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Title (*Maximum ten words):*

An outbreak of SARS-CoV-2 in a public-facing office in England, 2021

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Word Counts:

Abstract – 250 (max 250)

Teaser text – 74 (max 75)

Main text – 2876 (max 3000)

Abstract *(maximum 250 words)*

Background: An outbreak of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) with an attack rate of 55% (22/40 workers) occurred at a public-facing office in England during August to September 2021. Published evidence regarding outbreaks in office workplaces remains limited.

Aims: To study potential viral transmission routes, and workplace- and worker-related risk factors following an outbreak of SARS-CoV-2 in a public-facing office.

Methods: Between 3rd September and 27th October 2021, the COVID-19 (coronavirus disease 2019) Outbreak investigation to Understand Transmission (COVID-OUT) study undertook a comprehensive investigation of the outbreak. This included surface sampling, occupational environmental assessment, molecular and serological testing of workers, and detailed questionnaires.

Results: Despite existing COVID-19 control measures, surface sampling conducted during a self-imposed two-week temporary office closure identified viral contamination (10/60, 16.7% positive), particularly in a small, shared security office (6/9, 66.7% positive) and on a window handle in one open-plan office. Targeted enhanced cleaning was therefore undertaken before the office reopened. Repeat surface sampling after this identified only one positive (2.4%) sample. Ventilation was deemed adequate using carbon dioxide monitoring (typically <700 ppm). Twelve workers (30.0%) responded to the COVID-OUT questionnaire, and all had been vaccinated with two doses. One-third of respondents (4/12) reported direct physical or close contact with members of the public; of these, 75% (3/4) reported a divider/screen between themselves and members of the public.

Conclusions: The results affirm the utility of surface sampling to identify SARS-CoV-2 control deficiencies and the importance of evolving, site-specific risk assessments with layered COVID-19 mitigation strategies.

Key words: *3-10 key words including occupational health in the abstract preferably using MeSH terms: https://www.ncbi.nlm.nih.gov/mesh*

Occupational Health; COVID-19; SARS-CoV-2; Workplace; Disease outbreaks; Environmental sampling; Environmental assessment.

Teaser text (max 75 words)

Between August-September 2021, an outbreak of SARS-CoV-2, with an attack rate of 55% (22/40 workers), occurred in a public-facing office in England. To identify workplace- and worker-related risk factors, a comprehensive investigation involving surface sampling, occupational environmental assessment, molecular and serological testing of workers, and questionnaires was undertaken. The results affirm the utility of surface sampling to identify SARS-CoV-2 control deficiencies and the importance of evolving, site-specific risk assessments with layered COVID-19 mitigation strategies.

Introduction

Workplace outbreaks of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus that causes coronavirus disease 2019 (COVID-19), in public-facing offices have rarely been reported in the literature, despite workers' proximity to members of the public.

The COVID-19 Outbreak Investigation to Understand Transmission (COVID-OUT) study, part of the PROTECT COVID-19 National Core Study on transmission and environment [1], was established to contribute to a better understanding of why SARS-CoV-2 outbreaks associated with workplaces occur and how to prevent these outbreaks from happening in the future.

On 31st August 2021, the COVID-OUT team was informed of an outbreak at a public-facing office in England directly by the organisation. At this time, most UK Government restrictions on social contact had been removed, and the economy was considered fully opened (ref). While 78% of residents (aged ≥12 years) in the local community had received two doses of COVID-19 vaccines (ref), rates of confirmed SARS-CoV-2 infections had been increasing slowly in the two months prior to the outbreak (Figure 1). Following the emergence of a cluster of SARS-CoV-2 at the public-facing office, the workplace voluntarily implemented a two-week temporary office closure to minimise the risk to workers with all staff instructed to work from home. The outbreak therefore provided the COVID-OUT study with a unique opportunity to undertake surface sampling while the office was closed and provide any advice to the workplace before workers returned.

This paper reports the results of the detailed investigation undertaken by the COVID-OUT team to assess worker- and workplace-associated risk factors, which may have contributed to the transmission of SARS-CoV-2 in this setting.

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Methods

A number of SARS-CoV-2 cases among a workforce at a public-facing office in England was notified directly to the COVID-OUT team on 31st August 2021 by the organisation. Following notification, the COVID-OUT team undertook a comprehensive investigation from 3rd September to 27th October 2021, using a previously described protocol [2]. Ethical approval was provided by the NHS North East Research Ethics Committee (Reference 20/NE/0282). Two rounds of surface sampling were performed at this site. One was undertaken on 6th September during the two-week temporary office closure at a range of locations across the site; the other was undertaken on 21st September after the workers had returned to the office and targeted areas of interest. The sampling used either Envirostik with Neutralising Buffer (Technical Service Consultants Ltd) or UTM® Viral Transport swabs (Copan) as appropriate. Quantitative reverse transcription-polymerase chain reaction (qRT-PCR) for both ORF1ab and nucleocapsid (N) gene targets was performed in duplicate using the VIASURE SARS-CoV-2 Real Time PCR Detection Kit (CerTest) in accordance with the manufacturer's instructions. The reportable detection limit for the assay was a crossing threshold (Ct) value of 38.0 as recommended by the manufacturer's instructions. Confirmed positive samples were those with both replicates testing positive for at least one target, and suspected positive samples were those with a single replicate testing positive for at least one target. Samples with Ct values of <35 were further assessed for whole genome sequencing.

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An environmental assessment was conducted by specially trained occupational hygienists from the Health and Safety Executive when the facility re-opened on 14th September, which included collecting information on the building layout, temperature, humidity, staff working patterns and observing worker behaviour (ref). Ventilation was assessed using carbon dioxide (CO_2) as a proxy; concentrations were determined by spot measurements on 14th September, with continuous measurements logged over the subsequent two-week period in selected locations.

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From 3rd to 24th September, workers from the site were invited to participate in the study. Participants were asked to complete a detailed questionnaire at baseline [4], two rounds of SARS-CoV-2 antibody testing at baseline and week six collected by phlebotomy, and three rounds of self-administered nose and throat swabs for qRT-PCR testing at baseline, week two and week three [2]. Participants were also asked to complete a shorter follow-up questionnaire at the same time as testing at weeks two, three and six to collect data on recent symptoms and any changes to vaccination status. Confirmed cases were defined as participants who presented during the outbreak period with: (i) real-time polymerase chain reaction (RT-PCR) evidence of a SARS-CoV-2 infection, (ii) N-specific seroconversion, or (iii) self-reporting of a positive test (i.e., by qRT-PCR or lateral flow device [LFD]) with positive N antibody results confirmed during COVID-OUT testing. Suspected cases were defined as participants who had no positive qRT-PCR or N antibody results from the COVID-OUT testing but who presented during the outbreak period with: (i) a self-reported positive test (i.e., by qRT-PCR or LFD) or (ii) symptoms consistent with COVID-19 defined as: (a) acute onset of fever (>37.8C) and new continuous cough or (b) acute onset of any three or more symptoms of fever (>37.8C), cough, shortness of breath, loss of taste or smell, runny nose, fatigue, sore throat, muscle or body aches, headache, nausea or vomiting, and/or diarrhoea.

Results

The building occupied by the organisation reporting the outbreak was a public sector facility shared with other departments. There was minimal mixing of staff between departments, which occupied different wings of the building with just a shared entrance. The outbreak investigation was therefore restricted to the three floors and areas occupied by the reporting organisation only. Each floor had one or two large open-plan offices, low-occupancy offices, meeting rooms and toilets. In addition, there was a canteen/lunchroom on the second floor, and a small security office on the ground floor. There were 40 workers that included four (10.0%) cleaners, 30 (75.0%) office-based staff, and six (15.0%) security staff. Security staff patrolled the facility on 30-minute rotating shifts and operated shared equipment in the 7.8 m^2 security office. Office-based staff had up to 15 face-to-face meetings with visitors per day. Visitors had their own entrance on the ground floor, where they were met by security staff, booked-in and directed to their appointment. Appointments took place at desks in the open-plan offices on the ground and first floors.

The overall attack rate of SARS-CoV-2 was 55% (22/40), with 75% of cleaners (3/4), 50% of office staff (15/30), and 67% of security staff (4/6) testing positive. Between 31st August and 13th September 2021, a two-week temporary office closure was implemented to stop transmission within the workplace. Within the population of the lower tier local authority area, the seven-day average SARS-CoV-2 incidence rate increased from 34/100,000 in mid-June to around 300/100,000 from late July onwards, and ranged between 268 and 331 weekly cases per 100,000 population during the outbreak period (Figure 1).

The first round of surface sampling was conducted approximately one week after the first identified case and during the two-week temporary office closure. Out of 60 surfaces tested, 10 (16.7%) were confirmed positives and one (1.7%) was a suspected positive (Table 1). Five (8.3%) positive samples produced crossing threshold (Ct) values between 32.0 and 34.9. Whole genome sequencing was attempted on these five samples, but only a partial sequence was identified from a single sample (window handle, 2nd floor open-plan office). This sequencing implied delta variant sequence but, as less than 50% of the genome was recovered, this could not be confirmed. The security office appeared to be a site of enhanced viral contamination, with six of the nine (66.7%) samples from this location testing positive, including three in the 32.0-34.9 Ct bracket. Based on these initial findings, enhanced cleaning was performed prior to the site re-opening, and routine cleaning procedures were updated to include disinfection of window handles; maximum occupancy and cleaning regimens in the confined security office were also reassessed. Repeat surface sampling performed approximately one week after re-opening targeted the security office, sign-in area and canteen/lunchroom as areas of interest. This identified only one positive (2.4%) and one suspected positive (2.4%) sample, both near the assay's limit of detection (Table 1).

The workplace had a site-specific COVID-19 prevention strategy in place based on a generic template provided by the parent organisation. Control measures included COVID-19 training for workers, single occupancy desks with 2 m spacing, commercial hand sanitizers, and a cleaning regimen including cleaning in-between appointments with members of the public. There were plastic dividers between office-based workers and the public; although there was no screen at the sign-in desk used by security staff. In line with government guidance at the time, there was no formal requirement for staff to wear face coverings and no staff were observed wearing face coverings on the day of the environmental assessment site visit. Ventilation on-site was predominately natural (i.e., manually opened windows) with some locally controlled air conditioning units and limited forced mechanical general ventilation. CO_2 measurements indicated that, although largely by natural means, ventilation conformed with current guidance [3], including in the security office

where CO_2 levels did not exceed 1200 ppm and typically were less than 700 ppm. At the time of the outbreak, the maximum occupancy for the security office was two with security staff rotating positions regularly between this location and other areas within the building. Both occupancy levels for this office and security staff rotation patterns were modified upon reopening based on the initial findings of this study.

Between 3rd and 24th September 2021, 12 workers (30% response rate; 92% female; mean age 51 years, range 34 to 66 years; 100% office workers on regular day shift; 75% permanent contract) consented to participate in the COVID-OUT study. Of the 12 participants, five (41.7%) self-reported positive SARS-CoV-2 tests during the outbreak period; COVID-OUT serological testing confirmed all five were positive for both N- and S-specific antibodies against SARS-CoV-2 and two were positive by qRT-PCR during COVID-OUT. No suspected cases were identified. The five non-cases who had undertaken COVID-OUT testing were positive for S- but not N- antibodies, confirming that they had been vaccinated but not previously infected (Table 2). Prior to the outbreak, all participants who responded to the questionnaire had received two doses of COVID-19 vaccines (date range of second dose: 4th May to 12th July in cases and 21st May to 30th July in non-cases; n=2 [18%] with Pfizer/BioNTech, n=9 [82%] with Oxford/AstraZeneca, and n=1 did not report the vaccine type). All five cases were symptomatic for COVID-19 and reported having at least one of the following symptoms during the outbreak period: fever, dry cough, productive cough, shortness of breath, and/or loss of taste or smell.

All respondents reported a good supply of fresh air in the workplace, mainly through opening windows or doors (n=8, 88.9%) with just one reporting mechanical ventilation (Table 2). Four participants (33%; two cases and two non-cases) reported direct physical or close contact with co-workers and members of the public. Of these, two workers (50%, one non-case and one case) reported a divider/screen between themselves and members of the public, but not between colleagues; and one worker (25%, one case) reported a divider/screen between themselves and both members of the public and colleagues. One participant (non-case) reported no divider/screen between themselves and colleagues or the public, and they also reported that they could 'sometimes' maintain social distance with colleagues and 'rarely' with the public. Half the respondents reported needing to talk loudly or lean in to speak or listen to people at work at least some of the time (n=6) (Table 2). Of these, five workers reported wearing a face covering or mask nearly all the time while at work, and one reported wearing a face covering more than half of the time. Most participants thought their pay would not change if they needed to self-isolate (n=10, 83.3%); similarly, most thought their pay would not change if the workplace needed to close for two weeks due to COVID-19 (n=10, 83.3%). There were two participants who were slightly concerned about future unemployment if they needed to self-isolate due to COVID-19 (16.7%), but most were not concerned (n=9, 75.0%).

Participants were asked about infection control measures while at work (Table 2). The majority (n=11, 91.7%) reported having received training (e.g., reading guidance and/or formal training) about stopping COVID-19 in the workplace, and most had noticed signs or posters in the workplace promoting good hand hygiene practice (n=11, 91.7%). All reported having access to hand washing/sanitising facilities while at work and, of those who responded to the question, all reported using the facilities with the majority washing or sanitising their hands 11 times or more in a working day (n=9, 81.8%). Respondents did not wear FFP2/FFP3 or face shields while at work; the majority (n=10, 83.3%) reported wearing either a washable face mask/covering or a surgical/disposable mask at least half the time while at work. The two remaining participants, who reported not wearing any face covering while at work in the last 14 days, were both confirmed cases. All respondents

reported wearing either a washable face mask/covering or a surgical/disposable mask at least some of the time when outside work, with the majority reporting wearing them more than half the time (n=10/11, 90.0%).

Contact patterns were similar between cases and non-cases (Table 2). Most respondents reported some close contacts with others in their workplace (n=8, 72.7%), with half (n=6, 55%) reporting six or more close contacts per day on average over the prior 14 days. Just under half of respondents also reported long close contacts in their workplace lasting more than one hour (n=5, 41.7%). Most respondents reported close contacts during non-work activities such as socialising (n=8, 72.7%) and essential activities (e.g., food shopping or seeing a doctor) (n=9, 81.8%). Just over half of respondents (n=7, 58.3%; four non-cases and three cases) reported known contact with a COVID-19 positive individual in the 14 days. Of these seven, two (28.9%, one non-case and one case) reported the positive contact was someone they lived with, two (28.9%, one non-case and one case) reported the positive contact was someone they worked with, and one (14.3%, a non-case) reported the positive contact was someone they both lived and worked with.

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Discussion

In late August 2021, a public-facing office in England, with adherence to governmental COVID-19 control guidance and high vaccination coverage, experienced an outbreak of SARS-CoV-2 affecting 55% of the workforce. At the time of this outbreak, governmental guidance for workplaces in England prioritised policies for risk assessments, adequate ventilation, frequent cleaning, self-isolation, and communication/training; however, social distancing and face covering usage were no longer compulsory [ref]. On 16 August 2021, two weeks before the outbreak, government guidance was amended so fully vaccinated people did not need to self-isolate if they were identified as a close contact of someone with COVID-19 [ref].

Despite existing COVID-19 control measures, surface sampling identified potential deficiencies in routine disinfection procedures that informed targeted strengthening of infection control practices to support workplace re-opening. Similar to other SARS-CoV-2 outbreak studies, relatively low-level contamination was identified even in locations associated with recent occupancy of symptomatic people [5–10]. No positive surface sample yielded complete genome sequence suggesting degradation of the viral genome and a lack of transmission potential at the time of sampling. Similar investigations imply Ct values of less than 30 correlate with presence of infectious virus [11].

While vaccines remain highly effective for preventing severe COVID-19 illness and death, SARS-CoV-2 infections among fully vaccinated individuals in this outbreak are consistent with previous reports [12] and reinforce the importance of a layered SARS-CoV-2 transmission mitigation strategy prioritising risk assessment-informed interventions, such as testing, social distancing and transmission control measures (e.g., use of high quality surgical face masks or FFP2/3 respirators), as well as ventilation and appropriate occupancy levels, in addition to vaccination.

The limitations of this study warrant consideration. Surface sampling and participant testing performed closer to the peak of cases could yield a more representative indication of viral contamination within the facility and facilitate more informative genomic sequencing and epidemiological assessment [13]. Although workplace transmission appears likely, given the clustering of cases in some areas and positive environmental sampling, we were unable to clarify chains of transmission and determine whether cases may have been independently introduced from community sources. Notably, the worker participation rate in COVID-OUT was 30%, with an underrepresentation of male workers as well as cleaning and security staff. The small sample size and potential for selection bias limit our ability to evaluate individual risk factors within this workplace. In addition, differences in behaviours reported by participants compared to those observed by the COVID-OUT team (i.e., wearing face coverings while at work), suggests that social desirability bias could be overestimating adherence to infection control measures.

Maintaining core societal functions during future pandemics is of upmost importance, and thus the ability to rapidly investigate infectious disease outbreaks and implement data-informed transmission mitigation measures will be required. This is particularly relevant to workplaces with public-facing elements that have a dynamic population with an elevated risk of virus introduction and onward transmission. Mechanisms to encourage workplaces to report potential outbreaks as early as practicable and engage with research studies, like the one presented here, should be prioritized to further our understanding of transmission and to provide safer work environments.

Overall, our findings highlight the need for evolving, site-specific risk assessments that adapt for changes in local community infection rates and recognize heterogeneity within a workplace in the risks associated with different workspaces (e.g., rooms with high occupancy) and worker roles (e.g.,

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desk-based versus circulating staff). For public-facing workplaces, these assessments must inform suitable control measures to minimize potential close interactions of staff members with co-workers and visitors.

Key points

What is already known about this subject

- Workplaces are important when considering sites and routes for potential SARS-CoV-2 transmission.
- Outbreaks of COVID-19 in public-facing offices are rarely reported or studied in the literature.

What this study adds

- This study illustrates that office settings are vulnerable to acute SARS-CoV-2 outbreaks.
- Our findings reinforce the value of environmental analysis, including surface sampling, for providing insights into potential infection control deficiencies; dissemination of these findings can assist other workplaces to maintain suitable control measures in order to maintain essential work and core societal functions.

What impact this may have on practice or policy

- Evolving, site-specific risk assessments with layered control strategies are imperative to mitigate against transmission of SARS-CoV-2 within workplaces.
- These assessments require regular review to ensure suitability as the pandemic evolves, especially in regard to changing infection rates within the local community.

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Competing Interests

None declared

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Disclosure Statement

The contents of this paper, including any opinions and/or conclusions expressed, are those of the authors alone and do not necessarily reflect Health and Safety Executive or UK Health Security Agency policy.

References

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Vancouver format

Current

Have enough but not too many and not more than 30 for a long format paper and 10 for a short format paper or case report

Don't miss out important ones

Avoid too much "grey literature"

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