproportionately affected, with studies suggesting that they were more likely to work in high-risk production areas and more likely to commute to work with individuals outside of their household when compared to workers from a non-ethnic minority background. The literature surrounding the FDP sector also found that ethnic minorities made up a large majority of the workforce when compared to other sectors.

2) Environmental factors: poor ventilation mixed with a lack of social distancing between workers in food factories was more likely to cause further aerosol transmission. Transmission of the virus was found to occur over distances of at least 8 metres in conditions with low air exchange and high rates of recirculated unfiltered air, which was found to be particularly common in many food production facilities.

3) Low income / sick pay: A majority of workers in the FDP sector were shown to have a lower source of income, alongside a lack of health insurance. This suggested that they were more likely to attend work even if they were unwell, and were more likely to share accommodation/transport with other individuals, meaning a further risk of transmission would be evident.

The literature focusing on the most effective preventative methods to reduce COVID-19 in the FDP sector was generally lacking, given that most studies focused on general risk mitigation strategies (often provided by local governments guidelines or organisations), rather than studying ones that may be specific to the FDP sector. Despite this, the most notable risk mitigation methods found in the literature ranged from effective testing/screening in the workplace, access to PPE for workers, good ventilation systems in place, social distancing and adequate hygiene practices.

Further research focusing on the food production sector as a whole would help to understand how transmission and risk may vary with each sub sector. Similarly, research focusing on the application of preventative measures and their efficacy is needed to understand which methods work well in the sector, while further qualitative research could help identify key gaps and provide in-depth information regarding enablers and barriers to transmission, risk factors and mitigation.

In parallel to the literature review members of our team worked on analyses of Office for National Statistics (ONS) data on COVID-19 mortality and infection as part of Work Package 4 within Theme 3 of PROTECT (Cherrie et al., *in prep*; Nafilyan et al., 2021; Rhodes et al, *in prep*). These results did not reveal elevated risk of infection for workers in the food production industry in general, although a proportionate mortality analysis suggested an interaction between region and occupation with elevated risks for food production workers in London early in the pandemic. Food production tends to aggregate factory based and agricultural trades so it is possible that group level analysis masks heterogeneity within the group. In addition, temporary or migrant workers, known to be common in this sector, may be missing or misclassified in these epidemiological analyses.

Conclusions

The CAWS evaluated the COVID-19 experience in the food and drink processing industry using a number of different methods. These included surveys of a subset of food and drink processing companies, interviews with various stakeholders involved in these industries, a literature review and analysis of population level data on COVID-19 risks to different occupational sectors.

Analysis of data from the Office for National Statistics found that workers in the FDPI were not at higher risk of infection overall compared with other essential worker occupational sectors, however this varies by region, with London having higher risks than other areas especially early in the pandemic. This analysis is based on an aggregation of factory based and agricultural sub-sectors, so the results could not distinguish, any differences between sub-sectors of the FDPI. Additionally, temporary or migrant workers, an important part of the FDPI workforce, may not be adequately represented in this analysis. Therefore, the results may not reflect the full impacts across all workers employed in this sector.

Stages 1 and 2 of CAWS were completed by a relatively small subset of the FDPI, primarily encompassing the beverage, grain milling, malting, distilling, prepared meals, and baked goods sub-sectors, with a few respondents from other sub-sectors. The infection rates appeared to be most influenced by deprivation in the surrounding community, with those with more remote workers at less risk and those with larger numbers of workers overall, to be at higher risk.

The CAWS study results, particularly in the qualitative interviews done in Stage 3, identified similar issues as the literature review done as part of the study. These interviews were done with representatives from government agencies, industry/trade federations or associations, unions, and academics.

- Environmental factors
    - Building infrastructure was a potential limiting factor for controlling COVID-19 transmission, as some buildings were limited in size or design (particularly older facilities), which limited facilities' ability to implement improved ventilation or social distancing.
    - Additionally, the need for stringent temperature controls, particularly at low temperatures, meant that it was not easy to cost-effectively increase intake of fresh air.

    - Noise in the production area was also an issue limiting social distancing.
- The workforce of the FDPI tends to be lower-paid and often temporary or migrant in nature. Challenges related to this include communication (especially for those for who may not speak English as a primary language) and the need for adequate sick pay to ensure an incentive for people to not go to work when ill.
- The accuracy and consistency of reporting of workplace COVID-19 cases was noted as a potential limitation, and could impact the understanding of the true impacts on the sector.
- There were a number of challenges around external factors such as supply/demand chain inconsistencies due to both COVID-19 and other political events (e.g. Brexit) and constantly changing and inconsistent rules or guidance, frequently inconsistent between the different nations in the UK as the pandemic evolved.

Going forward, a number of recommendations and research suggestions or knowledge gaps were identified by participants of CAWS:

- The need for financial support for the sector, particularly for providing adequate sick pay above statutory requirements, to prevent future outbreaks of infectious disease.
- Improved understanding of ventilation's impacts on infection transmission, as well as the influence of temperature and relative humidity.
- Further understanding of the FDPI workforce, especially the temporary/migrant sector and the role of work-related factors (e.g. housing and commute situations, activities during breaks) on transmission.
- Use of technology to manage risks, e.g. through more automation, wearable technologies for close contact activities, wastewater monitoring.
- Lack of knowledge of future COVID-19 variants and their impacts.
- Identification of practices implemented during the pandemic, which were considered useful to continue in practice for improved health and safety.

We consider these insights helpful but acknowledge the limitation that CAWS did not reach all sectors in the FDPI. The 66 workplaces are a small proportion of the total number of sites, however, the 21 stakeholder interviewees could in many cases provided oversight of the whole sector. The sector faced numerous challenges, and the urgency of the work and rapidly changing situations may have limited the number of FDPI groups that were willing to participate in the study.

References

Cherrie M, Rhodes S, Wilkinson J, Pearce N, Mueller W, Nafilyan V, van Tongeren M Longitudinal changes in proportionate mortality due to COVID-19 by occupation in England and Wales. To be submitted to Scand J Work Environ Health March 2022.

Nafilyan V, Pawelek P, Ayoubkhani D, et al. Occupation and COVID-19 mortality in England: a national linked data study of 14.3 million adults. Occupational and Environmental Medicine Published Online First: 27 December 2021. doi: 10.1136/oemed-2021-107818
https://oem.bmj.com/content/early/2021/12/26/oemed-2021-107818

Rhodes S, Wilkinson J, Pearce N, Mueller W, Cherrie M, Stocking K, Gittins M, Katikireddi V, van Tongeren M. Occupational differences in infection from SARS-CoV-2: Analysis of the UK ONS Coronavirus (COVID-19) Infection Survey. To be submitted to Journal of Epidemiology and Community Health March 2022.

Appendix 1. Stage 1 manuscript

An assessment of COVID-19 infection rates within the UK food and drink processing industry

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Abstract

Background

Food processing facilities represent critical infrastructure that have stayed open during much of the COVID-19 pandemic. Understanding the burden of COVID-19 in this sector is thus important to help reduce the potential for workplace infection in future outbreaks.

Methods

We undertook a workplace survey in the UK food and drink processing sector, and collected information on workplace size, characteristics (e.g., temperature, ventilation), and experience with COVID-19 (e.g., numbers of positive cases). For each site, we calculated COVID-19 case rates per month per 1,000 workers. We performed negative binomial regression to assess the association between COVID-19 rates and workplace and local risk factors.

Results

Respondents from 33 companies including 66 individual sites completed the survey. COVID-19 cases were reported from the start of the pandemic up to June 2021. Respondents represented a range of industry subgroups, including grain milling/storage (n=16), manufacture of malt (n=14), manufacture of prepared meals (n=12), manufacture of beverages (n=8), distilling (n=5), manufacture of baked goods (n=5), and other (n=6), with a total of 15,563 workers across all sites. Lowest case rates were reported from sites working in distilling with an average of 0.9 monthly COVID-19 cases per 1,000 workers; highest reported rates were in the sites working in grain milling/storage sector with an average of 6.1 monthly COVID-19 cases per 1,000 workers. Negative binomial regression analysis suggested that some differences between industry subgroups remained after adjusting for workplace and local factors, such as background rate, deprivation, and the proportion of remote workers.

Conclusion

Our analysis suggests heterogeneity in the rates of COVID-19 across sectors of the UK food and drink processing industry. This survey will be followed up by more in-depth questionnaires involving a subset of these same sites, as well as informed by additional deep dive interviews in this sector.

Keywords

COVID-19; Occupational health; Pandemic; Infection control; Workplace transmission

Introduction

Food processing facilities represent critical infrastructure that have stayed open during much of the COVID-19 pandemic. Work-related transmission risks of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus that causes COVID-19, were highlighted early in the pandemic, especially in meat and poultry processing plants (Dyal, 2020; Hailu, 2020; Pokora et al., 2021). Conditions that can enhance virus transmission, such as high density work areas, prolonged close contact with others, shared transport and housing, and community contact among co-workers, have been highlighted in food processing facilities (Waltenburg et al., 2021).

Analysis of COVID-19 outbreaks by sector across England during May-October 2020, found the highest rates for food manufacturing and packing (Chen et al., 2021). Similarly, a study of workplace outbreaks in Los Angeles County, USA identified the most outbreak-associated cases among industry subsectors to be in ‘food manufacturing’ (Contreras et al., 2021). A review of SARS-CoV-2

transmission in the food processing sector suggested increased risks in workplaces with colder and more humid environments, lack of social distancing, and poor ventilation. Various risk mitigation strategies for the sector have been offered, including social distancing, cleaning and disinfecting high-touch areas, enhancement of ventilation, and providing more community and work-based testing (Hosseini et al., in prep). The effectiveness of these measures may be strengthened by supportive workplace policies, such as educating workers about hygiene measures and offering sick pay (Bui et al., 2020; Herstein et al., 2021).

As part of a National Core Study programme, Partnership for Research in Occupational, Transport, Environmental COVID Transmission (PROTECT), we undertook a workplace survey in the UK food and drink processing sector to obtain more detailed information on the rates experienced across different types of facilities in the sector and to assess the association with risk factors and mitigation measures.

Methods

We developed an online Covid at Work Study (CaWS) survey to ascertain site-specific information on workplace factors (e.g., site purpose, number of workers), characteristics potentially related to transmission (e.g., ventilation, temperature), and COVID-19 outcomes (e.g., testing, positive cases) (see supplementary material for full survey). To recruit companies, we held discussions with food federations and associations relevant for the UK food and drink processing sector. We encouraged them to send their members information about the survey, including the survey website.

The survey was administered via onlinesurveys.ac.uk from 15 January to 15 July 2021. The study was approved by The London School of Hygiene and Tropical Medicine Research Ethics Committee (ref: 22908).

Local characteristics

Cumulative COVID-19 case rates per 100,000 population for lower tier local authorities (LTLAs) were obtained from the UK government (coronavirus.data.gov.uk/details/download). Site postcodes were matched to LTLAs. Cumulative cases were ascertained for the three time periods of the study: March-June 2020 (T1), July-December 2020 (T2), and January until the date of survey submission in 2021 (T3). As an indicator of area-level socioeconomic status (SES), the mean Index of Multiple Deprivation (IMD) decile in a 1 km area surrounding each facility was calculated separately for sites in England and Scotland using data for the years 2019 and 2020, respectively. The IMD is scored out of 10 and represents such neighbourhood-level features as housing, education, and health; higher scores represent lower levels of deprivation.

Statistical analysis

Monthly COVID-19 incidence rates per 1,000 employees at each site were calculated for the three time periods. The numerator was positive cases reported in a given time period and the denominator was total workers at the site; the ratio was then divided by the number of months in the period and multiplied by 1,000. For T3, the number of COVID-19 cases was assumed to be current as of the date of survey submission.

We performed negative binomial regression on only a subset of reported characteristics (those with a potential association with COVID-19 rates) due to the small sample size of our dataset. We assessed the association between COVID-19 rates with local and workplace risk factors using four sets of

models (M) that calculated Incidence Rate Ratios (IRRs). M1 included analyses separately for: a) industry subgroups; b) the LTLA rate and deprivation (local factors); and c) number of workers, proportion working remotely, proportion working in close proximity (<2 metres), and the presence of mechanical ventilation (workplace factors). M2 included the industry subgroup with local factors. M3 included the industry subgroup with workplace factors, and M4 included the industry subgroups with both local and workplace factors. The main analysis used manufacture of beverages as the reference group, since it had the median COVID-19 incidence rate across the three time periods. In sensitivity analyses, we calculated IRRs based on the mean COVID-19 rate for all industry subgroups as the reference, and also compared IRRs separately for T2 and T3. We only included sites that had complete data for each covariate, ≥5 workers on site, and ≥5 sites within each industry subgroup (i.e., we excluded 'other'): n=52 sites were included in analysis. Geospatial analyses were undertaken using QGIS (v3.10.1) and statistical analysis was completed in Stata (v16.1).

Results

Respondents, mainly health and safety (H&S) managers, from 33 companies covering 66 individual sites, completed the CaWS survey across the UK (see Figure S1). COVID-19 cases were reported from the start of the pandemic (March 2020) through to the time of completing the survey (range: February to June 2021). Respondents represented various industry subgroups, including grain milling/storage (n=16), manufacture of malt (n=14), manufacture of prepared meals (n=12), manufacture of beverages (n=8), distilling (n=5), manufacture of baked goods (n=5), and other (n=6) (see Table S1). The number of workers at each site ranged from 5 to 1726, with a total of 15,563 workers across all sites. Over three quarters (52; 79%) of sites reported at least 1 positive case, with a total of 1,068 COVID-19 cases across all sites. Lowest case rates were reported from sites working in distilling with an average of 0.9 monthly COVID-19 cases per 1,000 workers; highest reported rates were in the sites working in grain milling/storage sector with an average of 6.1 monthly COVID-19 cases per 1,000 workers (see Table; Table S2 for characteristics by industry subgroup).

In the regression analyses, unadjusted models suggested initial differences in reported infection rates between industry subgroups, with IRRs ranging from 0.25 (95% CI: 0.07-0.85) for distilling to 1.92 (95% CI: 0.93-3.99) for grain milling/storage (Figure S2). In fully adjusted models, all IRRs included the null value except for grain milling/storage (IRR = 2.22 [95% CI: 1.13-4.34]) (Figure). Several local and workplace factors were related to decreasing risks of COVID-19 cases, including deprivation (IRR = 0.77 [95% CI: 0.64-0.93]), proportion of remote workers (IRR = 0.76 [95% CI: 0.61-0.96]), and the proportion of workers in close proximity (IRR = 0.91 [95% CI: 0.83-0.99]); higher numbers of workers were associated with an increased risk (IRR = 1.52 [95% CI: 1.15-2.00]) (Figure). Some differences in IRRs were apparent in T2 and T3; for example, there was a decreased risk for manufacture of prepared meals in T3 only and the presence of mechanical ventilation was associated with an increased risk in T3 (Figure S3). Similar IRRs were obtained when based on the overall industry subgroup mean as the reference category (Table S3).

Table. Summary statistics for workplace factors collected in the CaWS survey for all sites (n=66).

Factor	Median (range) / n (%)
Industry subgroup	
Distilling	5 (8%)
Grain milling/storage	16 (24%)
Manufacture of baked goods	5 (7%)
Manufacture of beverages	8 (12%)
Manufacture of prepared meals	12 (18%)
Manufacture/storage of malt	14 (21%)
Other	6 (9%)
Positive COVID-19 cases: count per worksite	
March-June 2020	0 (0-19)
July-December 2020	2 (0-168)
January-June* 2021	2 (0-64)
Local COVID-19 rate (per 100,000 population)	5,529 (1,097-10,085)
Missing	2 (3%)
Deprivation decile	5.9 (3.1-8.25)
Missing	2 (3%)
Number of permanent workers	72 (5-1726)
Missing	3 (5%)
Number of remote workers	6 (0-150)
Missing	2 (3%)
Sites in operation	65 (99%)
Operate in shifts	60 (91%)
Staggered breaks	59 (89%)
Number working in close proximity to others	1 (0-1500)
Proportion working indoors for ≥50% of shift	53 (80%)
Hygiene areas on site:	
Basic	32 (48%)
Med	38 (58%)
High	20 (30%)
Open windows and doors (≥50% of the time)	27 (41%)
Mechanical supply and exhaust	39 (59%)
Areas on site where work occurs at <18°C	40 (61%)
Areas on site where work occurs at >22°C	38 (58%)
Hearing protection zones within the facility	62 (94%)
Retail or public-facing area?	11 (17%)
Contacted by a public health authority	15 (23%)
Missing	4 (6%)
Regular employee testing	12 (18%)
Frequency of employee testing	
>Once per week	3 (25%)
Once per week	7 (58%)
Other	2 (17%)

*Respondents completed the survey from February-June 2021.

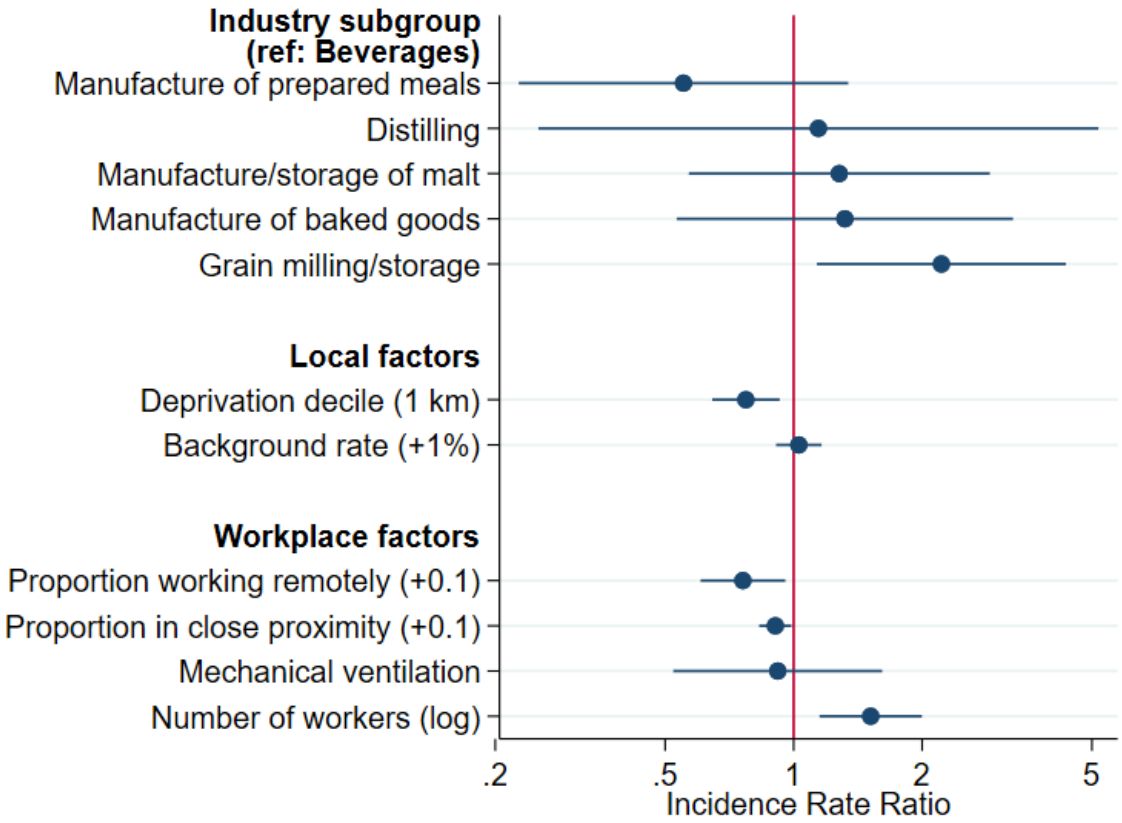

Figure. The Incidence Rate Ratios (IRR) for industry subgroups, local and workplace factors, adjusted for all covariates present (i.e., Model 4) (n=52 sites).

Discussion

We undertook a survey of 66 sites in the UK food and drink processing sector tracking positive COVID-19 cases from March 2020 up to June 2021. We observed variation in risks across industry subgroups, which were partially attenuated after adjusting for several local and workplace factors (i.e., risks for one subgroup remained elevated). We are not aware of any other studies examining different subgroups within the food processing sector.

COVID-19 infection risks appeared to decrease with average lower deprivation in a 1 km radius, similar to findings of other studies (Baena-Díez et al., 2020; Patel et al., 2020). Risks with higher deprivation, while adjusting for background rates, could be related to areas where workers are exposed to greater transmission risks, such as living in crowded housing or taking shared/public transport to work. Sites with a greater proportion of remote workers had lower rates of COVID-19, suggesting that excess risks could be related to workplace, commuting or other work-related factors. However, lower rates could be biased if remote workers were less likely to report a positive test result to their employer, which would artificially decrease calculated risks. As might be expected, we found greater risks at sites with a higher number of workers, however, unexpectedly, risks were slightly lower at sites where more workers were in close proximity. This finding could possibly be related to the implementation of additional mitigation measures where work in close proximity was unavoidable, though we do not have data to support this.

A limitation of this study is the modest number of responses, which also may entail self-selection issues involving either those who feel that their companies are doing well, or, conversely, those who

feel their industry most needs help with respect to COVID-19. Our survey commenced in early 2021, which was the peak of the second COVID-19 wave in the UK; thus, many Health & Safety managers may not have had sufficient resources to participate. Although there were no facilities related to meat processing in our survey, these sites have been researched elsewhere (e.g., Dyal et al., 2020; Gunther et al., 2020; Herstein et al., 2021).

Conclusion

Our analysis of a sample of the UK food and drink processing sector showed variation in COVID-19 infection rates across industry subgroups, with risks in one remaining elevated after adjusting for local and workplace risk factors. This survey will be followed up by more in-depth structured interviews involving a subset of these same sites, as well as informed by additional “deep dive” interviews of experts and stakeholders across the sector.

Funding

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We are grateful to the food and drink processing associations, federations, and companies that participated in this research.

References

Baena-Díez, J.M., Barroso, M., Cordeiro-Coelho, S.I., Díaz, J.L. and Grau, M., 2020. Impact of COVID-19 outbreak by income: hitting hardest the most deprived. *Journal of public health*, 42(4), pp.698-703.

Bui, D.P., McCaffrey, K., Friedrichs, M., LaCross, N., Lewis, N.M., Sage, K., Barbeau, B., Vilven, D., Rose, C., Braby, S. and Willardson, S., 2020. Racial and ethnic disparities among COVID-19 cases in workplace outbreaks by industry sector—Utah, March 6–June 5, 2020. *Morbidity and Mortality Weekly Report*, *69*(33), p.1133.

Chen, Y., Aldridge, T., Ferraro, C.F., Khaw, F.M. and UK COVID-19 National Core Studies Consortium, 2021. COVID–19 outbreak rates and infection attack rates associated with the workplace: a descriptive epidemiological study. *medRxiv*.

Contreras, Z., Ngo, V., Pulido, M., Washburn, F., Meschyan, G., Gluck, F., Kuguru, K., Reporter, R., Curley, C., Civen, R. and Terashita, D., 2021. Industry Sectors Highly Affected by Worksite Outbreaks of Coronavirus Disease, Los Angeles County, California, USA, March 19-September 30, 2020. *Emerging Infectious Diseases*, *27*(7).

Dyal, J.W., 2020. COVID-19 among workers in meat and poultry processing facilities—19 states, April 2020. *MMWR. Morbidity and mortality weekly report*, 69.

Hailu, G., 2021. COVID-19 and food processing in Canada. *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie*, *69*(2), pp.177-187.

Herstein, J.J., Degarege, A., Stover, D., Austin, C., Schwedhelm, M.M., Lawler, J.V., Lowe, J.J., Ramos, A.K. and Donahue, M., 2021. Characteristics of SARS-CoV-2 transmission among meat processing workers in Nebraska, USA, and effectiveness of risk mitigation measures. *Emerging infectious diseases*, *27*(4), p.1032.

Hosseini, P., et al. 2021. Transmission and control of SARS-CoV-2 in the food production sector: A review of the literature. (In preparation).

Günther, T., Czech-Sioli, M., Indenbirken, D., Robitaille, A., Tenhaken, P., Exner, M., Ottinger, M., Fischer, N., Grundhoff, A. and Brinkmann, M.M., 2020. SARS-CoV-2 outbreak investigation in a German meat processing plant. *EMBO molecular medicine*, *12*(12), p.e13296.

Patel, A.P., Paranjpe, M.D., Kathiresan, N.P., Rivas, M.A. and Khera, A.V., 2020. Race, socioeconomic deprivation, and hospitalization for COVID-19 in English participants of a national biobank*. International journal for equity in health*, 19(1), pp.1-4.

Pokora, R., Kutschbach, S., Weigl, M., Braun, D., Epple, A., Lorenz, E., Grund, S., Hecht, J., Hollich, H., Rietschel, P. and Schneider, F., 2021. Investigation of superspreading COVID-19 outbreak events in meat and poultry processing plants in Germany: A cross-sectional study. *PloS one*, *16*(6), p.e0242456.

Waltenburg, M.A., Rose, C.E., Victoroff, T., Butterfield, M., Dillaha, J.A., Heinzerling, A., Chuey, M., Fierro, M., Jervis, R.H., Fedak, K.M. and Leapley, A., 2021. Coronavirus disease among workers in food processing, food manufacturing, and agriculture workplaces. *Emerging Infectious Diseases*, *27*(1), p.243.

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Covid at Work Survey – Stage 1

1. Please confirm if you would like to participate in this survey. If you do not wish to participate, please close this window. Thank you for your time.
   a) I agree to participate in this survey.

<u>Contact and industry information</u>

2. What is the name of your company? (Free text field)

3. Please enter your name. (Free text field)

4. Please enter your position. (Free text field)

5. How many sites do you oversee? (Free text)

    a. How many of these sites have had at least 1 COVID-19 case? (Free text)

<u>Site 1 specific information</u>

6. Please provide the postcode of the site. (Free text field with postcode field)

7. What is the primary purpose of this site? (Drop-down menu with SIC codes specific for each industry. For example, the food processing industry menu would include the following options:
    a. Grain milling
    b. Manufacture of bread; fresh pastry goods and cakes
    c. Manufacture of cocoa; chocolate and sugar confectionery

d. Manufacture of malt
e. Manufacture of prepared meals and dishes
f. Manufacture of rusks and biscuits; pastry goods and cakes
g. Operation of dairies and cheese making
h. Other processing and preserving of fruit and vegetables
i. Preparation of frozen food primarily baked products
j. Preparation of frozen food primarily fish
k. Preparation of frozen food primarily vegetables
l. Preparation of frozen food other
m. Processing and preserving of meat
n. Production of meat and poultry meat products
o. Other (free text)

8. How many people are employed at this location? (Number field)
    a) How many of these workers are permanent?
    b) How many of these workers are zero hour contracts?
    c) How many seasonal workers are employed?
    d) How many employees are furloughed?
    e) How many employees at this site currently work remotely?
        i. Of the remote workers, how many employees have moved to remote working since March 2020?

9. On a typical work week since the COVID-19 outbreak started, how many people would be on-site? (Number field)

10. Is this site currently in operation? (Y/N)

    a. If not, when did it close? (Date field)
        i. When do you expect operations to resume? (Date field)

11. Does the facility operate in shifts? (Y/N)

12. Are breaks staggered (i.e., do they occur at different times for different workers)? (Y/N)
13. How many people at this site work in close proximity to others (i.e., <2 metres) for an extended period of time (>15 minutes)? (Number field)

14. What proportion of workers at this site work indoors for at least half their working shift?
    a. 0%
    b. 1-9%
    c. 10-25%
    d. 26-50%
    e. 51-75%
    f. 76-99%
    g. 100%
    h. Don’t know

15. Please indicate whether you have any of these areas on site:
    a. Basic hygiene areas (Zone B)
    b. Medium hygiene areas (Zone M)
    c. High hygiene areas (Zone H)
    d. None of the above
    e. Don’t know

16. How often are windows and doors kept open?
        i. 0%

ii. 1-25% of the time
iii. 25-50% of the time
iv. 50-75% of the time
v. 75-99% of the time
vi. 100%
vii. Don't know

a) Does this apply to all areas of the site or just some?
i. All
ii. Some
iii. Don't know

17. Does this site use mechanical supply and exhaust? (Y/N/Don't know)
    a) Is mechanical supply and exhaust used in recirculating mode? (Y/N/Don't know)
    b) Does this apply to all areas of the site or just some?
        1. All
        2. Some
        3. Don't know

18. Are there areas on site where people work at less than 18°C? (Y/N/Don't know)

19. Are there areas on site where people work at more than 22°C? (Y/N/Don't know)

20. Are there hearing protection zones within the facility? (Y/N/Don't know)

21. Does this facility include a retail or public-facing area? (Y/N)

    a. If so, approximately how many members of the general public will come to this facility on an average day? (Number field)

22. Since the start of the pandemic, have there been any workers that you know of at this location that have tested positive for COVID-19 ? Please include temporary or contract workers, and any workers known to have tested positive while off work during a period of self-isolation or illness.
    a. How many workers overall at this location have tested positive for COVID-19 that you know of? As above, please include temporary or contract workers, and any workers known to have tested positive while off work during a period of self-isolation or illness.
    b. Approximately how many tested positive between 1st March and 30th June 2020? (Number field)
    c. Approximately how many tested positive between 1st July and 31st December 2020? (Number field)
    d. Approximately how many tested positive since 1st January 2021? (Number field)

23. If you have had any positive cases, were you contacted by a public health authority regarding a suspected COVID-19 outbreak on site? (Y/N/Don't know/Not applicable)
    a. If so, when did this occur? (Date field)

24. Have any workers had to self-isolate, regardless of whether they had a positive test or not?(Y/N)
    a. If so, how many (please include all workers who self-isolated for any reason related to COVID-19)?

25. Has your company tested employees at this site for COVID-19? (Y/N)
    a. Was this part of a mass testing campaign? (Y/N)
    b. How often do employees get tested?
        iv. Once a month
        v. Once a week
        vi. More than once a week

vii. Other (please specify)

26. Would you like to enter details for another site? (Y/N).

Additional information

27. Would you be happy to be contacted to participate in any follow-up research in this study? (Y/N)

If you would be willing to participate, please indicate your name, email, and other contact information here. You may also indicate another contact person if more appropriate for follow up.

We will only contact you to provide any results from our study and to see if you would be willing to participate in further parts of this study. Follow-up research to update the numbers of cases and obtain more detail on work practice may include: an online survey, site visit, interview or other activities. You may change your mind at any time if you no longer wish to participate.

a) Name
b) Email address
c) Telephone number (if preferred mode of contact)
d) Other

28. Select the answer below that best describes how you found completing the questionnaire.
    a. Very easy
    b. Easy
    c. Neutral
    d. Difficult
    e. Very difficult

29. Please use the box below to make suggestions about how the survey could be made more user friendly, or describe any difficulties you had when completing the survey. We are also keen to ensure that the outputs from this study are relevant and useful to those operating within the food production and processing industry. Please let us know if there is anything in particular you would like us to explore, if feasible, from this study. This could be a concern, knowledge gap or challenge related to facility operation during the current COVID-19 outbreak (Free text)

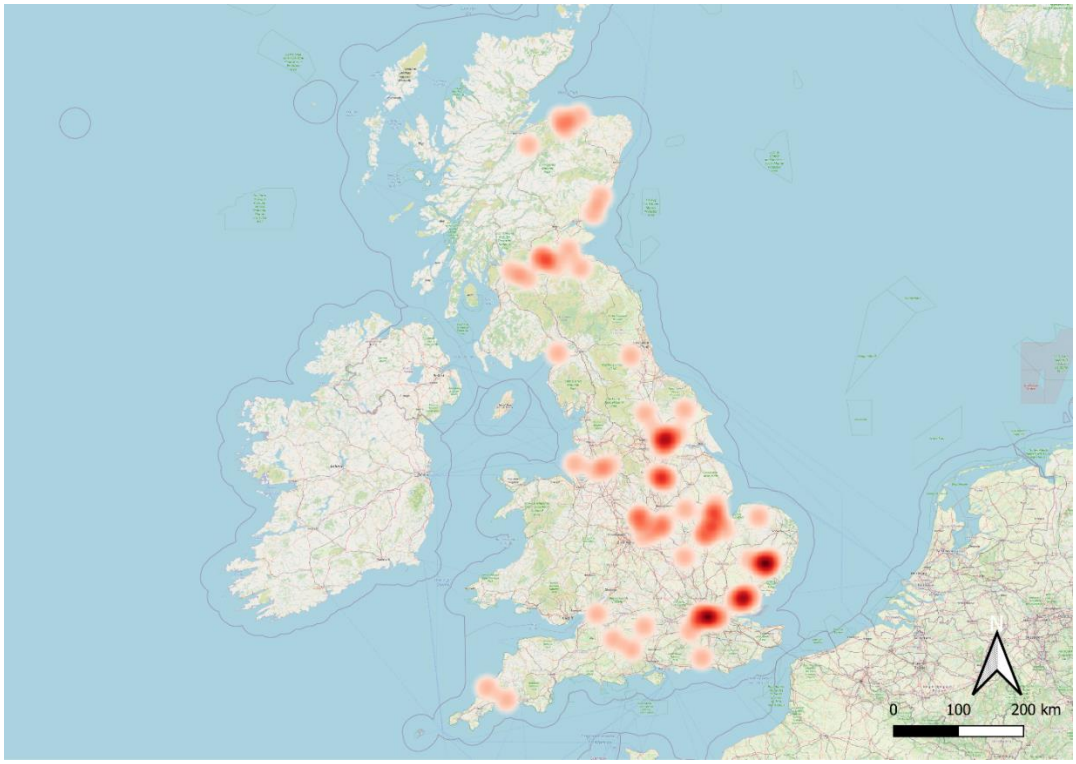


Figure S1. A heatmap of the approximate locations of sites that participated in the CaWS survey (n=64; two postcodes were not matched). Darker areas indicate multiple sites. Basemap from ©OpenStreetMap contributors (www.openstreetmap.org), available under the Open Database License.

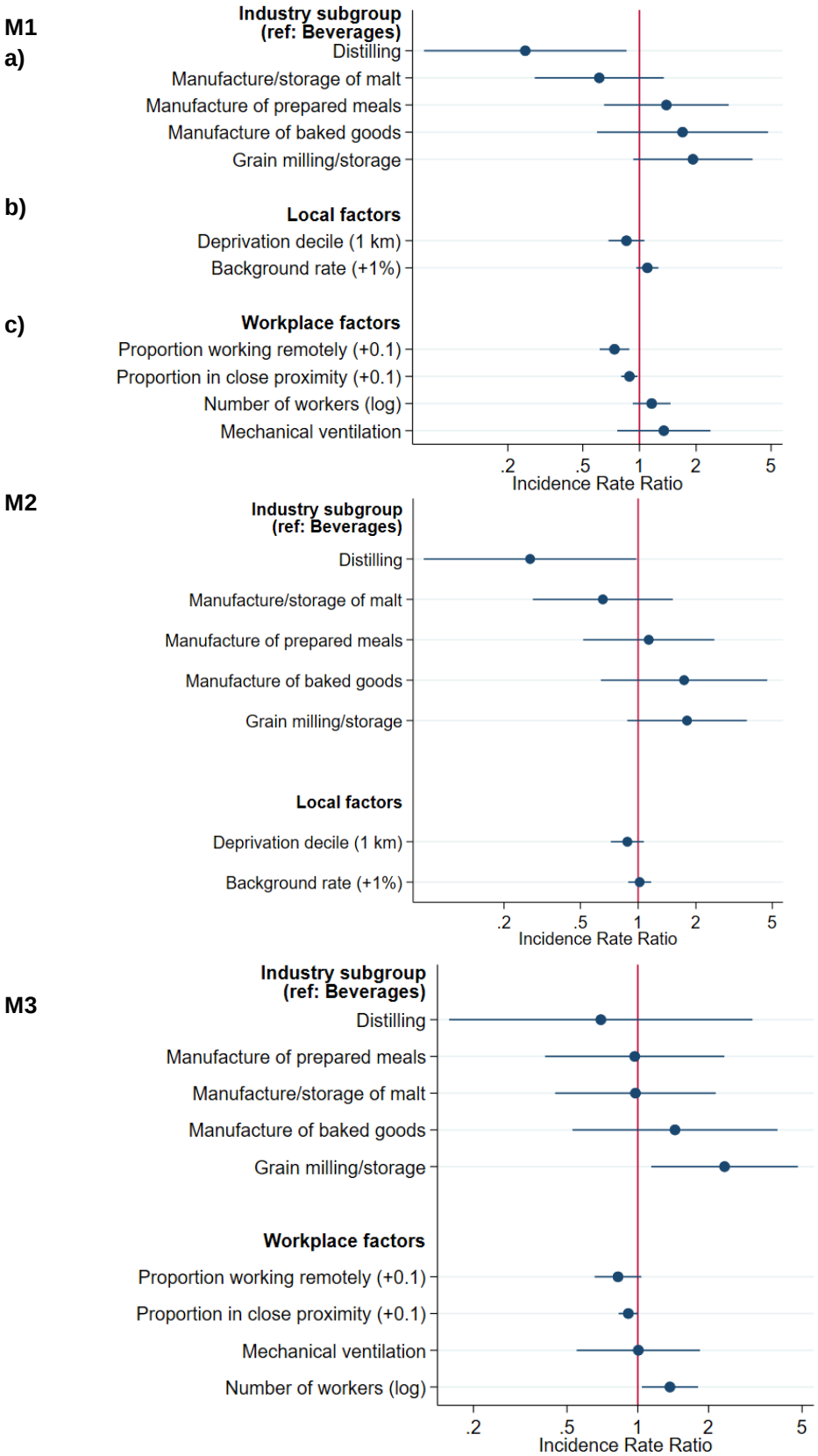
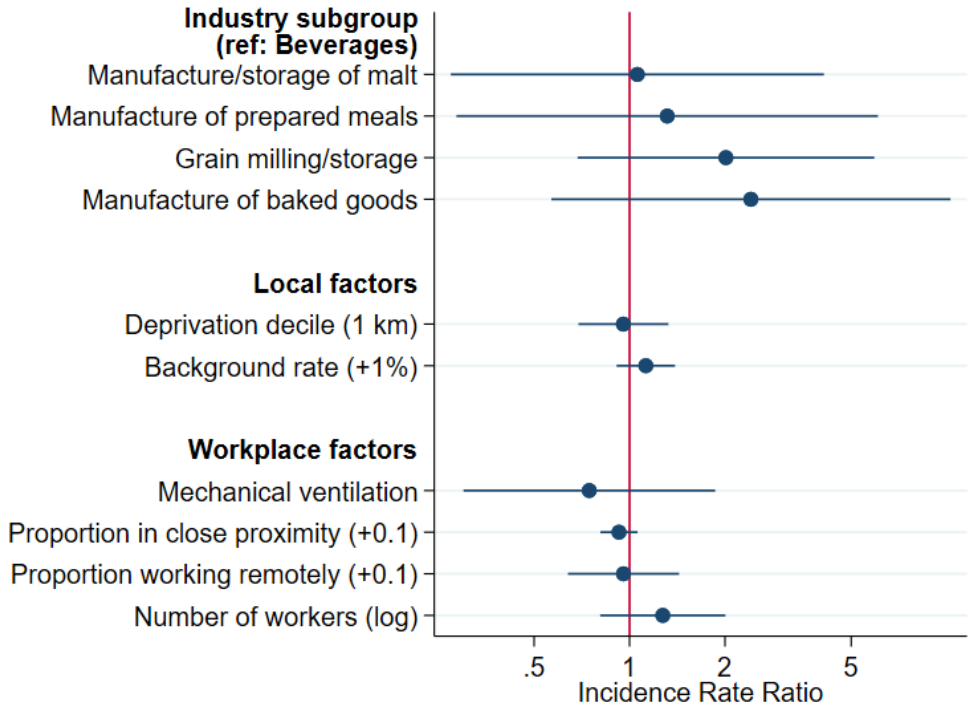


Figure S2. Coefficient plots of models (M) 1-3 (n=52 sites). M1 includes: a) industry subgroups; b) the LTLA rate and deprivation (local factors); and c) number of workers, proportion working remotely, proportion working in close proximity (<2 metres), and the presence of mechanical ventilation (workplace factors). M2 includes industry subgroup with local factors. M3 includes the industry subgroup with workplace factors.

T2



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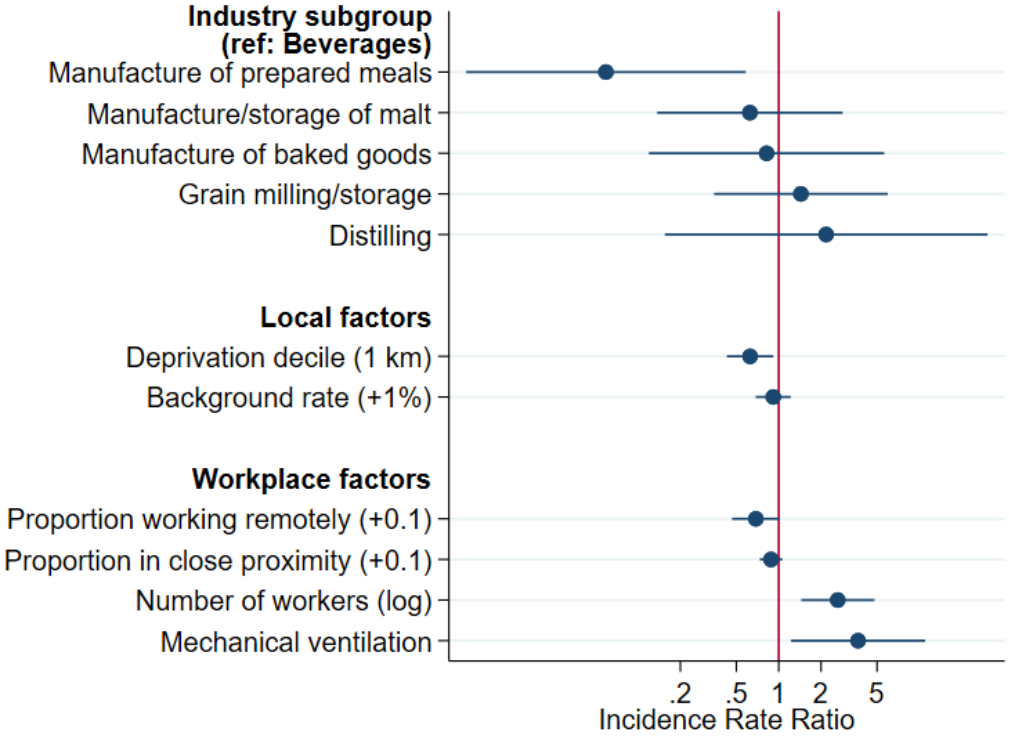

Figure S3. Coefficient plots of M4 (fully adjusted) in T2 (n=47 sites; no cases at distilling sites in T2) and T3 (n=52 sites). July-December 2020 (T2), and January until the date of survey submission in 2021 (T3).

Table S1. The industry subgroups compared to reported site purposes.

Industry subgroup	**Reported purpose**
Distilling	• Distilling, rectifying and blending of spirits • Distillery
Grain milling/storage	• Grain milling • Food Ingredient Manufacture and Flour Milling • Grain storage
Manufacture of baked goods	• Manufacture of bread; fresh pastry goods and cakes
Manufacture of beverages	• Manufacture of cider and other fruit wines • Manufacture of beer • Manufacture of beverages
Manufacture of prepared meals	• Manufacture of prepared meals and dishes
Manufacture/storage of malt	• Manufacture of malt • Storage & Supply of malt only
Other	• Retail shop • Offices • Production of animal feed • Liquid animal feeds . Molasses • Aquaculture diets • Manufacture of condiments and seasonings

Table S2. Summary statistics for workplace factors collected in the CaWS survey by industry subgroup (n=66).

Characteristic	Distilling (n=5)	Grain milling/storage (n=16)	Manufacture of baked goods (n=5)	Manufacture of beverages (n=8)	Manufacture of prepared meals (n=12)	Manufacture/ storage of malt (n=14)	Other (n=6)
	Median (range) / n (%)						
Positive COVID-19 cases							
March-June 2020	0 (0-1)	0 (0-5)	0 (0-1)	0 (0-2)	2 (0-11)	0 (0-19)	0 (0-1)
July-December 2020	0 (0-0)	1.5 (0-9)	8 (7-110)	1.5 (0-42)	15 (2-168)	0 (0-5)	1 (0-10)
January-June* 2021	0 (0-1)	0.5 (0-12)	6 (2-22)	2.5 (0-25)	13.5 (5-64)	0 (0-16)	0 (0-8)
COVID-19 rate (per 1,000 employees)	0.96 (0-2.4)	3.8 (0-16.4)	6.2 (3.2-7.4)	3.0 (0-7.6)	5.0 (0.88-8.51)	0.68 (0-10.1)	2.3 (0-18.2)
Local COVID-19 rate (per 100,000 population)	1642 (1522-6408)	4926 (2604-6832)	6639 (3438-9227)	4716 (2463-9140)	7148 (5331-10095)	2882 (1097-6759)	5468 (4156-6857)
Missing	-	1 (6%)	-	-	-	1 (7%)	-
Deprivation decile	6.7 (4.9-6.8)	5.5 (3.9-7.6)	5.4 (4.4-6.8)	5.8 (3.9-8.1)	4.8 (3.1-6.1)	6.2 (4.5-7.1)	
Missing	-	2 (13%)	-	-	-	-	-
Number of permanent workers	64 (21-160)	63 (5-225)	320 (240-900)	104 (6-601)	08 (239-1726)	42 (18-340)	12 (5-535)
Missing	-	-	2 (40%)	-	-	-	1 (17%)
Number of remote workers	31 (6-122)	6 (0-12)	5 (2-6)	12 (0-130)	7 (0-70)	8 (0-150)	2 (0-40)
Missing	-	-	2(40%)	1 (13%)	-	-	1 (17%)
Sites in operation	5 (100%)	16 (100%)	5 (100%)	8 (100%)	12 (100%)	14 (100%)	5 (83%)
Operate in shifts	4 (80%)	15 (94%)	5 (100%)	7 (88%)	12 (100%)	14 (100%)	3 (50%)
Staggered breaks	5 (100%)	15 (94%)	5 (100%)	7 (88%)	12 (100%)	10 (71%)	5 (83%)
Number working in close proximity to others	0 (0-6)	0 (0-10)	20 (0-30)	0 (0-20)	20 (0-1500)	4 (0-50)	3 (0-50)

Proportion working indoors for ≥50% of shift	4 (80%)	9 (56%)	4 (80%)	7 (88%)	12 (100%)	10 (71%)	6 (100%)
Hygiene areas:							
Basic	0 (0%)	13 (81%)	1 (20%)	1 (13%)	7 (58%)	9 (64%)	1 (17%)
Med	1 (20%)	14 (88%)	4 (80%)	2 (25%)	7 (58%)	9 (64%)	1 (17%)
High	1 (20%)	1 (6%)	1 (20%)	3 (38%)	12 (100%)	2 (14%)	0 (0%)
Open windows and doors (≥50% of the time)	5 (100%)	34 (19%)	1 (20%)	8 (100%)	7 (58%)	4 (29%)	1 (17%)
Mechanical supply and exhaust	0 (0%)	11 (69%)	3 (60%)	5 (63%)	12 (100%)	5 (36%)	3 (50%)
Areas on site where work occurs at <18°C	3 (60%)	8 (50%)	2 (40%)	4 (50%)	12 (100%)	6 (43%)	5 (83%)
Areas on site where work occurs at >22°C	1 (20%)	8 (50%)	5 (100%)	2 (25%)	5 (42%)	13 (93%)	4 (67%)
Hearing protection zones within the facility	3 (60%)	16 (100%)	5 (100%)	8 (100%)	12 (100%)	14 (100%)	4 (67%)
Retail or public-facing area?	2 (40%)	1 (6%)	1 (20%)	5 (63%)	12 (100%)	1 (7%)	1 (17%)
Contacted by a public health authority	0 (0%)	4 (25%)	3 (60%)	1 (13%)	2 (17%)	3 (21%)	2 (33%)
Missing	1 (20%)	1 (6%)	-	-	-	2 (14%)	-
Regular employee testing	0 (0%)	0 (0%)	1 (20%)	3 (38%)	5 (42%)	1 (7%)	2 (33%)
Frequency of employee testing							
>Once per week	N/A	N/A	0 (0%)	1 (100%)	0 (0%)	0 (0%)	0 (0%)
Once per week	N/A	N/A	1 (100%)	0 (0%)	5 (100%)	0 (0%)	1 (50%)
Other	N/A	N/A	0 (0%)	0 (0%)	0 (0%)	1 (100%)	1 (50%)

Table S3. M4 (fully adjusted) IRRs using the overall industry subgroup weighted mean as a reference category.

Industry subgroup	IRR (95% CI)
Manufacture of prepared meals	**0.47 (0.23-0.97)**
Manufacture of beverages	0.85 (0.51-1.42)
Distilling	0.97 (0.26-3.60)
Manufacture/storage of malt	1.09 (0.66-1.78)
Manufacture of baked goods	1.12 (0.53-2.38)
Grain milling/storage	**1.88 (1.27-2.79)**

Appendix 2. Stage 2 questionnaire and results

Covid at Work Study: Stage 2 Results

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Summary

We completed a follow-up survey of sites in the UK food and drink production sector. Out of the 49 sites that were invited to Stage 2 interviews, 24 (49%) sites participated. Interviews were held in November-December 2021. The majority of the COVID-19 mitigation measures were implemented at all sites and most of these measures were introduced during the initial phase of the pandemic. There was a positive relationship between the number of employees at a site and the number of introduced measures. Although these results are based on a limited sample of sites, and therefore should be interpreted with caution, it was clear that both the Stage 2 and community rates were elevated compared to those during Stage 1.

Background

Food and drink processing facilities represent an essential sector that maintained operations throughout the pandemic and periods of lockdown. Due to the continued transmission risk of the SARS-CoV-2 virus and also the nature of this work, which often requires numerous workers in the same vicinity, assessing and mitigating infection risks is important for the current and potentially next pandemic.

This report presents the findings of a telephone interview of individuals working in health and safety in the UK food and drink processing sector regarding their workplace experiences with COVID-19. These results represent a follow-up study to an online survey known as the Covid at Work Study (CaWS) that was collected during the first half of 2021. The work presented in this report was completed as part of Work Package 2 in Theme 3 of the PROTECT study.

Questionnaire development and dissemination

The purpose of the Stage 2 questionnaire was to update workplace and COVID-19 related data that had been collected in the first stage of the CaWS survey. The Stage 1 survey included 33 submissions, representing 66 unique sites; surveys were submitted during January to June 2021. COVID-19 case data were collected as counts for each site over three time periods, as well as testing and isolation information. Workplace features included the number of employees (with details on permanent, temporary, seasonal, furloughed, and remote workers), work habits (e.g., shiftwork, working in close proximity), and physical characteristics (e.g., if the site used mechanical ventilation, working above/below certain temperature thresholds).

The results of the Stage 1 survey identified some increased risks of COVID-19 incidence associated with higher levels of deprivation in the area surrounding the facility, as well as with a lower proportion of remote workers and greater numbers of on-site staff. Most sectors had similar rates of COVID-19. The Stage 1 CaWS results were submitted as a separate report and also included in a manuscript that is at present under review with the peer-reviewed journal, *Annals of Work Exposure and Health* (Mueller et al., under review).

The Stage 2 questionnaire (see Appendix) was developed to collect data on any workplace changes since the Stage 1 survey, such as the number of workers, and also to collect additional information on experiences relating to the implementation and employee uptake of COVID-19 mitigation measures. We used a review we recently completed on transmission and control of COVID-19 in the food

production sector (Hosseini et al., in prep) to inform the selection of mitigation measures in the questionnaire. To elicit more detailed responses, we contracted a professional survey company to undertake telephone interviews of the survey respondents; interviewers simultaneously completed the online questionnaire during the interview process. As with the Stage 1 survey, we used the online platform, https://www.onlinesurveys.ac.uk/, to collect data.

Companies were recruited to the Stage 1 survey through food and drink industry federations. Of the 66 sites that were included in the Stage 1 submissions, we selected 49 to invite for the Stage 2 interviews. Since more information was being collected in this round, and to ensure a reasonable interview length, we limited to 3 the number of sites for which an individual could report. Therefore, we excluded some of the Stage 1 sites for those companies that submitted 4-5 sites. To ensure we obtained data on those sites that would provide the most informative results on COVID-19 experiences since Stage 1, we first selected sites with the highest and lowest absolute case numbers, then the largest site not already selected.

We emailed all individuals from the 49 sites who had completed the Stage 1 online survey. We notified individuals that they would be contacted by a professional survey company, Civica, who would then book a time for them to complete the Stage 2 interview. In the initial email, we included the interview questions and information sheet to provide more details on the study.

Analysis

We calculated for each site monthly COVID-19 incidence rates per 1,000 employees. As the numerator, we used the number of positive cases reported and the denominator was the total workers at the site; this ratio was then divided by the number of months in the period between the stages 1 and 2 surveys and multiplied by 1,000.

As an indicator of area-level socioeconomic status (SES), the mean Index of Multiple Deprivation (IMD) decile in a 1 km area surrounding each facility was calculated separately for sites in England and Scotland using data for the years 2019 and 2020, respectively. The IMD is scored out of 10 and represents such neighbourhood-level features as housing, education, and health; higher scores represent lower levels of deprivation.

We obtained from the UK government (coronavirus.data.gov.uk/details/download) cumulative COVID-19 case rates per 100,000 population for lower tier local authorities (LTLAs). Sites were matched to LTLAs using postcodes. COVID-19 case rates were calculated by subtracting the rate as of the date of the Stage 1 survey submission from that of the Stage 2 survey submission. Rates were then divided by the number of months between the two dates, and then by 100, to generate a monthly rate per 1,000 population (thus to be on a comparable scale to the site-specific COVID-19 rates).

Results

Completed interviews

Out of the 49 sites that were invited to participate in Stage 2 interviews, 24 (49%) sites were represented in 13 completed interviews. Interviews were undertaken from 3 November to 22 December 2021. Of the 49 sites selected for Stage 2, those that did and did not participate had similar data in Stage 1, namely reported rates of COVID-19, numbers of employees, deprivation, and LTLA rates (Table 1).

Table 1. Comparison of Stage 1 characteristics (median) in sites that completed (n=24) and did not complete (n=25) Stage 2.

Characteristic	Completed Stage 2	Did not complete Stage 2	p-value*
Monthly COVID-19 rates per 1,000 workers	3.6	2.7	.90
Number of employees	83	69	.36
Deprivation (1 km radius)	5.6	6.2	.41
Monthly local authority COVID-19 rates per 1,000 population	4.1	3.9	.35

*Kruskal-Wallis non-parametric test.

Summary statistics

Nearly all (23/24, 96%) sites experienced at least 1 COVID-19 case since completion of the Stage 1 survey. A total of 419 COVID-19 cases since the Stage 1 survey were reported, of which the majority (396/419, 95%) were reported on-site and the rest (23/419, 5%) were reported for remote workers; 1 site was unsure of the allocation between on-site and remote workers (89 cases overall). Routine testing was carried out at 10 sites at intervals of twice weekly to twice monthly. Table 2 displays COVID-19 related results.

Table 2. Summary statistics of COVID-19 indicators.

Characteristic	Mean (SD) or n (%)	Minimum	Maximum
COVID-19 cases	17.5 (29.8)	0	97
Sites testing workers	10 (42%)	N/A	N/A
Staff needing to isolate	4.9 (5.7)	0	25
Contacted by a public health team	5 (21%)	N/A	N/A

Five (21%) of the sites included areas where the temperature was regulated between 2-13 °C (3 sites were regulated at 5-8°C). Three sites (13%) regulated the relative humidity range, though only 1 site specified a limit (60%) for areas occupied with workers.

Mitigation measures

The interview questionnaire asked about the implementation of 30 different mitigation measures. Two thirds (20/30, 67%) of the measures were implemented at all sites. The least implemented was 'Monitoring of ventilation or CO_2', which was undertaken at 10 (42%) sites. Table 3 shows the number of sites where each of the mitigation measures were implemented.

Table 3. The number of sites implementing each of the mitigation measures included in the questionnaire (sorted from most to least under each subheading).

Mitigation measure	n (%) of sites
Physical distancing	
Physical barriers	24 (100)
Floor markings	24 (100)
Limiting duration or volume of personnel on site/in a given area	24 (100)
Worker 'bubbles'	24 (100)
One way systems	23 (96)
Cleaning and hygiene practices	
Increased frequency of workplace cleaning	24 (100)
Extending cleaning regime outside of operational areas	24 (100)
Increased communication clarity/detail regarding cleaning requirements/responsibilities	24 (100)
Cleaning between users of equipment	24 (100)
Provision of cleaning/hand wash/sanitising materials	24 (100)
Non-touch bins and access to paper towels in bathrooms	21 (88)
Non-touch options where possible in other areas	14 (58)
Ventilation	
Increased use of natural ventilation options	24 (100)
Introduction/improvement/maintenance of mechanical ventilation	20 (83)
Monitoring of ventilation or CO_2	10 (42)
Risk Assessment, policies and procedures	
Communication and response to workers showing symptoms/confirmed cases	24 (100)
Support to staff wellbeing	24 (100)
Mental health support	24 (100)
Coverage for the need for staff to isolate	23 (96)
Encouragement to get vaccinated	22 (92)
Conduct temperature checks on staff	18 (75)
Personal Protective Equipment (PPE)	
Provision of PPE to workforce and visitors as required	24 (100)
Requirement to wear face coverings or masks	24 (100)
Appropriate location(s) to don/doff PPE	20 (83)
Cleaning/disposal arrangements	20 (83)
Visitor measures	
Clear instructions/signage for visitors	24 (100)
Restriction of movement around site	24 (100)
Advance booking and record keeping	24 (100)
Revise procedures/processes as necessary	24 (100)
Temperature checks and screening at entrance	24 (100)

Most of the sites introduced measures during the initial phase of the pandemic in March-April 2020. However, some measures were implemented later in the pandemic, such as encouragement to get vaccinated and measures relating to visitors, possibly due to not allowing visitors on-site until later in the pandemic. All sites reported that measures were implemented across all areas of each site. Figure 1 shows the range of dates across sites when mitigation measures were implemented. Measures that were introduced prior to the pandemic were entered as '1 January 2020'.

	2020												2021											
Mitigation measure	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Appropriate location(s) to don/doff PPE	24																							
Cleaning/disposal arrangements for PPE	19		1																					
Non-touch bins and access to paper towels in bathrooms	10			11																				
Increased frequency of workplace cleaning	4		6	13		1																		
Increased communication clarity/detail regarding cleaning requirements/responsibilities	1		6	16		1																		
Cleaning between users of equipment	12		4	7		1																		
Provision of cleaning/hand wash/sanitising materials	10		3	10		1																		
Non-touch options where possible in other areas	6		3	4		1																		
Worker ‘bubbles’	5		3	15		1																		
Support to staff wellbeing	16		3	4		1																		
Coverage for the need for staff to isolate	1		6	15		1																		
Introduction/improvement/maintenance of mechanical ventilation	6			11		3																		
Monitoring of ventilation or CO_2	4			3		2					1													
Requirement to wear face coverings or masks	2		3	10		3	4					1		1										
Mental health support	15		3	4		1												1						
Provision of PPE to workforce and visitors as required	19			4									1											
Clear instructions/signage for visitors	1		3	11	5			1	1				1							1				
Restriction of movement around site	6		4	5	5				1				2							1				
Advance booking and record keeping	7		4	4	5				1				2							1				
Physical barriers			6	16	1	1																		
Floor markings			6	17		1																		
Limiting duration or volume of personnel on site/in a given area			6	17		1																		
One way systems			6	16		1																		

	2020												2021											
Mitigation measure	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Extending cleaning regime outside of operational areas			6	17		1																		
Communication and response to workers showing symptoms/confirmed cases			6	17		1																		
Conduct temperature checks on staff			6	11		1																		
Increased use of natural ventilation options			3	15		3							3											
Revise procedures/processes as necessary			4	8	5				1				2		3					1				
Temperature checks and screening at entrance			4	11									2							1				
Encouragement to get vaccinated				3								3	6	2			5			3				

Figure 1. A timeline of when mitigation measures were introduced at each site (sorted from earliest to latest). The numbers represent the sites implementing each measure in a given month.

The majority of the sites had implemented most of the queried COVID-19 mitigation measures (median=28, minimum=24, maximum=30). Figure 2 presents a histogram of the total number of introduced measures at each site. Interviewees were asked about any other measures that were implemented, which included the introduction of COVID-19 marshals, free flu vaccinations, and use of fogging machines (these other measures are not shown in Figure 2).

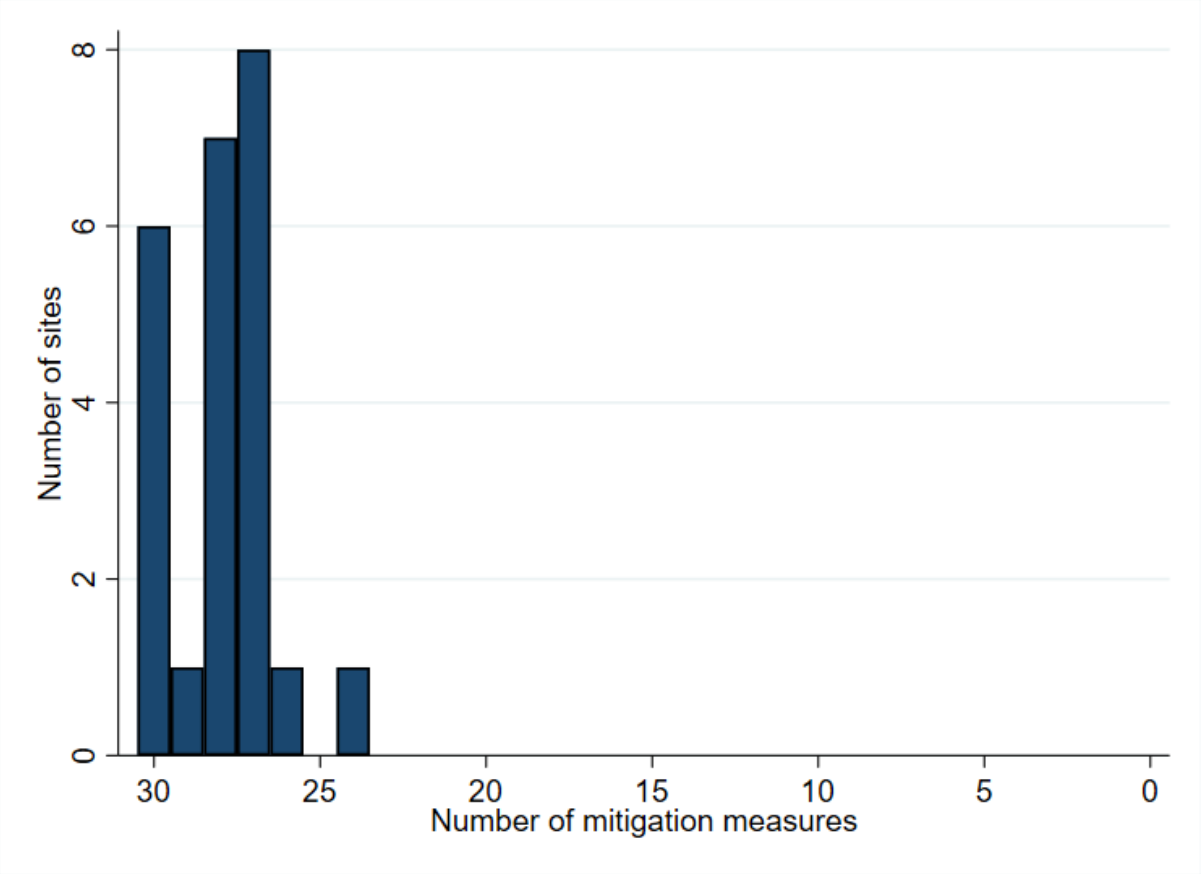

Figure 2. A histogram showing the total number of COVID-19 mitigation measures implemented at the surveyed sites (N=24).

Some sites reported changing some of the measures during the course of the pandemic, for instance, reintroducing face-to-face meetings and removing requirements for face masks, temperature checks, and screens. Six companies (25%) reported no issues with the introduction of measures to reduce virus transmission at the workplace, and one reported that workers wanted faster implementation of measures. However, some of the challenges that were noted included language barriers, cost, getting workers to wear masks, and the usual early resistance to any workplace changes.

Interviewees reported a number of efforts used to attempt to enhance the uptake of measures by workers. Some key points that were expressed in the interviews are as follows:

- Educating staff (e.g. more vaccinations may lead to removing need for masks)
- Providing face masks and cleaning products
- Flexible shift patterns
- Support from management/leadership
- Meeting groups to explain different masks
- Talks from external people, e.g. public health officials, consultants
- Employee survey

COVID-19 infection rates

Monthly COVID-19 rates per 1,000 workers were calculated for the period between the Stage 1 (2 February-27 May 2021) and Stage 2 (3 November-22 December 2021) submission dates (mean=7.7, minimum=6.1, maximum=9.4 months).

We calculated rates based on the total number of workers at each site, including both on-site and remote workers, as most interviewees were not able to distinguish these populations. We used the number of workers reported in the Stage 1 survey, unless this number had changed, as indicated in the Stage 2 questionnaire. The median COVID-19 rate for the Stage 2 period was 7.2 (minimum=0, maximum=23.4) monthly cases per 1,000 workers. The rates tended to be higher in Stage 2 compared to Stage 1, as presented in Figure 3.

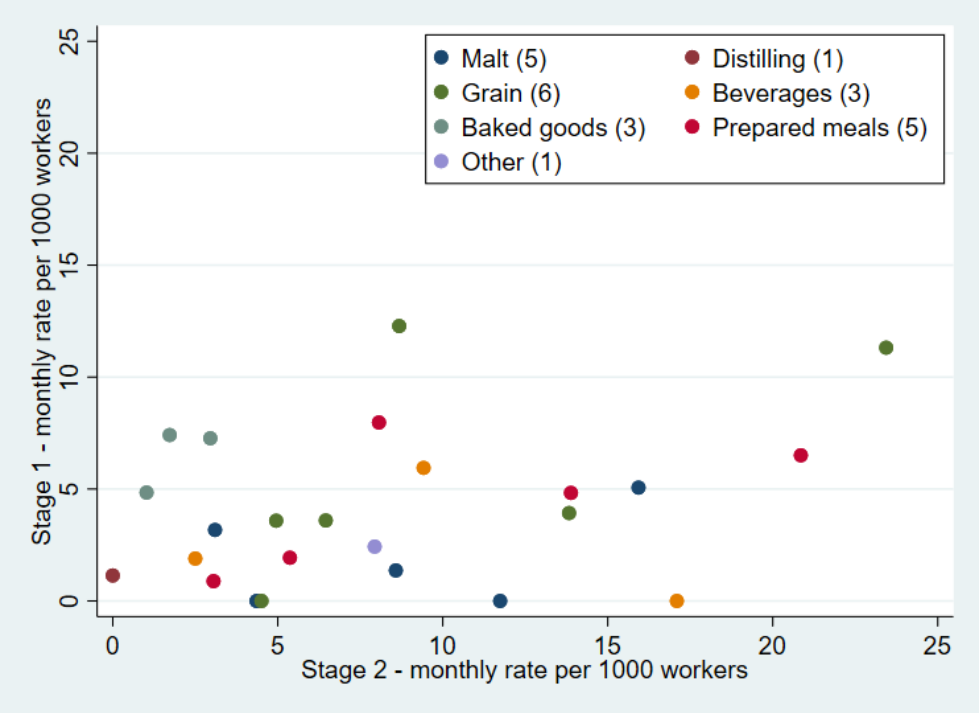

Figure 3. A scatterplot of the monthly COVID-19 rates per 1,000 workers reported in the Stage 1 and 2 surveys; colours refer to the product related to each site.

The observed pattern of higher COVID-19 rates during Stage 2 also reflects the trends in community rates, which were much higher during the Stage 2 period (Figure 4). The lower tier rates during the Stage 1 and 2 periods were moderately positively correlated (r=0.43, p=.04).

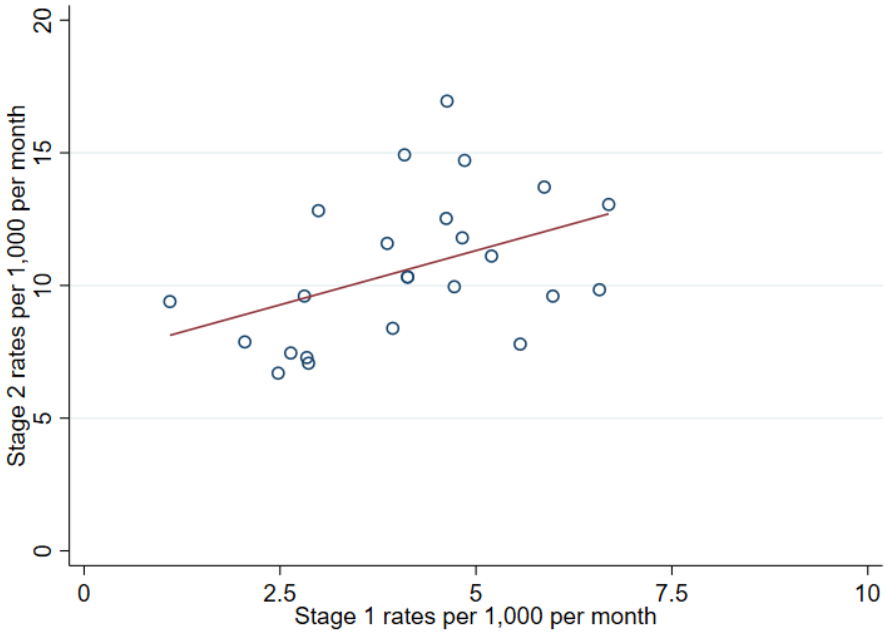

Figure 4. A scatterplot of Stage 1 and 2 rates in the lower tier local authorities with which site postcodes were associated.

There was a weak negative correlation (*r*=-0.32, p=0.13) between the COVID-19 rates at each site and the local authority rates in the period between the Stage 1 and Stage 2 submission dates (Figure 5). It appears there is not an especially strong spatial link between the site and surrounding community (i.e., local authority) rates during Stage 2. A possible explanation for a negative correlation could be hesitation in remote workers to return to the workplace in areas of higher community transmission. Nevertheless, this was only a weak correlation, which was not statistically significant. In general, both the Stage 2 and community rates were elevated compared to those during Stage 1.

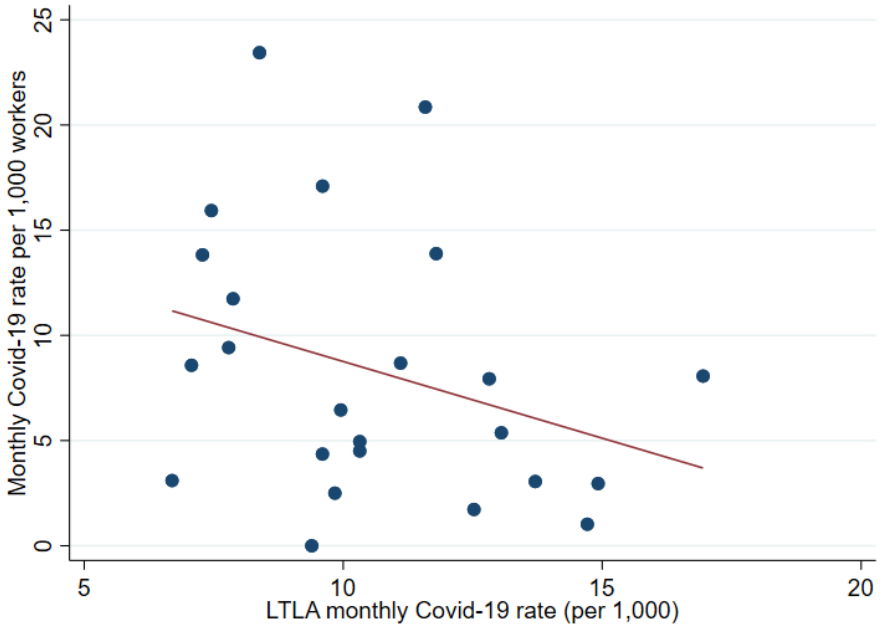

Figure 5. A scatterplot of the monthly COVID-19 rates per 1,000 workers compared to the monthly COVID-19 rates of the lower tier lower authorities (LTLA).

There was little correlation between the number of mitigation measures at a site and the COVID-19 rate (r=-0.06, p=.80). Since most of the sites had implemented the majority of queried measures, it is not surprising that there was not a clear association with rates of COVID-19. Figure 6 plots the monthly COVID-19 rates against the number of mitigation measures at each site. The markers are weighted so that the larger ones represent higher numbers of workers at a given site. Figure 6 suggests a positive relationship between the number of employees and the measures and indeed there is a strong correlation (r=0.64, p<.01).

Facilities with more employees likely have a greater potential risk of transmission given the higher numbers of susceptible individuals. Therefore, larger companies may wish to minimise the risk of outbreak by introducing more measures. Another possible reason is that facilities with more employees may have greater resources with which to implement physical and policy measures to reduce risks of COVID-19 and also to support those employees who test positive or need to isolate.

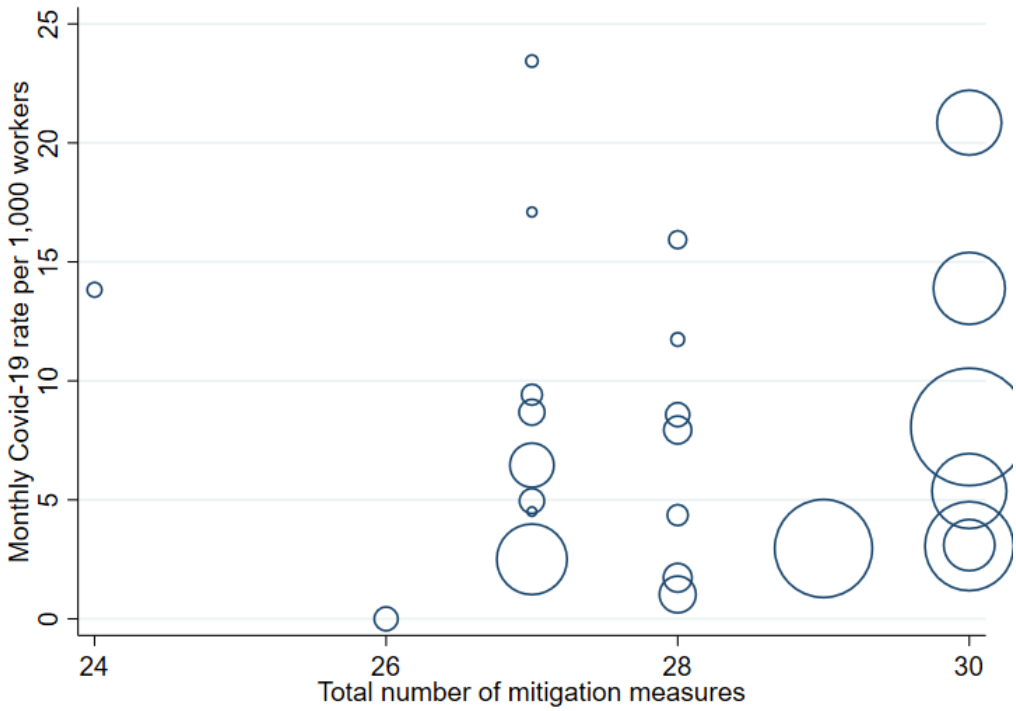

Figure 6. A scatterplot of the monthly COVID-19 rates per 1,000 workers compared to the number of surveyed mitigation measures implemented (marker weighted by number of workers).

There was little apparent relationship between the COVID-19 rates at each site and the mean deprivation levels around each site (1,000 m radius) (Figure 7). The larger sites appear to be located in areas of higher deprivation.

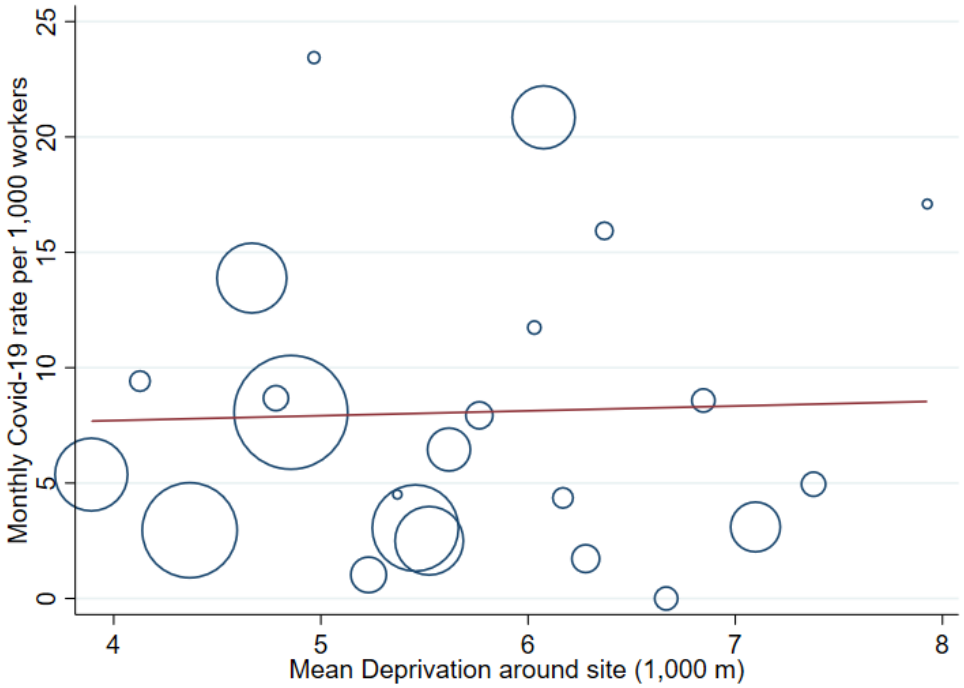

Figure 7. A scatterplot of the monthly COVID-19 rates per 1,000 workers compared to the mean deprivation (Index of Multiple Deprivation decile) around each site (1,000 m radius) (marker weighted by number of workers).

There was little difference in the monthly COVID-19 rates in those sites where ongoing testing had been implemented (n=10; rate=9.3 per 1,000 workers) compared to those sites where testing was offered, but not implemented (n=9; rate=10.3 per 1,000 workers) (Figure 8).

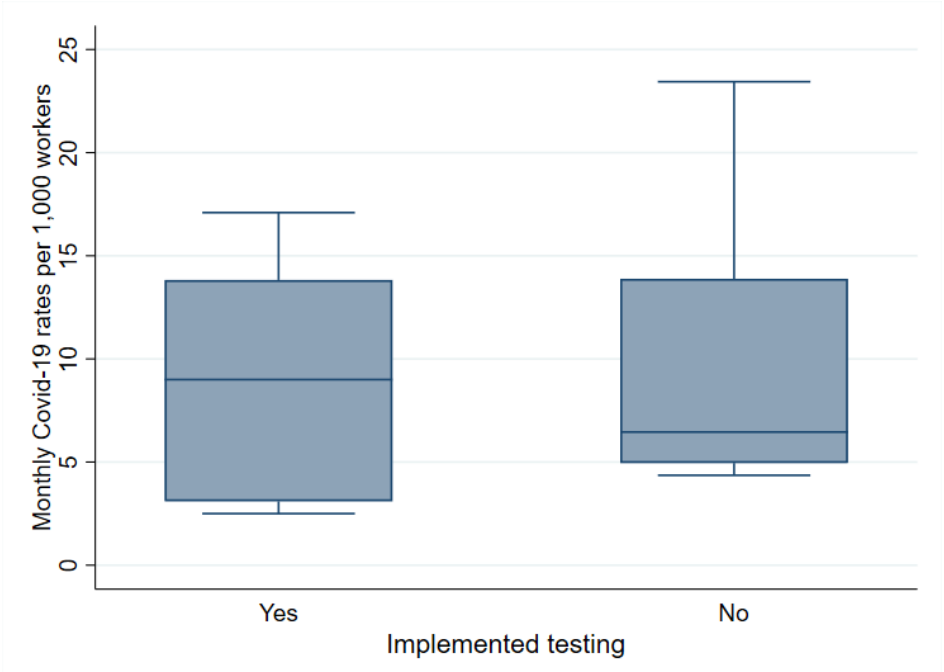

Figure 8. A boxplot of monthly COVID-19 rates in those sites where testing was implemented compared to those sites where testing was not implemented (n=19).

References

Hosseini, P., et al. 2021. Transmission and control of SARS-CoV-2 in the food production sector: A review of the literature. (In preparation).

Mueller, W., Loh, M., Fletcher, T., Rhodes, S., Pembrey, L., Pearce, N., van Tongeren, M. An assessment of COVID-19 infection rates within the UK food and drink processing industry. (Under review).

Appendix. Covid at Work Study (CaWS) - Stage 2 Questionnaire

Page 1 - Contact and industry information

1. What is your name?

2. What is the name of the food processing company that you work for?

3. What is your position?

4. Did you complete the Stage 1 survey?

   a) Were you the individual who completed the Stage 1 survey? *[Yes/no]*

Page 2- Site specific information

5. Confirm the postcode and stated purpose for each site is correct (as provided by the study team).

#	Question	Site 1	Site 2	Site 3
Confirm postcode:				
Confirm purpose:				
6	Have there been any changes to the number of staff since the Stage 1 survey? a. Yes/No/Don't know b. If Yes, then what is the current number of employed staff?			
7	Currently, on a typical work week, at most how many people would be on-site at any given time? *a.* Direct employees and contractors *b.* Visitors/external people			
8	Have there been any confirmed positive COVID-19 cases amongst any staff members since the Stage 1 survey? [Y/N] **If yes:** a. Please enter the number of confirmed positive COVID-19 cases amongst your workforce (Number) i. How many were site based workers ii. How many were working remotely/at home (record 'unsure' if unable to provide split of work location). b. If you have had any positive cases, did you have any contact with a public health team or HSE regarding a suspected COVID-19 outbreak on site? [Y/N/Don't know/Not applicable]			

#	Question	Site 1	Site 2	Site 3
8	**If yes to Q 8b),** i) Following contact with a public health authority, what did they identify as the route/contributors to transmission: a. Within the workplace b. Outside of the workplace ii) What would you consider as key causes or contributors to transmission in this suspected outbreak and why? jj) Would you be willing to provide the research team at IOM, LSHTM, and University of Manchester with any of the written outputs issued to you following investigation by the Public health authority? [Y/N]			
9	What was the largest number of on-site workers who have had to isolate at any one time since *date of Stage 1 questionnaire*?			
10	Has your company been offered a COVID-19 testing programme for any of the sites in question? [Y/N] a. **If Yes,** Has your company enrolled in any regular testing? [Y/N] **Route to Q11 if no**			
10	**If yes to Q10,**, i. Who is subject to regular testing? ii. How frequent is this regular testing? iii. When was this testing started?			
11	Is temperature controlled? a) If yes, where in the facility is temperature controlled? b) If yes, what is the controlled range?			
12	Is relative humidity controlled? a) If yes, where in the facility is relative humidity controlled? b) If yes, what is the controlled range?			

Page 3- Mitigation measures

Questions 13-18 include different mitigation measures recommended by UK government and the HSE that may help prevent transmission of COVID-19. Were any of these measures in place? If so, please enter the date of initial implementation.

Type of mitigation measure	Example application	Site 1	Site 2	Site 3
13. Physical distancing measures	• Physical barriers • Floor markings • One way systems • Limiting duration or volume of personnel on site/in a given area • Worker 'bubbles'			

Type of mitigation measure	Example application	Site 1	Site 2	Site 3
14. Cleaning and Hygiene practices	• Increased frequency of workplace cleaning • Extending cleaning regime outside of operational areas (e.g. changing rooms, bathrooms and break rooms) • Increased communication clarity/detail regarding cleaning requirements/responsibilities • Cleaning between users of equipment • Provision of cleaning/hand wash/sanitising materials • Non-touch bins and access to paper towels in bathrooms • Non-touch options were possible in other areas (e.g. taps, doors)			
15. Ventilation	• Introduction/improvement/maintenance of mechanical ventilation • Increased use of natural ventilation options (opening windows, doors, shutters etc where safe to do so) • Monitoring of ventilation or CO_2			
16. Risk Assessment, policies and procedures	• Conduct temperature checks on staff • Coverage for the need for staff to isolate (e.g. financial support for staff) • Communication and response to workers showing symptoms/confirmed cases • Support to staff wellbeing • Mental health support • Encouragement to get vaccinated			
17. Personal Protective Equipment (PPE)	• Provision of PPE to workforce and visitors as required (e.g did PPE requirements change due to Covid?) • Appropriate location(s) to don/doff PPE • Cleaning/disposal arrangements • Requirement to wear face coverings or masks			
18. Visitor measures	• Clear instructions/signage for visitors • Restriction of movement around site • Advance booking and record keeping • Revise procedures/processes as necessary • Temperature checks and screening at entrance			
19. Other Measures				

Next we will further explore site based implementation of the mitigation measures tabulated above. Please refer to the above tables of mitigation measures as you answer the next questions.

20. In which areas of your workplace were these measures implemented?
    - *Operational areas of plant*
    - *Administrative areas of premises (e.g. within management offices)*
    - *Break areas/communal areas (e.g., staff room, corridors)*
    - *Toilets and change areas*
    - *Visitor areas*
    - *Across all areas*
    - *Other [state]*

21. Since implementation, have there been any changes to the mitigation measures you mentioned in questions 13-19? (Y/N)
    a. **If yes**, please state the type of mitigation and nature of the change made, including for which site and approximately when.
    b. **If yes**, were these changes made as a result of confirmed cases within your business?

22. Did you encounter any barriers/challenges in implementing any of the above types of mitigation measures? Please state if these challenges were generic (across the business) or site specific.

23. What support/enablers helped you to implement the above types of mitigation measures

24. Have you done any monitoring or evaluation within your company related to mitigation measures, such as compliance? If so which and would you be willing to share this data with the study team?

25. Since 1st April 2021, have you made any changes to your production volume or variety?

Page 4 – Additional information

Thank you for taking the time to participate in the interview, your valued contribution to this research is greatly appreciated.

26. Do you have any suggestions for further information or research which you think would help either your company or the food processing sector as a whole with regards to your ability to manage the evolving COVID-19 situation?

27. Would you be willing to be contacted for further participation in this study? [Y/N]

Appendix 3. Stage 3 report

PROTECT National Core Study on COVID-19 transmission: ‘deep dive’ qualitative insights from the Food and Drinks Processing Industry

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EXECUTIVE SUMMARY

INTRODUCTION

A series of qualitative semi structured ('deep dive') interviews were conducted with experts across the Food and Drink Processing Industry (FDPI) within the UK. The work formed part of the "Partnership for Research in Occupational, Transport, Environmental COVID-19Transmission (PROTECT)" National Core Study programme[1]. The interviews sought to enhance understanding of COVID-19 virus transmission within the FDPI as well as challenges and enablers to the industries response to the pandemic.

METHOD

A total of 21 semi structured ('deep dive') interviews were conducted remotely via video conferencing (e.g. Zoom or by phone) between August and November 2021. Written transcripts were generated and subject to independent quality checks before being subject to thematic analysis. This report presents the findings from across and within the different stakeholder groups consulted, namely: Government Agency representatives, Federations and trade associations, Unions and Academics in their respective fields deemed relevant to the study scope.

RESULTS

Supporting information exchange and engagement

- Unions, Government agencies and Federations used a variety of channels to communicate and engage with the FDPI. Amongst the most frequently cited were websites, emails/calls and webinars.
- Websites were considered the most effective channels across all stakeholder groups though stakeholders reported using them in different ways. E.g. Government agency respondents referred to websites used to signpost businesses to central sources of Government guidance, while Federations wrote quarterly newsletters which were accessible through their website for members.
- Additional communication channels cited included the use of industry forums, having "teams on the ground", magazine articles and feedback through meetings and groups.

Risk perceptions of the FDPI

- Specific risk factors identified for the transmission of COVID-19 within the FDPI included poor social distancing, size and age of buildings, temperature/humidity, noise and ventilation. Some respondents were however cautious not to attribute isolated risk factors for transmission of the COVID-19 virus.
- Wider transmission factors, including shared accommodation and transportation to and from the workplace were identified by Unions, Government agency and Federation respondents.
- Respondents acknowledged the difficulty of comparing food processing with wider industries, acknowledging the variation in production practices, products and facilities between different FDPI facilities and sub-sectors.
- FDPI sub-sectors believed to be at greatest risk for COVID-19 transmission were meat processing facilities, agricultural food picking/production and sandwich making.

Implementation of mitigation measures and protective practices

- COVID-19 mitigation measures believed to be effective within the FDPI included: effective testing, self-isolation, use of PPE, vaccination, physical distancing, cleaning/hand hygiene,

[1] https://sites.manchester.ac.uk/covid19- national-project/)

good ventilation, risk assessments and limiting staff contact. Emphasis on these risk mitigation measures varied across different stakeholder groups.

- The importance of ensuring adequate risk assessments was emphasized as a key measure to mitigate COVID-19 transmission, as this should be specific to the workplace in question. Some respondents however felt that risk assessments had been too generic, based on Government guidelines, or focused too much on specific mitigation measures.
- Respondents generally acknowledged the importance of using a variety of mitigation measures together, rather than focusing or prioritizing one.

Compliance

- Government agency, Federation and Union respondents generally perceived good levels of compliance with COVID-19 measures within the FDPI. Challenges to securing industry compliance are discussed however, including frequent changes in Government guidelines.
- Many respondents cited FDPI businesses had implemented some form of compliance monitoring and support, e.g. car park spotters, COVID-19marshals.
- Some respondents noted challenges in communication faced between workers and employers, particularly in settings where there were large numbers of agency workers and/or workers for whom English is not their first language.

Industry challenges in responding to COVID-19

- Balancing competing priorities and responding to changes in supply and demand was a challenge cited amongst Federations, Government Agencies and Union respondents.
- Workforce related challenges included labour shortages, self-isolation/ sickness absence and worker exhaustion.
- Financial challenges included costs associated with the implementation of COVID-19 control measures and staff sick pay.
- Federations, Unions and Government Agencies identified the fast pace of changing guidance as a challenge for the FDPI
- A number of challenges outside of the DFPI were also said to be impacting the industry alongside the COVID-19 pandemic, namely EU exit (‘Brexit’), furlough and interwoven supply chains with other industries

Enablers to preventing COVID-19 transmission

- The introduction of financial support, either as sick pay from FDP businesses or through self-isolation payment support provided by the Government was the most prominent enabler cited.
- Other enablers cited by small numbers of interview respondents included the introduction of COVID-19 home testing, management buy-in within FDP businesses, introduction of the seasonal agricultural workers scheme within the agricultural sector, improved communication between workers and managers, mechanical ventilation and use of technology in general.

COVID-19 detection and response

- Means of identifying a COVID-19 outbreak varied between and within different stakeholder groups and encompassed notification from the FDP business themselves, contact with public health bodies, import bans introduced from other countries, Federation member surveys.
- Specific subsectors identified to have suffered large outbreaks included meat/poultry facilities, agricultural food picking/production and sandwich making.
- Some respondents were of the opinion that workplace outbreaks mirror rates of COVID-19 within the wider community, whilst others reflected on the significance of outbreaks within the FDPI when community rates were reportedly low.

- Some respondents expressed distrust in the accuracy of reported COVID-19 cases and outbreaks.

Looking forward

- It was anticipated that some COVID-19 measures would be retained within the FDPI, for reasons of maintaining good practice and in anticipating of needing to put them back in practice in future, though some anticipated challenges in trying to maintain practices within the workplace that will no longer be maintained within the wider community.
- Continued provision of financial support was considered to be important by some to ensure that people don't feel the need to come to work when they are unwell.
- Some respondents emphasised the importance of keeping good ventilation to prevent the spread of COVID-19 and other viruses.
- Lessons learned from the COVID-19 pandemic were considered relative to the design of future production facilities in order to allow more space for implementation of mitigation measures that may be needed and incorporating ventilation systems at the time of their construction.
- Respondents considered the potential use of technology in future to support management of the COVID-19 virus or similar, including automation of tasks, wearable technology to support social distancing; wastewater testing to support detection of COVID-19.

Gaps in knowledge

- Enhancing understanding of ventilation relative to transmission of the COVID-19 virus within the FDPI was identified as a gap in knowledge across three of the four stakeholder groups.
- Further gaps in knowledge identified by different stakeholder groups included: understanding transmission routes within the FDPI; understanding the FDPI workforce (in particular migrant workers); unknown future of the COVID-19 pandemic; the impact of temperature relative to transmission of the COVID-19 virus; and symptoms of the COVID-9 virus (said to change with different variants).

Industry concerns

- Respondents expressed various concerns related to future variants of the COVID-19 virus.
- Federations expressed concern for further lockdowns and the impact this may have on production, demand and staffing within the FDPI.

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1. INTRODUCTION

1.1 OBJECTIVES AND CONTEXT

This research sought to understand transmission of the COVID-19 virus in the food and drink processing industry (FDPI) as part of the 'COVID-19 at Work Study' (CAWS) conducted jointly by The London School of Hygiene and Tropical Medicine (LSHTM) and the Institute of Occupational Medicine (IOM)[2]. The research discussed within this publication relates to qualitative consultations (collected as part of a wider research study) with FDP industry experts to better understand risks, mitigation measures, barriers and opportunities to prevent transmission along with the impact of COVID-19 on the FDP industry.

Findings of this wider research study (including a systematic review of existing literature and quantitative survey data (related to COVID-19 cases and mitigations) provided by businesses across the FDP industry) have been published elsewhere.

2 METHODS

A total of 21 semi-structured qualitative interviews were conducted remotely (via Zoom/MS Teams) with UK based stakeholders across the FDP industry between late August and mid November 2021. Interviews generally lasted 60 – 90 minutes and were conducted by a team of three researchers, skilled in the use of qualitative methods. Interview schedules were tailored to the different stakeholder groups consulted to ensure consistency of interview coverage whilst remaining relevant to the working role (relative to the COVID-19 pandemic) of interviewees. The interview schedules broadly explored the following areas with respect to COVID-19 within the FDP industry:

- Sub-sectors and work areas considered to be high risk for COVID-19 transmission;
- Mitigation measures to prevent transmission along with barriers and enablers to their implementation;
- COVID-19 information, guidance and support provided, along with knowledge gaps remaining;
- Impact of the COVID-19 virus to business operations and more generally to the industry as a whole;
- Challenges and anticipated practices to support future management of the COVID-19 virus.

Interview schedules for the different stakeholder groups are provided as an appendix (Appendix 1: Example interview schedule).

The study was given favorable opinion to proceed from The London School of Hygiene and Tropical Medicine Research Ethics Committee (LSHTM Ethics Ref: 26122). Following on from engagement with FDPI Federations and trade associations and industry forums, and dissemination of online surveys amongst FDP businesses (Stages 1 and 2 of CAWS), researchers reached out to existing contacts with pan-industry knowledge to explore their willingness to take part in semi-structured interviews. Desk based scoping research was also conducted to identify relevant Academic experts, Unions and Government agencies that could be approached for interview. A snowballing approach was then used to identify further industry contacts with knowledge and experience reaching beyond a single FDP business. A number of conglomerate companies were approached for interview but no response was received within the timeframes for data collection.

With expressed prior consent from participants, interviews were audio recorded and auto-transcribed using the videoconferencing technology, before being subject to an independent check for accuracy prior to detailed thematic analysis. Interview transcripts were analysed deductively within their

[2] https://sites.manchester.ac.uk/covid19-national-project/research-themes/sector-specific-studies/covid-19-at-work-understanding-transmission-in-the-food-processing-sector/

stakeholder groups before comparisons were then made between the different stakeholder groups. The findings discussed (below) are structured around the prominent themes identified within and across the different stakeholder groups.

3 PARTICIPANTS

A total of 21 interviews were conducted with 32 FDPI experts, including representatives from Government Agencies (N=7), Federations and trade associations (N=5), Unions (N=4) and academics (N=5) in their respective fields deemed relevant to the study scope (e.g. occupational health, specialising in ventilation or food). The participant representation across different stakeholder groups is presented within Table 1.

Table 1: Participant representation across stakeholders

Type of stakeholder	Number of interviews conducted	Number of expert representatives consulted	Abbreviated reference throughout
Government agency/department representatives	**7**	**9**	**GA**
Academics	**5**	**12**	**A**
Federations/ associations	**5**	**5**	**F**
Unions	**4**	**6**	**U**

3.1.1 Role scope of stakeholder groups

Government Agencies

The area coverage for Government Agencies that agreed to be interviewed varied with respect to whether their undertaking was UK wide or specific to one or multiple countries within the UK. Furthermore, the scope of undertaking amongst some Government Agencies consulted was specific to the FDPI, whilst others encompassed wider industries, often through a structure of discrete departments. In all cases, interview respondents had some responsibility and undertaking within their role for supporting COVID-19 management within the FDPI. In many cases, Respondents identified that their Government agency had a large role in supporting the localised implementation of national COVID-19 guidance amongst different settings and environments within the FDPI.

Federations and trade associations

The five Federations that participated in this study represented a range of FDPI members including those from food and drinks sub-sectors. The Federations reported that their role involves representing their members in the respective sub-sectors and as part of this they provide proactive support on a variety of topics including health and safety and more recently COVID-19. This support includes communicating, translating and interpreting Government guidance to provide members with key messages and sub-sector specific summaries, along with sharing good practice examples.

The Federation interviewees that participated in this study had leading, specialist and technical roles within their organisations.

Unions

Unions representing a wide range of FDP members were contacted, and the four individuals who participated in the research represented members associated with various sub-sectors of food and drink production.

Academics
A range of academics from different organisations/institutions were contacted to gather a collective coverage of information, knowledge and experiences surrounding this topic. The areas of expertise for the five Academic respondents who agreed to participate in the study included; COVID-19 transmission/risk in the food production sector and amongst food workers, occupational health and ventilation in various work settings.

4 RESULTS

4.1 SUPPORTING INFORMATION EXCHANGE AND ENGAGEMENT

4.1.1 Commonly cited communication channels across stakeholder groups

Union, Government agency and Federation respondents most commonly referred to the use of their own **websites, emails/calls and webinars,** respectively as communication channels to effectively communicate and engage with the FDPI.

Websites were most commonly cited as an effective channel of communication by Union, Government agency and Federation respondents during the COVID-19 pandemic. The majority of Government agency respondents also reported signposting businesses to central sources of Government guidance or replicating this on their own media channels/website.

> *"The web page included our guidance document […] that basically had information on everything that was coming out from [country anonymised] Government that was in this easy to access, one platform, and it was food focused." (GA2)*

> *"...we've got a quarterly newsletter we send so that's all health and safety information in but it's also got COVID-19stuff in there as well..." (F4)*

Emails were reportedly used as a means of engaging with FDPI businesses. For example, Federations sent weekly or daily emails basis depending on the stage of the pandemic in response to the needs and wants of their members. Unions also went further to explain the role of emails and branch structure, as follows.

> *"...But generally, it (communication) was on the website. It was via emails. It was via the regional structure. It was via the branch structure. So, branches will also disseminate information and it is dependent on people reading it." (U2)*

> *"So we do react a lot to what they are needing or wanting, but we also at the same time, are going to feel for what might help […] good practice guidance and […] sharing of information." (F3)*

In addition, Federations and Unions both highlighted their role in **responding to queries through incoming emails, calls and webinars** from member organisations and FDPI workplaces.

> *"But we certainly had centrally quite a large number of emails to deal with from members and reps in workplaces. Asking questions around COVID-19and the precautions that employers should be putting in place and whether the precautions were right." (U1)"*

> *"...absolutely yeah [webinars were well attended] and you know questions are asked and, you know Members would think of something that was quite you know that we've not thought of you know, then we have to look at those sort of things." (F4)*

In addition to websites, emails/calls and webinars, each stakeholder group also referred to a number of additional communication channels, as summarised below.

4.1.1.1 Additional communication channels cited by Government Agency stakeholders

Industry forums and having 'teams on the ground' who are able to visit operational sites in person were the most prominent communication channels cited amongst Government agency stakeholders.

With respect to **industry forums,** interviewees reported these as a valuable means of identifying and sharing good practice across the FDP industry. The Food Resilience Industry Forum (FRIF) was cited as one such example, said to meet twice a week during the peaks of the COVID-19 pandemic, with this subsequently reducing to bi-monthly during X at the time of interview conduct. With a remit reportedly encompassing both COVID-19 and Great Britain's exit from the European Union (EU), the FRIF was estimated to achieve representation from over 200 industry stakeholders, and provide a means for two-way exchange of information, as illustrated by the following interview extract.

> *"It also got good attendance from other departments across Whitehall, so we would have to fund health and social care, or test and trace or PHE come and talk and answer questions about it." (GA4)*

Some Government Agency interviewees believed that industry forums provided support to enable discussion that contributed to subsequent development and implementation of recommended measures and practices within FDP industry businesses.

The use of industry forums were considered by some to provide an effective means of understanding the practical application and impact of changes to COVID-19 guidance 'on the ground' within operational businesses. One example cited was the development of the track and trace app. Forum stakeholders reportedly highlighted the need to pause the contact tracing functionality on mobile devises when storing them, along with other personal possessions within lockers so as not to trigger other peoples devises stored close by, whilst the owner of the device was elsewhere.

> *"Having them involved in the policy development is helpful for having them, then deliver the policy." (GA4)*
>
> *"I was out at the various stakeholder forums, informing the food stakeholders, about the surge testing programme and encouraging them to take it up" (GA6)*

Many Government Agency stakeholders believed that having **teams on the ground** was beneficial to ensuring prompt exchange of information. Specifically, participants cited the ability to gather first-hand information from the site, as well as being able to promptly communicate COVID-19 guidance changes as specific benefits to having teams on the ground.

> *"… our operations team, because they're actually on the ground, so if they then know okay well rules on physical distancing changed and […..] I would have alerted them to any guidance changes and then, if they're going to this particular and meat plant on Tuesday, then they're able to sort of communicate that information." (GA2)*

4.1.1.2 Additional communication channels cited by Unions

Additionally, Union respondents made reference to writing **magazine articles** for members which were believed to support information provision in addition to calls and emails.

> *"So during the pandemic letters, printing didn't really happen that much, so it was emails. (…) And then when I can, I write a magazine for them, or publish a magazine for them with information in it. I started doing that towards the end of the initial lockdown but also via email." (U2)*

4.1.1.3 Additional communication channels amongst Federations

All of the Federations identified the importance of learning from industry and practices that are happening at member worksites, for example through feedback, meetings and groups. An example from one of the Federations was an **industry survey** that they conducted with member organisations on various topics related to COVID-19 in their sub-sector and more specifically the impact in companies. This survey was said to allow companies to benchmark against each other, share good

practice and collect data to inform good practice. To facilitate this communication amongst their members, the Federation shared the survey results on a daily basis at the peak times of the pandemic, the frequency of which evolved as the pandemic progressed. The survey was also said to help the Federation remain aware of the issues being experienced in the sub-sector and allow them to inform Government of current practices and impacts experienced by the FDPI.

> *"Basically you're just keeping Government appraised of the issues within your industry […] It was useful […] appreciated by officials, because when industry bodies are telling them that something's going on, they like to see the data and the story behind it, they know it's not just a complete conjecture or anecdotal reports." (F5)*

As part of their COVID-19 response, the Federation respondents identified various stakeholders they were informed by and worked alongside including; Government, expert groups, forums, committees, sub-sector specific groups and authorities.

4.2 RISK PERCEPTIONS OF THE FDP INDUSTRY

4.2.1 Risk factors for COVID-19 transmission within the FDP industry

A number of specific risk factors for transmission of the COVID-19 virus were identified by the various stakeholders, including: **poor social distancing, size and age of buildings, temperature/humidity, noise and ventilation**. Wider transmission factors such as **shared transport and accommodation were also raised by respondents**. These findings are discussed in turn with illustrative quotes below. It should be noted however that whilst Government Agency respondents identified risk factors for transmission of the COVID-19 virus within the FDPI, they were generally cautious not to attribute isolated risk factors, such as temperature, as illustrated by the following participant quote.

> *"What makes the food industry slightly different is that some of the sectors are chilled and cold environments and potentially high moisture environments as well, but it's a difficult one really to assess and put down just for the fact that the factories are chilled from the point of view that chilled factories tend to be hard labour, so a lot of people." (GA1)*

4.2.1.1 Poor social distancing as a risk factor for COVID-19

Poor social distancing was a prominent theme to emerge across all stakeholder groups as a risk factor for the spread of COVID-19. Respondents often referred to the large workforce often required within subsectors of the FDP industry, said to make it difficult to maintain social distancing in various areas of the facilities. Emphasis was said to have been placed on ensuring adequate social distancing within operational areas through rearranging production lines and staggering shifts while also using different workspaces (e.g. changing rooms) to have less people working in close proximity at once.

> *"Physical distancing on the shop floor was very effective. There were lots of organisations that did actually rearrange their production lines, even if it meant slowing production down (…) They've managed quite effectively to spread people out so they were standing a few meters apart which definitely made a difference." (U1)*

> *"…stagger your shifts and stagger people going to change in rooms and you know, try and make one way systems rather than everybody sort of just heading towards each other…" (F4)*

However, some Unions, Federations and Government Agency respondents were keen to highlight the difficulties faced by FDP businesses in maintaining social distancing between workers in non-operational areas (e.g. smoking shelter, canteen) and entry/exit points.

> *"People are used to it [social distancing] if you're in the working environment and again this goes back to when the risk is not solely in the workplace […] They kind of switch off from that when they're going to have their sandwiches lunchtime […] I think that's what employers struggled with more was outside the production area."(GA3)*

"Workers would get off the bus and wait in a queue to get into the slaughterhouse […] and then inside - for example, people walk down the corridors and they're not necessarily that big, so how you create a one-way system to stop people coming into contact with each other was also a concern." (U2)

One Government agency respondent highlighted that staff canteens could not be closed within the FDPI, unlike in many other industries. This is due to the risk of workers bringing in allergens and contaminants into the processing environment as a result of eating their own home prepared food. Some Federation respondents also identified the practice of increasing the communal space available for workers to spread out, for example within canteens and locker rooms.

"…some of them changed some of their some of their canteens and where they were sitting there would have another room as well, because they needed more space […] they expanded the areas that people could go to sit in. So they weren't all sitting close together." (F3)

Conversely, most Academic respondents and some Government agency respondents commented on poor social distancing as a risk factor for COVID-19, believing this to be more of an issue during production hours and work areas. This was not always considered to be specific the FDPI. They also stated that while poor social distancing may be a contributing risk factor across the FDP as a whole, it was seen to be a more prominent problem in meat and poultry facilities, and some agricultural work.

"…they're working that quite close to one another and may be handling things which they pass on to one another, you know?." (A1)

"...you know, the number of people, the proximity and duration so regardless of setting if you have a lot of people in small space for a long period of time, the risk is increased."(GA3)

Some of the Federation respondents also identified that in some instances it was not possible to avoid social distancing when working safely on particular tasks in the workplace.

"…you need a maintenance team working next to each other, to make sure they're working safely on a bit of machinery, then you can't social distance in accordance with the guidance." (F5)

"There are some activities which require more than one person. I mean, an example is where you've got some engineering work or electrical work where people have got to go in in pairs because of existing health and safety reasons, so that might be into a confined space." (F2)

4.2.1.2 Size and age of facilities/buildings as a risk factor for COVID-19

Union and Government agency respondents stated that many FDP facilities in the UK suffer from **buildings** which are old and often quite small. This was echoed by one of the Federations who reported how some FDPI buildings have been modified several times. The design and age of many buildings was said to have made it very difficult to implement COVID-19 measures, such as social distancing (as discussed above within section 4.2.1.1) and installation/update of ventilation systems that would help prevent COVID-19 transmission.

"The food industry is got a mixture of establishments. Some of them are very new, very spacious. Some of them are extremely cramped, and I mean it, were very well aware that a number of the factories that have been involved in outbreaks are the latter variety. There's very little they can do from a from a physical point of view. Once they the walls are built." (GA1)

"Quite a lot of the UK food manufacturing is in very poor states in terms of the actual infrastructure, like the sites in the factories are a rundown. Its investment in technology and in innovation has been very poor, so many companies were trying to retrofit measures on buildings that were fifty 60, 70 years old, and so that was an added challenge for a number of companies." (U3)

Whilst the smaller size and age of buildings has been seen as a risk factor, interviews with Federation representatives also referred to the use of automation in other parts of the FDPI, whereby larger buildings have very few workers involved in processing activities and therefore reduces the risk of transmission.

> *"When it comes to [FDPI type of site] they're quite large buildings, with very few people in them, you know, one of the biggest [FDPI type of site] in the country that's producing you know significant portion of the nation's [product] may only have two or three people in the building at one time, and this is a five story building, but is, you know vast. Because so much it's automated nowadays, it doesn't say there are areas without risk." (F5)*

4.2.1.3 Temperature and humidity as a risk factors for COVID-19

Cold temperature and humidity were mentioned by various stakeholders as potential risk factors for COVID-19 transmission in the FDP facilities. Union and Government agency representatives highlighted the challenges of having to ensure temperature-controlled areas in certain sub-sectors, such as meat/poultry sites, making it difficult to ensure a fresh air supply. This was also seen as another risk factor due to research showing the effect of cold temperatures on increasing the life of the SARS-CoV-2 virus (Aday & Aday 2020).

> *"...in areas where they've got strict hygiene controls, they can't open the windows and they can't open doors where they got temperature-controlled areas. Meat manufacturers is a classic one because the rooms have got to be kept below 10 degrees and typically it's kept about 5 degrees to protect the quality of the product. That means you don't want to bring in lots of outside air because you have to chill it down all the time". (U1)*

> *"When you've got environments which are chilled, most environments are, you know, hygienic for the products. However, with lower temperatures, the stability of the SARS-CoV-2 increases exponentially when temperature decreases". (A5)*

Academics also referred to the combination of humidity alongside low temperatures causing a further risk for infection within FDP facilities, alongside other compounding factors, such as poor ventilation and poor social distancing etc.

> *"The particular environments in food factories makes it the highest risk because it's got the perfect combination of low temperature, low humidity and poor ventilation, coupled with the fact you've got high aerosol and particle generation. So that combination makes it the highest risk area..." (A5)*

In contrast, one Government agency respondent described warm and humid processing environments, such as meat cutting plants, as presenting an increased risk for COVID-19 transmission to occur. One Academic also emphasised the impact of humidity alone as a risk factor and described the impact of this on transmission.

> *"There is an absolute need to have chilled areas and frozen areas to maintain the food, you know and the actual slaughterhouses themselves are, if you could ask for a better area for bacteria spread you'd be tough to find one because they are warm and humid."(GA5)*

> *"The other big environmental issue is the humidity. So chilled environments again optimal for infection because with low humidity the air is drier, sometimes below 40% relative humidity. The air being dry means that the moisture in your nasal passages and your trachea dry out, which means that the virus can infect much, much quicker." (A5)*

4.2.1.4 Noise as a risk factor for COVID-19

Approximately half of Government agency respondents were keen to emphasise **noise** as an influencing factor thought to impact transmission risk within the FDPI. One Academic respondent also referred to noise as a risk factor, particularly when mixed with poor ventilation. Noisy production environments or loud machinery was said to encourage workers, and in particular supervisors, to shout or move closer together in order to communicate effectively and thereby increase the risk of COVID-19 transmission.

> *"We did frequently or repeatedly find instances where transmission would occur because the supervisor has to get up close to someone to shout […] throughout all of our involvement with food processing, that it would just be one of those things they couldn't satisfactory resolve. And the thing about the Supervisor was that not only were they having to do this repeatedly and were there for risk from getting it from everyone on the line, once they had it, they were then able to pass it very effectively." (GA7)*

> *"(With COVID-19 viral loads) When you talk, you're generating 10s of thousands of particles … Now when you're shouting you're pushing into 100,000 particles (…) so the thing about food factories is that they are noisy and people have to shout to have their voices heard (…) So there's another major factor of why the food sector is in the highest risk category." (A5)*

One of the Federation respondents cited the use of blue-tooth technology headsets to avoid the need for staff to shout above the noise level of the machinery.

4.2.1.5 Ventilation as a risk factor for COVID-19

Ventilation was by far one of the most prominent risk factor cited by Academic respondents, along with and some Union representatives. Most academics noted that the existing ventilation systems in place at various FDP facilities were not adequate enough to reduce transmission of the COVID-19 virus and required amendment or updating. Some also stated that ventilation systems being installed failed to take account of the structure of the building/site.

> *"you've got to look at the direction of airflow, because what you don't want to be doing is picking up contaminated air and blowing it into dead corners. So for example, you might see a lot of packing areas to be at the end of the building, so if you're blowing air across it (…) you're blowing into a dead zone where people are packaging. Those people in the packaging areas are then very high risk then aren't they?" (A5)*

Academic respondents also stated that ventilation was one of the most overlooked risk factors, particularly by the Government and site managers at the beginning of the pandemic, and too much emphasis was placed on factors which arguably did not contribute to as much of a risk. They also noted the importance of adequate ventilation alongside other measures (discussed further in section 4.3.7 Ventilation as a mitigation measure), such as access to PPE.

> *"I have found that ventilation tends to almost come second because of the need to maintain a certain thermal gradient, and often hasn't been well serviced and so on. But then of course if you've got people working in very close quarters where one person's breathing zone is abating on the other person's breathing zone, then you probably could not achieve stopping transmission by ventilation alone." (A3)*

Many Union and Government agency respondents commented on how ventilation would be an effective mitigation strategy to help prevent transmission. They were however less likely to comment on ventilation as a risk factor for transmission. That said, one Union respondent commented on the poor nature of the airflow in meat/poultry facilities, which may be a risk.

> *"When you're processing meat or chicken (…) sites have massive big circulation for these systems that are there to actually recirculate the air in that enclosed space. Because they've got these massive fans recirculating there all the time, this means that people are actually circulating the virus along with anything else in the air very efficiently" (U1)*

4.2.1.6 Wider risk factors for COVID-19 outside of the work place

Shared transport and accommodation

One of the prominent themes in discussion amongst Government agency, Union and Federation respondents were the perceived risks outside of the work environment. Various stakeholders made reference to **shared accommodation and transportation** to and from the workplace amongst employees. This was believed to increase the risk of viral transmission, even if mitigation measures within the workplace were strong. Moreover, Government agency respondents considered this risk to be most pronounced amongst agency staff who may work across different facilities and businesses, thereby increasing the potential breadth and speed of transmission amongst their fellow FDPI workers.

> *"We put in staggered start times. We put different entrances for people to go away and we had clear markings on the floor and we didn't see a breakout really in our industry. I'm not saying people didn't get it because they did, I mean, because obviously traveling on buses to and from work, you know, it was inevitable that there was going to be cases" (U4)*
>
> *"But the other thing that hurts us is they live together they travel together." (F1)*
>
> *"..for example, poultry processing, etc but there maybe three or four poultry processes drawing people from the same locality so we did see issues from shared travel and shared accommodation arrangements. […] They may be working at one processer that one day, another processer that the day, so you've got workers that were moving, not necessarily to the knowledge of the site operators, but moving between different businesses."(GA3)*

Some Union, Federation and Government agency representatives highlighted there being a reliance on **shared transport** amongst some workers due to often-remote locations of FDP businesses.

> *"Some of these slaughter houses are not in the city centre, they are out in the middle of nowhere, so buses would take people to the slaughter house at 5:00 AM in the morning. And of course, they will be full of people" (U2)*
>
> *"in Yorkshire they're spread up and down the M1 and the M62 so you've no way of getting there other than by car and people car share." (GA7)*
>
> *"I think there were challenges around travelling to work because there are rural areas. Because car sharing wasn't encouraged, I mean that was quite a difficult one for some companies, and there wasn't public transport. So how else do people get to work? So it was trying to encourage them when they arrived in a car together that they shouldn't be doing that and if they are, they should wear face coverings and opening windows…" (F3)*

A small number of Government agency respondents emphasised the limited financial means believed to limit FDPI workers choice of transport to and from work.

> *"People, because they are sort of your minimum wage, they don't necessarily all own a car and they perhaps can't afford to own a car"(GA3)*

One respondent also highlighted that their regulatory powers stop at the physical work site and hence the way in which FDP employees travel to and from work is beyond the scope of their role.

> *"...what our powers extend to are the workplace. We can't tell people how they should travel to work" (GA3)*

One of the Federation respondents also mentioned the risk of sharing transport in relation to deliveries, not only commuting activities.

"So there would be lorries that would take deliveries. Sometimes you would have more one more than one person in the cab, so that's obviously a risk as well." (F2)

Shared living arrangements/accommodation was also identified to increase the risk of viral transmission amongst workers within the FDPI, commonly cited by all stakeholder groups. This was most commonly with respect to workers living together, though one Federation respondent highlighted the sharing of hotel accommodation as a contributor to transmission amongst three members of one of their member companies.

"I wouldn't be at all surprised if they provide vectors for the transmission of the disease if you've got people cohabiting and shared accommodation, large migrant workforce living in bunkhouses or something like that, or shared accommodation somewhere. And that could be quite specific to the food sector." (A1)

"Well, we had one particular Member and they had a couple of, well three actually, positive cases and that was through onsite testing. And it turned out these people have not been in contact with each other and it all stemmed from the hotel they were all staying in [location] […] staying in a hotel somewhere near and there was three in the same hotel and it wasn't the fact they've been working together, it was the fact they just stayed in the same hotel and perhaps touched the same handrail." (F4)

Some Academic and Government agency respondents made explicit reference to **shared accommodation relative to migrant communities/workers**, who they believe make up a large proportion of the FDP workforce in particular sub-sectors (e.g. meat processing and agricultural).

"In lots of meat processing within, for example, chicken processing, there's sort of a long tradition of gang-based working, even of modern slavery. People live in very, very confined conditions, very close to each other (…) you have people who are living together and working together, actually in relatively sort of poor working conditions and therefore are at a higher risk of compressional transmission, but not in the sense of transmission in the workplace itself" (A2)

"Obviously there's a large [volume of] work for temporary migrant workforce, often accommodated on site. So yeah, with fruit picking, vegetable picking that that kind of thing, so that's not really about the preparation of the food, […] if you had a lot of lots of people moving in and out, living in relatively close proximity housing, then transmission might not be anything to do with the job they're doing." (GA1)

4.2.2 Comparative industries

Interviewees were asked how safe they would regard the FDPI and whether they could make relative comparisons to other industry with respect to transmission risk of COVID-19. Government agency respondents acknowledged the difficulty of comparing different industries with respect to COVID-19, and acknowledged the variation in products, facilities and practices across subsectors of the FDPI as well as commonalities, such as continued operation over the course of the pandemic and prevalence of site-based working (described in section 4.2.1).

"It's [the FDPI] obviously got its own peculiarities and the sectors across the food industry, very considerably, with things like the capability to social distance and types of ventilation..." (GA1)

Generally, some interview respondents **did not perceive an increased risk of COVID-19 transmission amongst workers within the FDPI, relative to other industries**. That said, some Government and Federation respondents made comparative reference to wider industries but acknowledged of elements the FDPI that make it distinct and hence difficult to compare relative risk of COVID-19. This included:

- Other manufacturing/processing industries

"...if you look at manufacturing in being very generalist here, so if you're looking at making a car, you don't have very crowded production lines anymore people making cars because it's been automated" (GA3)

"…the food production that you know you've got people sort of standing next to each other all day long, and you know it is a production line at the end of the day. Whereas the warehouse is a little bit more spread out for food distribution…" (F4)

- Sectors familiar with the use of PPE

"You might compare it to kind of other sectors where they are very used to PPE, all the construction sector for example […] I guess the difference is that there's much less flexibility in the food sector […] you know move your chicken preparation outside." (GA1)

- Sectors employing large volumes of people

"The food industry is one of the very few that still employs a lot of people, yeah outside of say call centres or sort of office environments […] if you're in a call Centre you're sitting at a desk speaking to somebody in a very close room not lots of windows, we haven't seen the risk because the risk is being controlled - people doing it from home" (GA3)

4.2.3 Subsectors perceived to be of greatest risk

Across all stakeholder interviews, it was clear that some subsectors were perceived as higher risk for COVID-19 transmission, namely those with **meat processing facilities, agricultural food picking/production and sandwich making.**

Government agency, Unions and Academics most prominently referred to **meat/poultry facilitie**s, and made reference to a number of outbreaks across meat/poultry sites. Small numbers of respondents from these stakeholder groups also perceived **sandwich making facilities** as high risk due to their chilled environments or temperature variations across site.

"Well, there were certainly issues around meat. There were definitely outbreaks in meat processing. Not sure if you could say it's a trend, but there were some big outbreaks." (A4)

"..there's international evidence of long-range transmission in meat processing plants. For example, in Germany they were identifying transmission over about 8 meters" (GA4)

"Slaughterhouses are genuinely cold in the winter and hot and humid in the summer. So you've got 2 forms of ventilation. You've got mechanical or you've got manual. A manual is opening up the window and of course you can't really do that in the slaughter house, so it's really whether the building itself has the ventilation that cleans the air on a regular basis to protect people because we know that COVID-19 is airborne infection" (U2)

One Union respondent attributed the outbreaks within meat processing plants to a number of factors including: more frequent car-sharing arrangements; difficulties in communication between employees (such as those caused by language barriers); and a high propensity for agency workers who often share accommodation. Moreover, this individual felt that meat/poultry facilities were more likely to require certain equipment and clothing, which meant that more individuals were sharing facilities in close contact such as changing rooms.

"most people change from outdoor clothing into their work clothing on site. So there's like changing rooms, showers as well, and those are often pinch points where you get a small enclosed space where you get people spending not a great deal of time, but long enough for them to be swapping the virus if someone is infected in that group." (U1)

Agriculture/fruit and vegetable processing was also suggested by a small number of Government agency and Academic respondents to be a subsector at particular risk of COVID-19 transmission. This was in the context of large volumes of workers that are conducting manual tasks, working in close proximity, and in the case of agricultural work, often sharing accommodation.

> *"In the vegetable packing industry, there is some sort of dimensionality (…) obviously, sort of cold temperatures, which tend to be prevalent in meat processing is a potential factor, but then there are some factors like the close proximity of workers within production lines which are going to be common to both meat and to vegetable processing." (A2)*

> *"...offering a lot of people sort of minimum wage to do roles which are very monotonous […] standing at the conveyor belt and your job is to place a piece of tomato or three slices tomato in a line across a piece of bread. […] In meat processing again, there are lots of small tasks that are done that you can't automate and so you're employing lots of people to do them."(GA3)*

One Government agency respondent shared an internal phrase used by colleagues to describe the level of COVID-19 risk in FDPI subsectors, this being: *"sausages, KitKats and then lettuce" (GA4)*. This was said to acknowledge the COVID-19 prevalence in meat processing plants, along with ambient production and horticulture.

4.3 IMPLEMENTATION OF MITIGATION MEASURES AND PROTECTIVE PRACTICES

Interview respondents described a variety of mitigations and protective practices being implemented across the FDP industry in order to try and prevent transmission risk of COVID-19. These included: testing, Isolation, vaccination, use of PPE, physical distancing, cleaning/hand hygiene, ventilation, cohorts and contact tracing, limiting staff contact and risk assessments.

4.3.1 Testing as a mitigation measure

There was representation from across all the stakeholder groups (all Federations, most Government agencies, some Unions and one academic) in reference to **testing** as a valuable practice to help prevent the spread of COVID-19. Specifically, respondents discussed the positive impact of both contact testing and asymptomatic testing amongst workers, misconceptions between testing and self-isolation, along with the use of wastewater testing perceived to be a valuable use of emergent technology at the time of interviews.

> *"...a miss perception amongst people that if they test with LFDs people aren't gonna have to self-isolate with but if they do with PCR they are and mixing up, just the issue of testing your staff with the issue of being a contact in self-isolating" (GA4)*

> *"I think testing really does make a difference. I think daily contact testing in particular makes a difference. That's what all the policy holders have been saying." (GA6)*

> *"…there's some sites […] still lateral flow test twice a week now or several times a week, so people, people have commented, they feel safer in work than they do out and about." (F1)*

One Government agency respondent also spoke about the changing access routes for COVID-19 testing encompassing workplace testing, community testing and home testing. The introduction of home-testing in particular was said to have reduced barriers to testing with associated costs, training and logistics acknowledged to pose barriers to businesses setting up workplace testing sites prior to the role out of home test kits.

> *"You know, the food sector is so varied, it's very broad and it's very spread out. To get, you know, a company with 18 factories setting up a testing site within each workplace is quite a clunky way of doing it. […] a barrier to testing, which is setting up a testing site, but an enabler is being able to take the test kit home." (GA6)*

While rapid testing was acknowledged to be effective in reducing the transmission of COVID-19, one Union respondent acknowledged the accuracy of relying on individual workers taking the test at home, whilst an Academic highlighted the disruptive nature of conducting daily rapid testing for both the employee and employer on site.

> *"(testing at home) that's probably the least accurate way of doing the test. (…) I think in the food industry, it could be more controlled. There could do on site testing. They could supervise to make sure it was being done more, more reliably." (U1)*

> *"I've been to a factory site where the staff have to COVID-19test every day, which is, you know, very time consuming and very disruptive for the staff as well. And it's costly, isn't it?" (A5)*

Speaking about lessons learned, one Union respondent noted the importance of ensuring better testing in the future, with a further Union respondent noting the importance of ensuring testing can be conducted within the workplace.

> *"Assuming we don't have any other major lockdowns, the most important things going forward are going to be getting a better understanding of what the most effective control measures are in your workplace and accurate and better testing." (U1)*

> *"…the Government should have gotten into supporting workers so they could afford to isolate and, testing should have been done in workplaces." (U4)*

Some Federation respondents and Government agency respondents highlighted their role in encouraging sites to introduce and maintain the onsite COVID-19testing. As part of this, it was also highlighted that there was some initial reluctance from companies in forcing workers to take the tests.

> *"…we were communication point so we were keeping companies informed of any developments and also any opportunities. Because when we did the lateral flow testing of that became available for factories and so we try to encourage our sites to take part." (F2)*

> *"Also there was reluctance in forcing workers to take tests, and I mean I think as time has progressed people have become so used to that that there is no longer an issue, but I think initially people in companies where we're kind of perhaps a had a slight reluctance because they felt perhaps this is forcing people to do something which in they weren't quite sure where the workers rights were." F2)*

In addition to COVID-19 testing, many of the Federation respondents also highlighted the use of temperature control checking within the FDPI. This was used to test the temperature of workers and visitors coming on to the site. However, there were concerns raised about the accuracy of this as there are examples where temperature readings were high and the individual then took a few minutes before retesting and having an acceptable temperature.

> *"Some of them had good temperature testing as well when they arrive and there were different views on that because we all know, our temperatures can fluctuate and it doesn't necessarily mean you have COVID-19but some staff find that reassuring if temperature check were done as well." (F3)*

4.3.2 Isolation as a mitigation measure

Interview respondents generally referred to **isolation** as an effective measure to prevent transmission of COVID-19, although this was also acknowledged to present a substantial resource challenge for the FDP industry and continued operation of some businesses (Discussed further within section 4.5.3 - challenges). Despite this, Government agency representatives reported that in some cases, they felt there was no alternative but to advise entire shifts to isolate at home.

> *"...once you've identified a certain number of people in a shift and you can't tell exactly how it's gone from one person to another, you know transmission's going on there or you'd strongly suspect that it is, but you can't tell exactly where that transmission*

occurred our advice was right that the whole shift has to be considered as contacts […] and they all have to isolate" (GA7)

Interview respondents also made reference to the subsequent changes that they felt had eased resourcing challenges across FDP businesses, specifically with respect to the duration of isolation (from 10 days to 7) and circumstance when isolation was required (from close contacts initially to active carriers of the virus).

"potentially this change in the self-isolation rule in relation to being a close contact and you not having self-isolate if your double vaccinated and have a negative PCR tests, then that actually is a positive and hopefully that will allow more staff to go back to work, rather than have to do the 10 day isolation." (GA2)

4.3.3 Vaccination as a mitigation measure

A number of Government agency and Federation respondents suggested **vaccination** as an impactful protective practice with respect to COVID-19. Although the demographic trends (young, migrant, partially/not yet vaccinated) in some parts of the FDP industry were acknowledged, new policies and practices, such as the 'seasonal agricultural worker scheme' were said to be helping mitigate these trends related to vaccination. A small number of respondents however feared that overreliance on vaccinations may lead to a decline in other protective practices and others raised concern for new variants of the COVID-19 virus relative to vaccine effectiveness.

"Some parts of the food sector is quite young, they will be partially vaccinated. […] we know, obviously, a large part of our workforce, also from the EU who may not have been vaccinated or partially vaccinated, that plays into things" (GA6)

As soon as their vaccination program gathered a pace, people stepped away from lateral flow testing and when we looked into this it was clearly because they felt that vaccination was the panacea of everything in COVID-19, it was to cure, the magic bullet and it clearly is not. (GA1)

"I think the challenge is getting people to be vaccinated because there are quite a lot and the younger age group who are reluctant […] they've got a lot to do to encourage younger generation" (F3)

4.3.4 Use of Personal Protective Equipment a mitigation measure

Most Government agency, some Union and all Federation respondents made reference to the wearing of **face masks/coverings** amongst FDP industry workers within operational environments and within communal areas. Whilst some respondents highlighted this to be one of the measures businesses may look to retain in future, others expressed concern for placing over-reliance on Personal Protective Equipment (PPE) not considered appropriate in this operational context. Furthermore, respondents also highlighted the noisy operational environments within many food processing sites which were said to cause workers and supervisors to shout in close proximity to one another. This shouting was acknowledged to increase transmission risk in the absence of face masks/coverings.

"a lot of businesses, I spoke to are looking to retain the face coverings and some were even saying until 2022 there is absolutely no plans to remove them, even if the rules change." (GA2)

"Your PPE, is designed to protect the worker from the environment. These were being used to protect the environment from the worker it doesn't work like that. If you're an asymptomatic case, wearing an FP3 some of those have an exhalation valve on so whilst you're breathing in filtered air you're breathing out straight through a whole." (GA3)

Furthermore, one Federation respondent feared the wearing of masks subsequently provided a false sense of security amongst workers.

"I'm not so sure that the masks were as effective as we thought […] you know you're not filtering air with it or anything like that […] and I think you know the people that think they're indestructible because they have got a mask on, they can go anywhere and do anything…" (F4)

One Union respondent also noted that in some sub-sectors, such as meat/poultry facilities, many of the employees already wore PPE (e.g. masks and uniforms) to protect themselves from the meat they were cutting. However, they did comment on how certain members were asking for visors:

"Some people wanted visors and we negotiated for the PPE, but it wasn't really that important because at the end of the day it was more to do with social distancing and the risk assessment." (U2)

Federation respondents and one Union respondent also noted that constant changes to Government guidelines, particularly around the use of face masks/coverings, and inconsistency across the devolved nations had made it difficult to ensure face masks/coverings were an effective mitigation measure.

"Members obviously didn't want the battle of forcing people to wear a facemask you see so obviously they've said it's basically down to the individual. The companies are providing masks, and I mean they're trying to keep it. They're trying to lead by example in many cases but individuals don't see why they should, because you know it's all gone now." (U4)

"I think that really was a big problem that rules have been made by the UK Government and the different within the different nations." (F3)

4.3.5 Physical distancing as a mitigation measure

Relative to **physical distancing**, many respondents across the stakeholder groups acknowledged this to be a widespread measure amongst FDP businesses over the course of the pandemic. Although some respondents emphasised that sub-sectors of the FDP industry vary considerably with respect to capability to physically distance. Some processing activities, such as sandwich making, also remain heavily reliant on manual labour whereby large numbers of people are required to work in relatively close proximity to one another.

"Certainly in the early days of the pandemic, there was a lot of focus, and rightly in my opinion, on the principle control measures of social distancing, personal hygiene, alcohol rub, and workplace or environmental cleansing".(GA1)

"the size of the facilities would determine whether they were safer than other environments to work in, but there are some food business operators that took their role very seriously in how to create social distancing" (U2)

One Academic respondent also stated that they believed social distancing to be one of the most effective ways of controlling the spread of the virus in the FDP industry, particularly in the agricultural sub-sector.

"Distancing, it's sort of from all the reports that we get. Distancing is number one, ventilation with distancing also, very effective." (A2)

4.3.6 Cleaning/hand hygiene as a mitigation measure

Government agency, Union and Federation respondents referred to stringent effective **cleaning/hand hygiene practices** already established within the FDPI (prior to the COVID-19 pandemic). Understanding the reasons behind effective cleaning/hand hygiene practices was said to already be established amongst workers within the FDP industry in general. One respondent reported these to

be the easiest measures to implement and were therefore said to be amongst the first measures to be applied within the FDP industry.

> *"…obviously a long history of working with PPE and you know good hygiene and those kind of things for reasons that were completely unrelated to COVID. And so I think they were both kind of in a good position to adapt their practices, but also very understanding of the reasons behind it." (GA1)*

> *"…and if I look at the factories and I look at the way we run some of our environments, the cleanest environment you could imagine. […] Because of the way we clean and the chemicals we used to do that and we still got a lot of our controls to it, even now." (F1)*

> *"I think COVID-19actually highlighted how that the hygiene standards in most food production plants, Certainly where we represent, was at a level that that enables a good practice…" (U4)*

On the other hand, the majority of Academic and some Union respondents felt as though too much emphasis had been placed on cleaning/hand hygiene throughout the duration of the pandemic, particularly in Government guidelines and in workplace risk assessments. These individuals did not believe this was the most effective risk mitigation measure to prioritise.

> *"I think there has been considerable underestimation of the airborne nature of SARS-CoV-2 transmission, and so there was a lot of emphasis on cleaning surfaces, cleaning hands, cleaning door handles, cleaning loos and all those things which does help, but probably not as much as ventilation would do." (A3)*

> *"the virus wasn't identified as an aerosol threat as early as perhaps people could have done and there was obviously quite a lot of measures in place around hands, hygiene and surface hygiene (…) whether in the end was useful or not I don't know because I think again it was about the social distancing and about the masks and face coverings." (U3)*

4.3.7 Ventilation as a mitigation measure

All academics along with several union, Government agency and Federation respondents identified **ventilation** as a valuable measure to mitigate transmission of COVID-19. It was acknowledged by many respondents to be a measure implemented later than other controls following developments in scientific knowledge (transmission through aerosols, droplets as well as surface contamination) and subsequent changes to Government guidance. Some respondents made reference to the 'Delta' variant of the COVID-19 virus and acknowledged the benefit of ventilation to be particularly beneficial in this context where infected individuals were believed to shed more virus with this more contagious variant.

> *"Ventilation is very important when you're dealing with a hazard which is airborne" (A3)*

> *"Towards late 2020 in truth and into the early parts of this year, there was an increased emphasis on the role ventilation played in workplaces and you saw guidance then issued […] We didn't drop our focus on the other control measures, but our attention then really focused on and engaging with FBO's around ventilation in the workplace."(GA1)*

> *"I think ventilation was a crucial point and I think it was unfortunately realised a bit too late in some places just how important ventilation was then." (U1)*

The variation of production facility layouts and nature of operations was acknowledged by some to present a challenge with respect to the use of ventilation to reduce transmission of COVID-19 in some circumstances where this may present increased risks for food safety. One Union respondent also noted that while ventilation is important for risk mitigation in the FDP sector, it cannot work as efficiently without taking other contributing factors into account, such as the size and build of the

facilities, which could arguably affect how the ventilation works. Considering the building, one of the Federations also mentioned the impact of the age of a building on the ventilation requirements.

> *"The chilled nature of some of the work areas and the low level of ventilation that exists in some factories they have been designed deliberately to maintain an environment which has a low level of transmission of bacteria to the food […]. Because at the end of the day we want to preserve both food safety and human health."(GA1)*

> *"So ventilation is a key mitigation, but usually it's mapping your building and where people interact. That's the most important and then using data to suggest how contaminated the areas in that particular place that you're in and how you get those contaminants out of the air, and you can only really do that using mechanical ventilation." (U2)*

> *"…looking at heating ventilation in the old buildings and thinking about the challenges of keeping windows and doors open in the winter." (F3)*

Two Academic respondents also spoke about the importance of using ventilation alongside other mitigation measures, such as social distancing and access to PPE in order to maximise their effectiveness in limiting the spread of the virus.

> *"distancing on its own without taking account of ventilation is not enough because those people or some of them are always potentially going to be source generating" (A3)*

> *"The most dangerous thing is assuming that a kind of a droplet surface contact-based approach […] So even in a building with lots of ventilation but close proximities, this is still going to be a real challenge." (A2)*

In contrast, one respondent and several Union respondents cited particular food processing operations where ventilation is already a requirement for operating. In these settings, the focus was said to be more about understanding the effectiveness of pre-existing ventilation as a measure to prevent COVID-19 transmission. Similarly, a few of the Federation respondents identified office spaces as a particular area of need for ventilation.

> *"...the slaughter houses themselves are required to have ventilation, so it was just a case of us understanding the flow and the food industry understanding what they have in place and whether it could be deemed effective." (GA5)*

> *"A lot of our offices and things now have COVID-19filter units and recirculate again and filter it out, where possible, we put mechanical ventilation and or, we increase the ventilation in the workplace…" (F1)*

Union respondents however noted that pre-existing ventilation requirements in certain factories made it more difficult to ensure ventilation was altered to meet temperature requirements for COVID-19 mitigation (as discussed in 4.2.1.5 risk perceptions in the industry). For example, it was mentioned that many slaughterhouses, sandwich making facilities and meat/poultry facilities could not adjust their temperatures, nor rely on natural ventilation (such as opening windows) given that the facilities have very strict regulations on both these factors for the safety of the food.

4.3.8 Cohorts and contact tracing as a mitigation measure

Reference to **cohorts and contact tracing**, whilst less prominent across Government agency stakeholders they were cited as effective mitigations amongst a small number of respondents, in particular where operational tasks or the physical environment make it challenging for people to physically distance. Whilst contact tracing was said by one respondent to initially be poor the need for keeping accurate records of staff positioning and movements within the operational facility was thought to have since improved.

"People only interact if you can't manage social distancing. If you can keep your cohorts small and prevent that cross transmission doesn't help if it's a community outbreak, but certainly for workplace transmission." (GA4)

"...a lot of the early outbreaks, we just weren't able to say who was stood close to which Member of staff once we know someone's positive […] if you're Looking back over a week or just a couple of days, people can't remember or there aren't adequate records to cover it." (GA7)

In relation to tracking cases, one of the Federation respondents detailed an example from the FDPI where companies are tracking the cases in the local community in order to tighten mitigation measures within the workplace when cases are seen to rise in particular post codes where their workforce live.

"…we track cases in the local community by post code […] yeah so we've worked out where people live assign that post codes and then we pull the raw data from the Government. […] will tell people to work from home, we will enforce distancing a lot more people have been quite a bit relaxed, haven't they. We will enforce it a bit harder you know, covering some in any way we might step up the hygiene, you know the do extra cleaning of contact surfaces and stuff, might be some comms engagement…" (F1)

4.3.9 Limiting staff contact as a mitigation measure

Government agency and Federation respondents made reference to wider measures being taken by FDP organisations to **limit staff contact** such as staggering breaks, use of Perspex screens, additional staff to manage traffic flows of people going in and out of the facility, and controls for people moving around the work sites. In particular, Perspex screens were acknowledged to be in place where the nature of operations meant that social distancing would be challenging to implement (for example when workers are by side along a production line). However, the benefit of screens when used in this context was questioned by some, partly due to the operational need for workers to reach out and handle the products on the line in front of them but also due to people leaning around the Perspex to speak to one another.

"…they have very strict controls around how people are transferred around the site. They may have had one way systems, they may have created a situation where a block of people went through pinch points at any particular time, so you avoided congestion." (GA1)

"…it's a very social environment, and we've gone on side screens and forward facing screens, effectively put somebody in a cubicle yeah. Working on a line eight hours with no contact, no conversation, nothing." (F1)

"We did a series of webinars for our Members and it was things you know we read through the guidance […] stagger your shifts and stagger people going to change in rooms and you know, try and make one way systems rather than everybody sort of just heading towards each other in a corridor or yeah so all that sort of really simple stuff." (F4)

4.3.10 Risk assessment as a mitigation measure

Several Union and Academic respondents, along with a small number of Government agency representatives, referred to the importance of ensuring adequate **risk assessments** when asked about the most effective mitigation measures in reducing the spread of the COVID-19 virus. The small number of Government agency representatives perceived businesses to have been overly focused on the provision of PPE.

"...each setting will be different, and I suppose it's about principles rather than specifics, so the principles are a hierarchy of controls and effective risk assessments, using the Swiss cheese model." (A4)

"it's how we plan accordingly for reducing or mitigating risk. And that's again where those risk assessments came into place." (U2)

"They were issuing lots of PPE. […] As a mitigation measure but not necessarily focusing on other controls higher up the hierarchy because they will just that more difficult to implement." (GA1)

Some Academic respondents noted that risk assessments were not adequate enough as they were either too general, based on Government guidelines, or focused too much on certain mitigation measures, which may not be applicable for all sites.

"The risk assessment has been I think not adequate […] the control measures are as set out by Public Health England almost mirroring public health guidance which obviously can't be applied to specific workplaces." (A3)

"Its important to begin with risk assessment policies and procedures […] There was a lot of focus on hand hygiene and controlling the risk of transmission by cleaning surfaces [...] but the more that the research is developed on that, it now doesn't seem to be a significant risk transmission rate as we start to be at the start of the pandemic." (U1)

4.3.11 Management of visitors on site

The majority of the Federation respondents identified issues and measures for managing **visitors** on site to ensure this did not pose an increased risk of COVID-19 transmission. This included ensuring that they are complying with measures that are being enforced more widely on the site and the use of COVID-19 testing.

"…deliveries and things like that was something that can be overlooked, because you're so busy thinking just about that specific site and your employees. But there are other, you know, you've got the postman coming in you've got this and that and the other and they might not be wearing their face mask, but you know getting them to comply with measures." (F3)

"I mean in other areas where, I mean, the way that the materials come onto sites as they come in. They come in HGV lorries and there and they're tested before they accepted and brought onto site. So you've got quite regular visitors to site. And then you've got people also taking away final materials to customers, so they're going to customer sites. So there is a risk. If you're mixing with people from other companies." (F2)

4.3.12 Combination and simple mitigation measures

The majority of the Federation respondents referred to the structure and types of measures being implemented. There was agreement in terms of the need for there being a **combination of measures** for effective management of COVID-19 in the workplace, implementation of **simple measures** and the importance of **early development** of measures in the workplace.

"…you don't have to put your finger on one thing, I think it's a combination of things […] yeah and it depends on the setting and everything else." (F3)

"…there wasn't a clear one that emerged as the kind of the most effective measure was a package of measurements…" (F5)

"…yeah so all that sort of really simple stuff." (F4)

4.4 COMPLIANCE

4.4.1 Levels of compliance within COVID-19 measures

Government, Federation and Union respondents generally perceived **compliance** with COVID-19 measures to be good within the FDPI. One Government agency respondent however perceived difficulty in truly understanding levels of compliance amongst FDPI businesses and a couple of the Federations mentioned the difficulty in complying more generally with some of the COVID-19

measures. Union and Federation respondents also noted the difficulty in complying with COVID-19 measures, given the extent and pace to change Government guidelines (discussed further within section 4.5.5 Fast pace of changing guidance).

> *"If they're going to break the rules they're definitely not going to tell us about it, do you know what I mean? They'll be the ones who tell us that they're complying." (GA6)*

> *"And workforces have been very compliant, and they've tolerated the changes, some of which have been quite difficult for them." (F2)*

> *"I think, where there were challenges, particularly with around maintaining 2 metre distancing at the outset. That became a bit of indifference to that after a while. I think we always felt you needed a tannoy. […] it was very easy to let it slip after a while and become complacent about it." (F3)*

With respect to the business benefits to compliance, one Government agency respondent highlighted that whilst (at the time of interview) there was a legislative requirement for businesses to comply with COVID-19safe guidance/requirements, there was also a substantial organisational benefit to the business in that they were able to continue operating.

> *"I thought compliance was good and I'll say it was born out of two things really, A. They wanted to be compliant, B they there was a very clear business benefits from being compliant."(GA1)*

4.4.2 Enforcement and monitoring of COVID-19 measures

Over half of Government agency respondents made reference to businesses implementing some form of compliance monitoring, support and and/or **enforcement of COVID-19 measures**, in particular in non-operational areas of the facility (e.g. smoking shelters, car parks, communal areas). Most commonly, Government Agency respondents, described having COVID-19marshals' in place, these individuals were responsible for reminding staff to implement COVID-safe measures. Similarly, one of the Federations mentioned that COVID-19champions had been appointed within the sector to reinforce compliance, and another mentioned the use of hi-vis jackets with social distancing reminders on as a reminder to distance from each other.

> *"With people having like COVID-19marshals and such walking round to ensure that they are wearing the correct face covering where they should be." (GA2)*

> *"...the thing we saw was, you know, making sure that there was somebody to remind people not to stand too close to each other – to supervise things [….] if people can't get that close together, then the risk is reduced" (GA3)*

One Government Agency respondent spoke of workers traveling to work together but not wanting to tell their employer this, hence the requirement for 'car park spotters' to remove the personal conflict associated with having to identify colleagues as a personal contact. Another individual highlighted the powers given to Local Authorities or regulators to use if needed to close or restrict individual premises in order to manage COVID-19 within the local area (though the individual acknowledged that they did not know the extent to which this influenced the degree of resistance from businesses).

> *"One company had somebody, a spotter in the car park.[…] (GA3)*

> *"…actually when you know you've done everything inside the factory, you need to go outside and make sure they stand 2 metres apart, while they are smoking." (GA7)*

> *"So there was mostly, we try and work on a voluntary basis, justify our actions for the mutual benefit of a company or organization and the public health because both are intertwined. But there was a stick at the end as well if needed" (GA4)*

In addition, a couple of the Federations highlighted challenges with compliance in relation to COVID-19 (and more generally with health and safety) is encouraging people to want to comply and not find ways of getting round the measures. Therefore, active monitoring of behaviours and continuous reminders to the workforce of the benefits to justify compliant behaviour were considered important.

A reason for this raised by all the Federation respondents was that employees are exhausted and fatigued with all the mitigation measures (discussed further within section 4.5.6 workforce exhaustion as an industry challenge).

> *"I think a challenge for the sector […] in all health and safety is encouraging people to do the right thing and I think people will often find ways around it. […] you don't want to run a system where they're just penalized if they don't do the right thing." (F2)*

> *"But you know you can't it's difficult, someone's a key Member of production, for example, it's hard to just send someone home because they breached social distancing and put that workload on the rest of the team or try and bring someone in on that day off it's not quite fair so it's just about reiterating the messages to people, but it sounds like for the majority of companies it was a relatively smooth process once they get PPE in." (F5)*

Union respondents also noted some of the challenges faced by members in the enforcement and monitoring of COVID-19 measures. In particular, some respondents commented on the communication barriers faced between managers and workers whose first language was not English, along with agency workers, who are often recruited for work in the FDP industry. This was particularly seen as an issue given that many agency workers were often being given a different set of actions, responsibilities and rules surrounding COVID-19 compared to the management team at the sites.

> *"There was some communication issues with agency staff, particularly if they're from Eastern European countries, for example, because managers face more difficulties in communication with them." (U1)*

4.5 INDUSTRY CHALLENGES IN RESPONDING TO COVID-19

Industry stakeholders referred to a number of industry challenges in responding to the COVID-19 pandemic, with prominent themes including: competing priorities, staff/labour shortages, changes in supply and demand, self-isolation of staff, financial challenges and challenges outside of the DFPI industry (including Brexit, furlough and interwoven supply chains with other industries). Each of these themes are discussed in term below.

4.5.1 Competing priorities and demands

Government agency respondents referred to a number of **competing priorities** that needed to be balanced when responding to the operational challenges brought about by COVID-19 in protecting public health. Specifically these encompassed maintaining food supply, ensuring animal welfare and challenges with food safety and quality.

> *"Its not usually a case of just doing one or the other. You can do both. So let's work out how to deliver on the health outcomes and protect food supply and keep people in jobs. And you know, make sure that you don't having animal welfare problems."(GA4)*

> *"We have this list of critical national infrastructure and food processing was on it […] before there was like a written list there was still an understanding that we couldn't have supermarkets empty." (GA7)*

Over half of Government agency respondents acknowledged **changes in supply and demand** as an operational challenge that the FDPI has to contend with. Specific peaks or reductions in demand cited included initial panic buying at the start of the pandemic, Christmas (and other festivals), seasonal crop picking and when travel into work was restricted/discouraged. One Union respondent also reported on witnessing the sudden production demand after witnessing the same process occurring in countries such as France when the pandemic was first starting, therefore they had time to prepare and ensure labour production didn't reduce. However, the "panic buying" which occurred during the start of the pandemic made it difficult to provide items for shops in time.

> *"people's habits were changed so you know, the factories weren't making as many things, people weren't going into work, they weren't buying the sandwiches from boots or wherever. (GA3)*

"….anything in terms of supply and demand where there's big surges so you know, like the migrant workforce is [brought in] to pick crops." (GA1)

"We start emptying all the shelves by panic by and of course, it does look like you're running out of food because they can't get it from the warehouse to the supermarket in time (…) it's even harder to fill those shelves back up and then you know it's just manic." (U4)

Federations, Government agency and Union respondents spoke of FDP businesses adapting their way of working in order to balance competing priorities, changing production demands, food quality and public health. Specific adaptations said to have been made by FDP businesses included extending operating hours, reducing product lines/changing the range of products being manufactured, altering recipes, moving staff between operational sites (to cover staff shortfalls). In addition, Federations reported there to be instances where the product volume remained constant but the packaging and distribution of the product was adapted to the changing customer demand. Unions also referred to the effect caused by the sudden increased demand in food and drink products during the beginning of the pandemic, which has since returned to normal.

"..for example, do you really need three different types of green leaf in your sandwich? Won't one do? Change the recipe, take 2 people off the line […] people were thinking about not to how to achieve the best they could, but still feed the nation. So you know it's always a balance" (GA3)

"…One of the sites had 12 [production] lines and they have gone down to two." (F3)

"…some sites that had a massive uptick in demand, because they're producing [product] [… demand] can easily be met by the capacity on a kind of tonnage basis in the UK so how much [product] can be produced per hour. But you can't pack it into [specific packaging] quickly enough, there only so many [specific packaging] lines in the UK." (F5)

"…the food industry has grown by 2.3% during COVID. I mean, one of the amazing things is the increase in production at the outset, but obviously now as well as we're coming back out, everybody's eating habits is going back to normal. So we're now seeing the downside of that because all those jobs that were being offered at the start are going to go out the out the system again (…) it's having an impact on redundancies in our industry" (U4)

Some of the Federation stakeholders highlighted that due to changes in production it also resulted in their role as a Federation changing and adapting in terms of the guidance being developed and disseminated to the FDPI. This ensured that the sub-sector were able to safely produce a different product and adapt their practices. These adaptations and changes to meet customer demands were identified by the Federations as allowing companies in FDPI to remain open during times when otherwise their production may have decreased.

"…moved across into helping with hand sanitizer because ethanol is a key ingredient is the ingredient in hand sanitizers […] we set up a portal online to help put companies in touch with each other, because it wasn't just producing of the ethanol […] It was the other bottles and everything else, the supply chain really to get that to whoever needed it." (F3)

4.5.2 Staff/labour shortages

All Federation stakeholders and most Government agency and Union respondents highlighted that the FDPI had experienced **staff absence and labour shortages**. This was said by some to have placed a strain on the production and those that work within the industry though not to a level of compromising food supply. The impact of staff absence due to sickness, COVID-19 related illness and self-isolation requirements were commonly cited (discussed further within section 4.5.3).

"...we usually say that if you get up to 15% of absences in the workplace, you know, across the supply chain, that when food supply starts to get compromised, and most of the time it stayed somewhere around 5% to at most 10%. I think maybe there was a

month, somewhere way for some companies that went up to 15. But never went to a level where we thought, gosh, you know, COVID-19has really impacted the industry to the point where food supply has been compromised in an enduring way." (GA6)

Some Union respondents also highlighted how labour shortages were particularly affected by changes in agency staff available to employ, whilst one Academic respondent suspected that the high levels of staff shortages experienced may have deterred some FDP businesses from accurately reporting the number of cases at their sites.

"There was a shortage of suitable agency workers prior to COVID. Almost all food processing companies will have some sort of agency cover, but they would get people who had no background in working in factories prior to COVID-19(…) and the quality of the agency workers wasn't quite what it could have been, and then that became another issue of OK, wait, whats going to happen to the supply chain?" (U3).

"A lot of people are working on sort of piece work. They have to turn up and do work, so unless they are physically unable to work then it's unlikely that they would be reporting it and also because of the extreme labour shortages that being experienced over the past year and a half, I think there's there be a, uh, a likelihood of depressing reporting by employers within parts of this sector." (A2)

Some Federations specifically mentioned some of their members, where possible, have been cross skilling staff to allow for cover of work tasks across the workforce (as discussed under 'mitigations'). Staff absence was also mentioned by the Federations in relation to bringing in specialist contractor workers, and the wider impact of bringing in contractors from Europe and the need for them to isolate before entering the workplace.

"I think another problem was getting machinery engineer from Europe and things like that if they had come in from Europe with COVID-19and isolate at first you know because they needed to involve these contractors. Contractors was quite a big issue for some companies." (F3)

Wider issues of staff shortages were also mentioned by the Federations representing the FDPI largely due to the COVID-19 pandemic causing individuals to re-evaluate their work choices and life priorities. Therefore, where individuals have left or are leaving their jobs it is creating issues in relation to staff shortages and recruitment issues on a longer term and industry wide scale. Furthermore, staff shortages were also discussed relative to 'Brexit' with migrant workers returning to their home countries (discussed further within section 4.5.9).

"…it's all going to all to the wind, [in example FDPI company] probably nearly 1000 vacancies at the moment. […] In the longer term, I think labour challenges are here to stay for quite a while. […] COVID-19has also caused people to re-evaluate what they want in the future." (F1)

"Yeah, I think another unintended consequence of people being able to work from home and work more remote remotely. […] A lot of people moving jobs and not just in our sector but in other sectors as well. […] So I think it's made people reassess their own personal priorities." (F2)

4.5.3 Self-isolation of staff

The majority of the Federations and some Unions and Government agencies identified that the **self-isolation** of staff was a challenge to the FDPI and their respective sub-sectors. This was largely due to the impact that self-isolation had on the level of available workforce. Specifically, Federations highlighted the impact this can have particularly in smaller companies with smaller workforces or production lines with a smaller number of staff. Some Government agency representatives conversely highlighted how larger companies were able to move staff around between sites to cover shortfalls in order to continue operations. Union respondents highlighted that isolation requirements early on in the pandemic meant that large numbers of workers were required to self-isolate as a household close contact, something said to have caused severe problems for certain sub-sectors, such as the meat and poultry facilities.

“you have businesses sort of moving staff coming from different sites to fill, you know potentially entire shifts where shifts had to be taken off because of an outbreak in that whole shift to self-isolate, and sort of move people throughout their business in a way that they're there wouldn't previously had to do.”(GA4)

“There was certainly affect with people going off sick with it or going off and having to isolate because they shared households with people that had the virus” (U1)

“…when it came to the self-isolation requirement where you have people that are testing negative for COVID-19being told they have to self-isolate and that was impacting site production. Yeah I think there was some frustration, but there was never any indication from our Members that they weren't going to comply.” (F5)

“…a few cases where people have either had to self-isolate or have had COVID-19[…] if a key engineer or an electrician is off work often that they have no backup. So that can cause a problem. […] we can't borrow somebody from somewhere else because they may only be one of these people. […] There have been a few cases where factory has had to close for a short period of time.” (F2)

Other union, Government agency and Federation respondents also noted workforce challenges associated with isolation during the summer of 2021, often referred to as the “pingdemic”.

“With the so-called pingdemic (…) when there was a rapid increase in number of cases and numbers of infections, there were also rapidly increasing number of contacts. There were definitely issues with that, on top of the shortage already feeling in some places, which made big problems for the industry.” (U1)

“... if you go into a food production plant and where the lockers are placed. Obviously you can't take your phone on the floor, but you have to put them in your locker so you leave them in your locker. And of course, you might not be next to that person on the shop floor, but obviously your phones gonna ping. So everybody's phones gonna ping, which is what started to happen.” (U4)

“Whether that was through close contact or through yourself being symptomatic that clearly placed significant pressure on industries ability to produce products. […] the peak of that problem was best exemplified through the ‘pingdemic’”(GA1)

“…people were having to self-isolate for reasons they didn't feel were valid because they didn't feel that they were particular, they were a risk. I mentioned one company where they discovered the pings were all in a locker. I think one company may even have asked their workers to switch off their phones when they're at work.” (F2)

4.5.4 Financial challenges

Some Federations and Government agency respondents discussed the **financial costs associated with COVID-19 measures** and mitigations. The finances available were said, in part, to be dependent on the size of the company. In other instances, respondents identified continued changes to the COVID-19 landscape (encompassing advancements in knowledge as well as changes to advice/guidance and measures made available, both within and outside of the workplace) had caused financial challenges where investment had already been made. Some Government agency respondents made reference to the FDPI not being dominated by ‘cash-rich’ businesses and highlighted capital outlay as a barrier to implementing some measures. Furthermore one Government agency respondent cited rapid change as a barrier to financial investment amongst some businesses said to be reluctant to invest in measures that may subsequently become freely and more widely available thereafter.

“There was a lot of bad advice, right at the start. […] I know a lot of businesses, like, for example, went down the rabbit hole in terms of face coverings where they're spending you know [millions of] pounds worth of masks and […]And it's been very painful for the industry.” (F1)

"They work to tight margins. There's a lot of small to medium sized enterprises working in, in many cases, in older buildings, so it's not an insubstantial outlay to start looking at, you know, improve ventilation systems.." (GA1)

"...the asymptomatic testing that we were setting up for businesses. We put a lot of effort into getting people to sign up and then they decided quite quickly that actually they would open up home based [testing] to everyone…"(GA4)

Sick pay was also another theme to emerge in some union, Government agency and Academic interviews, with many noting that employers were either not providing sick pay, or that the amount being paid was insufficient.

"...we had the self-isolating support payment come in eventually, but for a long time people had to choose, and still do in some cases, choose between feeding their family or keeping their colleagues safe. And that's not a situation anyone should be in." (GA4)

"The statutory sick pay was low, and if you're low paid already then having to suddenly survive in 95, 96 quid a week or couple weeks is actually something you can't do." (U1)

"When you had to self isolates in the food processing and food processing is a low income, low paid role. Then with sick pay at the level it is at the moment. Then the incentive to be off work is negligible, and so people who have tested positive to go into work and then you know, potentially, you know increased risk of transmission." (A4)

"There were concerns particularly around the failure of the organization to ensure that people who had been sick and might have contracted COVID-19stayed away and partly because the sickly scheme was not up to standard" (A1)

Some Union respondents also commented on the effect of lack of sick pay for workers who were clinically vulnerable or had long-term health conditions who were affected by COVID-19.

"There are certainly problems we're dealing with people who are clinically extremely vulnerable and therefore at some stages couldn't come into the workforce and do the jobs that they would have normally have done" (U1)

Similarly, some Union and Government agency respondents also noted that a lack of sick pay meant that many workers were forced to come into work, even if they were sick, which could also be another risk factor for spreading COVID-19 and thought to have been a contributor to outbreaks by one Union respondent. Unions cited active discussions with businesses regarding the need to provide full sick pay to employees to enable them to isolate when needed, through no fault of their own.

"I think the failure to provide that [financial] support for self-isolation earlier on led to a significantly worse wave […] If from day one people learned that they would have had that support. I think it would have been quite different. As it was it, it encouraged people to hide symptoms."(GA4)

"Everywhere that didn't offer company sick pay had outbreaks, because people were coming into work (…) I mean, I understand the problems that the employers faced, you know, because obviously we would demand in that every time somebody had to isolate, they had to pay them full pay. We thought that was quite reasonable, because it's not their fault, you know." (U4)

"The slaughterhouse staff do not get occupational sick pay, and they're generally quite low paid workers as well. There have been recent increases in salaries for them but because they could not get occupational sick pay it meant that they had to come into work sick because they had no choice financially" (U2)

Sick pay was also cited as an enabler to effective management of COVID-19 within the FDPI, with pockets of positive practices cited by respondents (discussed further within section 4.6)

4.5.5 Fast pace of changing guidance

Federations, along with some Unions and Government agencies identified the **fast pace of changing guidance** as a challenge for the FDPI during the COVID-19 pandemic. Some reported that they found it challenging to implement changes within facilities at the same pace as changing guidance, others found the pace of change was causing confusion in the industry about what constituted current guidance in the workplace relative to guidance for community settings. However, there were examples of how the Federations were working to keep up with this, such as weekly webinars with their members and working closely with their members to agree on implementable changes.

> *"…if you talk to the managers who are trying to make those changes in the in the plants, they were frustrated by the speed of change that was going on and the fact that there were different rules in different parts of the UK because most of them are organizations that have sites in various parts of the country, so keeping up with the changing nature of it was a nightmare for everybody."(U1)*

> *"But also the Government messages, more recently, from September I think it's just it's thrown the industry into turmoil because I've got people asking me do we still need to distance do we still need to wear masks and because the Government said you don't need to distance anymore you don't need to wear masks…"(F4)*

> *"…we're doing a weekly webinar on you know, whatever was coming through on guidance, but it did change every five seconds you know." (F4)*

> *"Because it's run by the members […] who need it, then we just agree as a consensus and change it very quickly, you know, the food industry is a very fast moving industry. And a lot of people struggle with it because it's so fast paced and we run to keep up with it." (F1)*

4.5.6 Workforce exhaustion

All Federations and some Unions identified that within their sub-sectors there were reports of the workforce being exhausted with COVID-19 in terms of fatigue with measures, changes in work and disruption.

> *"I think a lot of fatigue, you know people, the same people doing everything where other people have just been on furlough, so I think some people are really, really absolutely worn out, you know and to think some of these people are driving fork lifts, and such like you think well you know that's kind of got." (F4)*

One Union respondent also mentioned the difficulties faced during the height of the pandemic to ensure the continued distribution of safe high quality food into the food chain, said to require various stakeholders in this process to work very long hours.

> *"... there are issues. Yes, there are resourcing problems. Were there corners cut, I don't know. I can't really comment. Our members refused to allow unsafe food through to the food chain. But there was a lot of work to enable that to happen, so people working very long hours. Including trade Unions staff, we were all working at extremely long hours during the height of the pandemic to make sure everything was in place." (U2)*

4.5.7 Difficulty sourcing PPE

Federations and some Government agency, one Union and one Academic respondent identified issues with sourcing PPE, in particular face masks, as a challenge faced by the FDPI, in particular at the beginning of the COVID-19 pandemic. One of the Federations also identified that in their role they engaged with HSE to request a change in the usual FFP3 masks to FFP2 masks to allow the production in the sub-sector to continue for their member organisations.

> *"where people are working in confined and relatively small rooms in fairly large numbers were actually it would have been appropriate to issue them with proper respiratory protection, but it would have been difficult because of the supply problem*

and because of the need to do all the face fit testing and all the things that go with it." (U1)

"…So if we could keep going so, for instance, an FFP3 mask used for [exposure]. And we couldn't get them anywhere, so we managed to get the HSE to say well in the short term could they use FFP2 […] meant that food production would keep going..." (F4)

4.5.8 Lack of flexibility innate within the FDPI

Around half of Government agency respondents acknowledged the lack of flexibility innate within FDP. Respondents cited inability to move or change operational environments, large proportions of workers unable to work from home and limited available space on site to implement some COVID-19 measures.

"…there's much less flexibility in the food sector, some sectors to do things very differently, and you know you can't. You can't move your chicken preparation outside, for example to compute ventilation."(GA1)

"Same with the retail stores, you know, they maximise their operating model is to maximise sales per square foot on the sales floor, they're not going to suddenly take out a big chunk of their retail floor to set up a testing site." (GA6)

4.5.9 Challenges outside of the FDPI

Respondents across the different stakeholder groups identified a number of challenges also impacting the FDPI alongside COVID-19. These included **EU exit ('Brexit')**, **furlough** and **interwoven supply chains** with other industries (e.g. hospitality), each of which is discussed in turn.

The impact of **Brexit** was cited by all stakeholder groups and included supply chain issues, operations, exports/sales and impacts on staff levels such as a shortage of drivers.

"Some companies have done better than others in terms of recovery, […] ultimately it will no doubt settle, but it it's actually quite difficult to judge overall, because you've also got the impact of Brexit." (F2)

"...it is partly related to Brexit, but also related to COVID, […] especially those working on picking vegetables in horticulture, or aspects of the sector, they tend to be EU workers, mainly from Europe."(GA6)

"supply chains have been seemed to be affected by Brexit, and you know you can't necessarily get everything you want in the supermarket"(A4)

"If you're running a food factory, particularly one which is meat processing, they have got all sorts of other problems to deal with. The current labour shortage because of Brexit is really hitting quite badly now (…) I think it's been more affected by Brexit than by COVID, though there would have been some changes that COVID-19is probably responsible for." (U1)

Union and Academic respondents also commented on the challenges faced due to Brexit and its impact on staff shortages across different sub-sectors:

"some of the staff went home before Brexit, for example. So there was already a shortage of staff. Then the aspects of COVID-19created another shortage of staff. And then you had the fact that the priority for the for the Government to keep food on the shelves because there was panic buying as well" (U2)

"And we can't ignore the impact of Brexit on this as well, particularly around labour shortages, you know which have a contributory impact on production" (U3)

"Obviously there are huge issues in certain parts of the sector now in relation to manpower, you know the availability of people to do the jobs that they need and some people under additional pressures. Because of that, we're hearing about lorry drivers and so forth, but I dare say that in parts of the sector where Brexit has an impact."

Some Government agency respondents reported **furlough** to have had a positive impact, with additional workers coming forward to work in FDPI whilst otherwise being furloughed from their usual roles in other industries. This additional pool of workers were said to have supported the FDPI to continue operation during labour shortages caused by wider challenges outside of the FDPI (mentioned above) as well as COVID-19 (e.g. staff needing to isolate). As wider industry restrictions on operations lifted, however this was anticipated to have impacted labour shortages further within the FDPI.

> *"...you've got people that were on furlough that that would also be backfilling roles. So, for example, if you worked in the hospitality industry or you worked in the arts and entertainment and your industry isn't working. […] but you also get the drift of people going back to their original roles again, leaving the holes that they backfield."(GA3)*

A small proportion of Government agency respondents, along with one academic, made reference to the **inter-woven supply chain** across wider industries beyond the FDPI, with plastic manufacturing, distribution and hospitality cited as specific examples.

> *"probably more so than any other sector is how incredibly interwoven it is […] something trivial like you know, plastic manufacturing somewhere has a knock on effect on cling film has a knock on effect on food packaging, has a knock on effect on supply and the shops (GA1)*
>
> *"...now the supply chain is more than just the people who know packed meat or sort of prepared food in in shops. It's other things such as the logistics of the supply chain, the availability of other materials, etc which is important." (A2)*
>
> *"…hospitality I expect to be crippled again within a few weeks by the increasing prevalence [of COVID-19] with so many of its workers young and so unlikely to be fully vaccinated at this point, and when hospitality falters, that affects all. There's a food supply chain that lead into it." (GA4)*

4.6 ENABLERS

Most Government agency respondents and some Union respondents cited the introduction of **sick pay** as an enabler to preventing COVID-19 transmission within the FDPI. Over half of Government agency respondents and some Union and Academic respondents made reference to FDPI workers often being low skilled and low paid. The introduction of financial support to those needing to isolate, in the form of company sick pay (usually seen in larger companies with available funds to do so) or Government support for people on low incomes (discussed within 4.5.4), was therefore highlighted by some as an enabler to preventing COVID-19 transmission within the FDPI.

> *"I think there was a very early initial and ongoing consultation around what was needed and I think that the majority of that was in the companies that have got significant membership and resources. I think they were the companies that responded with full sick pay. If people were off, you know, for isolating and for sickness and everything else and could afford to do that, then I think we had the vast majority of the industry sort of following along." (U3)*
>
> *"...we had the self-isolating support payment come in eventually…." (GA4)*

One Academic respondent also expressed the importance of providing adequate sick pay as an enabler to staff self-isolating if/when required.

> *"...There needs to be that incentive for workers to stay at home if they're symptomatic, even asymptomatic or you know, if they have COVID. That (sick pay) needs to continue..." (A4)*

A variety of other enablers for preventing the transmission of COVID-19 in the FDP industry were also cited by one or small numbers of respondents including:

- The ability to conduct lateral flow tests at home, with workplace testing sites described as 'clunky' and costly to the business;
- Management buy-in at the top of FDP businesses;
- The introduction of the seasonal agricultural workers scheme – a Government scheme to enable migrant workers to temporarily fulfil roles within the horticultural sector[3];
- Support for workers needing to shield;
- Ensuring better communication between workers and managers (particularly for workplaces with a large number of migrant workers);
- Improvements/introduction of mechanical ventilation within FDPI business;
- Technology in general with specific examples including technology that enables remote working where possible and worker home testing.

4.7 COVID-19 DETECTION AND RESPONSE

All federation, Government agency and Union stakeholders made reference to COVID-19 **cases and outbreaks**. Government agency stakeholders cited a variety of ways that they might find out about an outbreak. Most commonly cited mechanisms were formal notification by a food business operator themselves or through contact from public health bodies/incident management teams who may request their support with the investigation/response. Other methods of recognising an outbreak reported by individual respondents included import bans being introduced from countries overseas, word of mouth and through close contacts being notified within their own workforce.

> *"…we would occasionally hear about it is by China introducing an import ban. Certainly early on in the pandemic. […] we had a number of processes, particularly pig processors who had trade with China stopped as part of this and so yeah always a bit surprising when you hear about it through China complaining to us that we didn't tell them about it."(GA4)*

Many of the Federations identified they do not keep data on cases of COVID-19 within the FDPI industry and if there was an outbreak in one of their member organisations, this would not necessarily be communicated to the federation. For this reason, some of the Federations identified that they would only be aware of generalisations around outbreaks and therefore could not confirm any patterns of outbreaks.

> *"…we don't keep data on cases [...] I'm just trying to think did sites ever have to shut. Maybe one or two" (F3)*

> *"…I've not been monitoring specific individual cases, so we're talking fairly generalization here, so if there were if there were any patterns, I wouldn't necessarily be aware of that." (F2)*

Whereas one of the Federations in the FDPI identified that through their sub-sector member survey they would collect this information. The survey asked member organisations about a range of topics, including; staff absences, effects on production, accident reports, infection rates, levels of packaging, levels of disruption, levels of fuel, stock levels etc. It was reported that the survey allowed for sharing of practices being undertaken relative to COVID-19 and also benchmarking across the member organisations as the Federation shared the summary results with their members.

> *"…run a kind of series of surveys […] daily one for the first lockdown […] then the second lock down in November there was a weekly survey." (F5)*

With respect to trends in outbreaks/cases respondents noted some specific sub-sectors where they were aware of large or multiple outbreaks, including, meat/poultry facilities, agricultural food

[3] https://www.gov.uk/Government/publications/seasonal-workers-pilot-request-for-information/seasonal-workers-pilot-request-for-information

picking/production and sandwich making (discussed further within section 4.2.3). A small number of Union respondents in particular, perceived there to be a trend in outbreaks more common within facilities that did not offer their workers sick pay.

> *"Everywhere that didn't offer company sick pay had outbreaks" (U4)*

> *"There were concerns particularly around the failure of the organization to insist and ensure that people who had been sick and might have contracted COVID-19stayed away, partly because the sickly scheme was not up to standard" (A1)*

A small number of Government agency respondents discussed workplace outbreaks relative to wider community rates of COVID-19. One respondent felt that workplace outbreaks within the FDPI largely reflected the wider community rates within the local community. The other reflected back to the changing peaks of COVID-19 cases relative to the significance of FDPI outbreaks from early on in the pandemic compared with much later (at the time of interview).

> *"In general cases sort of after the summer and opening up pretty much, if we see what's reported to us, they pretty much followed those two peaks […] when case rates are high, we saw far more workplace outbreaks […] You could look at our view of workplace outbreaks pretty much mirrored the background case" (GA3)*

> *"Do cases in any setting just represent what's going on outside of the setting, or are they points where you're amplifying that transmission and sending it back out to the Community? […] So that initial phase March to the summer – when community case rates were low these outbreaks were really, really important. […] the significance is completely different like now, there may be a little bit of transmission in food processing plants, but you know we're on 40,000 cases a day, most of that is not taking place inside the workplace, you know it's outside".(GA4)*

A small number of academic, Union and Government agency respondents expressed distrust in the accuracy of reporting of COVID-19 cases, with one respondent citing a business being found to have changed the numbers being reported.

> *"...but they (site) had a very serious outbreak and there were a couple of worker deaths (…) And one of our concerns in in that instance, and this might be mirrored across the country, was that when the company was being questioned about the level of the outbreaks, they were fiddling the figures of the workforce." (U3)*

> *"I think I think one of the things that that will be of note in the future is that instances of COVID-19outbreaks in the food processing sector being reported are going to be incredibly low (…) A lot of people have to turn up and do work, so unless they are physically unable to work then it's unlikely that they would be reporting it" (A2)*

With respect to Government agencies and some Union involvement in response to outbreaks this was said to vary considerably on a case by case basis. Government agency respondents reported their contribution to include: specific expertise on a particular workplace or operational environment; reviewing risk assessments and workplace controls; joint visits and inspections of the premises alongside the incident management teams; providing advice or instruction to make improvements; ensuring that wider industry priorities are considered I the outcome and subsequent actions emergent following investigation.

> *" We work with the PHE team to make sure that there's an adequate solution that maintains the supply while keeping the factory COVID-19safe."(GA6)*

4.8 LOOKING FORWARD

4.8.1 Continuation of measures

The majority of the federations, unions, Government agency respondents and some Academic respondents anticipated the **maintenance of protective measures** in the FDP businesses in relation to COVID-19. Interview respondents cited a number of measures that they anticipated being

maintained by FDPI businesses, which included: Perspex screens, proximity sensors, high-vis jackets with distancing messages, cross skilling, improved ventilation, hygiene levels and sanitiser points, temperature checks facemasks and social distancing.

> *"…will keep you know what keeps sanitiser points all over the place, will probably keep temperature check […] don't want people […] got illnesses anyway so probably you know will probably leave those in. Now we've invested in them." (F1)*

> *"Your face coverings your and social distancing and they're here to stay […] it seems like the businesses want to keep that up as well to try and be as safe as they can."(GA2)*

> *"I'd like to think that in some of the places some of the physical distancing measures they've introduced in their workplace will stay in place because there's other benefits from that and terms of noise levels and other safety risks too..." (U1)*

Federation and Government agency respondents stated that FDP business are (variously) continuing to keep measures in place for reasons of maintaining good practice and in anticipation of needing to put thee back in practice in future. In some instances (e.g. temperature checks, improved ventilation, use of facemasks), it was identified that by maintaining the measures it will help with reducing and controlling non-COVID-19 illnesses such as colds and coughs.

> *"A lot of them are keeping them as good practice." (F3)*

> *"if they've implemented physical segregation etc within the plant I think most of them will keep them because, give them a guarantee that they won't have to re-implement them [...] there's no reason to take it out." (GA3)*

Where measures are not being maintained, some respondents cited the possibility to put them back in place if needed at a later date. One Federations identified that if their member organisations see a measure as annoying people then they would not continue with it in the workplace. Government agency respondents also highlighted people's tolerance and acceptance of the different measures will largely impact on whether they are maintained in future.

> *"…if it is something that is annoying people I can see them getting rid of it." (F5)*

> *"...for example, how tolerant or intolerant are people of wearing face masks, how much are they bothered by 2 meter social distancing measures" (GA1)*

Federations highlighted the potential challenge in future of trying to maintain COVID-19 measures in FDP businesses when they are no longer mandated outside of the workplace, such as social distancing. Conversely, one Government agency respondent made explicit reference to the lessening of controls amongst the general public, which was not thought to have impacted practice within the FDPI to date (at the time of interview).

> *"…I mean this is a challenge with particularly masks because obviously you know if you go into a supermarket you'll find maybe 50% of people will wear masks, 50% don't. In a workplace, if you make the rule that as 100% […] you've got to work quite hard to enforce that rule. And we don't tend to work in workplaces where people have, you know strict at sort of measures to force rules. […] you're relying on people to comply without needing to keep telling him that they've got to comply. So in other words, you need them too you know to enforce the rules for themselves, not to necessarily. Yeah, being forced by you know strict penalties if they get the rules wrong…" (F2)*

> *"Although there has been a lessening of controls or unexpected lessening of controls and public areas that hasn't really been reflected in the industry, they stuck to what they know."(GA3)*

4.8.2 Need for continued financial support

Most Union respondents, along with one Government agency respondent made reference to the need for continuation of adequate sick pay or provision of **financial support** to ensure that people don't feel the need to come to work when unwell.

> *"Yeah, where companies have introduced full sick pay for absences, I think that should continue at the start of the pandemic we wrote to Defra and the six major retailers calling for an urgent review of industry standards because the vast majority of the industry don't receive full pay for when they are sick like a lot of like a lot of industries in the United Kingdom, and you know, for A and essentially industry." (U3)*

> *"I would like to see staff themselves have occupational sick pay because that protects everybody. It even protects people. It protects bus drivers, it protects shopkeepers, it protects everybody. So it's a societal benefit as well as an individual." (U2)*

> *"...the self isolation support payment. That was welcomed and necessary and it should've come much sooner. But the fact that it does exist, it's very good and right now, I am concerned about the removal of it, with the thought that, you know, where ventilation should be built in..."(GA4)*

4.8.3 Importance of keeping good ventilation systems

A few Union and one Academic respondent also commented on the importance of keeping good ventilation systems in place to control the spread of not only COVID-19, but also other flus and viruses which may cause future problems.

> *"So any improvements to awareness of the need for good ventilation in workplaces and ventilation which stops the spread of airborne infection risk is going to be good news" (U1)*

> *"...but also the ventilation aspect. It's how we make sure that there's adequate mechanical ventilation that filters out the contaminants and protects against transmission of viruses in the business, and how that will be funded and regulated is really important as we move forward." (U2)*

> *"If there is a good thing about COVID-19and there isn't many really, the good thing is it's taught us that buildings have got the ability to make us sick or keep us well. So if they invest in proper fresh air ventilation systems or UV air disinfection, you've got a very healthy air to breathe and put in your body. You got healthier workforce, more productive workforce. So I think that's probably the up side of it." (A5)*

4.8.4 Future design of production facilities

Some Government agency respondents made reference to the future design of FDP environments to allow more space for mitigation practices that may be required, such as social distancing, in addition to incorporating ventilation systems from the outset.

> *"there's very little they can do from a from a physical point of view once the walls are built. So this is probably an area that would be best served in terms of future design of factories. […] if you're a business and you've got a building, you're not about to go and put up a new building just to deal with COVID, but I think as we go forwards, using what we've learned to influence the design of things that will be built anyway is a really important thing."(GA1)*

> *"designing the work place and processes with that in mind, it's going to be a lot easier in the future […] than trying to retrofit something, it's poorly designed and doesn't fit." (GA3)*

4.8.5 Use of technology and automation

Approximately half of Government agency respondents made reference to the use of technology when looking ahead to the future management of COVID-19 within the FDPI. This included the potential for automating work tasks currently completed by hand; wearable technology to support

social distancing; and technology (reportedly being trialled at the time of interview) to enable wastewater testing to support detection of COVID-19.

> *"...there are some businesses that were already, you know, for other reasons. Looking at these kind of systems […] image recognition for example, seems like a no brainer. Having a system that is reliably scanning thousands of chicken carcasses or whatever and telling you if they're safe, you know it's great for the industry. It's great for food safety, and it's great for reducing viral transmission." (GA1)*

> *"the APP didn't necessarily do what people wanted it to do, because it was set to draw into wider circle. If you make something industry specific that you know they could control […] Give them all a little pendant to wear that was set to whatever distance you wanted." (GA7)*

> *"...with wastewater testing, we've done some pilots in the food sector, […] by testing the wastewater for presence of COVID-19 and you basically test every person of every member of staff with a single test. You don't have to worry about opting in and out, 'cause it's not generally seen as particularly invasive to check the wastewater and if there is COVID-19there then you can then go in and do more targeted testing."(GA4)*

Speaking about lessons learned, one Union respondent noted the importance of ensuring better testing in the future, with a further Union respondent noting the importance of ensuring testing can be conducted within the workplace.

> *"Assuming we don't have any other major lockdowns, the most important things going forward are going to be getting a better understanding of what the most effective control measures are in your workplace and accurate and better testing." (U1)*

> *"…the Government should have gotten into supporting workers so they could afford to isolate and, testing should have been done in workplaces." (U4)*

4.8.6 Gaps in knowledge

Respondents cited great variety when asked about gaps in knowledge and understanding regarding the transmission of COVID-19. Gaps in knowledge identified by different stakeholder groups are summarised below.

4.8.6.1 Gaps in knowledge amongst Government agency

Most prominent knowledge gaps cited by Government agency respondents were: better understanding how transmission occurs within the FDPI, practical understanding of the role of ventilation and better understanding the FDPI workforce, in particular with respect to migrant workers and how best to support them.

> *"...evidence of transmission and how it occurred and whether it is happening due to like, wet surfaces or […] you know we didn't have good answers for the challenges that we're being faced with."(GA4)*

> *"...really having a practical, practitioner understanding I might describe it as, but you know, at shop floor level of how ventilation works, the role it plays in that workplace, and how critically important it is."(GA1)*

> *"...if there are gaps for the food industry to understand and I would say, you know, does the food industry understand its workforce well enough […] do they understand you know the needs of their workforce in terms of language and health beliefs? […] probably 10, 15 years ago that was predominantly white British drawn from the local area or surroundings, but over the years, it became more Eastern European migrant Labour." (GA4)*

> *"... management of migrant workers, particularly those who don't speak English as a first language. I'm not aware of a specific piece of guidance focusing on that."(GA1)*

4.8.6.2 Gaps in knowledge amongst Federation respondents

A couple of the Federations referred to the unknown future of the COVID-19 pandemic as a gap in knowledge, as well as understanding how the COVID-19 virus behaves to enhance knowledge of transmission routes.

> *"Who really knows you know there's still a lot of unknowns about it and the disease as far as I understand it, no expert but it's evolving over time." (F3)*

> *"I think we need to understand more about how a virus naturally behaves when it's airborne […] What pandemic comes next but it's probably only going to be transmitted through certain mediums." (F1)*

4.8.6.3 Gaps in knowledge amongst academics

The most popular theme to emerge from the Academic respondents as a knowledge gap was around ventilation and temperature. This was also frequently mentioned as a knowledge gap when compared to other factors, such as hygiene and cleaning

> *"Mainly ventilation, and personal protective equipment where ventilation is not sufficient" (A3)*

> *"Risk assessments are based upon hand washing and so droplet spread etc. And that's not trap tremendously helpful as we get more and more sort of know over a strong understanding about now airborne nature, transmission" (A2)*

> *"I would say knowledge on ventilation is very low (…) this has to change; we've got to protect people. We've got legal duty to. It's the moral duty to. And you know, we've also got to protect the food chain (…) We've got to keep the supermarket shelves with food on them, and if we've got, you know closure after closure or major disruption, that's only going to impact the food chain more"(A5)*

4.8.6.4 Gaps in knowledge amongst Union respondents

Union respondents commented on a range of knowledge gaps, such as poor knowledge of ventilation, transmission routes, the role of temperature and general confusion on symptoms, which seem to change depending on the variant of the virus. Furthermore, they perceived a lack of knowledge around COVID-19 symptoms when the pandemic started, and how this may still make it difficult to keep infection outside of the workplace.

> *"The biggest difficulty was actually just not knowing what the symptoms were so that you could actually persuade people that it was appropriate not to come into work". (U4)*

> *"The big problem there was persuading people that they should stay at home and get tested if they had symptoms that might be COVID-19because nobody was very clear what symptoms might be COVID." (U1)*

Similar to Academic respondents, the knowledge gap surrounding ventilation was also mentioned by Union respondents. The importance of engaging with workers from a multi-ethnic background and understanding their needs, noting this level of communication was quite limited in the FDP industry, despite large numbers of ethnic workers within the FDPI.

> *"Engaging with workers from a multi-ethnic background and a multilingual background I think is the main challenge (…) if companies are actively seeking out workers from different ethnic backgrounds in order to plug gaps, then there's a responsibility on them to ensure that the information they provide is understood. And I think that's one of the massive challenges going forward." (U3)*

4.8.7 Industry concerns

The majority of the Federations and some Government agency Academic and Union respondents identified concerns around there being **further variants** of COVID-19. Some feared that new variants would potentially undo all the work that has been done and would impact upon the trust that has been

built around the vaccines and measures that have been implemented. It was mentioned that this would be a concern for the industry in terms of having to switch back to previous measures that could lead to significant changes being required or more stringent measures being imposed at a time when people have got more used to having more freedom compared to the start of the pandemic. One or two Government agency respondents were also concerned for the impact of new variants of COVID-19 on vaccine effectiveness, whilst one Union respondent expressed concern for reliance on 'herd immunity' should further variants of COVID-19 emerge.

> *"Going forward, the greatest challenge will be if it repeats again and mutates into something worse and we're back to square one." (F3)*
>
> *"new variants, which could lead to significant changes. No one anywhere is saying that we're going back into lockdown, but if you had a new variant that was, you know, resistant to the vaccine."(GA4)*
>
> *"they're not taking account of the fact every time this virus is given the opportunity to replicate, in the workplace or elsewhere (…) it's going to stand that small chance multiplied by the frequency of replication, it is not a trivial chance of mutating into something more horrible."(A3)*

In addition to future variants, the majority of Federations also identified that there are concerns in the sub-sector of there being **further lockdowns** and the impact this could have in the workplace on production, demand and staffing. Future concerns associated with long-COVID-19was also cited by Union respondents along with one academic. This was mainly with respect to the long-term effects on workers' health, which may be further impacted upon with the lack of sick pay schemes available in the FDP industry.

> *"There's actually a whole new area we've got to look at which is the problems of the post COVID-19syndrome in the workplace and managing people who've got that." (U1)*
> *" If you're sick again a few months down the line because of COVID, that's considered long COVID-19and you are conditioned to the sickness policy. And that's where we disagree with, because there are some people who are more susceptible than others at having long COVID." (U2)*

APPENDIX 1: EXAMPLE INTERVIEW SCHEDULE

COVID-19 at work study – understanding the transmission of Covid-19 in the food processing sector

<table>
<tr><td colspan="2">Interview schedule for: Trade associations/federations</td></tr>
<tr><td colspan="2">FPI = Food Processing Industry, C-19 = Covid-19</td></tr>
<tr><td colspan="2">Demographics & contextual information</td></tr>
<tr><td colspan="2">About you
What are your current roles & responsibilities?
Which trade association/Federation do you represent?
Have you experienced any changes in role and responsibilities since March 2020 as a result of C-19?
Which food industry sub-sector do your members cover/represent?</td></tr>
<tr><td colspan="2">Interview questions</td></tr>
<tr><td>1.</td><td>Your views of Covid-19 transmission in the FPI<ol type="a">
How safe do you regard the FPI within the [above answer] sub-sector? Is this consistent with the wider FPI industry? What other industries would you consider to be similar in safety/risk and why?
Where do you consider the greatest risk of C-19 transmission within the [above answer] sub-sector? (e.g. sector, manufacturing/processing stage, work area, time of day/shift, areas with poor ventilation)? Why is this?
Are you aware of any trends in confirmed cases/clusters/outbreaks? (e.g. demographics of who is affected, types of facility?)</td></tr>
<tr><td>2.</td><td>Mitigation measures to prevent transmission in the FPI<ol type="a">
What do you consider the most effective measures to reduce C-19 transmission in the within the [above answer] sub-sector and why?
Physical distancing measures
Cleaning and hygiene practices
Ventilation
Risk assessment policies and procedures
Personal Protective Equipment
Mask wearing
Other
What barriers/enablers are you aware of for successfully introducing and maintaining such measures (above) within the [above answer] sub-sector?
Are you able to provide an indicative timeline of when such mitigation measures were introduced within the [above answer] sub-sector and when, how and why they have evolved?
How do you perceive [above answer] sub-sector compliance with C-19 guidance/requirements issued by Government/industry bodies? Why is this?</td></tr>
<tr><td>3.</td><td>C-19 Information, knowledge, guidance and support<ol type="a">
What role does your organisation have in preventing transmission of C-19 in [above answer] sub-sector?
How have you/your agency provided support to [above answer] sub-sector during C-19? What prompted provision of such support (e.g. specific requests from member companies)?
How do you go about sharing information/practices amongst your members with respect to the management of C-19 across the FPI (both good and poor practices)?
We have seen some of the generic C-19 guidance issued to the food industry from external sources (e.g. Government departments). Are you aware of any</td></tr>
</table>

	further activity undertaken to develop more detailed/specific guidance for the [*above answer*] sub-sector? (*e.g. industry forums/working groups, engagement with subject matter experts, creation of business specific guidance)*. If yes, can you describe who is involved and the development process? e) What are the barriers/enablers to the [*above answer*] sub-sector implementing C-19 guidance and preventing transmission of C-19? f) What/who do you/your agency consider the primary sources of information for staying up to date with changes in the C-19 pandemic and implication of these changes for industry? g) What support have you/the [*above answer*] sub-sector received from external agencies (*e.g. HSE, industry groups*)? Are there any areas you would like to see more support for FPI? h) What are the knowledge gaps with respect to C-19 within the [*above answer*] sub-sector that require greater understanding?
4.	**C-19 impact on the FPI** a) How have the C-19 measures affected business operations and workers within the [*above answer*] sub-sector over since March 2020? (*e.g. hours of operation, remote working of personnel, shift rotations, dispersion of staff across operational environment, visitor/suppliers on site etc..*) b) How has your agency responded to the uncertainty and rapidly evolving situation of C-19? How have your member companies responded? c) How has C-19 affected the supply chain in the [*above answer*] sub-sector? Do you envisage any such impact in the next 6 months? d) How have requirements to isolate impacted the [*above answer*] sub-sector over the course of the pandemic?
5.	**Future management of C-19 in the [above answer] sub-sector** a) What do you consider to be the greatest challenges to [above answer] sub-sector being able to effectively respond/adapt to C-19 going forwards? b) Are there any changes to practice/ways of working that [above answer] sub-sector is looking to retain/continue beyond C-19? Why is this? What is the benefit?
6.	Is there anything else you think would be useful for us to consider in investigating C-19 relative to the FPI?

Appendix 4. Literature review draft

Transmission and control of SARS-CoV-2 in the food production sector: A review of the literature

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Keywords: COVID-19, COVID transmission, food production sector, occupational health, food and drink production

ABSTRACT

The COVID-19 pandemic has created unprecedented challenges for many workplaces. The food production sector has drawn attention over the duration of the COVID-19 pandemic due to a large number of outbreaks/clusters reported, particularly during the early stages of the pandemic. The essential nature of the food-production sector during this time has suggested that further understanding is required on the transmission and control of COVID-19 in this setting. As such, this review aimed to provide an overview of the literature assessing the extent of transmission in the food processing sector along with the risk factors associated with COVID-19 infection/mortality rates in this setting, and the preventive measures used to reduce transmission.

An electronic search was conducted using various scientific databases, including Web of Science, OVID, PubMed and Medrxiv. The search strategy identified 26 papers that met the inclusion criteria. Six of these total studies were based in the UK and the country with the most papers was the USA, with a total of nine papers.

While there was a lack of research focusing on the UK, there was some overall evidence that showed a high transmission level of SARS-CoV-2 within certain areas of the food production sector, risk factors associated with the spread, and the suggested preventative measures to be taken. However, further research focusing on the food production sector as a whole would help to understand how transmission and risk may vary with each sub-sector. Similarly, research focusing on the application of preventative measures and their efficacy is needed to understand which methods work well in the sector, while further qualitative research could help identify key gaps and provide in-depth information regarding enablers and barriers to transmission, risk factors and mitigation.

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DATA

All data underlying the results are available as part of the article and no additional source data are required.

COMPETING INTERESTS

No competing interests were disclosed

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INTRODUCTION

Coronavirus disease 2019 (COVID-19) is an infectious disease caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (Gorbalenya et al., 2020). It is a novel RNA coronavirus from the same family as SARS-CoV and Middle East Respiratory Syndrome coronavirus (MERS-CoV) (Pascarella et al., 2020). Since the beginning of the COVID-19 pandemic, research has been conducted to understand more about the virus's transmission routes. The risk of transmission is increased when standing close to a person who is infected (WHO, 2020). It is also now accepted that the primary transmission route appears to be through close contact human-to-human aerosol transmission, which can occur through contaminated droplets, hands or surfaces (Pascarella et al., 2020). The virus has also been found to last several hours on different surfaces, however, it is uncertain how much surface to eyes, nose or mouth transmission is likely to contribute to outbreaks (WHO, 2020). Importantly far-field airborne transmission can also occur through virus-laden aerosols emitted from an infected person, which is a particular problem in indoor or enclosed environments with crowding or poor ventilation (Morawska and Milton, 2020).

It is clear that the COVID-19 pandemic has been having a negative effect in many workplaces, where employers have struggled to effectively exercise their legal duty to protect staff from harm in the workplace (Agius et al., 2020). Millions of workers have jobs that cannot be conducted at home and in the UK alone, 33% of the total workforce were identified as key workers during the pandemic, according to the Office for National Statistics (ONS) (The Lancet, 2020). A number of publications have highlighted reports of hotspots and evidence of COVID-19 risks being raised in the food production sector (The Lancet, 2020). This review aims to provide an overview of the existing literature to assess the evidence on COVID-19 cases, infection and mortality rates, potential transmission risk factors, and preventative measures within the different areas of the food production sector. The research questions that we aim to address in this review include:

1. What is the evidence for an increased risk of infection, outbreaks and COVID-19 mortality rates in the food production sector compared to other sectors?
2. Which risk factors contribute to any elevated COVID-19 infection and mortality rates in the food production sector?
3. Which preventative measures/ risk mitigation strategies have been taken to reduce COVID-19 in the food production sector, and which have shown to be effective?

METHODS

An electronic search was conducted using scientific databases, including Web of Science, OVID, PubMed and Medrxiv (last search 28th October 2021) to gather the existing literature on this topic. Search terms included can be found in the appendix. Other relevant studies identified outside of this search were also included in our review. In the case of finding the papers, the term "food production sector" also included the production of drinks and beverages.

The inclusion criteria consisted of: 1) papers involving the level of transmission in the food production sector (including risk of infection, outbreaks/cases and mortality rates), 2) papers with information on factors that are linked to an increased risk of COVID-19 infection in this sector, and 3) studies focusing on preventative measures or risk mitigation strategies in the sector. As there were a limited number of food-sector specific studies, papers that involved a broad range of work sectors (as well as the food production sector) were also included, as were studies based outside of the UK.

RESULTS

General findings

Our search retrieved 26 papers that fit the inclusion criteria for this review (table 1). The country with most publications is the USA (n=9), while others were based in the UK (n=6), France (n=1), Ireland (n=1), Spain (n=1), Germany (n=1), Greece (n=1), Sweden (n=1) or focused on a more global perspective (n=4). One study focused on both the USA and the UK.

Table 1 presents the details of the papers extracted for this review

Table 1: Characteristics of the papers included in the review.

Author & date	Peer reviewed?	Location/country	Area of focus	Area of food sector	Transmission, risk factors or prevention?	Study design
Aday & Aday (2020)	Yes	Global	Literature review on effects of COVID-19 on food production, processing, distribution, and demand.	Food Processing facilities	Risk factors and prevention	Literature review – food supply chain – including food processing, production and distribution
Anand et al (2020)	Yes	USA and UK	Provide evidence for work and personal predictors of COVID-19 transmission.	Factories;	Risk factors	Discussion paper on work predictors of COVID-19
Bui et al (2020)	Yes	Utah, USA	Analyses the racial and ethnic differences in COVID-19 cases and occupation.	manufacturing; meat processing	Transmission & prevention	Multiple sector study
Billingsley et al (2021)	Yes	Sweden	Analyses mortality across occupations and secondary risks for elderly individuals in the household	Meat packing	Transmission and mortality	Sector-specific study - population register-based study Meat packing
Chen et al (2021a)	Yes	California, USA	Estimates excess mortality among Californians 18–65 years of age by occupational sector	Food and agriculture workers	Transmission	Sector-specific study – including food and agriculture sector
Chen et al (2021b)	Pre- print	UK	Analysed Public Health England (PHE) HPZone data on COVID-19 outbreaks in workplaces between 18 May – 12 October 2020.	Manufacturers and packers of food	Transmission - Outbreak rates and infection attack rates	Sector-specific study - Epidemiological surveillance data
Dyal et al (2020)	Yes	USA	Reports of the number of COVID-19 cases across meat and poultry processing facilities	Meat and Poultry processing factories	Transmission and cases	Sector-specific study – meat and poultry processing

Author & date	Peer reviewed?	Location/country	Area of focus	Area of food sector	Transmission, risk factors or prevention?	Study design
Gunther et al (2020)	Yes	Germany	Describe a multifactorial investigation of the COVID-19 outbreak in a large meat processing complex in Germany.	Meat processing plants	Cases and Risk	Sector-specific study – meat processing plant
Herstein et al (2021)	Yes	Nebraska, USA	Details demographics and outcomes of severe COVID-19 cases among workers in Nebraska meat processing facilities.	Meat processing facility	Transmission/cases and prevention	Sector-specific study – meat processing
Hiironen et al (2020)	Pre-print	UK	Analyses occupational exposures were associated with COVID-19 between August-Oct 2020.	Food production workers	Transmission	Retrospective studies – food production / agriculture
House et al (2021)	Yes	USA	Characterises the association between meat packing plant exposure and clinical outcomes amongst emergency department patients with COVID-19	Meatpacking	Transmission, risk	Retrospective cohort study – meat packing
Kotsiou et al (2020)	Yes	Greece	Investigate if the prevalence of COVID-19 changes amongst different occupations during lockdown.	Catering and food sector	Transmission and prevention	Sector-specific - catering/food sector
Mallet et al (2021)	Yes	France	Analyses risk factors and level of transmission for a COVID-19 cluster detected in a French processing plant	Meat processing plant	Transmission and risk factors	Sector-specific study – meat processing

Author & date	Peer reviewed?	Location/country	Area of focus	Area of food sector	Transmission, risk factors or prevention?	Study design
Moore et al (2021)	Yes	UK	Responds to the TUC's calls for a strengthened health and safety agenda, improved safety guidance and tougher regulatory activity in the light of COVID-19	Food and drinks sector	Transmission, prevention and risk	Sector- specific study – food and drinks sector
Mutambudzi et al (2020)	Yes	UK	To investigate severe COVID-19 risk by occupational group.	Process, plant and machine operatives	Transmission/cases	Multiple sector study – includes food workers and process, plant and machine operatives
Nakat and Bou-Mitri	Yes	Global	Aims at assembling all current knowledge about COVID-19 and its impact on the food industry.	Food sector as whole	Prevention	Literature review – focus on food industry as whole
Nafilyan et al (2021)	Yes	UK/England	Analyses occupation and COVID-19 mortality in England	Food production	Mortality	Multiple sector study – includes food production
ONS (2021)	Yes	UK	Reports on COVID-19 related mortality rates within different occupations between March and December 2020.	Various - process, plant and machine operatives & food, drink and tobacco process operatives	Transmission/cases/mortality	Epidemiological surveillance data
Rizou et al (2020)	Yes	Global	Summarises possible transmission routes of COVID-19 through the food supply chain.	Food sector as whole	Transmission	Literature review – food supply chain as whole

Author & date	Peer reviewed?	Location/country	Area of focus	Area of food sector	Transmission, risk factors or prevention?	Study design
Rubenstein et al (2020)	Yes	Maryland, USA	Investigates the factors contributing to transmission of COVID-19 within foreign born workers.	Poultry Facility workers	Risk Factors	Sector- specific study - Poultry Facility Workers
Steinberg et al (2020)	Yes	South Dakota, USA	Investigates COVID-19 outbreak among employees at a meat processing facility	Meat processing plant	Transmission	Sector specific study – meat processing plant
The national COVID-19 outbreak monitoring group (2020)	Yes	Spain	Outbreaks notified to the national level in Spain during early summer of 2020 are reported.	Meat processing plants	Transmission	Epidemiological surveillance data - Fruit/agriculture, slaughterhouses
Vanderwaal et al (2021)	Yes	USA	Examined PCR testing and modelled transmission at pork plants in the US.	Pork processing plants	Transmission and prevention	Sector-specific study – pork plants
Walshe et al (2021)	Yes	Ireland	Provides retrospective outbreak investigation in a meat processing plant and a description of the measures taken to prevent or contain further outbreaks	Meat Processing plant	Transmission and prevention	Sector specific study – meat processing plant
Waltenburg et al (2021)	Yes	USA	Describe COVID-19 among US food manufacturing and agriculture workers.	Food processing, manufacturing and agriculture workplaces	Transmission and prevention	Sector-specific study – food manufacturing and agriculture
Zuber & Brussow (2020)	Yes	Global	Literature review addressing the presence and persistence of COVID-19 in the food environment.	Food industry	Prevention	Literature review – food environment

What is the evidence for an increased risk of infection, outbreaks and COVID-19 mortality rates in the food production sector compared to other sectors?

Evidence on outbreaks and infection and mortality rates within the food production sector in the UK has been limited. Many of the papers which focused on the transmission levels within the food production sector were US-based studies (n= 7). Of these, the Centres for Disease Control and Prevention (CDC) published several papers covering the number of cases in various factories across the USA.

Meat and Poultry facilities

One of these CDC papers included COVID-19 among workers in meat and poultry processing facilities across 19 states in April 2020 (Dyal et al., 2020). The study showed that across the 19 states, there were a total of 4,913 (3.0%) confirmed COVID-19 cases and 20 (0.4%) COVID-19 related deaths. The state with the highest number of COVID-19 cases during this time was Iowa, with a total of 377 cases (18.2%) and South Dakota, with a total of 794 cases (17.3%). The state with the highest mortality rate was Colorado, with a total of 5 deaths (3.6%).
Another study published by the CDC also analysed transmission among meat processing workers in Nebraska, along with the effectiveness of risk mitigation measures (Herstein et al., 2021). The study found that out of the 26,000 workers in meat processing factories across the state of Nebraska, 5,002 (19%) were diagnosed with COVID-19 from March to July 2020. They also found that the attack rate during this time period was more than double the 9.1% attack rate reported in a multistate analysis of meat processing facilities across the USA (Herstein et al., 2021).

House et al (2021) performed a retrospective cohort study of patients less than 65 years of age attending an emergency department (ED) with COVID-19 symptoms in the USA between March-May 2020. They found that amongst all the patients, 8.4% stated they were potentially exposed by working in a meatpacking plant. Out of the overall 582 patients in the ED, 74% of meatpacking plant exposed patients tested positive for COVID-19, while 12% of those without a meatpacking plant exposure tested positive. However, this large difference between the two groups could possibly be explained by the overall small sample of individuals from the former group compared to the latter. This can also be seen in the multivariable model produced in the study, which found that despite having higher COVID-19 positivity rates, meatpacking plant exposed individuals had similar rates of hospital admissions to individuals who were not exposed. They also concluded that in-hospital mortality did not vary significantly by meatpacking plant exposure. Ethnicity seemed to play a significant role, with figures showing that 57.1% of individuals with a meatpacking exposure were Hispanic/Latino, but only made up 11.8% of the non-meat packing exposure group (House et al, 2021).

Steinberg et al (2020) also investigated an outbreak among employees at a meat processing facility in South Dakota between March and April 2020. They found that of the 3,635 people working in Facility A (a facility with 38 departments that harvested and processed animals during two shifts per day), there were a total of 929 (25.9%) COVID-19 cases and that out of the 2,199 COVID-19 cases identified among community residents, facility A employees represented 920 (41.8%) of them. The highest attack rates also occurred in the Cut (30.2%) and Harvest (29.4%) department groups, while the attack rate remained higher for nonsalaried employees (26.8%). However, this difference between nonsalaried and salaried employees could be associated with salaried employees having access to workstations that could be adjusted to maintain social distancing, something that nonsalaried employees were not given access to (Steinberg et al, 2020).

Outside of the USA, Mallet et al (2021) investigated a COVID-19 cluster that occurred in the pork section of a plant in France during May 2020. A total of 1,347 worked in this area of the site and were predominantly male (62.7%). In total, there were 140 occupational cases identified during this period, of which 27 were identified through hospital or outpatient sampling. Although there were no mortality rates, four individuals were hospitalised (2.9%), two of whom were admitted to the intensive care unit. All four cases that were hospitalised worked in the deboning and cutting department of the plant. Foreign-born workers accounted for half of the total cases (52.1%) compared to a quarter (25.4%) of non-cases and were more likely to be placed in the deboning and cutting department. The majority of cases were employed by subcontracting companies (50.7%) or were temporary workers (30.7%). The attack rate in the study population was also 11.9% but was 16.6% among workers of the deboning and cutting department. It was concluded that there was a significantly increased risk of SARS-CoV-2 infection for workers of subcontractors and some foreign-born workers. (Mallet et al, 2021)

A paper published by the national COVID-19 outbreak monitoring group reported outbreaks notified at the national level in Spain during the summer of 2020 (29th May – 2nd August), while also describing settings where outbreaks were most frequently identified (The national COVID-19 outbreak monitoring group, 2020). They found that out of the outbreaks which were linked to occupational settings (representing 20% of all active outbreaks), the ones related to workers in the agricultural/fruit and vegetable sector were the most frequent, with 31 active outbreaks and around 500 active cases ("active" defined as new cases diagnosed within the last 14 days). In total, this sector had 45 outbreaks and 1,022 cases during this period. Workers at slaughterhouses/meat processing plants were the second most affected group, with 12 active outbreaks and 360 active cases identified. This group also had a total of 19 outbreaks and with a total of 767 cases within this period. This was substantially higher than other occupational settings, such as long-term care facilities and healthcare facilities, which made up 7% and 3% of the active outbreaks, respectively (The national COVID-19 outbreak monitoring group, 2020).

VanderWaal et al (2021) modelled transmission dynamics and effectiveness of worker screening programs for COVID-19 in three different pork-processing plants during spring of 2020 in the USA. One of the plants ("plant B") was located in a region with high levels of community transmission early in the pandemic, which they believe was a factor for the steep epidemic curve within the plant during late April. Plant C was the only plant to offer company-sponsored PCR-testing for individuals who had mild signs of the virus, and stated that this caused further documenting of cases and reporting of an apparent larger outbreak, with a cumulative of ~25% of workers clinically affected. They also found that plant C had a policy that asked all household and carpool contacts of potential cases to self-isolate at the same time as the employee showing clinical symptoms. VandelWaal et al (2021) concluded that it was difficult to determine whether Plant C experienced a larger outbreak than Plant B, or if they simply had better documentation of cases from the PCR testing available for symptomatic individuals.

Walshe et al (2021) described a retrospective outbreak investigation in a meat processing plant in Ireland, along with a description of the measures taken to prevent future outbreaks. They found that across a five-week period, the plant had a total of 111 confirmed positive asymptomatic cases and an estimated attack rate of 38%. Mass screening was provided four weeks after the outbreak, where they found a further thirty-two positive cases, of which 50% consisted of workers who were based in the boning hall of the plant. After carrying out various risk assessments and air quality monitoring in the boning hall, Walshe et al found that this area of the plant showed a gradual build-up of carbon dioxide and aerosol particles over the course of a work shift. They confirmed that this area was poorly ventilated and was highly favourable for aerosol transmission of COVID-19 (Walshe et al, 2021). However, the high number of cases from the boning hall could also be explained by the fact that this area had the greatest number of workers when compared to other production areas.

Conversely, a study focusing on COVID-19 mortality across occupations and secondary risks for elderly people's households in Sweden found that there were 0 deaths reported in the meatpacking sector, making it the only occupation in the database with 0 deaths. However, the analysis was limited to workers who lived in the same household with an elderly person in the household, making it a very selected group (Billingsley et al., 2021).

Other food production facilities

Many papers focused on food processing relative to other sectors or focused on comparing risks across different occupational sectors. Of these, Waltenburg et al (2021) outlined COVID-19 cases among workers in various food processing, food manufacturing and agriculture workplaces in the USA. They found that from March to May 2020, there were a total of 742 food manufacturing and agriculture workplaces affected, with a total of 8,978 confirmed COVID-19 cases among workers and 55 (0.6%) related deaths across the USA (Waltenburg et al., 2021).

A report by Bui et al (2020) analysing racial and ethnic disparities among COVID-19 cases in Utah during March-June 2020 found that the manufacturing sector, along with wholesale trade, had some of the highest workplace outbreak-associated cases when compared to other sectors. For example, the manufacturing sector had a total of 43 (20%) workplace outbreaks and 467 (20%) workplace associated cases, while the wholesale trade industry had a total of 29 (14%) outbreaks, of which 200 (14%) were workplace associated cases. This was significantly higher than other occupational settings, including health care and assistance, which had a total of 5 outbreaks (2%) and 21 (2%)

workplace associated cases (Bui et al, 2020). A study by Chen et al (2021a) investigating COVID-19 mortality among Californians also found that workers in the food and agriculture sector had a 31% increase in relative excess mortality during June and July 2020. Excess deaths within this sector were also significantly higher than sectors such as government and community, health/emergency and retail. They concluded that the pandemic's effects on mortality have been greatest among essential workers, particularly for those in the food/agriculture sectors, and specifically for Latino and black workers in this sector, who had a 59% increase in mortality when compared to other ethnic groups (Chen et al., 2021a).

In the UK, the Office for National Statistics (ONS) published COVID-19 related mortality rates within different occupations between March and December 2020. While figures for the food production sector specifically had not been highlighted, they found that within the process, plant and machine operatives, there were a total of 827 deaths for men (52.8 deaths per 100,000 males), making it the third-highest mortality rate out of the nine major occupational groups for men (elementary occupations having the highest mortality rate, followed by the caring, leisure and other service occupations). For women, this group had the highest rates of COVID-19 related deaths when compared to the nine other major occupational groups, with a total of 57 deaths (33.8 per 100,000). They also found that there were 103.7 deaths per 100,000 males in the food, drink and tobacco process operatives during this same period (Office for National Statistics, 2021).
A study by Chen et al (2021b) analysed Public Health England (PHE) HPZone data on COVID-19 outbreaks in workplaces across 9 different regions in England. They calculated outbreak rates and infection attack rates associated with different occupational groups, one of which included manufacturers and packers of food. In total, 1,317 confirmed workplace outbreaks were identified from the HPZone data between May and October 2020, of which 1,305 were available for estimation of outbreak rates. Of the 6,998 workplaces for manufacturers and packers of food in England, there were a total of 117 outbreaks during this time period, resulting in an outbreak rate of 1,672/100,000. This was higher than any other industrial sector and was consistent over seven of the nine geographical locations. While the attack rate varied, and typically increased as the size of the enterprise decreased, they concluded that it was higher amongst workers in close contact services, restaurants and manufacturers and packers of non-food products (Chen et al, 2021b).

Kotsiou et al (2020) analysed COVID-19 prevalence in Greece pre-lockdown and during lockdown across various occupations using repeated Antigen-Based Rapid Diagnostic Testing. They found that employees working in the catering/food sector (term not defined but often referred to as the "food processing sector") experienced some of the highest odds of COVID-19 positivity than those employed in other jobs. Their data showed that 35% of the 48 individuals working in the food sector tested positive for COVID-19, making it the highest figure out of all the occupations. However, the sample size of this group was small, with only a total of 48 workers in the food sector being included in the study, making up only 5% of the total sample size (Kotsiou et al, 2020).

Some studies found that other occupational groups were at a higher risk of COVID-19 infection and mortality. For example, a study by Mutambudzi et al (2020) analysing the occupational risk of severe COVID-19 in a study of 120,075 UK Biobank participants found that 271 had severe COVID-19 symptoms. Of these, healthcare workers, social workers and education workers were at highest risk, with 0.2% of food workers having severe COVID-19, and 0.4% of process, plant and machine operatives (Mutambudzi et al., 2020). When using the Standard Occupation Classification (SOC) major occupational groups list, they found that process, plant and machine operatives were considered high risk, particularly when compared to managers and senior officials. Nonetheless, they stated this was mostly explained by socio-economic factors.

Similarly, a study by Hiironen et al (2020) used three retrospective studies (late August, September and October 2020) and case data from the NHS Test and Trace programme to analyse transmission and occupational exposures associated with COVID-19 cases. They found that across all study periods, there was strong evidence showing that those working in healthcare, social care, hospitality and warehouse settings had increased odds of being a COVID-19 case. There was limited evidence of any elevated risk for food production and agriculture workers (OR of 1.20, 1.84 and 0.90 in the three different time periods listed above), however, the risk for this group was still considerably higher than occupations such as education, retail, work-related travel and arts, entertainment and recreation. Nonetheless, the study has its limitations due to potential selection bias as 85% of the cases transferred to the NHS Test and Trace app were reached by the contact tracing programme, and

those who do not engage in contact tracing may differ from others in terms of their exposure. Similarly, the Test and Trace app would not pick up those not using the app, and would not identify asymptomatic cases, which may be more prevalent in certain occupations (Hiironen et al., 2020). A paper by Nafilyan et al (2021) also analysed the hazard ratios for COVID-19 related deaths for adults aged 40-64 years in England. They found no evidence of elevated risks for males (HR 1.15 [0.89-1.50]) or females (HR 1.15 [0.750-1.77] working in food production compared to non-essential workers after full adjustment for potential confounders (Nafilyan et al, 2021). Table 2 provides a breakdown of the total number of COVID-19 related cases and deaths reported by each study.

Table 2: summary of study findings for COVID-19 related cases and infection and mortality rates

Study	**Food Processing Sector facility**	**COVID-19 related cases or outbreaks**	**COVID-19–related deaths**	**Time frame**	**Other**
Billingsley et al (2021)	Food packing	n/a	0	12 March 2020 to 23 February 2021	n/a
Bui et al (2020)	Manufacturing sector and wholesale trade	Manufacturing - 467 (34%) Wholesale trade - 200 (14%)	Manufacturing - 12 (3%) Wholesale trade – 3 (2%)	March 6 – June 5 2020	n/a
Chen et al (2021a)	Food and Agriculture	n/a	1,050 (897–1,204) (excess deaths)	March – October 2020	n/a
Chen et al (2021b)	Manufacturers and packers of Food	117 / 1,317 outbreaks (9%) 6,998 total workplaces in this category	n/a	18 May – 12 Oct 2020	Outbreak rate: 1,672 / 100,000
Dyal et al (2020)	Meat and Poultry processing	4,913 (3.0%) (Total across 19 states)	20 (0.4%) (Total across 19 states)	April 2020	n/a
Herstein et al (2021)	Meat processing	5,002 of 26,000 (0.192%)	n/a	April 2021	n/a
Hiironen et al (2020)	Food production and agriculture	-	n/a	late August, late September, and late October 2020	Odds ratio 1.03(95% CI 0.60 to 1.78) comparing infection in food productio nand agriculture compared to other workers.
House et al (2021)	Meat packing	Out of 582 patients in the ED, 74% of meat packing plant exposed patients tested positive for COVID-19, while 12% of those without a meat packing plant exposure tested positive.		March – May 2020	n/a

Study	Food Processing Sector facility	COVID-19 related cases or outbreaks	COVID-19–related deaths	Time frame	Other
Kotsiou et al (2021)	Food production sector	(pre lockdown) 17 of 48 (35%) (during lockdown) 1 out of 17 (5%)	n/a	2 sets – one before lockdown (5–6 November 2020) and one month after the lockdown initiation (30 November–1 December 2020)	n/a
Mallet et al (2021)	Meat processing plant	140 cases among 1347 workers, 87.5% of which were tested	0	May 2020	
Mutambudzi et al (2020)	Process, plant and machine operatives	17 out of 4775 (0.4%) with "severe" COVID-19	n/a	16 March to 26 July 2020	Relative risk 1.12(95% CI 0.52 to 2.42) comparing risk of severe Covid-19 for food workers comared to non-essential workers.
Nafilyan et al (2021)	Food sector	n/a	n/a	24 January to 28 December 2020	Hazard ratio 1.15 [95% CI 0.89 to 1.50] (men) 1.15 [0.750 - 1.77] (women) These compare mortality in food sector to non-essential workers and are adjusted for multiple demographic factors.
ONS (2021)	Process, plant and machine operatives	n/a	827 deaths for men (52.8 deaths per 100,000 males) 57 deaths for women (33.8 per 100,000)	March-December 2020	n/a
Steinberg et al (2020)	Meat processing plant	929 cases among 3,635 workers (25.95%)	n/a	March-April 2020	n/a

Study	Food Processing Sector facility	COVID-19 related cases or outbreaks	COVID-19–related deaths	Time frame	Other
The national COVID-19 outbreak monitoring group (2020)	Slaughterhouses/meat plants & Fruit and Vegetable sector	Slaughterhouses/meat plants - 767 cases Fruit and Vegetable sector - 500 cases (total number of workers not availabile)	n/a	May 2020	n/a
Walshe et al (2021)	Meat processing plant	107 cases among 290 workers	n/a	Mid to late 2020	n/a
Waltenburg et al (2021)	Food manufacturing and agriculture workplaces	8,978 cases among workers in 742 food manufacturing and agriculture workplaces in 30 states Among 15 states that reported worker populations in affected workplaces, 8.2% of 30,609 workers received COVID-19 diagnoses	55 (0.6%)	March 1 – May 31 2020	n/a
VanderWaal et al (2021)	Pork-processing plants	Cumulative incidence of clinical (PCR-confirmed) disease plateaued at ~2.5% to 25% across the three plants studied.		March – August 2020	n/a

Which risk factors contribute to any elevated COVID-19 infection and mortality rates in the food production sector?

Several papers found factors that they reported could increase the risk of COVID-19 spreading in the workplace and amongst workers in the food production sector. Table 3 summarises the main findings related to the risk factors found in the studies.

Table 3: summary of findings on risk factors

Study	Risk factor identified	Findings
Aday & Aday (2020)	Transport Income/sick pay Environmental factors	• Employees within food factories are more likely to share the same buses or use car-sharing systems, which they state allowed the virus to spread further within the community. • majority of workers in the food manufacturing sector have lower income and do not have health insurance / paid sick leave • cold and dark environments without any ultraviolet light can keep the virus alive for several hours, resulting in further transmission (not food sector specific).
Anand et al (2020)	Transport	• Analysed survey results from 2000 respondents in the USA and UK. Found that workers who were more likely to use public transport or share cars were at higher risk of catching COVID-19.
Bui et al (2020)	Ethnicity	• Only 24% of workers in Utah's 15 affected sectors identified as Hispanic or Latino, or another race apart from white, however, 73% of all the workplace outbreak-associated COVID-19 cases were within these ethnic groups
Chen et al (2021a)	Ethnicity	• The pandemics effect on mortality was highest for Latino and black workers in this sector, who had a 59% increase in mortality when compared to other ethnic groups.
Rubenstein et al (2020)	Ethnicity Transport	• The odds of foreign-born workers commuting to work with individuals from outside their household was around 1.9 times the odds for US-born workers. • Foreign-born workers were more likely to be disproportionately placed in certain areas and jobs. E.g., they were more likely to work in cold-temperature areas. • Among the 359 out of 2,345 workers interviewed, 35.7% commuted to work via shared transport with persons from outside their household.
Kotsiou et al (2020)	Ethnicity	• High number of foreign-born workers working in food production sector in Greece (a sector which had some of the highest number of positive COVID-19 results)
Mallet et al (2020)	Ethnicity Transport Shared-accommodation Temporary-workers	• Foreign-born workers accounted for half of the total COVID-19 cases, and 95.2% of these workers worked in the deboning and cutting department. • 62 cases (52.5%) reported carpooling or sharing their accommodation. These were both more frequently reported by Eastern European cases.
Mutambudzi et al (2020)	Ethnicity	• Non-white essential workers had the highest risk of COVID-19 (risk ratio of 8.34) when compared to white essential workers, including within the food and plant and machine operatives.

Study	Risk factor identified	Findings
Moore et al (2020)	Income/sick pay	• Of the workers who were required to self-isolate, one in five did not receive sick pay • 25% of their worker survey respondents in food manufacturing factories reported changes to sick pay, while 25% reported changes to sickness absence • These changes included over one in four managers reporting that there had been an increase of 34% in sick pay for food manufacturers.
Günther et al (2020)	Environmental factors	• Found that environmental conditions, including low temperature, low air exchange rates, air recirculation, along with lack of social distancing between workers, created an "unfavourable mix of factors promoting efficient aerosol transmission SARS-CoV-2 particles" • transmission of the virus can occur over distances of at least 8 metres in confined spaces, particularly in conditions with low air exchange and high rates of recirculated unfiltered air.
Herstein et al (2021)	Ethnicity	• Higher risks of poor outcomes among ethnic and racial minority groups in meat-processing facilities across the state of Nebraska, with evidence showing that 67% of confirmed cases in this sector were individuals who were Hispanic or Latino. • Ethnic and racial minorities also constituted 73% of hospitalised cases, 78% of ICU admissions and 86% of deaths
House et al (2021)	Ethnicity	• Patients from meatpacking plants were more likely to be Black or Hispanic than the emergency department patients without the occupational exposure • Although only 8.2% of people in the emergency department stated that their exposure was potentially from working in a meat packing facility, 60% of these individuals were of Hispanic ethnicity, compared to 10% of patients without this exposure.
Steinberg et al (2020)	Environmental factors Contract workers	• Highest risk areas of the meat processing facility were the Cut, Conversion and Harvest department-groups, all of which had numerous employees who were working with less than 2 meters distance between them. • Cases were higher amongst nonsalaried individuals.
Walshe et al (2021)	Environmental factors	• After carrying out air quality monitoring in the boning hall and abattoir of a meat processing plant, it was found that the boning hall had showed a gradual build-up of carbon dioxide and aerosol particles over the course of a work shift. They confirmed that this area was poorly ventilated and was highly favourable for aerosol transmission of COVID-19. • On the contrary, CO_2 concentration in the abattoir showed a marked decrease during the working shift and increased during the working day. However, the number of fluorescent particles was low and showed no significant change over time. The average air temperatures were 10°C in the boning hall and 18°C in the abattoir. The relative humidity was higher on average in the abattoir (71%) than in the boning hall (66%).

Study	Risk factor identified	Findings
Waltenburg et al (2021)	Ethnicity	• Higher number of confirmed COVID-19 cases amongst Hispanic and Latino workers, (72.8% of overall cases) within the food manufacturing and agriculture workplaces. • 83.2% of cases occurred among racial and ethnic minority workers • Racial and ethnic distribution of meat and poultry processing workers with COVID-19 differed slightly, with a higher percentage of cases being reported among non-Hispanic Black and non-Hispanic Asian/Pacific Islander workers

Ethnicity

Out of the 14 studies which analysed the risk factors associated with COVID-19 transmission in the food processing sector, 9 identified ethnicity as a contributing factor. All of these studies found that either migrant or minority ethnic groups were at substantially higher risk of being infected with COVID-19, or of working in areas of the food processing sector which increased the risk of transmission (e.g., working in cold-temperature areas). One study also found that ethnicity and transport were both risk factors, with the odds of foreign-born workers commuting to work with individuals from outside their household being around 1.9 times the odds for US-born workers (Rubenstein et al., 2020). This was also found in House et al's (2021) study on the association between meatpacking plant exposure and clinical outcomes amongst emergency department patients with COVID-19 symptoms. They found that overall, patients in the emergency department from meatpacking plants were more likely to be Black or Hispanic, compared to patients without this occupational exposure (House et al, 2021). While overall figures varied depending on the sub-sector (e.g., some variations in meat/poultry as outlined by Waltenburg et al (2020)), it can be implied that ethnic minority workers were at greater risk of contracting COVID-19. Some of these papers also highlighted the proportion of non-white workers in the industry, with Kotsiou et al (2020) finding that the food production sector in Greece had the highest number of foreign workers.

Transport

Transport was identified as a risk factor in 4 of the papers. The main finding related to transport was that many individuals working in the food processing sector were likely to travel to and from work with people from different households, hence increasing the risk of transmission. However, this factor was not analysed in much depth in these papers, suggesting that the evidence behind this may be lacking. For example, Anand et al (2020) concluded that there was "some, often weaker, evidence that income, car ownership, used of a shared kitchen, university degree type (…) are predictors of COVID-19 transmission", suggesting more evidence is required when referring to transport as a risk factor for transmission.

Shared accommodation

This was only identified as a risk factor in one of the papers (Mallet et al, 2021) and was found to be more common for foreign-born workers.

Temporary workers

Mallet et al (2021) found that the majority of COVID-19 cases found were amongst employees that were employed by subcontracting companies or were temporary workers. Steinberg et al (2020) also found that cases were highest amongst nonsalaried employees, as salaried employees were more likely to work in low-risk areas of the site (Steinberg et al, 2020).

Income and sick pay

The impact of income/lack of sick pay on the risk of COVID-19 was not analysed in many papers. However, Aday and Aday (2020), Moore et al (2021) and Anand et al (2020) found some significant links. For example, there was some evidence suggesting that the majority of workers in the food manufacturing sector have a lower income and do not have health insurance / paid sick leave, a factor that suggests workers are more likely to go to work even when they are feeling unwell/experiencing COVID-19 symptoms (Aday and Aday, 2020). Anand et al (2020) also found that

workers in the lowest household income groups were at higher risk of COVID-19 infection within both the USA and UK, though they noted that this evidence was “weak” (Anand et al, 2020). Alternatively, Moore et al’s (2021) findings showed that changes were made for workers’ sick pay entitlements in the UK food manufacturing sector during the course of the pandemic, (see table 3).

Environmental factors

Environmental factors, such as poor ventilation and cold and humid environments inside food-processing facilities, may be associated with increased transmission of COVID-19, as findings referenced by Aday and Aday (2020), which referred to Chin et al’s (2020) study on COVID-19 stability in different environmental conditions. Chin et al (2020) found that SARS-CoV-2 is highly stable at 4 °C, but sensitive to heat, suggesting that workers placed in areas with such temperature levels may be at higher risk of COVID-19 transmission.

Günther et al (2020) also found in their outbreak investigation of a German meat processing plant that certain environmental conditions mixed with a lack of social distancing between workers, created further aerosol transmission. They also found that the transmission of the virus could occur over distances of at least 8 metres in conditions with low air exchange and high rates of recirculated unfiltered air (Günther et al 2020). Other studies, such as Mallet et al (2021) and Steinberg et al (2020) also found that groups of people who were placed in certain areas of the workplace were more likely to test positive for COVID-19. In particular, they found that cases were highest in areas such as the deboning and cutting departments, as they were also areas where social distancing was less likely to be maintained.

Which preventative measures/ risk mitigation strategies have been taken to reduce COVID-19 in the food production sector, and which have shown to be effective?

Several studies found in this literature review focused on preventative measures/risk mitigation strategies in helping to reduce COVID-19 transmission in different areas of the food production sector. Summaries of each of the risk mitigation strategies and their effectiveness can be seen in table 4 .

Table 4: summary of main risk mitigations found in the literature

Risk Mitigation	**Findings**
Testing/screening	• Rapid antigen testing plays crucial role in providing infection control within different occupations and should be offered to all workers regularly. However, this can also produce limitations such as false negatives/false positive tests and fear/stigma of positive COVID-19 cases Kotsiou et al (2020). • Increase in uptake of visitor screenings at food production sites is essential for visitors, service providers, suppliers, delivery drivers, pest control etc (Nakat and Bou-Mitri, 2021) (Aday and Aday, 2020). • While transmission slowed amongst all the pork processing plants when routine PCR testing was put into place, it was mainly due to other biosafety measures employed at different plants, along with the possibility of herd immunity within the workforces (VanderWaal et al 2021).
Ventilation	• Increasing the number of air exchanges per hour and installing high efficiency particulate air (HEPA) filtration should be considered as one of the “most effective engineering control for COVID-19 (although) more study is needed on aerosol transmission dynamics in this setting” (Herstein et al., 2021). • EU food hygiene legislation requires that meat cutting rooms are maintained at a temperature of <12°C. However, it is important to research if meat cutting could be performed in rooms operated at a higher ambient temperature without compromising on food safety. Where possible, carbon dioxide concentrations should also routinely be used (Walshe et al, 2021). • Ventilation should be maximised within indoor work settings, as SARS-CoV-2 transmission can occur in a crowded and poorly ventilated space where viral concentrations within the room may

Risk Mitigation	Findings
	raise to levels similar to that of exhaled air by COVID-19 patients (Zuber and Brüssow, 2020). However, this was not analysed in a food production setting.
Sick pay	• Offering sick pay and flexible working schedules for workers is essential and can help reduce the racial disparities between ethnic minority workers and white workers that can currently be seen in the number of COVID-19 cases within the food sector Bui et al (2020).
Social distancing	• Incidence of COVID-19 cases reduced in 62% of studied meat processing facilities after the adoption of universal masking and physical barrier interventions. However, while physical barriers may help limit spread, the low temperatures and limited fresh air supply in meat processing factories could facilitate longer-range aerosol transmission, hence increasing risk of infection amongst workers (Herstein et al, 2021). • Separating employees with a minimum of 1-2 metre space were found by Nakat and Bou-Mitri (2021) and Zuber and Brussow (2020) as effective ways of limiting the spread of COVID-19. • Facilities should consider reducing work hours, rotating shifts and placing workers into bubbles so that more social distancing and better tracking of cases can take place (Aday and Aday, 2020).
Adequate hygiene practices	• Nakat and Bou Mitri (2021) and Rizou et al (2020) recommended laundry cleaning clothes after work shifts, identifying and disinfecting high-touch surfaces in the food facilities. Studies they reviewed also recommended minimising tool sharing and disinfecting equipment multiple times in a shift for items that must be shared/used by more than one person. • Frequent hand washing is essential (Bui et al 2020).
PPE	• The implementation of face masks in meat-processing facilities would only work if further education was also provided to employees on the topic (Herstein et al 2021). • Use of face masks should be considered as a complementary measure and not as a replacement for established preventative measures (Zuber and Brüssow, 2020). • Protecting workers with PPE is generally considered the least effective type of control in COVID-19 risk assessments, but can be helpful in reducing the spread of both cross-infection and cross-contamination (Nakat and Bou-Mitri 2021) • 25% of workers reported that their employer had not provided sufficient PPE in March/April 2020, while some managers also stated that they did not believe sufficient PPE was available in their workplace during this time. One in five workers reported that during this time, their employer had introduced insufficient social distancing measures, though there were reports of this improving over time (Moore et al., 2021).
Other	• Educational risk mitigation strategies, in the form of posters (in several languages), explanation of COVID-19 symptoms, information about isolating and ensuring risk mitigation is also controlled in the community can all help significantly reduce COVID-19 outbreaks and cases in Meat processing plants (Walshe et al, 2021).

According to the Hierarchy of Controls in occupational health, eliminating the source of hazards (in this case COVID-19) and/or substitution of the hazard are some of the most effective ways of eliminating the hazards/risk, while actions and measures which rely on an individuals' behaviour are often seen as the least reliable way of limiting risk (CDC, 2015). In this case, it can be implied that risk mitigation strategies such as adequate screening/testing for COVID-19, and providing generous sick leave for individuals who have symptoms, may be some of the most effective preventative measures

for individuals in the food processing sector, as they are both measures which can physically remove the hazard. Nevertheless, while factors such as elimination and substitution are the most effective at reducing hazards, they also tend to be the most difficult to implement in an existing process. This was found in papers focusing on the risk mitigation measures mentioned, with Aday and Aday (2020) suggesting that regular testing/screening, though effective, can be expensive and time-consuming . Similarly, VanderWaal et al (2021) found that frequent testing may not always prevent a large outbreak within food-processing workforces, given that the number of cases could be related to other factors, including community exposure/outbreaks.

Another effective control outlined in the hierarchy is engineering controls. Ventilation could fall under this category and can reduce the risk of far-field transmissions. While increasing effective ventilation in food processing settings could be more expensive, it can be more cost-effective in the long run due to the growing evidence that increasing ventilation can substantially reduce far-field COVID-19 transmission (Herstein et al, 2020).

Other risk mitigation strategies listed, such as respiratory protective equipment (RPE) and face coverings, social distancing and adequate hygiene practice, would likely fall at the bottom of the hierarchy as they require individuals to change the way they work and use RPE and face coverings adequately. While studies did outline the importance of providing adequate RPE face coverings to workers and ensuring social distancing is in place, there were some limitations and problems which could still be associated with them. For example, Herstein et al (2020) concluded that while wearing face masks is one of the most effective tools in reducing COVID-19 transmission, the effectiveness of a universal mask policy would only work if workers are being educated and adhering to proper mask use. They also stated that while physical barriers and social distancing may help reduce near-field transmissions, the low temperatures and limited fresh air supply in meat processing factories could facilitate longer-range aerosol transmission, hence increasing the risk of infection amongst workers regardless (Herstein et al, 2020). Similarly, papers focusing on hygiene practices, such as wiping high touch surfaces and regular cleaning regimes, were mainly drawn from grey literature and online reports that focused on COVID-19 prevention as a whole, rather than focusing on the food production sector. Similarly, the literature referenced did not include any which analysed the efficacy of these preventative measures within different areas of the food production sector.

It is clear that various strategies must be adopted in preventing infection, rather than the adoption of just one of these risk mitigation methods. Herstein et al (2021) state that challenges in the meat processing facilities cannot be addressed with only one or two measures, but rather require multi-layered interventions that target a range of strategies in reducing the transmission of COVID-19. Nakat and Bou-Mitri (2021) also emphasised the importance of hand-washing alongside all other preventative methods, along with further training and effective communication between employers and workers in food facilities/factories. Of all the studies focusing on prevention, only one study actively studied the risk mitigation strategies used at a site to assess the effectiveness of each measure in the setting (Walshe et al, 2021). By analysing these risk mitigation strategies, they found that the site was able to effectively control the spread of the virus once guidance from public health authorities were adapted and optimised to fit the needs of the site, particularly by plant emergency response teams (Walshe et al, 2021).

DISCUSSION

This review provides an up-to-date overview of the evidence of SARS-CoV-2 transmission, risk factors and prevention in the food sector. While it has given insightful information, a number of key gaps have been identified: (1) there remains a lack of evidence on the level of COVID-19 transmission and risk of infection within the food sector that is UK specific; 2) a very small number of studies have focused on transmission levels and cases found in the different areas of the food sector, with the majority focusing on various occupations at the same time, particularly shifting their focus onto perceived “higher risk” jobs, such as those in the healthcare and education sectors; 3) most studies analysing the transmission levels within the food sector did not include any personal accounts from staff members and managers and predominately used quantitative methodologies; 4) existing food production sector-specific studies mainly focused on meat/poultry facilities and 5) while there were studies highlighting the specific risk factors and the mitigation measures that can be taken, there remains little evidence on how these measures and factors have been used by different areas of the

food production sector. Therefore, it is difficult to establish the efficacy of the preventative measures highlighted.

CONCLUSION

In summary, there was some evidence showing high transmission of SARS-CoV-2 within the food sector including the risk factors associated with the spread, and the suggested preventative measures to be taken. While many studies did not only focus on the food processing sector as a whole, the ones that did found that individuals working in this industry were at significantly high risk of COVID-19 infection. In particular, there were high infection rates and outbreaks reported for various meat/poultry sites across the USA. Some risk factors associated with transmission included non-white ethnicity, and environmental factors such as cold and humid environments, lack of social distancing and poor ventilation. Various risk mitigation strategies were also outlined for the sector, including social distancing, cleaning and disinfecting high-touch areas, enhancement of ventilation and providing more community and work-based testing. There remains a lack of strong evidence behind the risk associated with sharing accommodation/transport to and from work. Similarly, many of the prevention methods outlined were recommended through general COVID-19 risk assessments provided by various organisations, rather than preventative measures that were analysed within the food production sector specifically.
Further research focusing on the application of suggested mitigation measures and their efficacy is needed to understand which methods work well in the sector. Similarly, more qualitative research would help in identifying key gaps and providing in-depth information regarding enablers and barriers to transmission, risk factors and mitigation. Finally, research focusing on extracting varied information on the levels of transmission and risk factors is required across all areas of the food production sector, as this likely varies by each type of facility, sub-sector and geographical area.

REFERENCES

- Aday, S., Aday, M.S., 2020. Impact of COVID-19 on the food supply chain. Food Qual. Saf. 4, 167–180. https://doi.org/10.1093/fqsafe/fyaa024
- Agius, R.M., Robertson, J.F.R., Kendrick, D., Sewell, H.F., Stewart, M., McKee, M., 2020. Covid-19 in the workplace. BMJ 370, 1. https://doi.org/10.1136/bmj.m3577
- Anand, P., Allen, H., Ferrer, R., Gold, N., Gonzales Martinez, R.M., Kontopantelis, E., Krause, M., Vergunst, F., 2020. Work-related and Personal Predictors of COVID-19 Transmission (preprint). Epidemiology. https://doi.org/10.1101/2020.07.13.20152819
- Billingsley, S., Brandén, M., Aradhya, S., Drefahl, S., Andersson, G. and Mussino, E., 2021. COVID-19 mortality across occupations and secondary risks for elderly individuals in the household: A population register-based study. *Scandinavian Journal of Work & Environmental Health*, [online] p.9. Available at: <https://www.sjweh.fi/article/3992> [Accessed 26 October 2021].
- Bui, D.P., McCaffrey, K., Friedrichs, M., LaCross, N., Lewis, N.M., Sage, K., Barbeau, B., Vilven, D., Rose, C., Braby, S., Wilardson, S., Carter, A., Smoot, C., Winquist, A., Dunn, A., 2020. Racial and Ethnic Disparities Among COVID-19 Cases in Workplace Outbreaks by Industry Sector — Utah, March 6–June 5, 2020. MMWR Morb. Mortal. Wkly. Rep. 69. https://doi.org/10.15585/mmwr.mm6933e3
- CDC.gov. 2015. Hierarchy of Controls, NIOSH, CDC. [online] available at: <https://www.cdc.gov/niosh/topics/hierarchy/default.html>[Accessed 19 October 2021].
- Chen, Y.-H., Glymour, M., Riley, A., Balmes, J., Duchowny, K., Harrison, R., Matthay, E., Bibbins-Domingo, K., 2021a. Excess mortality associated with the COVID-19 pandemic among Californians 18–65 years of age, by occupational sector and occupation: March through October 2020. Occupational and Environmental Health. https://doi.org/10.1101/2021.01.21.21250266
- Chen, Y., Aldridge, T., UK COVID-19 National Core Studies Consortium, Claire F, C. and Khaw, F., 2021b. COVID-19 outbreak rates and infection attack rates associated with the workplace: a descriptive epidemiological study. *medRxiv*, p.19.
- Dyal, J.W., Grant, M.P., Broadwater, K., Bjork, A., Waltenburg, M.A., Gibbins, J.D., Hale, C., Silver, M., Fischer, M., Steinberg, J., Basler, C.A., Jacobs, J.R., Kennedy, E.D., Tomasi, S.,

Trout, D., Hornsby-Myers, J., Oussayef, N.L., Delaney, L.J., Patel, K., Shetty, V., Kline, K.E., Schroeder, B., Herlihy, R.K., House, J., Jervis, R., Clayton, J.L., Ortbahn, D., Austin, C., Berl, E., Moore, Z., Buss, B.F., Stover, D., Westergaard, R., Pray, I., DeBolt, M., Person, A., Gabel, J., Kittle, T.S., Hendren, P., Rhea, C., Holsinger, C., Dunn, J., Turabelidze, G., Ahmed, F.S., deFijter, S., Pedati, C.S., Rattay, K., Smith, E.E., Luna-Pinto, C., Cooley, L.A., Saydah, S., Preacely, N.D., Maddox, R.A., Lundeen, E., Goodwin, B., Karpathy, S.E., Griffing, S., Jenkins, M.M., Lowry, G., Schwarz, R.D., Yoder, J., Peacock, G., Walke, H.T., Rose, D.A., Honein, M.A., 2020. COVID-19 Among Workers in Meat and Poultry Processing Facilities - 19 States, April 2020. MMWR Morb. Mortal. Wkly. Rep. 69. https://doi.org/10.15585/mmwr.mm6918e3

- Gorbalenya, A.E., Baker, S.C., Baric, R.S., de Groot, R.J., Drosten, C., Gulyaeva, A.A., Haagmans, B.L., Lauber, C., Leontovich, A.M., Neuman, B.W., Penzar, D., Perlman, S., Poon, L.L.M., Samborskiy, D., Sidorov, I.A., Sola, I., Ziebuhr, J., 2020. Severe acute respiratory syndrome-related coronavirus: The species and its viruses – a statement of the Coronavirus Study Group (preprint). Microbiology. https://doi.org/10.1101/2020.02.07.937862
- Günther, T., Czech-Sioli, M., Indenbirken, D., Robitaille, A., Tenhaken, P., Exner, M., Ottinger, M., Fischer, N., Grundhoff, A., Brinkmann, M.M., 2020. SARS-CoV-2 outbreak investigation in a German meat processing plant. EMBO Mol. Med. 12, 10. https://doi.org/10.15252/emmm.202013296
- Herstein, J.J., Degarege, A., Stover, D., Austin, C., Schwedhelm, M.M., Lawler, J.V., Lowe, J.J., Ramos, A.K., Donahue, M., 2021. Early Release - Characteristics of SARS-CoV-2 Transmission among Meat Processing Workers in Nebraska, USA, and Effectiveness of Risk Mitigation Measures - Volume 27, Number 4—April 2021 - Emerging Infectious Diseases journal - CDC. https://doi.org/10.3201/eid2704.204800
- Hiironen, I., Saavedra-Campos, M., Panitz, J., Ma, T., Nsonwu, O., Charlett, A., Hughes, G., Oliver, I., 2020. Occupational exposures associated with being a COVID-19 case; evidence from three case-controls studies (preprint). Public and Global Health. https://doi.org/10.1101/2020.12.21.20248161
- House, H., Vakkalanka, J., Behrens, N., De Haan, J., Halbur, C., Harrington, E., Patel, P., Rawwas, L., Camargo, C. and Kline, J., 2021. Agricultural workers in meatpacking plants presenting to an emergency department with suspected COVID-19 infection are disproportionately Black and Hispanic. *Academic Emergency Medicine*, 28(9), pp.1012-1018.
- Kotsiou, O.S., Pantazopoulos, I., Papagiannis, D., Fradelos, E.C., Kanellopoulos, N., Siachpazidou, D., Kirgou, P., Mouliou, D.S., Kyritsis, A., Kalantzis, G., Saharidis, G.K.D., Tzounis, E., Gourgoulianis, K.I., 2021. Repeated Antigen-Based Rapid Diagnostic Testing for Estimating the Coronavirus Disease 2019 Prevalence from the Perspective of the Workers' Vulnerability before and during the Lockdown. Int. J. Environ. Res. Public. Health 18. https://doi.org/10.3390/ijerph18041638
- Mallet, Y., Pivette, M., Revest, M., Angot, E., Valence, M., Dupin, C., Picard, N., Brelivet, G., Seyler, T., Ballet, S., Le Tertre, A. and Guillois, Y., 2021. Identification of Workers at Increased Risk of Infection During a COVID-19 Outbreak in a Meat Processing Plant, France, May 2020. *Food and Environmental Virology*, 13(4), pp.535-543.
- Moore, S., Ball, C., Cai, M., 2021. Research into Covid-19 workplace safety outcomes in the food and drinks sector 59.
- Morawska, L., Milton, D.K., 2020. It Is Time to Address Airborne Transmission of Coronavirus Disease 2019 (COVID-19). Clin. Infect. Dis. ciaa939. https://doi.org/10.1093/cid/ciaa939
- Mutambudzi, M., Niedwiedz, C., Macdonald, E.B., Leyland, A., Mair, F., Anderson, J., Celis-Morales, C., Cleland, J., Forbes, J., Gill, J., Hastie, C., Ho, F., Jani, B., Mackay, D.F., Nicholl, B., O'Donnell, C., Sattar, N., Welsh, P., Pell, J.P., Katikireddi, S.V., Demou, E., 2020. Occupation and risk of severe COVID-19: prospective cohort study of 120 075 UK Biobank participants. Occup. Environ. Med. https://doi.org/10.1136/oemed-2020-106731
- Nafilyan, V., Pawelek, P., Ayoubkhani, D., Rhodes, S., Pembrey, L., Matz, M., Coleman, M., Allemani, C., Windsor-Shellard, B., van Tongeren, M. and Pearce, N., 2021. Occupation and COVID-19 mortality in England: a national linked data study of 14.3 million adults. *Occupational and Environmental Medicine*, pp.oemed-2021-107818.
- Nakat, Z., Bou-Mitri, C., 2021. COVID-19 and the food industry: Readiness assessment. Food Control 121, 107661. https://doi.org/10.1016/j.foodcont.2020.107661

- Office for National Statistics, 2021. Coronavirus (COVID-19) related deaths by occupation, England and Wales - Office for National Statistics (9 March and 28 December 2020) [WWW Document]. URL https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/causesofdeath/datasets/coronaviruscovid19relateddeathsbyoccupationenglandandwales (accessed 4.13.21).
- Pascarella, G., Strumia, A., Piliego, C., Bruno, F., Buono, R.D., Costa, F., Scarlata, S., Agrò, F.E., 2020. COVID-19 diagnosis and management: a comprehensive review. J. Intern. Med. 288, 192–206. https://doi.org/10.1111/joim.13091
- Rizou, M., Galanakis, I.M., Aldawoud, T.M.S., Galanakis, C.M., 2020. Safety of foods, food supply chain and environment within the COVID-19 pandemic. Trends Food Sci. Technol. 102, 293–299. https://doi.org/10.1016/j.tifs.2020.06.008
- Rubenstein, B.L., Campbell, S., Meyers, A.R., Crum, D.A., Mitchell, C.S., Hutson, J., Williams, D.L., Senesie, S.S., Gilani, Z., Reynolds, S., Alba, B., Tavitian, S., Billings, K., Saintus, L., Martin, S.B., Mainzer, H., 2020. Factors That Might Affect SARS-CoV-2 Transmission Among Foreign-Born and U.S.-Born Poultry Facility Workers - Maryland, May 2020. MMWR Morb. Mortal. Wkly. Rep. 69, 1906–1910. https://doi.org/10.15585/mmwr.mm6950a5
- Steinberg, J., Kennedy, E., Basler, C., Grant, M., Jacobs, J., Ortbahn, D., Osburn, J., Saydah, S., Tomasi, S. and Clayton, J., 2020. COVID-19 Outbreak Among Employees at a Meat Processing Facility — South Dakota, March–April 2020. *MMWR. Morbidity and Mortality Weekly Report*, 69(31), pp.1015-1019.
- The Lancet, 2020. The plight of essential workers during the COVID-19 pandemic. Lancet Lond. Engl. 395, 1587. https://doi.org/10.1016/S0140-6736(20)31200-9
- The national COVID-19 outbreak monitoring group, 2020. COVID-19 outbreaks in a transmission control scenario: challenges posed by social and leisure activities, and for workers in vulnerable conditions, Spain, early summer 2020. Eurosurveillance 25. https://doi.org/10.2807/1560-7917.ES.2020.25.35.2001545
- VanderWaal, K., Black, L., Hodge, J., Bedada, A. and Dee, S., 2021. Modeling transmission dynamics and effectiveness of worker screening programs for SARS-CoV-2 in pork processing plants. *PLOS ONE*, 16(9), p.e0249143.
- Walshe, N., Fennelly, M., Hellebust, S., Wenger, J., Sodeau, J., Prentice, M., Grice, C., Jordan, V., Comerford, J., Downey, V., Perrotta, C., Mulcahy, G. and Sammin, D., 2021. Assessment of Environmental and Occupational Risk Factors for the Mitigation and Containment of a COVID-19 Outbreak in a Meat Processing Plant. *Frontiers in Public Health*, 9.
- Waltenburg, M.A., Rose, C.E., Victoroff, T., Butterfield, M., Dillaha, J.A., Heinzerling, A., Chuey, M., Fierro, M., Jervis, R.H., Fedak, K.M., Leapley, A., Gabel, J.A., Feldpausch, A., Dunne, E.M., Austin, C., Pedati, C.S., Ahmed, F.S., Tubach, S., Rhea, C., Tonzel, J., Krueger, A., Crum, D.A., Vostok, J., Moore, M.J., Kempher, H., Scheftel, J., Turabelidze, G., Stover, D., Donahue, M., Thomas, D., Edge, K., Gutierrez, B., Berl, E., McLafferty, M., Kline, K.E., Martz, N., Rajotte, J.C., Julian, E., Diedhiou, A., Radcliffe, R., Clayton, J.L., Ortbahn, D., Cummins, J., Barbeau, B., Carpenter, S., Pringle, J.C., Murphy, J., Darby, B., Graff, N.R., Dostal, T.K.H., Pray, I.W., Tillman, C., Rose, D.A., Honein, M.A., 2021. Coronavirus Disease among Workers in Food Processing, Food Manufacturing, and Agriculture Workplaces - Volume 27, Number 1—January 2021 - Emerging Infectious Diseases journal - CDC. https://doi.org/10.3201/eid2701.203821
- WHO, 2020. Getting your workplace ready for COVID-19: How COVID-19 spreads.
- Zuber, S., Brüssow, H., 2020. COVID 19: challenges for virologists in the food industry. Microb. Biotechnol. 13, 1689–1701. https://doi.org/10.1111/1751-7915.13638

APPENDIX

COVID-19 search terms	Food production terms	Transmission, Risk and Prevention terms
"coronavirus"[MeSH] OR "coronavirus infections"[MeSH Terms] OR "coronavirus"[All Fields] OR "covid 2019"[All Fields] OR "SARS-CoV-2"[All Fields] OR "SARS-CoV-19"[All Fields] OR "severe acute respiratory syndrome coronavirus 2" [supplementary concept] OR “coronavirus infection”[All Fields] OR “2019ncov”[All Fields] OR “sars cov2”[All Fields] OR “cov22”[All Fields] OR “covid-19”[All Fields] OR “covid19”[All Fields] OR "corona virus"[All Fields]	“food sector” OR “food processing” OR “food processing factor*” OR ”food factories” OR “food processing*” OR “food site” OR “food industry” OR “food processing facilit*” OR “food production” OR “food and drink manufacturing” OR “food and drink factor*” OR “plant” OR “factory plant” OR “meat processing*” OR “meat worker*” OR “meat factor*” OR “food worker*” OR “plant worker*” OR “factory worker”	“transmission” OR “transmission routes” OR “spread” OR “case*” OR “prevalence” OR “incidence” OR “mortality” AND “risk*” AND “prevention” OR “preventative*”

Appendix 5. Presentation at webinar: Food manufacturing: a high-risk environment for COVID-19 virus transmission?

PROTECT

A COVID-19 National Core Study

An interdisciplinary examination of risks and experiences of Covid-19 in the food and drink processing sector

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Special thanks

Our participants from the Food and Drink Processing Sector – we appreciate your time and effort during a challenging time

Research team:

- Tony Fletcher, Lucy Pembrey, Paniz Hosseini, Neil Pearce (London School of Hygiene and Tropical Medicine)
- Will Mueller, Rebecca Canham, Alice Davis, Katie Clabon, Mark Cherrie (Institute of Occupational Medicine)
- Sarah Rhodes, Martie van Tongeren (University of Manchester)

Review of Food/Drink Processing Sector Risks

Currently very limited literature on the UK food/drink processing sector Covid-19 risks

Most from the United States, esp. meat/poultry processing facilities and plants

Various risk factors were also found to elevate COVID-19 infection and mortality rates in the sector:

- **Ethnicity:** ethnic minorities more disproportionately effected
- **Environmental factors**: poor ventilation mixed with a lack of social distancing between workers in food factories more likely to cause further aerosol transmission.
- **Income/sick pay:** majority of workers in the food manufacturing sector have lower income and do not have health insurance / paid sick leave.
- Lack of strong evidence associated with **sharing accommodation/transport** to and from work

Food manufacturing high outbreak rate

Table 6 Number and rate of workplace outbreaks by sector in England, May-Oct 2020

Workplace Setting Type (from HPZone)	Number of Outbreaks	Number of Workplaces (England)	*Outbreak Rate* (per 100,000)
Manufacturers and packers of food	117	6,998	1,672
Warehouses	58	15,058	385
Manufacturers and packers of non-food	195	63,312	308
Retailers	219	195,025	112
First responders/Military sites	57	67,257	85
Distributors and transporters	84	125,414	67
Restaurants and caterers	53	117,836	45
Offices	193	721,351	27
Close contact services	13	52,866	25
No setting type assigned	54	511,071	11
Primary producers	8	93,086	9
Other	266	-	-
Total	1,317	1,969,274	67

From Chen et al. 2021
(https://www.medrxiv.org/content/10.1101/2021.05.06.21256757v1.full.pdf)

Theme 3 Studies

Aim: Understand food/drink processing sector specific risks

Review of literature

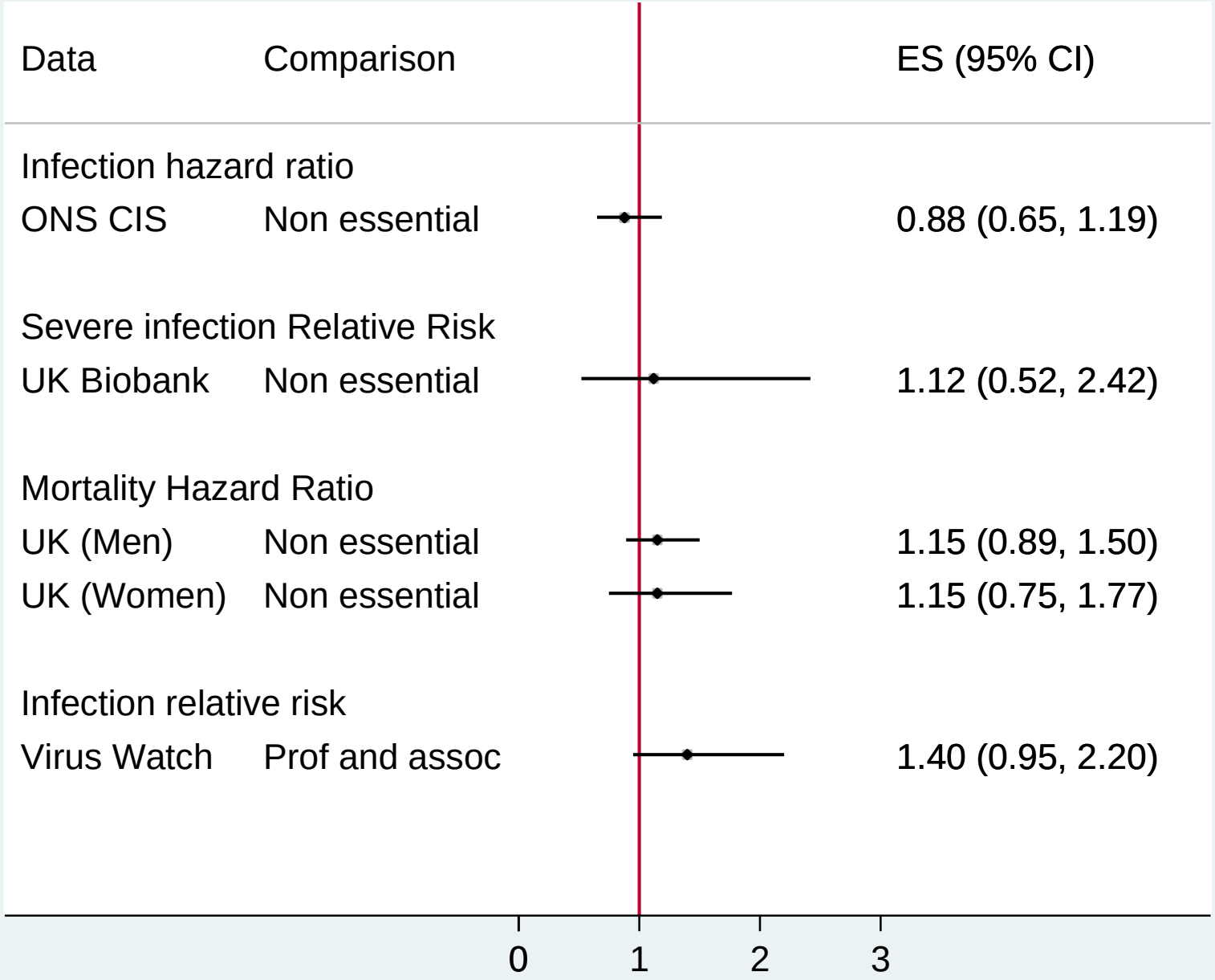
Evaluation of risks based on national statistical data (ONS)

- Are risks elevated relative to other occupations?

Sector and company experiences to understand impacts in more detail

- Quantitative methods (survey)
- Qualitative methods (interviews)

Relative effect of working in food production on Covid-19 outcomes



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Results from ONS infection survey

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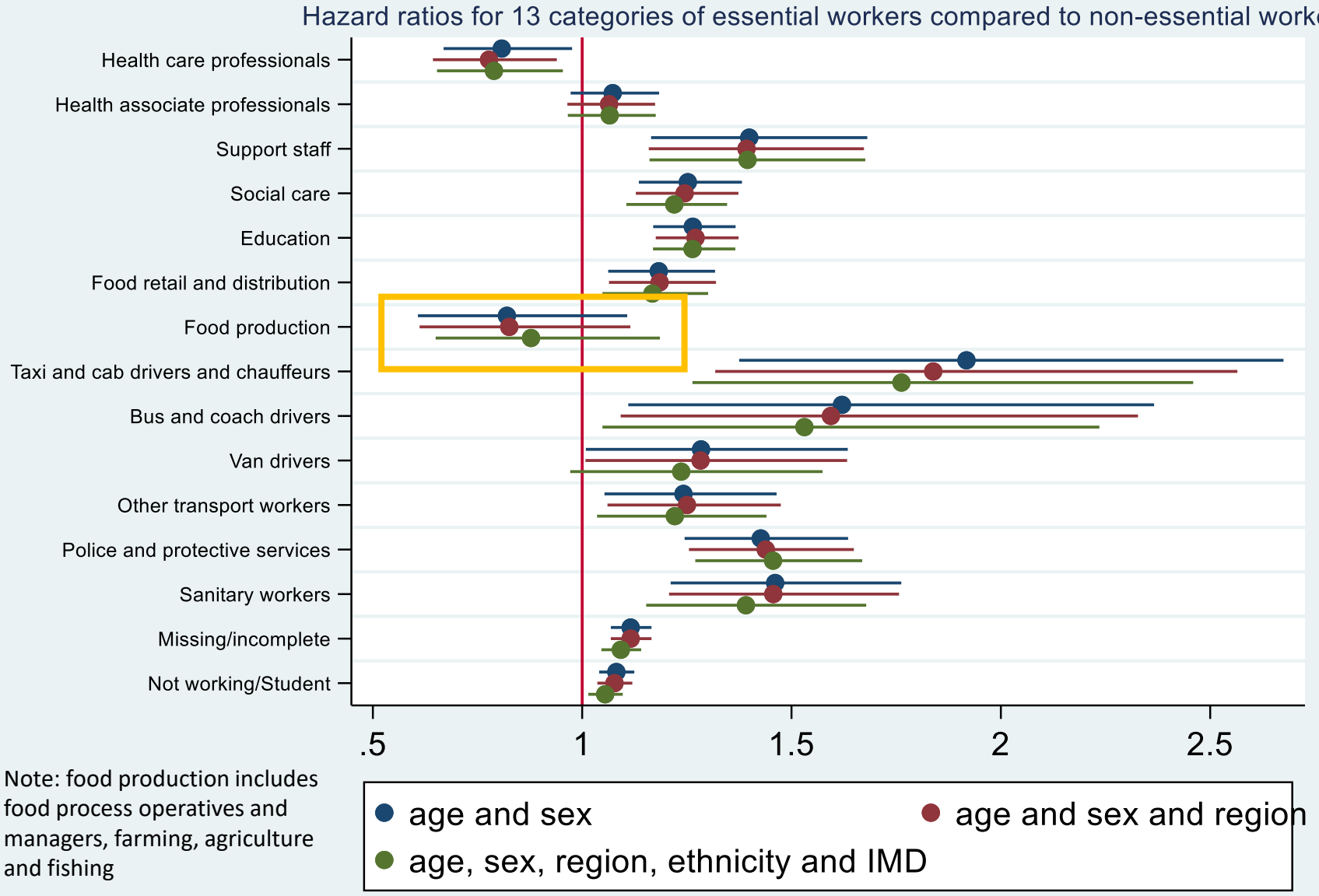
Data from April 2020 to Oct 2021

Cox regression based on first available occupation code, using time to first infection

N=286 990

17 048 events



Note: food production includes food process operatives and managers, farming, agriculture and fishing

What has the sector experienced in practice? How have they mitigated risks?

Covid@Work Study (CAWS)

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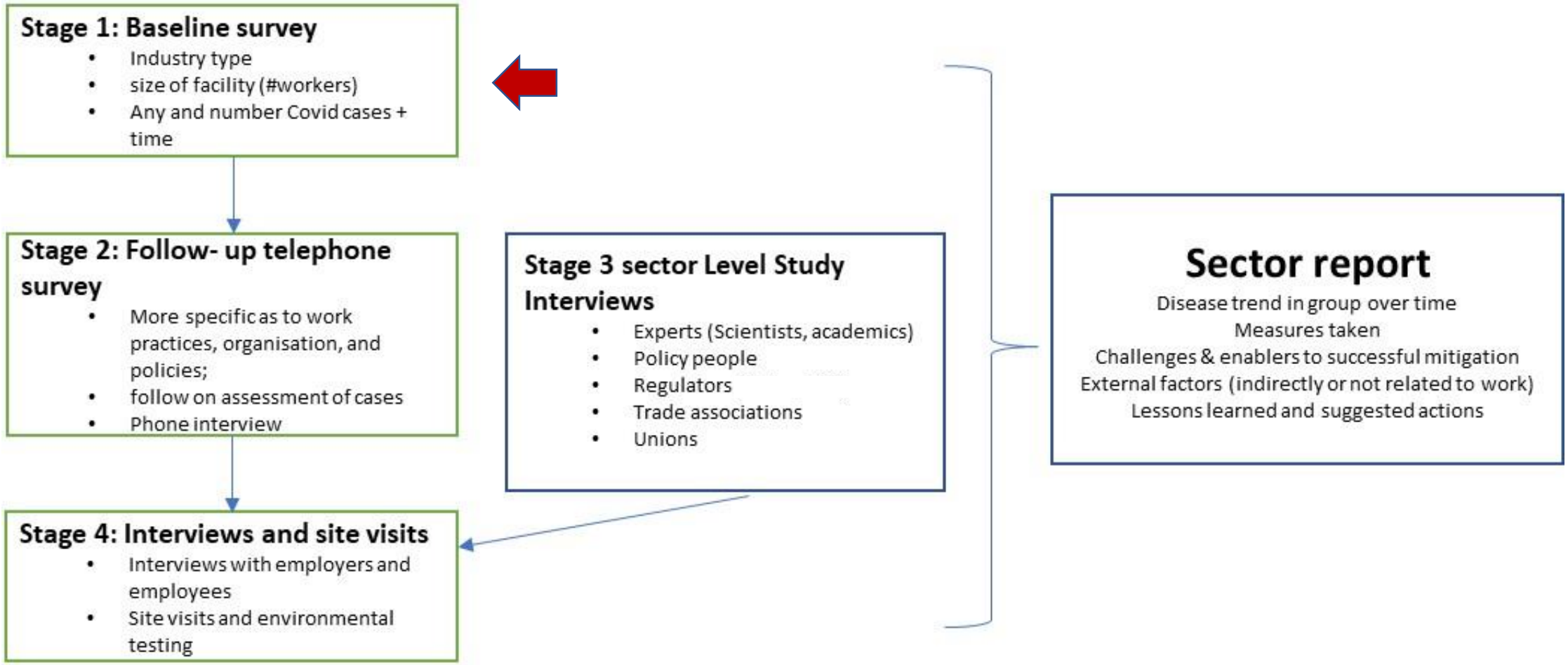
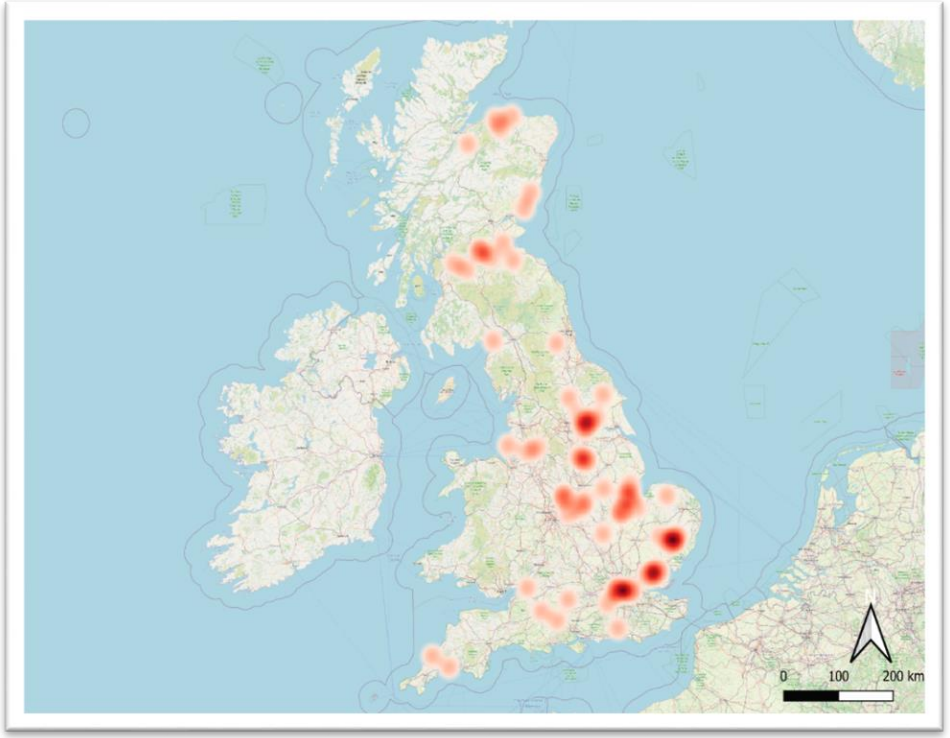


Covid at Work Study (CaWS)

- Online survey
- Site-specific questions on:
  - Number of workers (e.g. remote, furloughed)
  - Workplace features (e.g. ventilation, temperature)
  - Covid-19 cases, isolations, testing regimes
- Discussed with associations to encourage dissemination of survey to members
- Baseline survey:
  - **33 companies** completed the online survey, representing **66 sites** located across the UK
  - Reporting covered March 2020 to Jan/June 2021



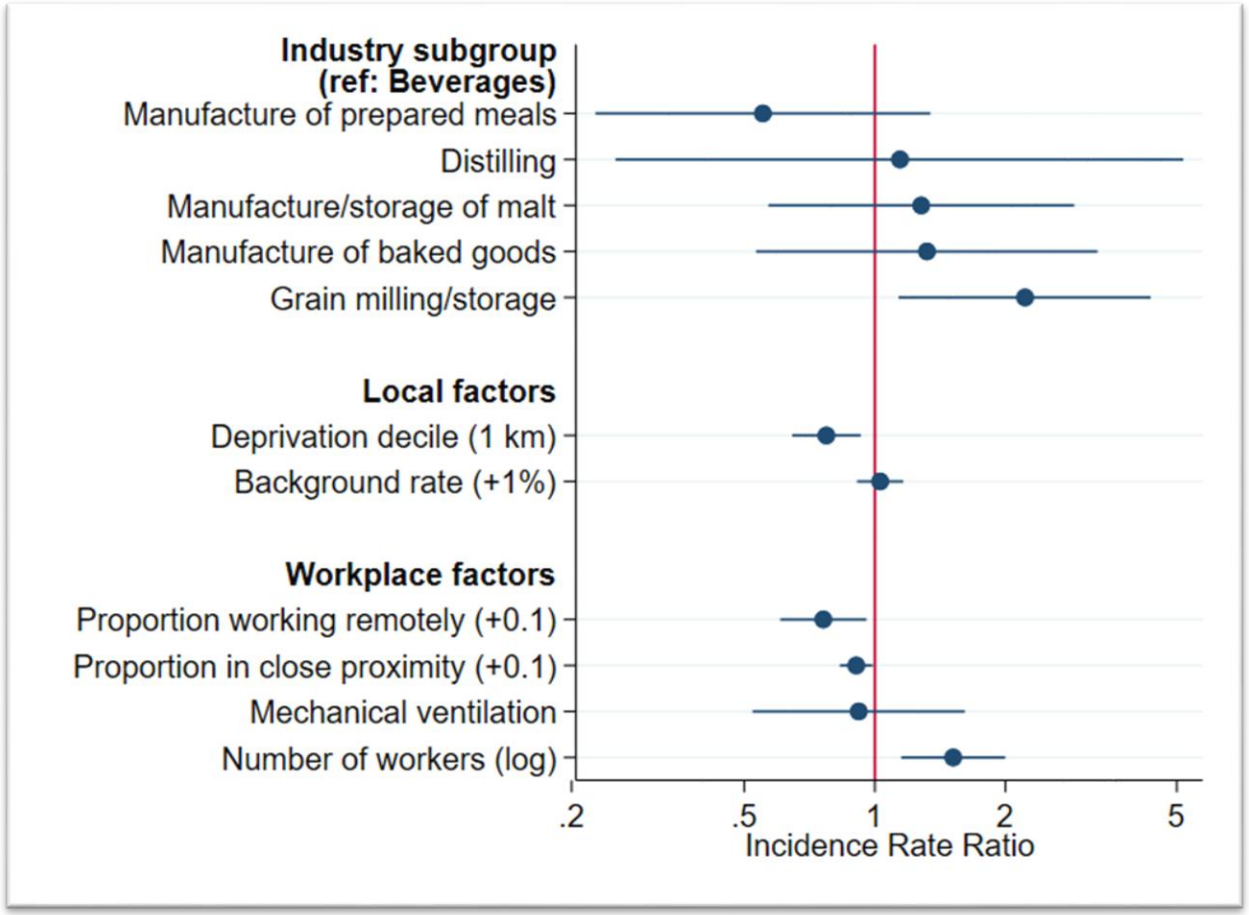
Purpose of sites

- Grain milling/storage (n=16)
- Manufacture/storage of malt (n=14)
- Manufacture of prepared meals (n=12)
- Manufacture of beverages (n= 8)
- Distilling (n= 5)
- Manufacture of baked goods (n= 5)
- Other (n= 6)

Covid at Work Study (CaWS): Baseline

- Key results:
  - n=52 (79%) sites had ≥1 case
  - 1,068 cases across sites (15,563 workers)

  - **Lower** risks with more remote workers and less deprivation (also workers in close proximity)
  - **Increased** risks with number of workers



Covid@Work Study (CAWS)

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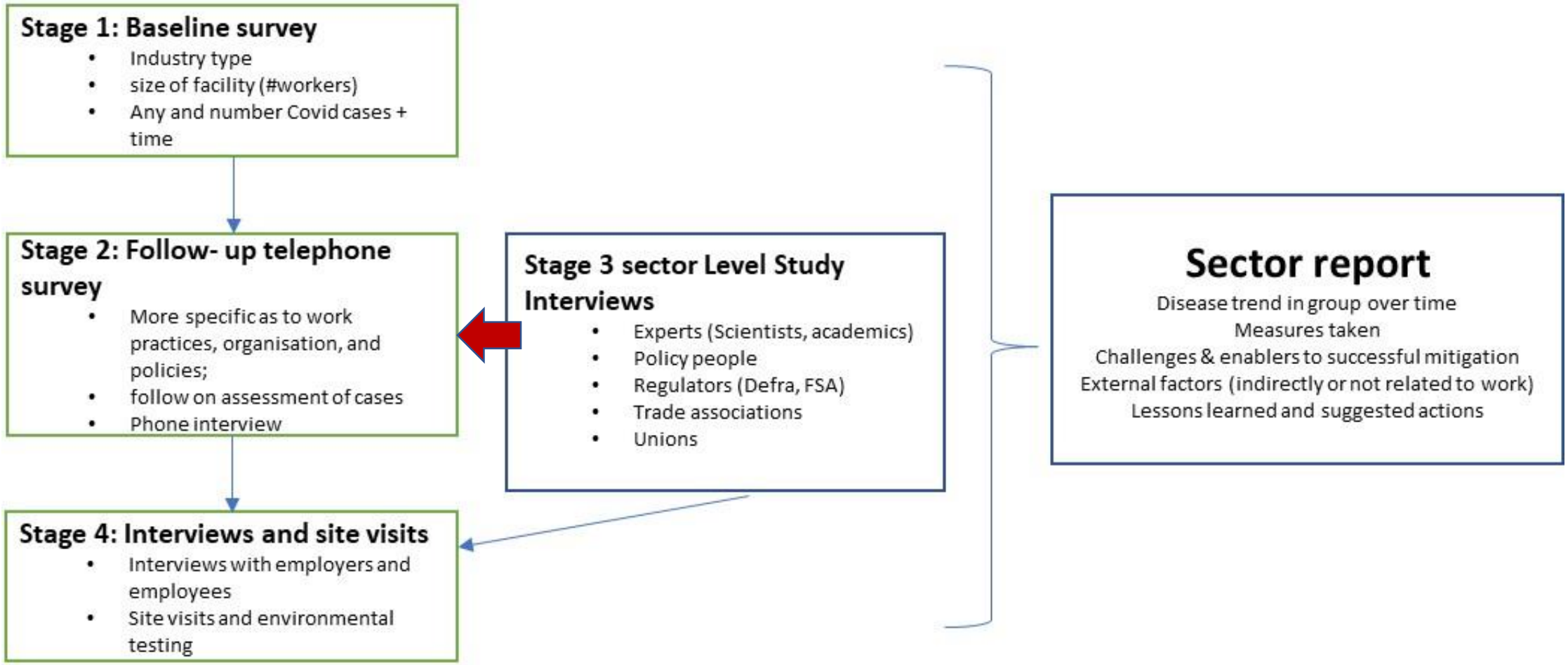
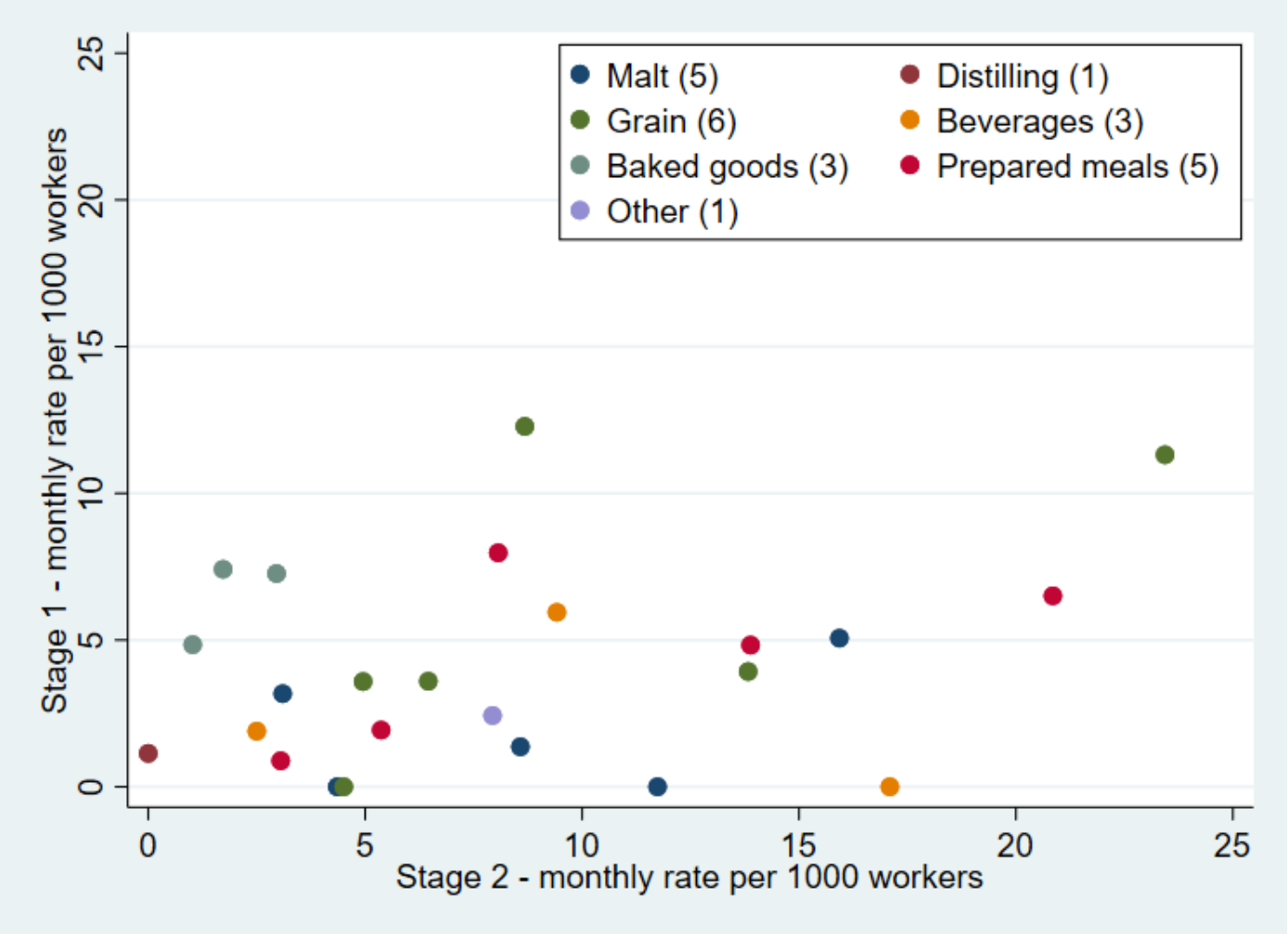


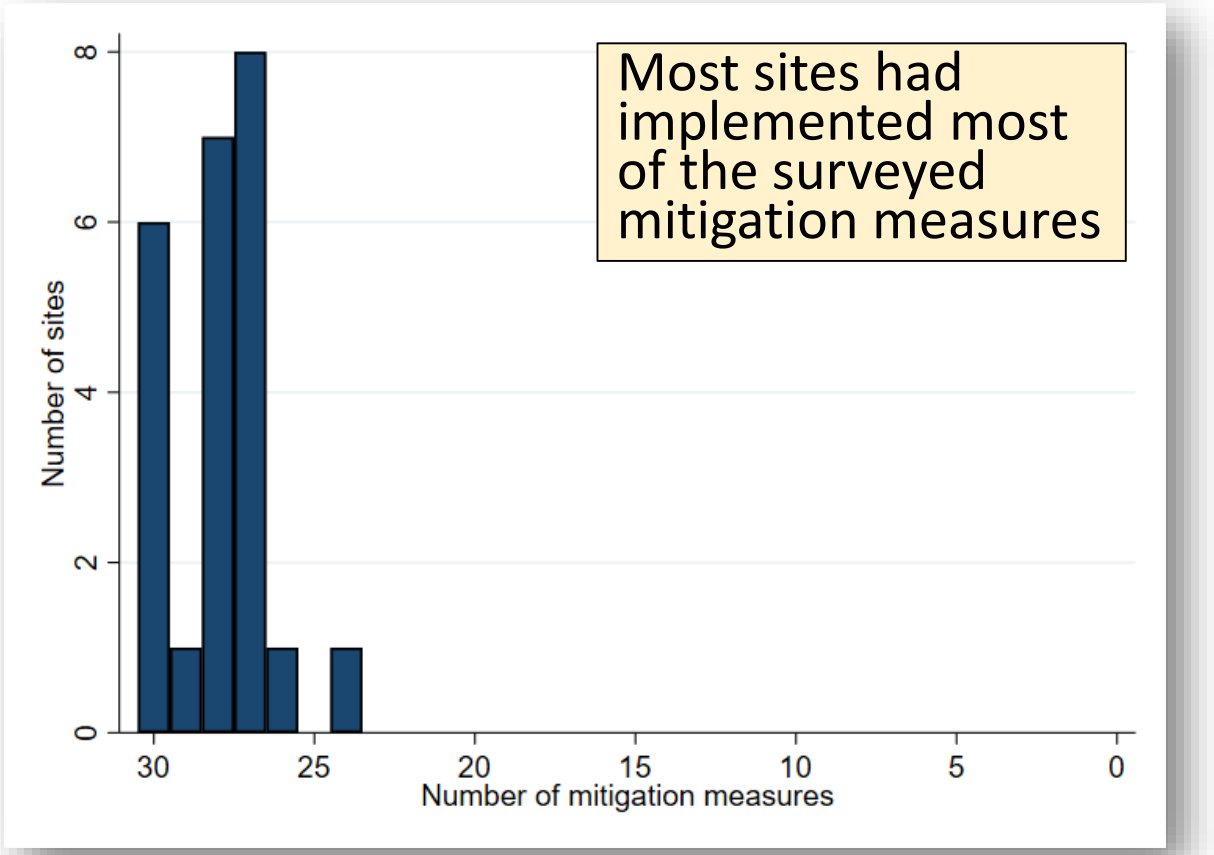
Covid at Work Study (CaWS): Follow-up

- Key results:
  - n=24 sites
  - Follow-up time since stage 1: 6-9 months (Feb-Dec 2021)
  - Overall: **higher** Covid-19 rates compared to baseline



Covid at Work Study (CaWS): Follow-up

- Surveyed mitigation measures included:
  - Physical barriers
  - Floor markings
  - One-way systems
  - Increased workplace cleaning
  - Non-touch options
  - CO_2 monitoring
  - Temperature checks (visitors, staff)
  - Provision of PPE
  - Mental health support
  - Restricted movement around site
  - + 20 more



Covid@Work Study (CAWS)

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Stage 1: Baseline survey

- Industry type
- size of facility (#workers)
- Any and number Covid cases + time

Stage 2: Follow- up telephone survey

- More specific as to work practices, organisation, and policies;
- follow on assessment of cases
- Phone interview

Stage 4: Interviews and site visits

- Interviews with employers and employees
- Site visits and environmental testing

Stage 3 sector Level Study Interviews

- Experts (Scientists, academics)
- Policy people
- Regulators (Defra, FSA)
- Trade associations
- Unions

Sector report

Disease trend in group over time
Measures taken
Challenges & enablers to successful mitigation
External factors (indirectly or not related to work)
Lessons learned and suggested actions

What did we do?

21 Semi-structured qualitative interviews

32 individuals across UK based industry stakeholders

(Late August - mid November 2021).

Type of stakeholder	Number of interviews conducted	Number of expert representatives consulted
Government agency/department representatives	7	9
Academics in their respective fields	5	12
Federations/ associations	5	5
Unions	4	6

Thematically analysed using NVivo Software for emergent themes.

What have we learned?

- **Risk factors** for transmission:
  - Requirement for site-based work (inability to work from home);
  - Reliance on manual labor (employing large volumes of people, high speed of production);
  - Proximity to others within the workplace (e.g. production lines);
  - Cold ambient temperatures and humidity
    - chilled factories require large volumes of workers;
    - temperature controls make it difficult to ensure adequate ventilation;
  - Infrastructure of buildings
  - Spread in non-operational environments and shared facilities;
  - Outside of the work environment
- **Risk perception of the industry:**
  - Generally not perceived to be an elevated risk within the FDP industry, relative to other industries;
  - Pre-COVID start point of familiarity with PPE, risk assessments, hygiene standards thought to position the industry well to respond;
  - Similar to other industrial environments that with similar risk factors.

What have we learned?

- **Mitigations** most commonly cited:
  - Cleaning and hygiene practices,
  - social distancing,
  - measures to limit contact (e.g. screens, one-way systems, cohorts, staggering shifts)
  - ventilation,
  - testing and monitoring (surfaces and workers),
  - PPE/face masks
- Levels of compliance perceived to be good generally, but…
  - Social distancing within and outside of operational environments was said to be poor amongst some (academic, union and government agency respondents).

What have we learned?

- Industry **challenges** to responding to the COVID-19 pandemic:
  - Competing priorities for operations (maintaining food supply, animal welfare, food safety and quality, public health);
  - External factors: labor shortages, haulier shortages, EU exit, furlough, interwoven supply chains with other industries (e.g. hospitality), responding to changes in supply and demand;
  - Business challenges including continuing operations, accessing PPE, operational restrictions to change;
  - Worker related challenges (low pay, staff working multiple jobs/across multiple sites, lack of job security, lack of sick pay (initially), large proportion of migrant workers.

Conclusions

Study on occupational risk of infection in food and drink processing sector not much higher that of other essential sectors but possibly more prone to outbreaks

Most facilities cited a similar set of mitigations and found shifting rules across time and space in UK challenging to respond to

Socioeconomic factors pose challenges for response

Uncertain contribution of workplace vs. work-related factors in transmission

Covid + Brexit and supply/labour issues made this a challenging time for industry, may have led to fewer companies willing/able to engage in research

What next?

We have explored a variety of viewpoints from the FDP sector, ranging from industry groups, unions, academics, and government

We are planning to get an idea of how the pandemic and its evolution is experienced by workers in the sector – Stage 4 of our study

If you work in this sector please get in touch if you would like to play a role in our research! Email CovidAtWorkStudy@iom-world.org

https://sites.manchester.ac.uk/covid19-national-project/research-themes/sector-specific-studies/covid-19-at-work-understanding-transmission-in-the-food-processing-sector/

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Thank you

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@PROTECT_NCS

IOM

The PROTECT COVID-19 National Core Study on transmission and environment is a UK-wide research programme improving our understanding of how SARS-CoV-2 (the virus that causes COVID-19) is transmitted from person to person, and how this varies in different settings and environments. This improved understanding is enabling more effective measures to reduce transmission – saving lives and getting society back towards 'normal'.

The Covid@Work Study (CAWS) was carried out with the aim of improving understanding of the impact of the COVID-19 pandemic on the Food and Drink Processing Industry (FDPI) sector, as well as the impact of mitigation measures on the sector. As an essential sector, the FDPI continued to operate throughout the pandemic as it had done prior, responding to and negotiating mitigating measures as they were introduced. This summary of results covers the findings of the study, which was broken down into three stages: an initial online survey, a secondary telephone survey, and finally stakeholder interviews from across the sector. The study was carried out by a team of researchers from the Institute of Occupational Medicine, the London School of Hygiene and Tropical Medicine, and the University of Manchester. The report identifies indicators of transmission risk, the challenges faced by companies in responding to mitigating measures and employee shortages and the efficacy of these measures within the sector.

Published by the PROTECT COVID-19 National Core Study 03/2022