



Study Name

An environmental study on assessing the risk of airborne transmission of SARS-CoV-2 at live events using CO2 measurement

Event Locations for Study

1. **Wembley arena, London** – events on the 13th and 18th of June
2. **The Royal Ascot** – events on the 15th-19th of June, with researcher participation on the 16th and 17th of June
3. **Download Festival** – events on the 19th-20th June.

Principal Investigators

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Key research questions

What is the level of environmental risk of airborne transmission indoors and in outdoor spaces, in relation to two specific factors: occupancy and poor ventilation?

What mitigations can be put in place to reduce environmental risk of transmission, in relation to the operation of ventilation, occupancy and distribution of people around the venues? How effective are those mitigations?

What is the impact of weather on level of environmental risk of airborne transmission, with specific reference to a) occupancy and distribution of people in outdoor venues which have some indoor spaces b) the effectiveness of natural ventilation?

Link to a published protocol for Phase I

<https://www.gov.uk/government/publications/events-research-programme-science/airbods-wp3-field-studies-work-statement>

Study Design

Our primary objective is to examine the risk of airborne transmission indoors, based on environmental data. We aim to evaluate the risk by investigating how venues operate in practice in terms of ventilation and crowd management, and the links between the two. We aim to identify scenarios leading to increased risk of exposure to airborne infectious diseases (including, but not limited to Covid-19) and the risk of infection associated with this exposure relative to a benchmark such as a day in the office. Finally, we aim to propose mitigation measures to reduce the risk of transmission by changes to venue operations, event organisation and ventilation strategies.

Indoor venues, or indoor spaces that are within primarily outdoor venues where customers may spend over an hour during an event, are those where there is a higher risk of “airborne” (via aerosols) transmission due to poor ventilation and accumulation of the virus in exhaled breath in the air. Outdoor venues frequently include many indoor spaces within which customers spend significant time, such as ticketing, waiting areas, refreshments, toilets and other facilities. Some outdoor venues operate primarily within tents or marquees, which can effectively create indoor spaces in terms of the risk of build-up of virus particles in the air if they do not have a good ventilation strategy such as a sufficient number of sides open. We are also interested in monitoring outdoors within spectator areas, to compare the outdoor airborne risk of transmission due to audience exposure whilst seated or standing closely, with risk of transmission at outdoor events that are more spaced out.

We will monitor CO₂, temperature and relative humidity in the occupied spaces to understand air movement and ventilation performance during pilot events. We will use this data to determine a cumulative exposure for customers for selected spaces within each venue. This can then be compared with a reference benchmark case such as working within a multi-person office space for several hours in a day, with the data expressed in relative terms. In the short term, the study will only investigate the environmental conditions as a result of the intended operation of the pilot events.

Two types of environmental studies will be carried out:

Environmental monitoring of the venues - Venues will be fitted with a large number of environmental monitors to allow monitoring of several indoor spaces at every venue over several days of events. The monitors will log data that is correlated to airborne transmission of the virus due to poor ventilation and overcrowding: CO₂ readings above outdoor levels (as a proxy for exhaled breath and poor ventilation), temperature and relative humidity (parameters that may affect virus viability in the air in ways that at present are still poorly understood). The data collection will be done at high resolution at key points throughout the domain to gain an understanding of air movement and ventilation performance during the events.

The environmental data from the pilot events of Phase I and Phase II will be input into an environmental database, which will be added to over time.

Personal exposure studies - in some venues, up to three researchers will participate in the events, carrying air quality monitors on their person. They will follow a typical customer journey from the moment of ingress as they attend hospitality, retail, and within the spectator areas. The air quality monitors will measure CO₂, temperature, humidity, and airspeed to indicate ventilation levels around the researcher. Cumulative exposure to CO₂ will be calculated from the data as an indicator of the cumulative exposure to exhaled breath throughout an event from start to finish. Researchers will take notes of their locations throughout the venues.

Key outcome measures

CO₂ levels will be assessed as a measure of air quality and of ventilation performance in relation to the occupancy of the various spaces. The study is designed in collaboration with the movement strategies group so that crowding and occupancy data from their study can be related to CO₂ levels at venues to allow for the air quality and its associated risks to be assessed in relation to the occupancy. This will help inform a qualitative assessment of what might be expected when the venues begin operating at a higher capacity.

Venue operations: The results of the measurements will immediately identify any potential higher risk settings, locations or activities. Mitigations will be proposed for the scenario of increased capacity at the venues, which could be communicated to the venue operators as soon as possible in Phase II as the venues and event organisers gear up for opening events at higher capacity.

NPIs being changed

Ventilation strategy, occupancy and distribution of people around the venues

Engagement with participants and communications

This study does not require engagement or communications with participants.

Engagement with the venues and requirements for information from the venues and event organisers are presented in the Appendix.

Peer Review

This protocol was reviewed and approved by the Events Research Programme Science Board on 2nd July 2021.

The research findings will go through full independent peer review process when submitting any resulting publications to academic outlets (e.g., journal papers).

Ethics Approval

This study was reviewed for the AIRBODs consortium project by the UCL ethics committee in March 2021 and approval was granted to conduct field studies under the ERP and AIRBODS for the duration of the project until 31st August 2022.

Project Reference: 0119/010 "Airborne Infection Reduction through Building Operation and Design for SARS- CoV-2 (AIRBODS)

Appendix - Arrangements with venues:

DCMS will obtain the necessary agreements from venues to allow us to work on site.

Venues would be responsible for H&S whilst our team is on site and the research teams will follow their guidance, following risk assessments taken by the universities involved.

Venues and organisers will be required to provide the researchers, as soon as possible, with detailed information about their site and their planning, to facilitate a fast discovery and planning process.

Large venues will be expected to allow the researchers to install equipment to remain on site for a few weeks, as well as facilitate personal exposure monitoring during events for a small number of the research team attending on site. Researchers may request access to the site over a few days prior to the events in order to set out the equipment. Researchers require practical help from venues in terms of logistics of the field studies, such as storage space, parking, named contact people and assistance with fixing equipment inside the venue.

Requirements for information from venues:

Drawings of the site will be needed before the first live event to help the researchers plan the locations of the instruments. Other information may be obtained soon after to inform a Relative Exposure Index model or CFD modelling.

This will include drawings of the site (ideally as built floor plans and elevations), as built mechanical ventilation schematics and specifications if available, building log books, other relevant information from the operation and maintenance manual, and any environmental studies previously conducted or Building Information Data (BIM) if these are available. The research team will also require information on typical dwell time and occupancy in each zone of the building during the events being proposed; for example, how long people remain at the venue, how much time they spend in the bar or ticketing hall etc.