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Documentary analysis of HSE COVID-19 outbreak investigations

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Essential work continued throughout the pandemic and reducing transmission of the virus in the workplace was a primary concern for the government in the UK. The process for conducting outbreak investigations was developmental rather than determined by an existing protocol. The study aimed to identify potential factors contributing to workplace outbreaks of COVID-19 and types and use of control measures recorded in HSE investigation records. The main purpose of the investigations during the data collection period was to control the outbreak quickly. This study sought to develop an approach to obtain insight quickly about factors that may be reflected in the content of investigation records and that could potentially contribute to an outbreak.

Four main themes identified give a broad overview of the issues raised in the 58 case sample: Workforce characteristics, Workforce behaviour, Organisation characteristics, and Management of the workforce environment. The prominent themes in the investigation records related to organisational characteristics and management of the workforce environment. Developing a method for gathering valuable information from data based on formative assessment alongside summative evaluations could add to new knowledge and understanding about workplace outbreaks and how these can be managed.

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Documentary analysis of HSE COVID-19 outbreak investigation records

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Key messages

SARS-CoV-2 outbreak investigations in workplaces involved HSE inspectors and each investigation generated an array of records and notes, with potential to reveal the factors investigators and business managers thought contributed to the outbreaks.

Four major themes found in the investigation records linked to potential risk factors for outbreaks and management of controls: **Workforce characteristics, Workforce behaviour, Organisation characteristics, Management of the workforce environment**.

Management and control of the workforce environment was frequently referred to in reports, particularly implementation and adherence to hand washing, cleaning and social distancing. There was little mention of ventilation controls, including hierarchy of controls in particular engineering and administrative control. This was notable given occupational hygiene controls for respiratory disease must include ventilation. The findings suggest a focus on hand-washing, social distancing and face coverings was prioritised before other controls.

Workforce characteristics such as employee terms, conditions and engagement, the use of temporary, agency and self-employed staff was not well documented in the records. Sick pay arrangements were not recorded in the documentation. Information was absent about workforce characteristics such as socio-demographic status , and behaviour such as shared offsite-accommodation, shared travel to work and employees holding second or third jobs.

Workforce behaviour factors in the documentary evidence highlighted frequent concerns from investigators regarding adherence to controls and management or supervisor oversight. There was limited information about the employee role in designing, implementing and managing control measures, a factor likely to promote greater employee adherence to control measures.

Organisation characteristics such as testing and contact tracing were areas of concern especially in relation to managing employee interaction outside the workplace. Emergency planning in health and safety management systems was not captured suggesting that emergency preparedness was not a feature of risk management planning in settings where biological hazards are considered low/no risk. The variability of the material contained in records and the limited detail exploring issues in specific workplaces suggests more research is needed into the causes of workplace outbreaks.

Variability in and range of case documentation meant that whilst the themes do not reflect the relative importance of risk factors or control measures in the workplace, they reflect areas noted by investigators, frequently as points for improvement or attention.

Executive summary

Introduction

Essential work continued throughout the pandemic and reducing transmission of the virus in the workplace was a primary concern for the government in the UK. Occupations providing essential services remained open during COVID-19 lockdowns. Essential sectors, such as healthcare, education and food production placed employees at greater risk of exposure to the SARS-CoV-2 virus and understanding mitigation of transmission was a priority. These services relied upon employees remaining fit for work. With increasing COVID-19 case numbers, understanding the mechanisms for occupational and community transmission was an important aspect for the UK Health and Safety Executive (HSE). As a regulatory organisation for health and safety at work, they contributed to investigations of workplaces to provide assistance for businesses, employing a "supportive process, providing advice and guidance for businesses where outbreaks have been identified[1]". The process for conducting outbreak investigations was developmental rather than determined by an existing protocol. We report the findings from a preliminary qualitative analysis of the investigation records into COVID-19 workplace outbreaks in the UK as part of the PROTECT National Core Study[2].

Aims

The study aimed to identify potential factors contributing to workplace outbreaks of COVID-19 and types and use of control measures recorded in HSE investigation records. The main purpose of the investigations during the data collection period was to control the outbreak quickly. This study sought to develop an approach to obtain insight quickly about factors that may be reflected in the content of investigation records and that could potentially contribute to an outbreak. The investigation records may also contain a range of control measures implemented in the real world scenario to support outbreak response. At the early stage of the pandemic evidence from other sources, such as scientific literature was very limited.

We used a qualitative thematic analysis of secondary data from the investigation records of COVID-19 workplace outbreaks conducted from June 2020 to June 2021. We undertook headline analysis of descriptive quantitative data that aimed to identify patterns and opportunities within the dataset.

We asked the following research questions:

1. What potential risk factors for outbreaks of COVID-19 in the workplace, were identified using thematic analysis of HSE investigation records, as recorded by workplace investigators?
2. What control measures were in use and considered by inspectors as valuable in managing outbreaks according to the thematic analysis?
3. What can we learn for future practice and research using thematic analysis of secondary data from investigation records of workplace COVID-19 outbreaks conducted between June 2020 - June 2021?

Methods

We conducted a qualitative thematic analysis of investigation records from a range of occupational settings visited by HSE inspectors in the first year of the pandemic (June 2020-June 2021). 58 cases and associated records from food processing and manufacturing, warehousing, distribution and wholesale trade occupational settings were randomly selected from 281 cases in specific sectors identified as high risk of outbreaks. This data was contained within the data set of 737. Industries at greater risk from outbreaks were identified in other PROTECT studies. The records were analysed descriptively and thematically to identify broad themes contained in the documents. Themes were refined into categories using main and subthemes, with the intention of conducting an in-depth analysis of further cases to ascertain if the records provided information on risk factors and controls employed by businesses, as perceived by HSE inspectors.

Findings

Thematic analysis is a well-established qualitative research method frequently used to examine verbal or text-based material, utilising a systematic and careful process to generate themes [17, 18]. It draws on people's perceptions and views, to help understand the underlying mechanisms contributing to an issue and identifying relationships between issues and contexts.

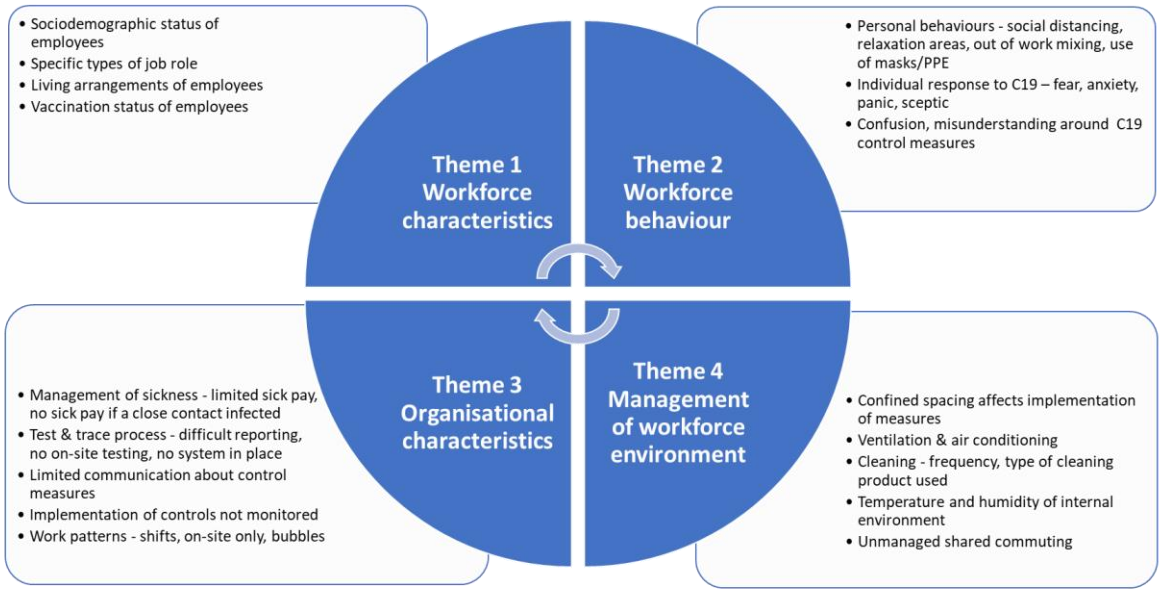
Four main themes identified give a broad overview of the issues raised in the 58 case sample. We provide further detail of these themes using the food sector as an exemplar.

Themes 1-2 related to the workforce (characteristics and behaviour), theme 3 referred to the organisation and theme 4 described the workforce environment issues.

The work is reporting on the information collected and recorded by workplace investigators, informed in places by records from other statutory bodies. The thematic analysis is of the records collected at the time, likely informed by the investigator's perspective of factors

linked to outbreaks. We are not able to objectively determine factors that linked to outbreaks without extensive onsite research. This said, whilst the variation in the type, quality and quantity of documentation in the records made it difficult to compare cases, the range of information contained within the documentation provided insight into the variation of activity between the types of workplaces.

Four main themes and subthemes identified from investigation records



The four main themes identified in this work are reflected in findings from reviews into work and health.

For example, in 2021 the World Health Organisation issued Preventing and mitigating COVID-19 at work, a policy brief [31] on the lack of consistency in national and sub-national policy recommendations guiding workplaces on how to prevent transmission and protect workers from COVID-19. Recommendations emphasised the importance of using hierarchy of controls for all settings, in particular engineering and administrative/organisational controls before PPE. The report advocates instituting paid sick leave and routine screening/surveillance for COVID-19 in particular with respect to at risk and vulnerable workers. In contrast, whilst the 2017 Taylor Review of Modern Working Practices 'Good Work' [29] focused on responsible corporate governance as a key factor in control, issues such as insecure working, regular and predictable hours were not addressed. Zero hours contracts and self-employment where pay is based on output (e.g. goods delivered by delivery drivers) and roles where non-productive working time is unpaid were not critiqued. As Moore et al[32] explored, whilst the Taylor Review concedes that a culture of unpaid

overtime has developed, this is increasingly a function of zero hours contracts and increases worker dependence on employers. Control over workplace environment may be diminished with insecure contract arrangements and lack of Union or employee representation[30].

The four themes and subthemes identified in this work, along with the example of the food sector thematic analysis exemplar allude to some of these issues and provide an opportunity for reflection of the role of organisational characteristics and management of the workplace environment in communicable disease outbreak control.

Conclusions

The following conclusions are in the context of a rapidly changing and unique environment of a new, highly transmissible respiratory infectious disease:

1. The prominent themes in the investigation records related to organisational characteristics and management of the workforce environment. Notable issues were cleaning, social distancing and employee terms, conditions and engagement. Whilst the themes did not reflect the relative importance of risk factors or control measures in the workplace, it reflected areas noted by investigators, frequently as points for improvement. Understandably, the investigators may focus on the issues that were part of their regulatory remit. The emphasis on cleaning and social distancing may be attributed to potential bias based upon regulatory priorities, however it may also have precluded discussion about other factors and controls that we now know are important. It is important to emphasise the source of the outbreak was not investigated. Investigations focused upon the factors which may encourage transmission and the control measures required to minimise transmission. Understanding of environmental factors, airborne transmission and infection risk was still evolving and not fully understood. This said, our knowledge of occupational hygiene tells us that controls for respiratory disease must include ventilation
2. Safety measures are more likely to be addressed in businesses than health impacts and the complexity of exposure science and evaluation does not translate well into traditionally ‘lower risk’ environments for chemical, physical and biological hazards.
3. Thematic analysis of the dataset identified high-level themes that may have contributed to occupational COVID-19 outbreaks in investigated settings. Due to the variability in case documentation, we were unable to assess the relative importance or suitability of control measures in different occupational settings from the documentation.
4. There was a notable absence of information about the workforce characteristics such as socio-demographic status of employees for example, housing occupancy, interaction outside of work, shared travel and accommodation.

5. The investigation records reflect the contact that inspectors made with workplaces where HSE had received notification of a COVID-19 outbreak. The contact includes telephone conversations, email communication and site visits intended primarily to provide businesses with support in a fast-changing situation with regulatory compliance being a more minor consideration at the time. The documentary evidence was in a variety of formats and data from records was variable. For example, records of total number of employees was unclear or missing in a large proportion of the sample. .
6. The documents used for analysis were first-person accounts of observations, conversations, actions and views [3]. Hence, there were limitations in using the material to answer research questions focused on identifying risk factors for outbreaks and use of controls in occupational settings. We could not be certain if the documents contained the full range and depth of advice and guidance given and if they represented a consistent written record of issues across all cases
7. Public enforcement organisations, such as HSE, Local Authorities and UKHSA, hold large amounts of qualitative data collected in the course of inspections and investigations. Developing a method for gathering valuable information from data based on formative assessment alongside summative evaluations could add to new knowledge and understanding about workplace outbreaks and how these can be managed.
8. The variable data quality and quantity per outbreak investigation prevents case-by-case comparisons. For future research projects, completion of data fields within a prescribed format will be very helpful in generating descriptive and possibly more detailed statistical analysis. Similarly an opportunity to interview employers, employees and investigators about the outbreak and investigations could have enhanced the thematic analysis
9. Gaps in the data regarding pre-pandemic emergency planning and response in low risk biological hazard environments provides an opportunity for educating businesses in emergency preparedness. Our findings suggest that a focus on hand-washing and social distancing was at the expense of other controls. This gap, whilst it may have been closed later in the pandemic is an opportunity to educate duty holders on occupational health issues such as ventilation as a control,

Understanding the factors contributing to a COVID-19 outbreak is complex. These investigation documents provided information relating to a single outbreak investigation in a workplace. Factors affecting community-based outbreaks may link to workplace outbreaks, making it difficult to identify primary factors in an outbreak. However, relationship between community and workplace outbreaks could vary greatly. In effect, strict administrative, engineering and PPE controls in the workplace may have little impact on outbreak factors that link to behaviour outside the workplace.

Introduction

COVID-19 outbreaks in occupational settings that provide essential services was a major concern during the pandemic. Many public health outbreak investigations in workplaces involved HSE inspectors during this time. Each investigation generated an array of records and notes, with potential to reveal the factors investigators and managers thought contributed to the outbreaks. This study examined secondary documentary data using qualitative methods to consider the feasibility of using administrative records, collected in the field in the midst of a public health crisis, to develop an understanding of workplace outbreak risk and controls.

SARS-Cov-2 presented significant challenges for managers and employees in a wide range of essential occupations and workplaces. The cases of self-reported incidences of contracting COVID-19 in the workplace in the UK are 93,000 in total[4] (at November 2021), with 52,000 of these related to workers in health, social care and education. Employers, employees and health and safety organisations largely responded at pace and had to draw on collective learning to understand the threat and introduce prevention and control measures for an unknown respiratory infectious disease (RID)[5]. Whilst a wide variety of public health protection measures were in place during the time period, for example quarantine, social distancing, mask wearing etc., the national implementation of population immunity vaccination programmes and availability of widespread treatment approaches to the disease were not in place.

Points of note during the research period:-

- A large number of self-reported COVID-19 cases stated that infection was acquired from the workplace[4] with many being from the healthcare sector and may not be homogeneous across all work types.
- At the point that the pandemic occurred, COVID-19 was a new disease with no underpinning research to inform guidance and practice. Guidance for controlling outbreaks was prepared rapidly, but in many cases, this was confusing and depended on organisations making adaptions on limited evidence.
- Workplaces with a higher risk of outbreaks had been identified in related studies within PROTECT, such as food production and packaging, warehousing and healthcare settings.
- Data collected as part of an investigation may contain essential insights into issues in the field, but cannot be guaranteed to provide sufficient range and depth for research.

- There are benefits of collecting and analysing data using qualitative thematic analysis methods as part of a documentary analysis, in addition to quantitative data[5].

Biological Hazards in Occupational Health and Safety Management

Legal instruments for infection prevention and control in workplaces are implicit in hazard and risk assessment for biological agents. Sectors such as healthcare, veterinary and farm environments, laboratory and biological research facilities are supported by NHS and HSE guidance on controlling for disease transmission risk. Emergency Preparedness, Resilience and Response (EPRR) for a range of extreme events is intrinsic in safety management systems in higher risk sectors such as nuclear power stations, healthcare and offshore oil and gas. Guidance on emergency planning for low risk industries is available from professional and statutory bodies (HSE, IOSH, and OSHA) however, controls tend to focus on physical, chemical and safety hazards.

Gaps in emergency preparedness and planning for public health hazards represented challenges for business premises because of the community-based nature of this novel infectious disease. At the onset and throughout the pandemic the UK HSE provided COVID-19 infection prevention and control practice guidance, along with other statutory agencies, such as the UK Health Security Agency, and various professional and industry bodies, for example, the Institute of Occupational Safety and Health (IOSH)[6] and British Occupational Hygiene Society (BOHS)[7].

At the start of the pandemic, understanding of SARS-CoV-2 transmission was limited and intensive scientific investigation and debate was conducted in the UK under the remit of Scientific Advisory Group for Emergencies[8].

Occupational settings were quickly identified as potentially posing a risk of infection to employees[9] and were considered potential 'super spreader events' (SSE)[10]. However, researchers discovered that the interplay of multiple factors created difficulties in determining the main risk factors with confidence[11].

Adopting a framework to categorise different kinds of factors (Table 1) proved a useful structure to consider SSEs, displaying the characteristics that are relevant to high-risk workplaces according to our knowledge to date[10].

Table 1: Framework for categorising the spread of SARS-CoV-2 virus [10]

Biological	Individuals with a higher probability of transmitting per contact	Hard to identify a priori. For SARS-CoV-2, individual-level viral loads are dependent on time since onset, asymptomatic exposure to contacts, and might be associated with demographics like age and disease severity.

Behavioural and social	Individuals causing SSEs may have a higher number of susceptible contacts per person.	Numerous studies have demonstrated marked differences in individual contacts by profession and over time. High density situations might include housing, public transport, shopping.
High risk facilities and settings	High-risk facilities and places such as meatpacking plants, workers' dormitories, prisons, long-term care facilities, or healthcare settings.	The nature of interactions in these places seem to repeatedly place individuals at higher risk of acquiring and transmitting infection.
Opportunistic	"Opportunistic" scenarios	Larger numbers of individuals temporarily cluster, and even with an average probability of transmission per contact, people are briefly far above their "average" number of susceptible contacts. The probability of transmission per contact is temporarily increased in an unusual way, such as singing or frequent loud speaking.

Within the PROTECT national core study, HSE identified higher risk workplaces as food production and packaging businesses, warehouse and distribution centres, motor vehicle and parts manufacturers and production centres. This concurred with research reported in the literature [12-14].

Aims

The study aimed to identify the potential factors contributing to workplace outbreaks of COVID-19 using information recorded in HSE investigation records. In order to analyse the records in detail, we used a qualitative thematic analysis of HSE investigation records from COVID-19 outbreaks in occupational settings conducted from June 2020 to June 2021. We asked the following research questions:

1. What potential risk factors for outbreaks of COVID-19 in the workplace were identified using thematic analysis of HSE investigation records, as recorded by workplace investigators?
2. What control measures were in use and considered by inspectors as valuable in managing outbreaks, according to the thematic analysis?
3. What can we learn for future practice and research using thematic analysis of secondary data from investigation records of workplace COVID-19 outbreaks conducted from June 2020 to June 2021?

Method for analysing documents from outbreak investigations

Qualitative inquiry plays an important role in researching social responses to infectious disease outbreaks, improving our understanding of how people respond to a communicable disease crisis and how people manage the challenges of disease outbreaks [15-16]. The methods employed to gather and analyse in depth qualitative data can be time consuming and difficult to ensure timely and prompt responses in the context of a pandemic. Therefore, we took the opportunity to examine data, collected as part of workplace outbreak investigations during the pandemic, to identify whether and how this could contribute to our understanding of disease outbreaks in the workplace.

Thematic analysis is a qualitative research method used to examine written or verbal data to generate new insights about underlying behaviour and attitudes. It can be widely applied to a range of research questions. Thematic analysis provides an opportunity to investigate additional, relevant issues arising from the data as it can be difficult to predict what might be revealed in secondary sources of data.

We analysed information recorded in HSE investigation records by conducting a thematic analysis of 575 case documents from 58 outbreak investigations. The food processing sector was particularly affected by SARS-CoV-2 outbreaks, as demonstrated in other PROTECT studies. We included an exemplar of our thematic analysis using investigation records from twenty two food processing businesses to illustrate risk factors and control measures from this sector and to look for additional insights that the food processing sector may provide.

Investigations were undertaken in response to a referral of a COVID-19 workplace outbreak from other public health bodies. Case information could include material such as site visit reports, risk assessments, action plans and updates depending on the nature of the investigation.

The records included email correspondence from public health, local authority, HSE and the Health and Safety lead employee for the organisation. The initial notification of an outbreak usually highlighted key issues thought to relate to workplace factors for the outbreak. Documents could include company risk assessments, but these may not link to the actual control measures implemented. In some cases, there were site visit reports, records of recommendations of controls provided by HSE and public health, and updates on the scale of the outbreaks and the progress made in implementing control measures.

The extent of supporting documentation varied considerably from case to case, with some providing a range of documents from the site visits and others having one or no documents.

Using naturalistic data

We used naturalistic data for a documentary analysis, examining the feasibility of using investigation documents collated from the field in the middle of a pandemic. Naturalistic data is material about human activity collected as part of routine practice rather than specifically for research purposes. This is widely recognised as a valid and valuable research method used in real world research.

Data often generates both quantitative and qualitative information, but may not encompass the whole range of information, including exchanges and intervention that took place between individuals during an investigation. The data is therefore potentially limited, but offers insight into real world practice.

It was essential to be aware of the nature and purpose of the documents used for analysis. The inspection records from HSE had the specific purpose of offering support and safety guidance to control COVID-19. Whilst 'regulatory compliance' might be an element of any investigation, in these circumstances, requirements on businesses were changing as the understanding of COVID-19 outbreaks and control measures evolved. HSE teams supported ongoing outbreak investigations, the priority being to provide risk management guidance, expertise and to encourage safety whilst enabling business continuity.

Features of the naturalistic dataset

We used a data set of 737 COVID-19 outbreaks associated with occupational settings that were investigated and recorded by HSE between June 2020 to June 2021. See Appendix B for a detailed anonymous breakdown by SIC code and description. A sample of 58 investigation records were analysed thematically to describe broad categories of concern for transmission risk factors of COVID-19 and controls, as percieved by inspectors and through dialogue with duty holders (60 were selected, one being a duplicate and one with no case records).

The 737 case dataset included 57 categories of 2 digit SIC ranging from SIC 01 to SIC 96 covering a range of occupational settings, each with variation in quality of written data (Appendix B). In order to evaluate the feasibility of using the naturalistic data, collected as the pandemic evolved, this study focused on high risk sectors for COVID-19 outbreaks represented by seven 2-digit SIC codes (Table 2).

Table 2: Selected industries by Standard Industrial Codes (SIC) and number of outbreaks investigations in the data set.

Type of occupational setting	*SIC codes*

Warehousing, transportation support, postal and courier activities	SIC 52 (n=8) SIC 53 (n=16)
Food and non food manufacturing	SIC 10 (n=169) SIC 22 (n=19) SIC 29 (n=28)
Wholesale trade; except of motor vehicles and motorcycles	SIC 46 (n=17)
Land transport and transport via pipelines	SIC 49 (n=24)
Total cases	281

Information from analysis of outbreaks in different industrial sectors in the early stages of the pandemic by projects within the PROTECT National Core Study. High risk sectors were identified and within the total cases we randomly selected 60 cases. We subsequently employed purposive sampling, identifying sectors with higher risk concerns regarding outbreak likelihood in order to gather insights quickly as illustrated by the food sector exemplar.

Descriptive Documentary Data Analysis

Documents were collated for each case by HSE and securely sent across to the research team. Case documents varied from case to case and included a range of material such as site visit reports, risk assessments, action plans, photographic images, email exchanges, meeting minutes and updates. Geographical breakdown by region was recorded using government office region and postcode data.

Qualitative Data analysis

The research team validated terms during data familiarisation and themes were agreed. A case analysis template was developed as part of the 'coding framework', recording issues evident in the investigation records and documents. The thematic analysis employed both deductive approaches, using a priori themes informed by early evidence from related studies within PROTECT and input from HSE, and inductive approaches, identifying themes raised in the documents. Analysis was conducted by four researchers and independently quality assessed by a fifth researcher. See Appendix A: Method of workflow and staged approach for a more detailed description of the research process and coding.

We used Bowen's framework for documentary analysis, as the documentation consisted of 'personal documents' and 'physical evidence' [3]. Document analysis is the interpretation by the researcher of documentation to give meaning to a specific topic. An effective and

efficient way of data analysis, documents can be read, reviewed and discussed many times, unchanged by the process. Limitations include working with documents which are not created to answer research questions. Gaps and variation in documents means cases cannot easily be compared.

Following the protocol for documentary analysis [3, 18], we evaluated the nature and quality of the documents using the staged approach. The following observations provide the context for interpreting the thematic findings.

i. Investigation documents comprised of 'personal documents' (rather than public records) and 'physical evidence' such as pictures, handbooks, guidance documents.
ii. The original purpose of the documents was intended to provide a record of investigations that were conducted with businesses to support their management of COVID-19 control measures.
iii. The documents ranged in their style and content, with examples of case notes, interchanges between participants and judgements about compliance with health and safety standards.
iv. The tone of the documents tended to be supportive and suggested a collaborative approach to improving control measures, with suggestions, recommendations and guidance.

Using the well-established qualitative method of thematic analysis[18] we considered the experience of managing COVID-19 in the workplace to identify new issues and underlying mechanisms contributing to outbreaks. Thematic analysis is particularly apt for social phenomenon that is not quantifiable and analyses peoples' observations, opinions and experiences as described in their own words. The investigation records represented the notes that inspectors prepared, using their own words, following an investigation. The analysis involves a six-step process outlined in Table 3.

Table 3: Process of conducting a thematic analysis[18]

1. **Familiarising with data**	Reading and rereading the data, noting down initial ideas.
2. **Generating initial codes**	Coding interesting features of the data systematically across the entire data set, collating data relevant to each code
3. **Searching for themes**	Collating codes into potential themes, gathering all data relevant to each potential theme.
4. **Reviewing themes**	Checking if the themes work in relation to the coded extracts and the entire data set, generating a thematic map.
5. **Defining and naming themes**	Ongoing analysis for refining the specifics of each theme and the overall story that the analysis tells, generating clear definitions and names for each theme.
6. **Producing the report**	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a report of the analysis.

The study method was adapted from this process to analyse the widely varying data. Descriptive statistics of overall SIC codes and the proportions of industries represented in the 737 cases are shown in Appendix B. These descriptive statistics informed the initial framework design and selection of premises that were likely to contain numerous types of documentation in the records. A pilot case analysis of six outbreak investigation records was used to develop the coding framework. See Appendix A.

Developing the network and analysing the themes

A thematic network map was developed following a detailed process to generate themes [17-19] (familiarisation of the texts, coding, generating themes, reviewing themes, defining and naming themes) the first iteration of which, the Thematic Analysis Map is shown in Appendix C and represents the themes identified from investigator observations during the investigation.

The four major themes represent a convergence of early findings from researchers in PROTECT and HSE, supplemented by those that became apparent from the thematic analysis of investigators' records, representing what investigators found important during the contact with the duty holder and considered important enough to record and include in correspondence with businesses.

Findings

Summary descriptive statistics

Within the n=737 dataset, which largely excludes schools and healthcare settings, over 85% of outbreak cases were in the manufacturing and service industries. Learning from research in other PROTECT studies using heat mapping data[9] we selected 58 sample cases based on the SIC codes most likely to record workplace outbreaks. Appendix B is a summary of the statistical composition of the dataset.

Table 4: Representation of n=737 outbreak cases by sector

Agriculture	13	1.8%
Construction	38	5.2%
Manufacturing	430	58.3%
Services	242	32.8%
Waste /waste management	9	1.2%
Extractive utilities	5	0.7%

Postcode data used in other PROTECT studies for mapping patterns and trends in occupational outbreaks includes developing mapping models which also use LSOA data and other UK datasets[9]. The themes generated from the documentary analysis sample may be more pertinent in some geographical areas and industry sectors. For example, urban population density and the number of small businesses may under report SARS-CoV-2 cases. As Chen and Aldridge[9] observe we can reasonably postulate that some regions may not be well represented in the dataset;

> *The potential under-identification of outbreaks in small enterprises (<50 employees) …coupled with the vast number of small enterprises … may greatly underestimate the outbreak rates. This could particularly impact on small business-dominated sectors, such as close contact services and restaurants/caterers, where estimated outbreak rates were relatively low, but attack rates were relatively high.*

Table 5: Outbreak by HSE recorded Government Office Region

Region		
Scotland	27	3.7%
Wales	88	11.9%
England		84.4%
West Midlands	158	21.4%
Yorkshire	104	14.1%
North West	86	11.7%
East Midlands	83	11.3%
London & South East	52	7.1%
East	43	5.8%
North East	34	4.6%
South West	32	4.3%
Unknown	30	4.1%

During the data collection period, the outbreak data by government office region identified West Midlands, East Midlands and Yorkshire as areas of high incidence. As the pandemic progressed, other regions became more prominent with high population case rates, and the three worst affected regions in March 2022, by number of coronavirus cases, were the South East, North West and London.

The total number of SARS-CoV-2 positive cases across the sample (n=58) was 1313. Fifteen premises outbreak investigations featured 9 or less cases of SARS-CoV-2 positive employees as far as we know, with most settings having 49 cases or fewer during the outbreak investigation. Information in the records relating to total number of cases in each setting as a proportion of the total workforce was variable.

Within the sample, 6408 employees were recorded as employed but this is likely an underestimate, as many records did not contain total employee data. The work did not set out to conduct a statistical analysis of data, and as such we cannot comment on numbers of cases, incidence, or proportion of workforce affected by outbreaks. Table 6 illustrates the modal number of outbreak investigations by range of cases per workplace as recorded in the documentation.

Table 6: Number of outbreak investigations by case range

Range of SARS-CoV-2 cases recorded in outbreak investigation	Modal number of outbreak investigations
	Mean 27 cases per premises [n=58]
0-9	15
10-19	13
20-29	7
30-39	4
40-49	5
50-59	0
60-69	7
70-250	1

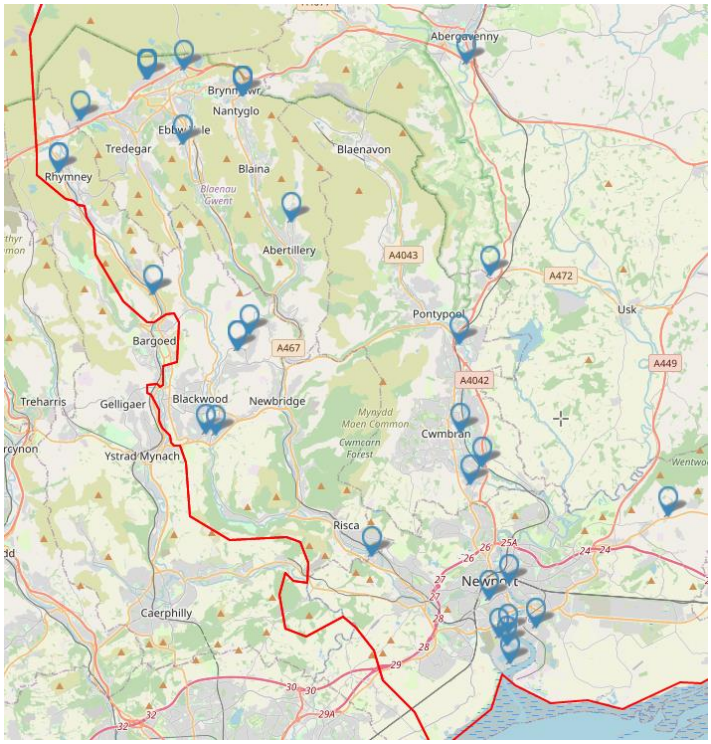
SARS-CoV-2 case numbers in individual businesses varied in case distribution, ranging from three cases to 248 cases per investigation. Missing data in the records means it is not possible to evaluate the data beyond summary descriptive statistics; however, the findings in the qualitative thematic analysis can provide insight into possible proliferation of outbreaks in some areas.

Within the sample (n=58) we undertook documentary analysis of one case from the NP postcode (Newport). This was an example of a SIC 52 business, Warehousing and support activities for transportation, with a 25 case outbreak. The documentary data could not tell us about the workforce environment or demographics but it did highlight observations on behaviours and compliance with COVID - secure measures as captured in the findings of this work.

An observation about this case and the NP postcode is the potential for the geosocial attributes of the area to inform patterns and trends of worker interaction within and across other employees and businesses within a postcode area. The NP postcode accounted for 5% of all outbreaks (n=35) in the 737 outbreak investigation dataset and could be a useful case study to inform further understanding of geosocial factors in outbreaks. See Figure 1 for illustration of outbreaks by geographical area.

As a proportion of total recorded outbreaks in the investigation data, the incidence of outbreaks in the NP region seems high and disproportionate. It is not possible from the quantitative dataset to determine the reasons for this, however the insight drawn from the thematic analysis and other work in PROTECT can inform future work particularly in developing study methods and qualitative data collection and analysis going forward.

Figure 1: Newport NP Postcode mapping of outbreak investigations n=35



Source: Map data © **OpenStreetMap** contributors, **CC-BY-SA**

Within the dataset, thematic analysis of premises within a postcode area is an opportunity to identify regional and geosocial factors that may influence outbreaks and transmission. The qualitative work focused on the high-risk sectors identified in earlier PROTECT work most likely to experience an outbreak. Documentary analysis of all SIC code outbreaks in a postcode area using the same method of data collection and documentary analysis using thematic analysis methods, including interviewing employers, employees and investigators could provide new understanding of the factors which influence occupational outbreaks.

Thematic Analysis themes derived from outbreak investigations and control measures noted in investigation records

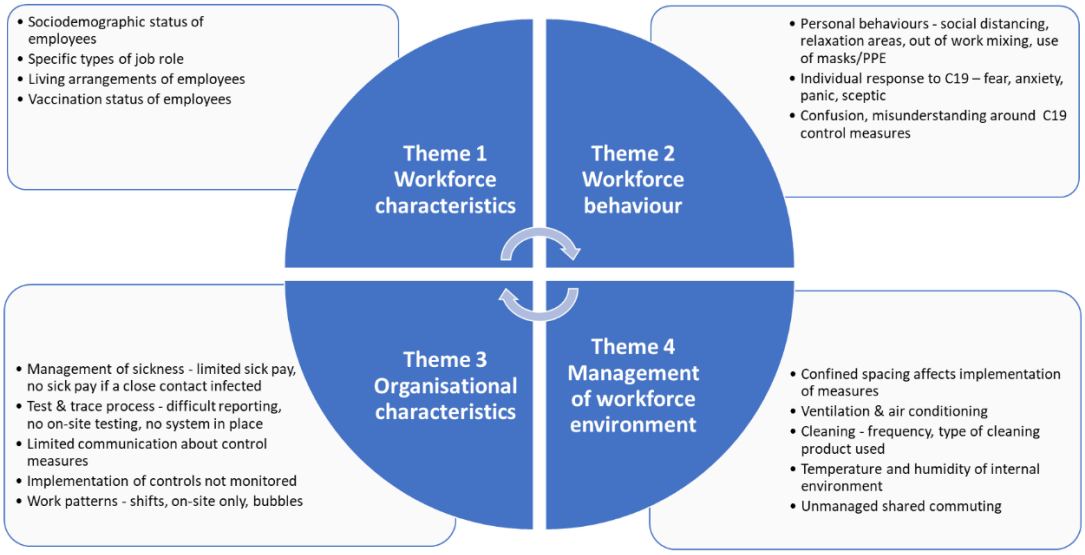
Approximately 575 case documents were associated with the 58 outbreak investigation records. The number of documents associated with an occupational setting varied from one document to 76 documents.

Four main themes and a number of subthemes were derived from HSE inspection records suggesting the risk factors for COVID-19 outbreaks and control measures as perceived by the investigators visiting businesses (Figure 2, Table 2 and Table 7).

The records tended to focus on specific features and not on areas that became increasingly important as our understanding of the virus increased. For example, there was limited reference in the records to workforce characteristics, in spite of the concerns about vulnerability linked to both age and ethnicity, suggesting that outbreaks may have been more likely where clusters of workers with specific characteristics existed. As the pandemic progressed, increasing attention was likely focused on ventilation and other controls. However, that knowledge developed over time could suggest gaps in understanding around implementation and audit of hierarchy of control. Uncertainty around transmission of SARS-CoV-2 was a potential barrier in this regard.

Figure 2 presents the four main themes which describe a range of risk factors and control measures noted in the investigation records

Figure 2: Four main themes and subthemes identified from investigation records



Themes 1-2 related to the workforce (characteristics and behaviour), theme 3 referred to the organisation and theme 4 described the workforce environment concerns thought to be linked to COVID-19 outbreaks. The themes provide a broad overview of the issues raised in the documentation.

Control measures relating to management of the workforce environment and workforce behaviour (Theme 4 and Theme 2 respectively), such as cleaning, social distancing and wearing of face coverings, were frequently noted by investigators, in line with national guidance and reflecting the intensive publicity about ‘hands, face, space’ messaging. It was less clear that discussions between investigators and managers of companies considered how these measures were communicated with employees, how well managers and

employees understood and implemented the guidance for specific settings, how training was undertaken and whether the measures were implemented consistently.

We consider three aspects of management of the workforce environment and workforce behaviour that featured prominently in the records:

(i) cleaning; (ii) social distancing and (iii) employee engagement

and discuss how this enables us to understand potential risk factors and approaches to management and control. We consider in depth the strengths and limitations of using investigations records to develop understanding of COVID-19 outbreaks.

i. Cleaning

The outbreak records focused strongly on cleaning regimes, suggesting other areas considered important in controlling outbreaks, for example, ventilation, high quality PPE might not have received as great a focus. This is in keeping with findings from the PROTECT deep dives research, where managers and employee representatives were interviewed for their views about control measures. Some findings implied cleaning regimes were over emphasised, possibly due to the lack of knowledge surrounding the transmission routes of the virus. Mention was made of risk assessments of workplaces and the types of controls used, and this included cleaning, social distancing and communication including the use of signage.

ii. Social distancing

Records indicated that investigations frequently focused on social distancing. The records included photographic evidence from across occupational sectors that suggested many measures were introduced, ranging from screening, physical spacing of employees and reducing the number of staff on site. However, the records indicated that less attention was paid to non-working periods, such as meal and rest breaks, suggesting that managers were unaware of employee behaviour during rest breaks or unaware of the increased risks associated with social contexts in the workplace.

The exemplar from the twenty-two cases in the food processing sector illustrates how prominent the discussion concerning social distancing, facemasks and cleaning regimes were in the majority of HSE investigation documents analysed. These three risk factors/control measures have been prominent in related studies in PROTECT.

iii. Employee terms and conditions and engagement

The salient features relating to risk factors and control measures in Theme 3, Organisational Characteristics related to (i) employee contractual arrangements, (ii) sickness absence management, (iii) working arrangements and (iv) employee engagement in control and mitigation measures.

Employee contractual arrangements referred to in the records suggested there could be a link between large numbers of temporary, agency and seasonal staff (for example SIC 10 Manufacture of food products, SIC 53 Postal and courier activities) and larger number of outbreak cases or clusters. However, the records did not provide the perceptions of the investigators and managers about the reasons for this observation.

Organisational measures to manage workplace absence and illness such as sickness absence pay arrangements were a common theme. This particularly related to employees attending work with COVID-19 symptoms because they could not afford to not work.

Working arrangements that reflected the needs of the business were reported as significant in creating risk factors. In all the cases analysed, the business activity could not support people working remotely and therefore one of the key national control measures during lockdown, home working, was not feasible for the majority of the workforce. In relation to production, warehousing and manufacturing industries there was no ability to work from home whilst the business was operating as normal.

Furthermore, some investigation records indicated that a number of workplace outbreaks were noted in industries with shared accommodation and shared transport. These were particularly evident at the start of the pandemic. Increased knowledge, awareness and uptake of vaccinations may have reduced later infection risks.

Organisational characteristics were evident in the way employees were involved in reducing risk factors. In many records, it was difficult to identify how, and if, employees were involved and engaged in the process of controlling outbreaks. In a large number of cases, there was no reference to employee participation or engagement in design and implementation of controls. It was observed that in food and farming environments signage and guidance was not provided in all languages spoken by the employees. This is an indication of lack of employee engagement in implementing control measures.

Table 7: Main themes and sub themes from records analysis of 58 outbreak investigations

	Main theme	Subthemes (basic themes as bullet points)
Theme 1	Workforce characteristics thought to be linked to C19 outbreaks	• Worker sociodemographic is perceived to influence outbreaks - younger workers - migrant workers - certain ethnic groups more susceptible to serious illness • Specific job roles are perceived to contribute to outbreaks • Vaccination status thought to vary according to job role. - Attitude - Beliefs
Theme 2	Workforce behaviours related to measures believed to control outbreaks	• Personal attitudes/attributes and behaviour are difficult to anticipate but are considered important in influencing outbreaks. - For example, out of workplace social mixing - Behaviour in relaxation areas e.g. canteens • Proximity of living linked to greater transmission e.g. sharing onsite accommodation/ crowded caravan park • Fear, panic and apathy in response to understanding the guidance and changes to guidance
Theme 3	Organisational and management characteristics	• Managing sickness was limited by contractual arrangements - Access to limited sick pay affects whether workers are able to take time off to isolate/recover after C19 - Mechanisms for reporting symptoms were inadequate - limited use of testing • Monitoring and reporting of C19 was inadequately planned - Mechanisms for reporting and investigating varied in how - efficient they were (speed of response, appropriate controls, communication with staff, support from management) - Risk assessments generally in order but implementation of control measures was queried by investigators - Monitoring of staff behaviour by management appeared an issue, including use of personal protective equipment • Use of bubbles and cohort working undermined by changes in working patterns • Job roles and work patterns created difficulties for careful control of measures - Job roles that cannot be conducted from home contribute to outbreaks - Changeable work patterns undermined COVID control measures such as working in bubbles and cohorts: shift work, frequent changes in work patterns, temporary staff, self-employed (including contracts and tenure) • Managers neglected to involve staff with arrangements to control outbreaks - Involvement of staff in implementing measures was limited - Issues evident in communication of managers with staff and representation in decision making • Getting to work was an unmanaged point of close contact between workers - shared commuting to work - transport arranged by businesses remained unmonitored

Theme 4	Management of the workforce environment	• Businesses that operated in confined spaces were considered more at risk linked to limited rest areas, increased sharing of facilities, reduced ventilation (later in course of pandemic) - Difficult to operate social distancing with the work demands. Many cases could not meet 2m distance requirement because of work requirements - Measures employed included screen, face coverings, standing people adjacent rather than facing each other - Social distancing was an issue in no- work areas such as smoking shelters, canteens, toilets, locker rooms - Visors provided rather than masks • Leadership in introducing and monitoring controls and managing staff sickness and support was limited - Low levels of staff involvement - Variable levels and consistency in implementation of controls and advice - Variable attention to adequate ventilation - Limited supervision and monitoring of areas of high traffic - Signage was absent or confusing in some settings • Temperature/humidity of businesses favours transmission • Insufficient cleaning, lack of resources to implement increased cleaning

Exemplar: Thematic analysis of investigation records from twenty-two Food Processing businesses

Of the 58-outbreak investigation cases selected, 22 were in the food-processing sector and we undertook a focused sector analysis of the sample cases in food processing from June 2020 to April 2021. Case records referred to risk factors and control measures in a number of subthemes from themes 2-4 (workforce behaviour, organisational characteristics and the management of the workforce environment, Figure 2). There is little reference to factors found in Theme 1, concerning workforce characteristics.

Table 8: Examples of risk factors and control measures from investigation records from food processing businesses.

Theme 1 Risk factors relating to workforce characteristics	Age, gender, socioeconomic status and ethnicity were rarely recorded in the records.
Theme 2 Risk factors relating to workforce behaviour	Social distancing was frequently referred to as both a risk factor and a control measure. However, there were few references to how socially distanced behaviour could be established and maintained, how employees were enabled/encouraged to understand and implement social distancing. Few references noted the specific challenges linked to the nature of the business, the environment (such as design of the building) or workforce behaviour in relaxation areas. Face mask/face coverings were frequently noted in the records as a risk factor and control measure. The observations referred to the difficulty of implementing face coverings. A number of

	HSE inspectors noted that masks were not being used appropriately or that visors were being used instead. There was also evidence of complaints regarding lack of mask-wearing from workers and members of the public, indicating that businesses were slow in adopting masks and monitoring their use.
Theme 3 Risk factors relating to organisational characteristics	COVID-19 testing and contact tracing was recorded as a point of discussion in over a third of the records, suggesting that this was a priority area for investigation. Where testing/contact tracing was mentioned it was usually after a site had an outbreak or clusters. Some organisations had to undertake mass testing by local authorities or UKHSA (formerly PHE). In some cases companies undertook this independently as part of their response. One case record indicated that swab tests were carried out regularly in the workplace. The investigation records indicated that supervision and monitoring of staff was a regular topic of discussion. Indeed, there were many comments from inspectors criticising the lack of supervisory staff/marshals on site, or stating that they were not being strict about implementing the COVID-19 rules. Cleaning regimes featured in almost all records with a lot of emphasis placed on adequate/inadequate cleaning regimes and information related to this provided in more detail than other control measures.
Theme 4 Risk factors relating to workforce environment	Community spread COVID-19 Outbreaks in the workplace that might be linked to community spread were recorded as a possible risk factor in some investigation records. Some records showed managers' concerns of infection outside of the workplace and in the local community. Some also showed contact tracing and testing to find where the cases were coming from indicating that managers believed some were from outside of the workplace. This type of activity was not consistent across the sector. Two records noted that managers reflected upon the difficulties of ensuring control outside of workplace, given many people socialised together

Themes derived from the food sector records analysis: potential risk factors and control measures

A number of themes were prominent in the investigation records. Whilst the themes did not reflect the relative importance of risk factors or control measures in the workplace, it reflected areas noted by investigators, frequently as points for improvement. Moreover, evaluation of the findings from the records alongside emerging research from other PROTECT studies, showed a number of risk factors and control measures were not highlighted in the records, suggesting they did not form part of the discussion between investigators and managers.

We discuss five prominent findings from the food sector documentary analysis:

i. **Overemphasis on cleaning regimes**. The analysis of the 22 cases found that themes surrounding social distancing, face coverings and cleaning regimes were the most evident across the HSE investigation documents provided. There was a strong emphasis placed on cleaning regimes. Some investigations took place prior to the PROTECT study commencing and during a global pandemic of a highly infectious and unknown disease. Guidance and standards at the time focused heavily on cleaning and hand washing. Whilst cleaning regimes were considered an important control measure across the PROTECT studies, some respondents (such as those in the Theme 3, Work Package 2 work) suggested that while cleaning is an important factor, other essential factors, such as ventilation and adequate PPE, were not always considered adequately when controlling the spread of COVID-19 in the food sector. Our analysis therefore confirms what has been found in accompanying studies, but we could not surmise the reasons for this in the documents provided.

ii. **Limited consideration of other environmental control measures** such as ventilation. The records suggests that environmental transmission routes were less frequently considered and person to person transmission was the main consideration in the majority of workplaces. Records from the food processing sector confirmed that few investigation documents referred to ventilation (less than four records). Ventilation of premises was recognised as an important control measure only as the pandemic progressed, however, it was discussed by respondents in the PROTECT deep dive interviews as an important risk mitigation strategy.

iii. **Limited discussion of sociodemographic factors**. Socioeconomic information was mentioned in some records, but there was a notable lack of data on ethnicity, age and gender. Given the importance of age and ethnicity in the debate about inequalities and COVID-19, and the likelihood of the workforce in food processing consisting of migrant workforce and low wages, important risk factors may have had less emphasis placed upon them because of the reactive nature of outbreak investigations.

iv. **Sick pay arrangements**. References to sick pay arrangements were made in only two records analyses. As such, the possibility that sick pay arrangements could be a risk factor for outbreaks could not be ascertained from the investigation records. In both cases, the records stated that absence of adequate sick pay was associated with employees attending work instead of isolating and reducing the risk of outbreaks

in the workplace. This aligns with the findings in accompanying PROTECT research studies that highlighted the implications of self-isolation for staff related to loss of earnings who are already on low pay[27, 28, 31, 32].

v. **Communication of health protection measures within an organisation**. The records contained little information about communication between managers, supervisors and employees. There were occasional examples of translated documents/emails/guidance for non-English speaking employees, but only one record commented on the importance of amending communication. We could not identify from the records if, and how, communication routes with temporary and agency staff were established and maintained. This is an important observation due to the number of agency and temporary staff that work in this sector. Good communication between all members of a business is an essential control measure in mobilizing rapid response to an emergency, such as pandemic controls, in a workplace. Whilst a third of records referred to contact tracing and testing, the context of the concerns is unclear. It is difficult to assess if this refers to testing and dealing with positive cases (exclusion from work, replacing staff with temporary staff) or whether it refers to production disruption, and wider business continuity issues if there is a large outbreak.

Discussion

This study applied qualitative thematic analysis to the documents and records generated from outbreak investigations of workplaces by HSE inspectors. Knowledge and knowledge and understanding of the SARS-CoV-2 virus was emerging during this time so the study was therefore exploratory, in studying the transmission of a new infectious disease through the eyes of workplace investigators. The results of the study provide insight into the investigation of disease outbreaks and use of control measures as captured in case records

Workplace investigations altered from analysing health and safety incidents using summative evaluations to assess compliance, to providing support to businesses equivalent to a formative assessment, evaluating duty holder responses for health protection and offering advice. The evidence generated from the records provides a framework for considering the risk factors, and represents a preliminary picture of the issues. We also discuss the value of using investigation records generated by HSE inspectors, in crisis response, as a secondary data source for research.

The discussion therefore focuses on

i) risk factors and control measures in investigation records and gaps in the evidence generated from the investigation records
ii) the potential benefits of using investigation records to understand outbreaks in the workplace and
iii) learning that may be pertinent for organisations responsible for monitoring, supporting and assessing workplaces' response to new health and well-being crises, including specific learning points form the exemplar of the food processing sector.

Potential risk factors and control measures evident in the investigation records and possible gaps in information reported

A wide range of risk factors and control measures were observed in the investigation records, relating to four features of the workplace: workforce characteristics, workforce behaviour, organisational characteristics and management of the workforce environment.

In applying an interpretive approach to the explicit themes in the documents, as recommended by qualitative methods, we drew on researcher knowledge and previous research to identify gaps and issues in the written data. The following observations reflect 'missing' information in the written records, that is, information that we anticipated would be present, given the emerging knowledge of COVID-19. To understand the significance of these points, we recognise that i) we could not know what was discussed verbally in the interchange between duty holders and inspectors, ii) the investigations took place in occupational settings where outbreaks had occurred, potentially suggesting less efficient risk management, iii) the context was changing rapidly.

We present these as points for future consideration for research:

a. The documents frequently referred to communication to all employees, either as written or verbal messaging. However, there were no/few references to employee training on managing biological risks and specifically COVID-19 transmission. Research indicates that ensuring staff are trained in risk management forms an important mechanism for improving safety in the workplace. The consistency of messaging and cascading good practice through managers to encourage changes in employee behaviour was a key point raised in the construction sector [21]. Investigating whether training for all employees had taken place, and what form this took, and if in the accessible language for employees could offer insight into potential differences in outbreaks and control in the workplace.
b. There was little reference to the involvement of employees in managing outbreaks or supporting the implementation of measures in place. It was difficult to assess the

extent and influence of employee relations within the cases, in particular involvement of workers in designing, implementing and managing control measures likely to increase adherence to guidance. Moreover, employees did not appear to contribute to the discussions during the investigations, suggesting a strongly top-down approach to control measures and a limitation in the investigation process. Not including or consulting the workforce or the Unions acting as the workers' representative when introducing new control measures on site can be a factor in poor outcomes [22-23,30]. For example, non-compliance can be inevitable in a situation where management has not fully considered how a worker can undertake the job using the mitigations proposed.

Many sectors such as warehousing, food production and packaging have large workforces with a regular turnover of staff. Exploring how to improve guidance on safety and health employee representation in decision making in high turnover sectors could form part of management action plans for future preparedness.

c. Many of the documents from investigations did not name the position or job role responsible for managing and assessing implementation of COVID-19 measures in the workplace, suggesting that in the midst of an emergency, the management for health and safety lacked clarity. Currently, there is little evidence evaluating the role of leadership in protecting health during the pandemic (reported in related PROTECT studies, such as KUBS). However, given the findings from previous research regarding the role of leadership in supporting safety in the workplace [24-25], we surmise that leadership that acts promptly, pro-actively and in close collaboration with employees could enhance workers' protection[26].
d. The factors affecting outbreaks in the workplace have been difficult to identify reliably. The investigation documents provided information relating to a single outbreak investigation and in almost all cases there was no information as to the source of the outbreak. This could give insight into how the virus entered the workplace. There was no opportunity to explore multiple outbreaks that may have been linked to the original outbreak. Similarly, the investigations could have provided a longitudinal perspective of controls and behaviour to enhance the richness of the findings.
e. As the pandemic progressed, understanding of the best approaches to controlling outbreaks increased. There was little reference to ventilation in the 58 cases examined, suggesting that businesses were initially unaware of this measure, but also raising the question of why adopting this control measure did not seem to keep pace with new knowledge and guidance emerging. Understanding the indoor environment and job tasks can identify higher risk activities relating to asymptomatic

transmission of respiratory infectious disease. For example use of conveyors, machinery and generator noise could contribute to workers using loud speaking or shouting to communicate. This has been identified as a factor in transmission in the PROTECT studies.

f. Contemporary emergency incident management planning for preventing and controlling workplace outbreaks of community-acquired respiratory infectious disease in the workplace was not observed in the records. We noted no reference in the sample of outbreak investigation records to EPRR procedures linked to general risk assessment and business continuity that existed prior to the pandemic. This suggests that businesses which typically do not operate in high risk environments (nuclear, biohazards in healthcare etc.) would benefit from support in emergency preparedness, resilience and response.

Benefits of using thematic analysis of HSE investigation records

There is merit in further analysis of the 737 dataset to identify factors that influence occupational outbreaks. Reflecting on the NP postcode n=35 outbreak investigation data, this is an interesting example that would benefit from qualitative thematic analysis of the full NP dataset. Comparing and contrasting with the example of Birmingham B postcodes, where there were 37 records of outbreaks could be explored.

Using a naturalistic data set, arising from HSE investigation records, to develop our understanding of factors contributing to outbreaks had great potential to reveal the way occupational settings were managing the crisis. The investigations, established to offer support to other agencies and workplaces, evolved as the pandemic became established and largely depended on the expertise of the inspectors. It is unclear if the investigations followed a protocol, or whether there were any expectations regarding the notes that were recorded. It is also unclear if examples of comprehensive and contemporaneous investigator notes and records were related to previous experience of the duty holder/organisation.

The findings represent the analysis of documents collated by investigators following an outbreak inspection. This could be virtual/remote or an onsite inspection. 575 documents consisted of a wide range of reports, risk assessments, emails, meeting minutes etc. The documentation suggests that a formative assessment[20] took place, indicating areas of success, aspects of concern and recommendations and guidance to minimise infection transmission in the workplace. The more usual HSE approach of summative assessment, such as judging compliance with statutory instruments, including the issuing of improvement notices, was less frequently noted because the priority was outbreak control. Consequently, the data is very variable in both quantity and quality of the information, precluding an in-

depth systematic thematic analysis. With the data available to us we were unable to extract information relating to differences in outbreak management between occupations and settings. Similarly, longitudinal tracking of changes in infection prevention and control could not be undertaken, limiting the insight generated from a thematic analysis.

Given the evolutionary nature of the investigations, additional qualitative evidence could triangulate the findings. This could support the development of protocols and guidance for a formative assessment process. Such additional evidence could include interviews with inspectors, duty holders, health and safety officers and employees to provide insight into the issues of infection prevention and control and how this changed over time.

Learning for organisations responsible for supporting and assessing businesses managing transmissible diseases

This study employed thematic analysis of outbreak investigation records to identify risk factors and control measures in workplaces. It was an exploratory study using secondary data that was collected as part of HSE's response to the COVID-19 pandemic. The following lessons could inform future research and enable a deeper understanding of the social and economic issues affecting outbreaks.

a. The opportunity to include qualitative methods in future study programmes in PROTECT and other HSE research projects can enhance the findings from quantitative studies. In this example, this is through examining how individuals and the social and economic context of the workplace promote or prevent outbreaks.
b. Outbreak investigation records varied considerably in the type and quantity of information collected. This limited the type of data recorded and the themes identified in a thematic analysis. Future research would benefit from consideration of consistency of data collection, potentially using the broad themes identified in this study as a framework for workplace discussions and investigations.
c. Incident management in transmissible disease control across all sectors was new to HSE and investigations of work places more frequently took the form of a supportive process rather than employing a traditional inspection routine. Consequently, the documentation from each investigation varied. Some written reports were informative, whilst others provided limited written information. The examples of descriptive records of adaptions made for managing outbreaks and records of discussions and recommendations, suggested that investigators were using a formative evaluation to support managers and employees to respond to the crisis. Assuming this reflected a 'best practice' approach, as judged by HSE inspectors and

shared through their networks, new methods of evaluation might be considered to guarantee more consistent recording of the process.

d. Collecting and utilising geographical and socioeconomic data in outbreak investigations and premises inspections will contribute to gleaning knowledge about the differences in regions as well as between sectors and could inform future preparedness, guidance and support for industry. The NP and B postcode outbreak investigations data would benefit from further qualitative analysis. Using region/national exemplars, designing a data collection and analysis method for future investigations to account for geographical and socioeconomic characteristics could identify further information about factors likely to contribute to workplace outbreaks.

Specific learning points from the analysis of the food sector records:

COVID-19 involved a complex interplay of risk factors demanding consideration of a number of control measures. Managing the spread of transmissible diseases will be more efficient if multiple factors and risk mitigation strategies are taken into account (e.g. engagement with workforce, ventilation, appropriate PPE, facemasks, social distancing).

a. A number of potential risk factors and control measures at an organisational level could be considered carefully in investigations alongside individual factors and measures. Specifically, sickness absence pay arrangements, ventilation measures and controls, employee engagement in facilitating social distancing and the involvement of the workers in developing the mitigation strategies in every part of the organisation.
b. Concern about poor ventilation as a risk factor emerged as the pandemic progressed. The focus during investigations tended to remain on person-to-person transmission. This underlines the importance of adapting new research to practice rapidly to inform discussion during investigations.
c. Understanding the workforce characteristics should form a central element of discussions between investigators and managers. For example, taking into account the number of workers who may have to share accommodation and transport to and from work; understanding the workforce employment patters and likelihood of employees taking second or third jobs, may help businesses prevent the spread of transmissible diseases at an earlier stage. We could not draw conclusions about the extent of health messaging communication in premises but we can deduce in sectors that rely heavily on agency and temporary staff that communication channels and mechanisms are adapted or implemented accordingly.

d. Investigations of workplace risks and control measures during a rapidly changing public health crisis depends on a flexible approach to evaluating the issues arising in each individual business. Tailoring the investigation process to the specific sectors with a mechanism for recording this in sufficient detail may help businesses monitor, appraise and review their actions as part of control and management strategies.

Conclusion

The impact of pandemic SARS-CoV-2 on workplaces highlighted knowledge gaps across all industries in relation to occupational and industrial hygiene. Safety measures are more likely to be addressed than health impacts and the complexity of exposure science and evaluation does not translate well in traditionally 'lower risk' environments for chemical, physical and biological hazards. Ventilation is a general principle of building safety and is increasingly implicated in healthy built environments. Our knowledge of occupational hygiene tells us that controls for respiratory disease must include ventilation. Similarly, gaps in the data regarding pre-pandemic emergency planning and response in low-risk biological hazard environments provides an opportunity for educating businesses in emergency preparedness. Throughout the pandemic, our findings suggest that a focus on hand-washing, social distancing and face coverings was potentially at the expense of other controls. This gap, whilst it may have been closed later in the pandemic, is an opportunity to further educate and discuss with employers knowledge and implementation of hierarchy of controls, and to research further our understanding of thermal environments, ventilation, fluid mechanics and dynamics on occupational health.

The four main themes identified in this work have been considered in previous works and are reflected in other reviews about work and health.

The Taylor Review of Modern Working Practices 'Good Work' [29] draws on the 'QuInnE' model of job quality developed by the Institute of Employment Research[30] which proposes six indicators of job quality: wages; employment quality; education and training; working conditions; work-life balance; and consultative participation and collective representation. It advocates attention on organisational culture and the beliefs and values underpinning businesses, with responsible corporate governance, the role of employee voice and consultation at the core of helping people stay healthy both in and outside of work.

In 2021, the World Health Organisation issued Preventing and mitigating COVID-19 at work: a policy brief [31]on the lack of consistency in national and sub-national policy recommendations guiding workplaces on how to prevent transmission and protect workers

from COVID-19. Recommendations emphasised the importance of using hierarchy of controls for all settings, in particular engineering and administrative/organisational controls before PPE. The report advocates instituting paid sick leave and routine screening/surveillance for COVID-19 in particular with respect to at risk and vulnerable workers.

Learning from this study of outbreak investigation records, we find the data from investigation records were variable, offering valuable insights in some instances, but limited to qualify new understanding of issues affecting outbreaks of COVID-19 in the workplace. We concluded that it was not feasible to use the investigation records, in their current format, as stand-alone evidence, to examine the risk factors and relative importance of risks/control measures, in different occupational settings. The following reasons underpin this conclusion:

i. The investigation documents are descriptive. They do not explore people's perceptions of issues contributing to or mitigating outbreaks of COVID-19
ii. Documents were very variable in their nature and content and did not represent contemporaneous notes. Importantly, they may not have reflected the true extent of the interchange between inspector and duty holder or include information discussed as part of the verbal advice
iii. The purpose of the investigations was supportive, intended to offer guidance, as a formative evaluation and do not represent a summative assessment of a set of standard measures.

The purpose of the investigations was advisory, offering guidance and recommendations, described as a "supportive process, providing advice and guidance for businesses where outbreaks have been identified." https://www.hse.gov.uk/coronavirus/regulating-health-and-safety/index.htm. Analysing the investigation records during the pandemic affords an excellent opportunity for developing an approach to investigations that are formative, adaptive and responsive. Adopting a supportive process that commends good practice, identifies issues and makes recommendations for improvement is an important approach alongside the regulatory approach of inspection to evaluate compliance using established legal tests and standards of good practice.

The documentary analysis cannot identify the range and frequency of specific workplace behaviours but helps identify the themes that investigators focused on as they evaluated and recorded workplace outbreaks. Documentary analysis is a valuable tool for analysing records however, the data set of investigation records is highly variable and presents

challenges to reliably reveal new perspectives and knowledge to extend our understanding of disease outbreaks and the effectiveness of controls in workplaces.

The variable data quality and quantity per outbreak investigation prevents case-by-case comparisons. For future research projects, completion of data fields within a prescribed format will be very helpful in generating descriptive and possibly more detailed statistical analysis. Whilst the pattern of outbreaks in the sample is interesting it is not possible to extrapolate to represent regions or sectors. Complete sets of data can minimise limitations, particularly where data collection methods are designed with specific aims and objectives. It is useful to reflect on what the data could not reveal: the discussions and advice that took place between investigators and managers may have been extensive, but unrecorded. Similarly, an opportunity to interview employers, employees and investigators about the outbreak and investigations could have enhanced the interpretation of the thematic analysis.

These challenges aside this was an excellent opportunity to glean knowledge and understanding from a large-scale secondary data set such as investigation records. It was an opportunity to undertake a rapid review of concerns and perceptions recorded in the records. Working with a specific data set that is not designed in response to specific research questions was challenging but we are confident that learning from this process can inform future data collection for qualitative analysis research in this area.

Recommendations

- Systematic approaches to data collection, from statutory inspections and outbreak investigations, with study designs in mind and including triangulation of data through closer observations (such as interviews) of employer and employees will benefit future research.
- Formative evaluation through discussion with employers and employees across the business spectrum on factors such as training, contractual arrangements, employee participation and collaboration in worker health protection interventions, focusing on developments and improvements in the workplace, can inform research into preparedness and management of acute and chronic workplace hazards and risks.
- Enduring prevalence research in the PROTECT study revealed higher proportions of people working in lower skilled occupations was associated with barriers to self-isolation and working remotely. Studies to understand structural factors at work

including deprivation, employment and housing in areas with high numbers of occupational outbreaks can be developed possibly based upon the dataset used in this work, particularly considering further application of postcode data and SIC code. Further thematic analysis of specific sectors in the dataset may be worthwhile.

- Research projects to assess design and implementation of management controls for emergency planning, preparedness and response in high-risk sectors could inform future response and controls. Findings could contribute to national guidance, to best practice, and support employers achieve controls that are ‘as low as reasonably practicable’/ ‘in so far as is reasonably practicable’ to ensure the health, safety and welfare of their employees and workers for future communicable disease hazards.

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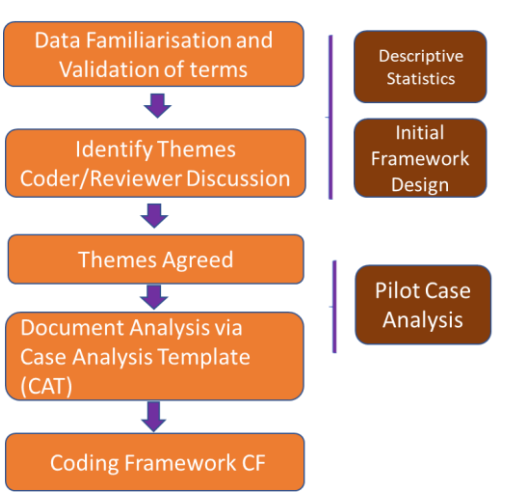
Appendices

Appendix A

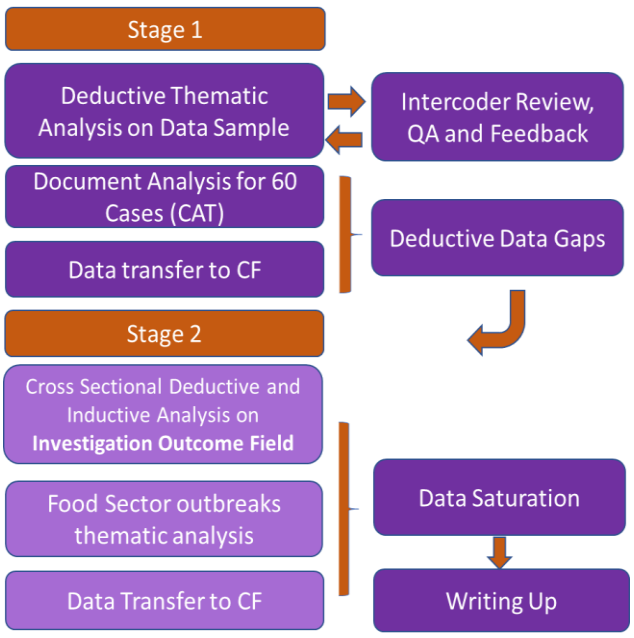
Schematic method of workflow for developing the Coding Framework



A Coding Framework was used to collect the data from each reviewer in relation to identified and emerging themes across the 58 outbreaks investigations. Two researchers had experience of occupational safety and health site investigations and outbreak management. 4 reviewers had varied experience in other sectors and identified and transcribed detailed information into the framework.

When researchers completed the outbreak analysis coding framework, the identification of themes was realised through inductive and deductive analysis, both in reading and reviewing the coding frameworks and in conversations within the research team. This informed discussions about confidence that data saturation had been reached. The food sector outbreaks thematic analysis formed part of the data saturation exercise and contributed to the identification of the 4 main themes in the writing up.

Schematic Method of Workflow for conducting Thematic Analysis



Stage 1 comprised a deductive and purposive in-depth qualitative analysis of 60 investigation records from occupational settings.

Stage 2 was inductive and evaluative in identifying themes from the document analysis.

The analysis is an iterative process conducted over a period of time. Presentation of early findings through to final research conclusions showed changes in how the findings were represented.
This is because of the deductive and inductive processes involved in thematic analysis.

Appendix B

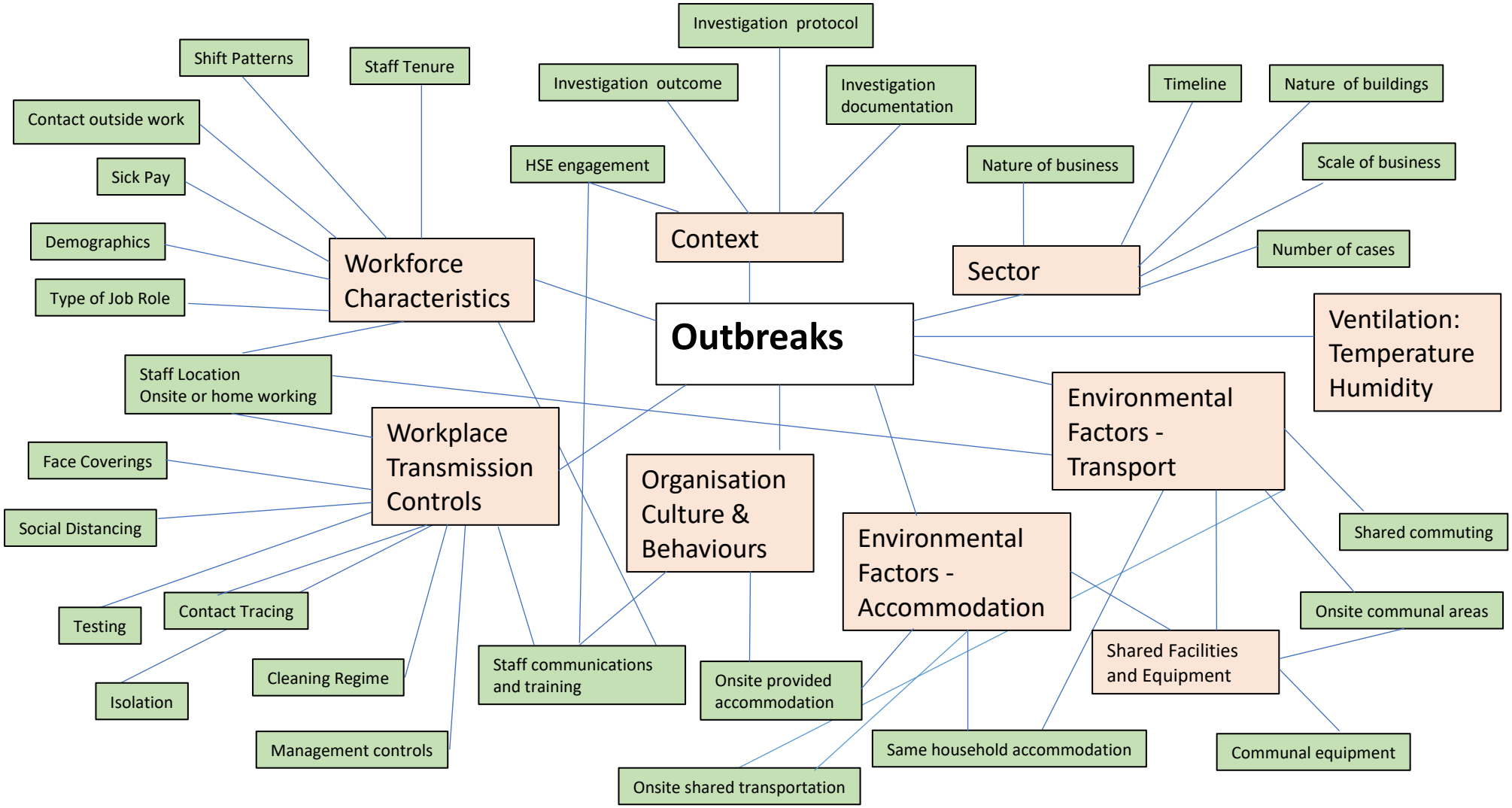
Outbreak investigations by Site SIC Code and Description n=737

Site SIC Code 2-Digit	SIC code description	737	
01	Crop and animal production;	10	1.4%
02	Forestry and logging	1	0.1%
03	Fishing and aquaculture	2	0.3%
05	Mining of coal and lignite	2	0.3%
10	Manufacture of food products	175	23.7%
13	Manufacture of textiles	15	2.0%
14	Manufacture of wearing apparel	4	0.5%
15	Manufacture of leather and related products	1	0.1%
16	Manufacture of wood and of products of wood and cork; except furniture; manufacture of articles of straw and plaiting materials	12	1.6%
17	Manufacture of paper and paper products	14	1.9%
18	Printing and reproduction of recorded media	2	0.3%
20	Manufacture of chemicals and chemical products	6	0.8%
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	4	0.5%
22	Manufacture of rubber and plastic products	21	2.8%
23	Manufacture of other non-metallic mineral products	13	1.8%
24	Manufacture of basic metals	12	1.6%
25	Manufacture of fabricated metal products; except machinery and equipment	33	4.5%
26	Manufacture of computer; electronic and optical products	3	0.4%
27	Manufacture of electrical equipment	9	1.2%
28	Manufacture of machinery and equipment n.e.c.	24	3.3%
29	Manufacture of motor vehicles; trailers and semi-trailers	29	3.9%
30	Manufacture of other transport equipment	12	1.6%
31	Manufacture of furniture	18	2.4%
32	Other manufacturing	21	2.8%
33	Repair and installation of machinery and equipment	2	0.3%
35	Electricity; gas; steam and air conditioning supply	3	0.4%

37	Sewerage	2	0.3%
38	Waste collection; treatment and disposal activities; materials recovery	7	0.9%
41	Construction of buildings	27	3.7%
42	Civil engineering	4	0.5%
43	Specialised construction activities	7	0.9%
45	Wholesale and retail trade and repair of motor vehicles and motorcycles	13	1.8%
46	Wholesale trade; except of motor vehicles and motorcycles	17	2.3%
47	Retail trade; except of motor vehicles and motorcycles	6	0.8%
49	Land transport and transport via pipelines	24	3.3%
52	Warehousing and support activities for transportation	8	1.1%
53	Postal and courier activities	17	2.3%
56	Food and beverage service activities	1	0.1%
59	Motion picture; video and television programme production; sound recording and music publishing activities	2	0.3%
62	Computer programming; consultancy and related activities	1	0.1%
64	Financial service activities; except insurance and pension funding	2	0.3%
68	Real estate activities	1	0.1%
70	Activities of head offices; management consultancy activities	2	0.3%
71	Architectural and engineering activities; technical testing and analysis	2	0.3%
72	Scientific research and development	3	0.4%
75	Veterinary activities	3	0.4%
77	Rental and leasing activities	2	0.3%
82	Office administrative; office support and other business support activities	10	1.4%
84	Public administration and defence; compulsory social security	37	5.0%
85	Education	38	5.2%
86	Human health activities	25	3.4%
87	Residential care activities	17	2.3%
88	Social work activities without accommodation	3	0.4%
90	Creative; arts and entertainment activities	1	0.1%
95	Repair of computers and personal and household goods	2	0.3%
96	Other personal service activities	5	0.7%

Appendix C

Thematic Analysis Map of risk factors



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'.

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