STUDY PROTOCOL

The COVID-OUT study protocol: COVID-19 outbreak investigation to understand workplace SARS-CoV-2 transmission in the United Kingdom [version 1; peer review: awaiting peer review]

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Abstract

Preventing SARS-CoV-2 transmission and protecting people from COVID-19 is the most significant public health challenge faced in recent years. COVID-19 outbreaks are occurring in workplaces and evidence is needed to support effective strategies to prevent and control these outbreaks. Investigations into these outbreaks are routinely undertaken by public health bodies and regulators in the United Kingdom (UK); however, such investigations are typically disparate in nature with a lack of consistency across all investigations, preventing meaningful analysis of the data collected.

The COVID-OUT (COVID-19 Outbreak investigation to Understand Transmission) study aims to collect a consistent set of data in a systematic way from workplaces that are experiencing outbreaks, to understand SARS-CoV-2 transmission risk factors, transmission routes, and the role they play in the COVID-19 outbreaks.

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Suitable outbreak sites are identified from public health bodies. Following employer consent to participate, the study will recruit workers from workplaces where there are active outbreaks. The study will utilise data already collected as part of routine public health outbreak investigations and collect additional data through a comprehensive questionnaire, viral and serologic testing of workers, surface sampling, viral genome sequencing, and an environmental assessment of building plans, ventilation and current control measures. At each site, a detailed investigation will be carried out to evaluate transmission routes. A case-control approach will be used to compare workers who have and have not had SARS-CoV-2 infections during the outbreak period to assess transmission risk factors. Data from different outbreaks will be combined for pooled analyses to identify common risk factors, as well as factors that differ between outbreaks.

The COVID-OUT study can contribute to a better understanding of why COVID-19 outbreaks associated with workplaces occur and how to prevent these outbreaks from happening in the future.

Keywords
COVID-19, SARS-CoV-2, outbreak, investigation, transmission, environment, workplace, epidemiology

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Introduction

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is a highly transmissible virus that has caused a pandemic of the "coronavirus disease 2019" (COVID-19)[1]. The relative contributions of different routes of transmission are not well understood, including droplets and potential roles of close-range airborne routes, long-range inhalation of aerosols, and contact with contaminated surfaces[2]. Uncertainties remain on what extent environmental factors, such as temperature, humidity and ventilation, can alter the dynamics of transmission in a range of indoor settings[3,4]. In October 2020, the United Kingdom (UK) established the COVID-19 National Core Studies (NCS), including a programme on Transmission and Environment, which is also known as "PROTECT": The Partnership for Research into Occupational, Transport and Environmental Covid NCS. This programme aims to provide critical evidence to prevent or more effectively control SARS-CoV-2 transmission in all potential exposure scenarios (e.g. in workplaces). The COVID-OUT (COVID-19 Outbreak investigation to Understand Transmission) study is part of Theme 1 of this wider programme and will specific focus on investigating COVID-19 outbreaks in the workplace[5]. This study is coordinated by the Health and Safety Executive (HSE) in collaboration with Public Health England (PHE), the University of Manchester (UoM) and the London School of Hygiene & Tropical Medicine (LSHTM).

Since the start of the pandemic, COVID-19 outbreaks have been reported in congregate settings, such as workplaces, schools, care homes, and hospitals. A PHE surveillance report of COVID-19 in England reported 645 of the 4,145 confirmed or suspected outbreaks of acute respiratory infections were linked to a workplace setting over a 4-week period, between November and December 2020[6]. A survey conducted by the European Centre for Disease Prevention and Control (ECDC) reported a total of 1,377 COVID-19 clusters in workplace settings across 13 EU/EEA countries and the UK between March and July 2020, which included 153 clusters in food packing and processing plants, 77 in non-food manufacturing facilities and 65 in office settings[7]. Factors associated with increased risks of viral transmission and outbreak occurrence in a workplace are *a priori* likely to be complex and could be related to worker's underlying health conditions; socio-economic position and living conditions (e.g. household crowding); preventative behaviours (e.g. adherence to physical distancing interventions, hand washing and wearing a face covering); nature of contacts and social interactions at work, outside of work or on the way to/from work; the physical workplace environment, as well as the types and effectiveness of control measures implemented.

In the UK, investigations into COVID-19 outbreaks in workplaces are routinely undertaken by public health bodies (e.g. PHE and local authority public health departments) and regulators (e.g. HSE). Due to the diversity of situations that occur, and the bespoke approaches needed for these, there is inconsistency in the types and quality of data collected across these investigations, limiting the potential for meaningful joint analyses of and comparisons between outbreaks at present. The COVID-OUT study will apply a standardised approach to workplace outbreak investigations in order to generate optimal data for research.

The COVID-OUT study aims to understand SARS-CoV-2 transmission risk factors, transmission routes, and their relative importance in COVID-19 outbreaks associated with workplaces. The primary objectives are: 1) to understand the potential risk factors for SARS-CoV-2 transmission associated with workers and work activities in workplace outbreaks; 2) to identify key characteristics associated with the workplace settings that could enhance viral transmission, and their relative importance in workplace outbreaks; and 3) to understand the potential transmission routes of SARS-CoV-2 in a workplace outbreak. The secondary objectives are: a) to estimate the number and proportion of SARS-CoV-2 infections in a workplace outbreak; b) to estimate the number and proportion of asymptomatic infections in a workplace outbreak; c) to evaluate the contribution of asymptomatic and pre-symptomatic transmissions to workplace outbreaks; d) to assess SARS-CoV-2 environmental contamination and its links to transmission within a workplace outbreak; and e) to generate evidence on the effectiveness of a range of control measures currently implemented in preventing COVID-19 transmission in workplaces.

The study is designed to achieve its aims and objectives through analysing data collected in real-time during ongoing COVID-19 outbreaks in workplaces in the UK.

Protocol

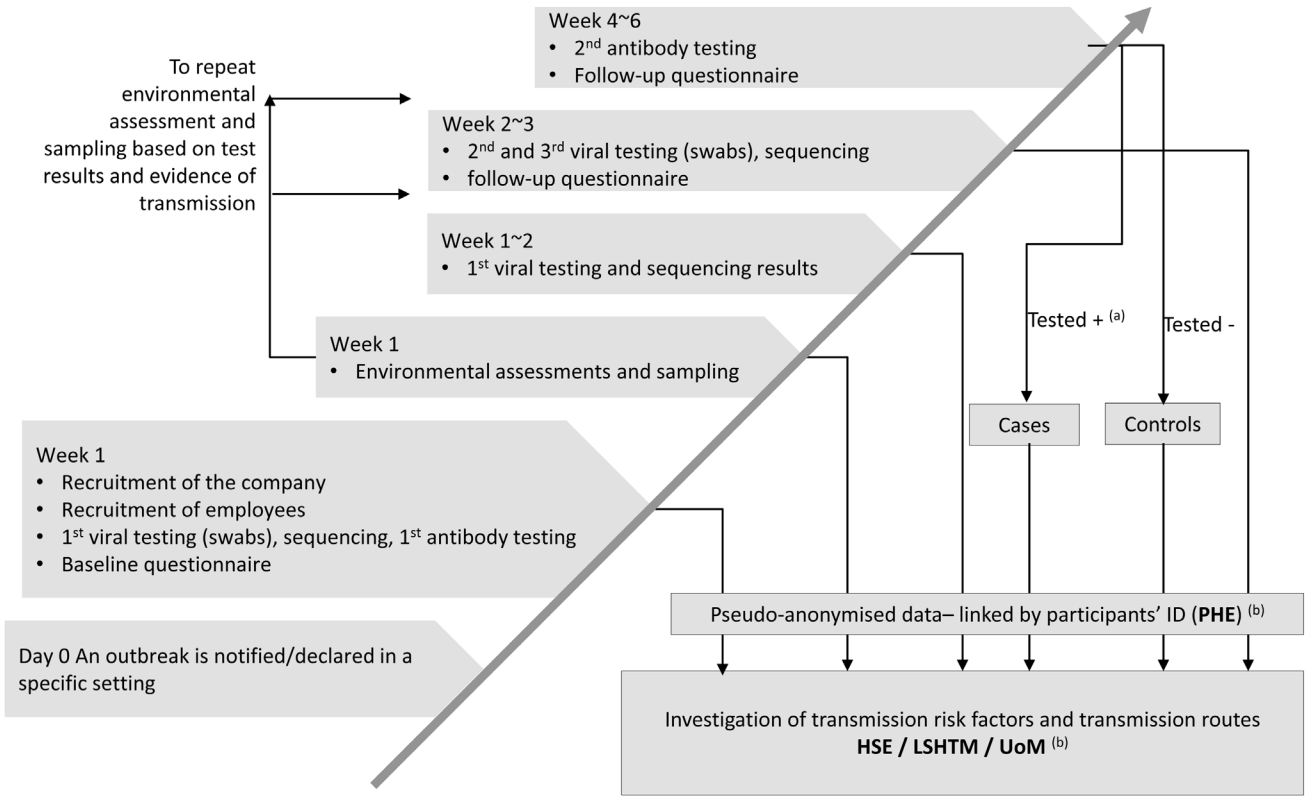
Study design overview

At each site, a detailed outbreak investigation will be conducted to evaluate potential transmission routes and a case-control approach will be used to assess transmission risk factors by comparing workers who have and have not had SARS-CoV-2 infections during the outbreak period.

Comprehensive data on workers and their work environments will be collected via questionnaires, biological sampling of workers (e.g. viral testing and genomic sequencing, and antibody testing) and environmental assessment and sampling (Figure 1).

A general data framework (Table 1), together with data collection tools, has been developed. These will be applied consistently to collect data from outbreak investigations in a range of workplace settings, so that data from multiple outbreaks can be pooled together to increase statistical power.

The COVID-OUT study has been designed using a set of relevant World Health Organization (WHO) COVID-19 Early Investigation Protocols, including the protocol for the assessment of risk factors for COVID-19 in health workers[8], the investigation protocol for the first few cases and contacts[9], the seroepidemiological investigation protocol[10] and the protocol for surface sampling[11]. These protocols have been combined and adapted for the investigation of workplace outbreaks in the UK.



(a)Tested +: Positive results in any viral tests or antibody test results turning from negative at the start to positive six weeks later

(b) PHE: Public Health England; HSE: Health and Safety Executive; LSHTM: London School of Hygiene & Tropical Medicine; and UoM: the University of Manchester

Figure 1. The COVID-OUT study activity flow chart.

Table 1. A general data collection framework for COVID-19 outbreak investigation.

1. Data at the individual level
○ Study participants' current infection status will be assessed using viral tests (diagnostic RT-PCR assays) and their past infection status using antibody tests.
○ Positive PCR samples will be further assessed via whole genome sequencing to support phylogenetic analysis.
○ Further data from participants will be collected using questionnaires, including demography, ethnicity, baseline health, history of COVID-19-related symptoms, tests and vaccination, employment contract, financial impact of self-isolation, work activities, nature of interactions within work and outside of work, hand hygiene, face covering, method of travel to work, living conditions and recent history of travel.
2. Data at the workplace environmental level
○ Influencing factors of viral exposure and transmission will be measured, including building layout, ventilation, temperature, humidity, air movement and noise level through environmental assessment. These will provide opportunities to link laboratory-confirmed cases with potential sources of infection.
○ The work environment will be sampled to measure the quantity of viral RNA from high-risk environments, in particular those linked to work areas from recent positive cases and communal areas.
○ Any environmental samples producing high levels of viral RNA will be further assessed by whole genome sequencing and viral isolation.

3. Data at the worker population level

- Data relating to the workforce will be collected, including shift patterns, break time, sick pay policy, organised transportation for workers travelling to and from work, potential working in fixed groups, and potential onsite accommodation.
- Observational assessments will be conducted on population density, movement of groups of workers and their connectivity, and the nature of the work activities.
- Observation assessments will be carried out on control measures implemented (e.g. physical distancing, using barriers, face covering, cleaning and other controls), time and location of control measure implementation, general adherence, and potential changes of these before and after the outbreak was declared.

A general data framework and data collection tools

A general data framework, based on knowledge acquired from previous responses to global emerging pathogens[12,13], and considering individual, environmental, and population level data, has been developed for this study to assist in the conduct of a comprehensive investigation of outbreaks in workplaces (Table 1).

In accordance with the general data framework, a set of core data collection tools have been developed that can be applied consistently to the study across multiple outbreak sites. These are described as follows:

Questionnaire[14]. A two-part, online, self-administered questionnaire was developed based on the European OMEGA-NET COVID-19 Questionnaires[15] and a PHE outbreak investigation checklist. In consultation with National Core Study programme scientists and HSE inspectors, additional questions were created and piloted to assess close contacts, control measures, talking loudly due to high noise level, ventilation, history of COVID-19 testing, and vaccination status. The questionnaire includes: 1) a baseline questionnaire to collect data from study participants at the beginning of the study, and 2) a follow-up questionnaire before each subsequent biological sample collection (RT-PCR and serology tests) to collect data on recent symptoms and vaccination.

Personal biological sampling and testing

1) *Viral testing and whole genome sequencing (WGS) of the virus*

   Three rounds of RT-PCR (real-time reverse transcription – polymerase chain reaction) testing will be offered to all participants to identify active SARS-CoV-2 infections. Participants will self-administer nose and throat swabs once a week for three consecutive weeks. A pictorial instruction with a link to a YouTube video for taking swab samples will be provided. Demonstration and supervision for taking swab samples will also be provided by on-site study team members. Swab samples will be sent directly to the PHE laboratory (Porton Down, UK) for RT-PCR, using Roche Cobas SARS-CoV-2 Test[16]. Home swab tests will also be arranged for participants who are absent from the workplace due to sickness, self-isolation or other reasons. Positive nose and throat swab samples showing high levels of viral RNA (i.e. Crossing threshold (Ct) value of ≤ 35) will be assessed via WGS to detect individual SARS-CoV-2 genotypes, and better understand chains of transmission and transmission routes.

2) *Antibody testing*

   Two rounds of antibody testing, 4-6 weeks apart, will be offered to all participants to identify individuals with pre-exiting SARS-CoV-2 antibodies and individuals who seroconvert during the study. A sample of venous blood (5ml) will be taken by a qualified phlebotomist at the workplace. The sample will be collected and transported the same day to the PHE Porton laboratory for analysis, using Roche Elecsys N (nucleocapsid) and S (spike protein) antibody tests[17]. The potential antibody test results and their interpretations are listed in Table 2.

Environmental assessment, sampling and WGS. A data collection framework for environmental assessment has been developed for this study[18], which maps out information to be collected consistently across COVID-19 outbreak sites. For each site, contextual information on the physical work environment is collected including location of spaces, typical occupancy and usage, types of work activities, ventilation and heating/cooling systems and measures applied in the workplace to mitigate COVID-19 transmission. Environmental sampling will be carried out to collect surface samples from work locations associated with confirmed cases including high-touch surfaces (e.g. door handles), infrequently touched surfaces (e.g. top of cupboard) and communal areas (e.g. locker rooms, canteen) for the quantitative assessment of viral contamination. These samples are collected using wetted swabs or sponges from surfaces in the workplace and returned to PHE-Porton laboratory for analysis, using a two target (nucleocapside and ORF1ab) RT-PCR assay (Viasure, Zaragoza, Spain) to detect and quantify viral RNA. Positive samples with Ct values ≤35 will be further analysed via WGS. Viral isolation will be undertaken on samples with a Ct value ≤32.

Study setting and study population

The COVID-OUT study will be conducted at workplaces with on-going COVID-19 outbreaks identified between December 2020 and March 2022. According to PHE, an outbreak in a non-residential setting requires two or more test-confirmed

Table 2. SARS-CoV-2 antibody test results and interpretation.

Roche N antibody	Roche S antibody	Interpretation
N-	S-	Consistent with no SARS-CoV-2 infection and no COVID-19 vaccination
N-	S+	Consistent with COVID-19 vaccination and no SARS-CoV-2 infection in the past
N+	S-	Consistent with past SARS-CoV-2 infection and no COVID-19 vaccination (Note: most people with past SARS-CoV-2 infection should develop both N and S antibodies)
N+	S+	Consistent with previous SARS-CoV-2 infection and may or may not have received a COVID-19 vaccine

Antibody test method: Roche Elecsys

N-: Nucleocapsid antibody test negative; N+: Nucleocapsid antibody test positive;

S-: Spike protein antibody test negative; S+: Spike protein antibody test positive;

cases of COVID-19 among individuals associated with the setting, with illness onset dates within 14 days, and with additional evidence of direct exposure between at least two of the test-confirmed cases in that setting or absence of an alternative source of infection outside the setting for the initial identified cases[19]. For the purposes of this study, workplaces are defined using PHE categories in community surveillance of COVID-19. Care homes, hospitals, educational settings, prisons, and food outlet/restaurant settings are excluded[6]. Separate studies have been conducted in these sectors[20–23].

When recruiting sites, this study will not be limited to specific type of workplaces or large enterprises. However, sectors such as food or non-food manufacturing plants, warehouses, goods distribution centres and large offices, will be prioritised as these workplaces are more likely to experience large outbreaks[24]. Identification of outbreaks and the associated population for this study are described as follows:

Identifying COVID-19 outbreaks. The criteria for outbreak eligibility for the COVID-OUT study are:

1) Outbreaks in food processing plants, general manufacturing facilities, packaging and distribution centres, or large office buildings, with 100 workers or more in any of these sites;

2) An attack rate (i.e. the proportion of the workers who become infected[25]) of 5% or more at the time of notification. An outbreak with an attack rate below 5% but with five confirmed cases or more in a workplace, will be monitored and included if the outbreak is considered likely to expand further in the next 1–2 weeks based on evidence gathered by the local public health team.

Early alerts of suitable outbreak sites for the study will be provided by PHE and HSE through their daily assessment of outbreaks/clusters reported in a range of workplace settings. Additional mechanisms for getting early notifications include reports from regional networks of Directors of Public Health, local authority public health departments and large membership organisations, following the pro-active stakeholder engagement of the study team.

Defining the outbreak setting and exposure period. At each site, the work area affected by the outbreak will be defined, which could include a whole factory with multiple buildings, a facility, a single building or an area within a building. A specific time period of potential exposure for individuals working within this site will be defined. The exposure period starts 2 days before the onset of symptoms (or, for an asymptomatic worker, 2 days before their first positive viral test) in the first confirmed case[26]. The PHE criteria for declaring an outbreak over is a period of 28 days after the symptom onset date of the last confirmed case[19].

Defining the study population. The study includes all workers who have been present in the outbreak setting during the potential exposure period as defined above, including workers who are subsequently on sick leave or self-isolating. Workers may include, but are not limited to, all employees, contractors, agency workers and other personnel who perform work at the facility or work setting (e.g. cleaners and security guards who may be employed by different companies). This study will exclude vulnerable adults with mental incapacity or adults in custodial care. In addition, due to tracking constraints, visitors to the outbreak setting will not be eligible for inclusion. Information on the visitor population of the outbreak sites will be collected, where possible, to assess potential implications for transmission.

Recruitment

Soon after an outbreak is notified by PHE or HSE (Figure 1), with agreement of the local public health team or HSE

inspectors, a teleconference/video conference will be arranged for the field study team to engage with the company/employer responsible for the outbreak site.

The study Information Sheet for Employers[27] and the Employer Consent Form will be provided electronically to the employer to seek consent for participation in the study. The Information Sheet provides information on the nature of the study and what the study will entail. By signing the Consent Form, the employer agrees to take part in the study, gives permission for site access and for onsite data collection, and allows employees to complete study associated activities within working hours as required.

Upon successful recruitment of the outbreak site, the study team will recruit eligible workers to the study. The employer will help to identify the work areas affected by the outbreak and all workers who have been present in the outbreak area during the at-risk exposure period.

A suitable way to contact and recruit workers to the study will be discussed and developed between the employer and the study team. The study team will not have contact information for workers before they are recruited, and only the employer will have this information. Therefore, the cooperation of the employer will be essential to recruiting workers on to the study. The employer may send an email to invite workers to take part in the study by sharing the study Information Sheet for Workers[28], and links to the online Worker Consent Form and the online study questionnaire[14]. The Information Sheet explains to workers the nature of the study, the purpose of the study, what their participation entails, and that participation is voluntary. Participants will be asked to provide their informed consent to a list of activities. Each activity is listed separately in the consent form, allowing participants to consent to some or all activities. Workers will be given the chance to ask questions before consenting. For workers who do not have internet access, paper copies of the Information Sheet, Consent Form and questionnaire will be available on site. To improve participation rates, a member of the study team will be available on site to assist with recruitment and answer queries.

Eligible participants will be provided with contact information (e.g. phone number or email) of the study coordinator, who they can contact directly to consent to the study, to complete the questionnaire over the phone, or if they want further information.

In situations where eligible participants do not read or speak English, all recruitment materials will be translated into their native language, where feasible, in the timeframe of the study. Language translation services from PHE and HSE will be used for this purpose.

Data collection

Data collection activities are outlined in the study flow chart (Figure 1). After giving informed consent, participants will complete the study baseline questionnaire online or on paper[14].

Participants are invited to have a paired blood test for antibodies against SARS-CoV-2, the first in Week 1 and the second one in Week 6. Participants will be asked to complete a short follow-up questionnaire about any recent symptoms or vaccination between the two antibody tests.

Participants will be asked to provide nose and throat swab samples to test for current SARS-CoV-2 infection in Week 1, 2 and 3. Positive swab samples will be sent for WGS to identify the specific viral strain. Participants will also be asked to complete a short follow-up questionnaire about any recent symptoms or vaccination since their last swab test.

An environmental assessment visit of the workplace will be conducted as soon as employer consent is obtained. Depending on the progression of each outbreak, a repeat visit for further environmental sampling may be required.

Employers will be asked to share with the study team information on workforce COVID-19 testing, where available, including the numbers and dates of positive cases found among workers and the location of their work areas. This information will be provided to the study team in a de-identified format.

Sample size

The study will use a case-control design to evaluate risk factors for SARS-CoV-2 transmission[29]. Statistical power is calculated for a range of scenarios of combined study population size and attack rate to detect an odds ratio (OR) of 2, for a binary risk factor with 50% prevalence (Table 3). In order to have an adequate statistical power (≥80%) to evaluate common transmission risk factors for an outbreak, the study would need 600 participants and a 10% cumulative attack rate, or 400 participants and a 20% cumulative attack rate. However, if the attack rate in an outbreak is only 5%, the study will need a much larger study population size (>1000). Pooled analyses

Table 3. Statistical power calculations.

Population size	Power to detect an odds ratio of 2 for a binary risk factor with 50% prevalence		
	5% attack rate	10% attack rate	20% attack rate
100	0.19 (19%)	0.27	0.39
200	0.28	0.42	0.61
400	0.44	0.66	0.86
600	0.58	0.81	0.95
700	0.63	0.86	0.98
800	0.69	0.90	0.99
900	0.73	0.93	0.99
1,000	0.77	0.95	1.00

of data collected from multiple outbreak sites will increase the sample size and statistical power. In such a scenario, a sufficient number of participants could be achieved through five to ten individual outbreak investigations, depending upon the numbers of workers at each site and the achieved participation rates.

Data analysis

Outbreak dynamics. For each outbreak site, a descriptive analysis will be conducted. The number of viral test-confirmed COVID-19 cases will be plotted to create an epidemic curve (epicurve) to assist rapid assessment of outbreak dynamics. Viral test-confirmed cases will also be plotted on a site map to visualise the distribution of cases which may guide the environmental sampling strategy and help to assess spatial dynamics of the outbreak. These findings will be combined with the environmental assessment results to support the generation of hypotheses about the potential factors contributing to the outbreak[13,30].

Environmental sampling results. Environmental sampling and analysis will provide evidence of SARS-CoV-2 contamination in different locations of the work environment. WGS of the positive samples collected from workers and from the work surfaces may identify clusters of identical SARS-CoV-2 virus strains which may uncover potential transmission links between infected workers, and between workers and the work environment. These will help to better understand potential transmission routes, their relative importance and the associated risk factors[31].

Case-control analysis. To assess transmission risk factors, a case-control study will be used to compare workers who have and have not been infected with SARS-CoV-2 during the outbreak period[32]. Cases and controls will be identified based on the laboratory test results. Workers with a laboratory-confirmed SARS-CoV-2 infection will be identified as cases and other workers in the same outbreak setting without infection will be identified as controls. Here, a case of laboratory-confirmed SARS-CoV-2 infection means an individual has either a positive result in any PCR test or has an antibody test result turning from negative to positive that is not due to SARS-CoV-2 vaccination. Both cases and controls will be from the same source population, because all eligible workers from the outbreak site will be invited to take part in the study. All study participants will be offered SARS-CoV-2 testing. The baseline questionnaire will collect possible exposure data from workers before tests are conducted to reduce potential recall bias. The analysis will use standard modelling strategies[33], including: 1) Descriptive analyses of the characteristics of the workforce under the study, the study participants, and comparisons between cases and controls; 2) Univariate analyses to consider each of the potential risk factors in turn and estimate their odds ratio, adjusted for age and sex; 3) Multiple regression analyses to estimate the odds ratio of the potential risk factors, adjusting for age, sex, and other possible confounders; and 4) Effect modification analyses for variables that are of a *priori* interest[34]. Pooled analyses across multiple outbreak sites will be carried out as described above, with adjustments for sites being considered a potential effect modifier. Data analyses will be performed using Stata version 17 and R version 3.6.2 (2019-12-12).

Ethical approval

The COVID-OUT study has been approved by the NHS North East Research Ethics Committee (Reference 20/NE/0282).

Data confidentiality

The participants' personal data will be protected by the Data Protection Act 2018, and the General Data Protection Regulations. Figure 2 summarises the flow of data in the study and the role of different study partners in data collection, processing and use.

The research findings will be published anonymously, and no study participant or outbreak site will be identifiable from reports or scientific publications.

Dissemination plans

Key findings will be reported back to the employers and other key stakeholders in the form of individual site reports. Presentations at scientific meetings and conferences as well as peer-reviewed open access publications will be used to disseminate the wider findings of the study.

As this study is a component of the National Core Studies, data from this study will be anonymised and made available through the Trusted Research Environments (TREs) in another National Core Study on Data and Connectivity to support national COVID-19 research.

Conclusions/discussion

Although there are many COVID-19 outbreaks in workplaces, comprehensive epidemiological field studies investigating SARS-CoV-2 transmission risk factors and transmission routes in workplaces are rarely reported in the scientific literature[35]. Prior to this study, the public health response to outbreaks in the UK focused on controlling the individual outbreaks. The COVID-OUT study aims to investigate multiple workplaces that are experiencing outbreaks to better understand the transmission risk factors and to help prevent and mitigate future outbreaks. To achieve these, the study will utilise data already collected as part of routine public health outbreak investigations and collect additional data through a comprehensive questionnaire, viral and serologic testing of workers, surface sampling, viral genome sequencing, and an environmental assessment for research purposes. A multiagency study team is formed, bringing together the necessary resource and a group of interdisciplinary scientists required to address the research questions set out for the COVID-OUT study.

A critical aspect of the success of this approach is getting early notifications of workplace outbreaks to facilitate early engagement, recruitment and data collection. For example, the collection of environmental samples would ideally be as close to the peak of the outbreak as practicable. Access to the

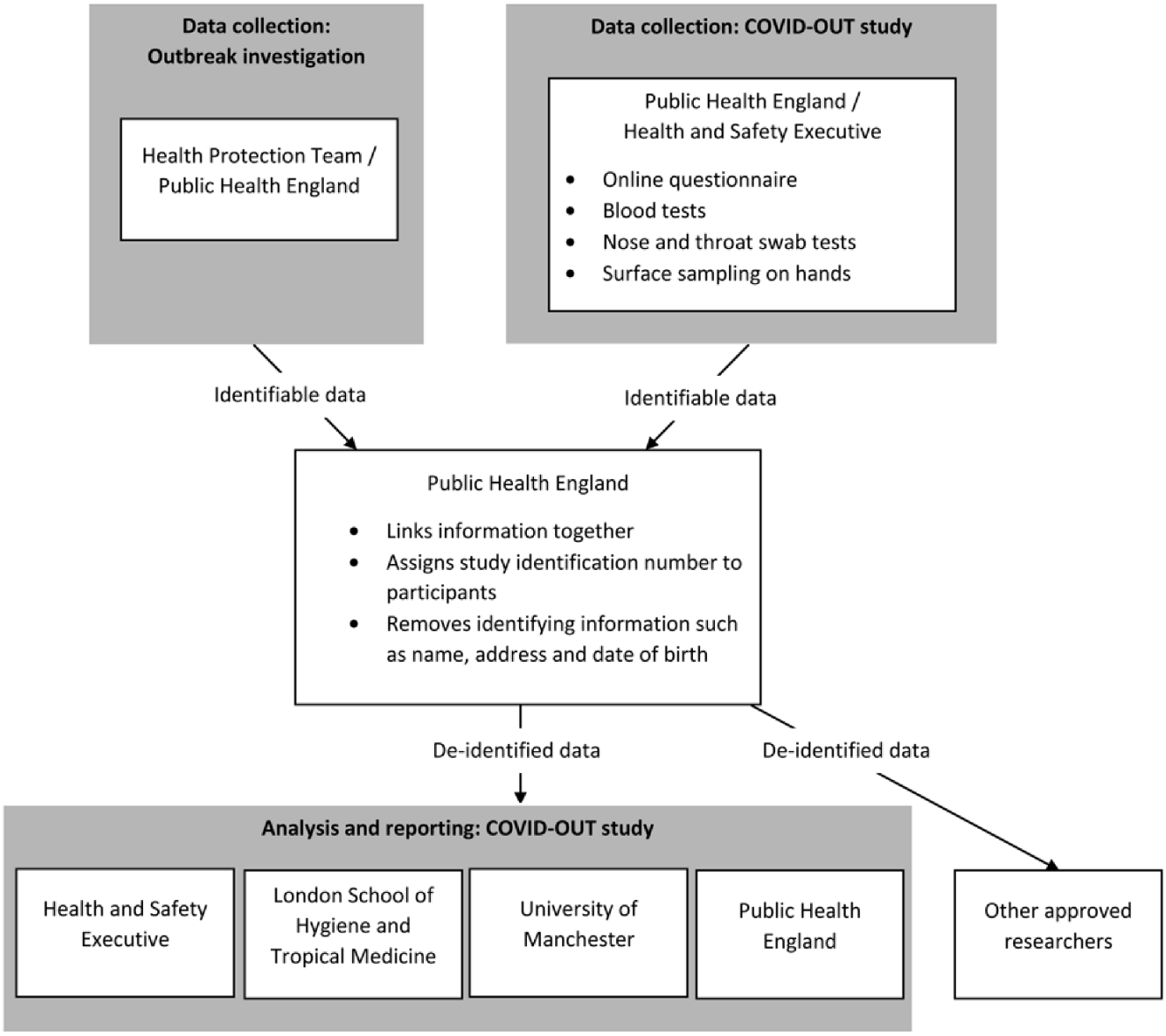


Figure 2. The COVID-OUT study data flow chart.

centralised PHE COVID-19 workplace outbreak surveillance data repository should allow for early recruitment, in addition to the identification of sectors that are more likely to experience outbreaks, such as food manufacturing plants, non-food manufacturing plants, warehouses and goods distribution centres[24]. Many of these sectors are part of the national critical infrastructure and have been operating throughout the pandemic. When outbreaks occur in these sectors, affecting a large number of workers, employers are under pressure to control the outbreaks and to keep the businesses operational, which may compromise our study participation rates. However, if businesses are willing to take part in the study and the worker participation rate is high, the study will identify more completely and rapidly SARS-CoV-2 positive cases in the workplace, and thereby improve isolation rates among infected people and break chains of transmission. This will allow for a quicker return to a safe working environment, thereby helping to protect and enable business continuity. This study will also carry out assessments of the work environment and working practices that may increase risk of transmission of the virus, such as sub-standard hygiene practices or insufficient ventilation. These findings have the potential to improve control measures and prevent further transmission at the affected sites, but also to inform policy at national and

international levels, provided specific data can be obtained to identify risk factors of SARS-CoV-2 transmission and outbreaks.

The risk of transmission is continuous. A worker or a workplace setting could be part of a network of transmission events, and any workplace could act as a vehicle for transmission. Therefore, transmission risk factors associated with workplaces or work activities cannot be considered in isolation. This study is designed to comprehensively understand the factors that may contribute to workplace outbreaks. The findings of this study will lead to greater understanding of how and why outbreaks are occurring, which, in turn, will provide insights on how to prevent the spread of the virus and make workplaces more COVID-safe. This will help keep businesses open while keeping people healthy and safe.

Data availability

Underlying data

No data are associated with this article.

Extended data

Open Science Framework: COVID-19 risk questionnaire for workers – COVID-OUT study, https://doi.org/10.17605/OSF.IO/WR8PH[14]

Open Science Framework: Information Sheet for Employers – COVID-OUT study, https://doi.org/10.17605/OSF.IO/7A285[27]

Open Science Framework: Information Sheet for Workers – COVID-Out study, https://doi.org/10.17605/OSF.IO/GDXCN[28]

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Disclaimer

The contents of this paper, including any opinions and/or conclusions expressed, are those of the authors alone and do not necessarily reflect HSE policy.

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