Long-distance airborne transmission of SARS-CoV-2: a rapid systematic review

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Supplementary Material 2. Data extraction of included studies

Author, setting, study period, objective	Participants, methods	Results relating to transmission routes	Results relating to transmission modifying factors	Study quality and key limitations
Charlotte et al, 2020[1] Setting: indoor choir rehearsal in a 45m^2 and 3m high room, France Transmission period: 2-hour rehearsal on 12 March 2020 Investigation period: main interview 9 May 2020, multiple telephone interviews up to 20 June 2020 Objective: to investigate an outbreak or superspreading event believed to have occurred at a choir practice	Participants: n=27 (25 singers, 1 conductor and 1 accompanist) Outcome assessment - COVID-19 diagnostic: confirmed if nasopharyngeal swab RT-PCR positive and/or a severe case requiring hospitalization; probable if diagnosed by general practitioners but no RT-PCR test Exposure assessment - Questionnaire to all participants (mainly about symptom and diagnostic, response rate 100%) - Telephone interviews with president and conductor of choir, discussing possible exposure, participant seating arrangement (sketch, including location of cases) and hall dimensions	- 19 COVID-19 cases identified 1-12 days following the rehearsal (7 confirmed and 12 probable); overall secondary attack rate (SAR): 70%. - None of the attendees presented symptoms on 12 March. Several possible primary cases: 1 with symptom onset the day after the event and possibly others who had a close contact with a COVID-19 case in the 7 days before the event and had symptom onset 2-3 days after the event. - Choristers were sat less close to each other than usual, at a distance of < 6 feet (1.8m). - Close contact and fomite transmission deemed unlikely based on interview with the choir president (rehearsal in one go, with minimal socialisation, no shaking hands or food sharing; participants left the room quickly after the session and no indoor side-by-side or prolonged face-to-face contacts observed). - High SAR suggests that some airborne transmission at distances >2m may have occurred.	Insufficient air replacement - The room was a narrow indoor space without ventilation Increased aerosol emission (singing) - May have increased the amount of aerosols generated by the primary case(s)	Quality rating: low Key limitations - Probable cases were not confirmed with a COVID-19 test and no asymptomatic testing carried out - No genomic sequencing performed, so transmission outside the event cannot be ruled out (rehearsal occurred 5 days before the first stay-at-home order in France, so community levels may have been high) - High risk of recall bias as the investigation is mainly based on interview with the president of the choir, which was conducted 2 months after the event - Singing as a modifying factor for airborne transmission was presented as a hypothesis, no data to support it

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Eichler et al, 2021[2] Setting: managed isolation and quarantine (MIQ) hotel, New Zealand; part of a wider outbreak investigated Transmission date: hypothesised to be 8 September 2020 Investigation period: started after a positive case was identified on 18 September 2020 (onward transmission from case D/E on a domestic flight) Objective: to investigate a chain of COVID-19 transmission, starting on an international flight, then during a stay in a MIQ hotel (relevant to this review), and further on a domestic flight and household transmission	Participants: 9 COVID-19 cases (including the primary case), of which 6 had travelled on the same international flight and were quarantined in MIQ, and 3 household contacts Outcome assessment - COVID-19 test (nasopharyngeal swab, RT-PCR) at days 3 and 12 for all those in MIQ - Regular health monitoring - Genome sequencing Exposure assessment - Epidemiological data obtained via public health authorities - Video surveillance (CCTV analysis) - Review of ventilation system in MIQ	- Genomic sequencing confirmed genomic link between the 9 cases. - Case C tested negative on day 3, symptomatic since day 10 of quarantine, tested positive on day 12 and was relocated to an isolation section. - Case D (and their child case E), who had travelled on the same flight as case C and were quarantined in an adjacent room in MIQ, tested positive 10 days after the end of MIQ stay (21 Sept 2020, although as asymptomatic, positivity could be any time after their last negative test on 8 Sept). They had had negative tests on days 3 and 12. Timeline of events and phylogenetic trees suggest that case D was infected by case C during hotel MIQ stay (rather than during international flight). - CCTV evidence showed that cases C, D and E were not outside their room at the same time, but that on the day 12 testing (8 Sept), there was a 50 second window between the door of case C being closed and the door of cases D and E being opened. Airborne transmission during this moment was hypothesised to be the most probable mode of transmission. - A communal bin was touched by cases C and D, but fomite transmission considered unlikely by study authors as CCTV showed that there was > 20 hours between they each touched it.	Insufficient air replacement - Hotel corridor outside of the rooms was enclosed and unventilated Directional air flow - The hotel room ventilation system resulted in a net positive pressure in the room compared to the corridor, meaning air and aerosol particles were likely to move from the hotel room of the primary case into the corridor	Quality rating: medium Key limitations - The transmission event spans over more than 2 weeks and includes a variety of settings. The information provided in the study is not enough to rule out other transmission routes and/or that case D had been infected by a primary case from this cluster other than C - The seats of cases D and E during the flight were not specified, nor were possible interaction between cases A, B and D before A and B tested positive on day 3

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		- Case E (child of case D) likely to have been infected by case D in MIQ or in household settings; in both cases close contact transmission cannot be ruled out. Similarly, for all the other transmission events of this outbreak (in flights or in household settings), close contact transmission cannot be ruled out.		
Fox-Lewis et al, 2022[3] Setting: New Zealand (Aotearoa) commercial hotel adapted for use as a managed isolation facility (MIF) Transmission dates: 19-27 July 2021 Investigation period: not specified, ~ late July-early August 2021 Objective: to investigate a transmission event that occurred at a MIF	Participants: A group of 5-persons BCDEF, arrived in New Zealand from UAE on 14 July. Solo traveller A arrived from the Philippines into New Zealand on 16 July Outcome assessment - COVID-19 test (nasopharyngeal swab, RT-PCR) at days 0, 3 and 12 for all those in managed quarantine facility (MQF) or MIF - Regular health monitoring - Genome sequencing Exposure assessment - Epidemiological data obtained via public health authorities - Security camera footage - Measurements at the MIF - Review of ventilation systems in MIF	- Solo traveller A and travel group BCDEF arrived in New Zealand on different dates and flights. Persons E and A, staying in separate MQFs, tested positive during screening (on 14 and 17 July 2021 respectively, both asymptomatic), resulting in transfer of group BCDEF on 15 July and person A on 19 July to the same MIF. - Persons B, C and D later tested positive (on 27, 27 and 29 July 2021 respectively) while in the MIF. Whole-genome sequencing indicated transmission from person A to persons B, C and D. Laboratory error was investigated and ruled out due to initial samples from A and E being collected on/from different dates and locations. - Person A was staying in separate, non-adjacent rooms to group BCDEF. The distance between the doors of the 2 rooms was 2.1 meters. Review of security camera footage showed that person A did not leave their room during their probable infectious period (19 to 27 July), but there was simultaneous opening of room doors (due to	Insufficient air replacement and directional air flow - Ensuite bathrooms had a continuously operating extractor fan which moved air from the room to outside - Each room contained a free-standing HEPA filter, which recirculated and filtered air within the room without affecting air movement in/out - Air from outside was pumped into the corridor at each end - Overall, there was an average negative pressure of ~-6.6 Pa, so air flowed directionally from the corridor into the rooms. However, opening either a window or door would negate this negative pressure within the room, allowing aerosols to disperse out	Quality rating: high Key limitations - Interviews with participants were not conducted - A possibility that 1 or 2 of the 3 transmission events were onward transmission through close contact within the group that shared a room - Camera angle of video recording could see door opening/closing but not whether participants in doorways were wearing masks or not (although policy was to wear masks).

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		food delivery or health check) on 4 occasions, each for 3-5 seconds. Medical mask mandated for participants when opening the door but could not be confirmed due to camera angle. Staff involved in these interactions were vaccinated, wearing full PPE, and had >3 negative RT-PCR test results. Nurse changed gloves and cleaned equipment between health checks. - Close contact and fomite transmission between A and B/C/D were deemed unlikely based on the epidemiological investigation and video analysis. Cumulative evidence indicates that the most plausible explanation was airborne transmission of the Delta variant of SARS-CoV-2 over a distance >2m from person A to persons B and C, and possibly D during their stay in the MIF. It is possible that D was an onward transmission from B and/or C. - The only vaccinated member of the travel group, person F (2 doses of Pfizer-BioNTech) did not test positive. No other members of the group (or the solo traveller) had been vaccinated.	- In addition, the location of the free standing HEPA filtration units led to air flowing diagonally from one side of the corridor to the other, from person A's door, towards the door of group BCDEF	
Groves et al, 2021[4] Setting: fitness facilities, Hawaii (US) Transmission date: 29 June 2020	Participants: n=63 Outcome assessment - COVID-19 test for symptomatic cases Exposure assessment	- Primary case: fitness instructor A with symptom onset on 29 June 2020. Classes taught before symptom onset: • 27 June: 1-hour yoga class; no masks except instructor; 27 participants – no symptomatic secondary cases	For the 1-hour stationary cycling class taught by instructor A 1 day before symptom onset (only class where long-distance transmission may have happened):	Quality rating: low Key limitations - Genomic sequencing not performed but transmission from outside the event considered to be low as

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<u>Investigation period:</u> started following notification to Hawaii Department of Health on 2 July 2020 <u>Objective</u>: to investigate a COVID-19 outbreak in 3 fitness facilities	- Questionnaire - Clinical and test records - On-site assessment of the 3 facilities	• 28 June: 1-hour high intensity static cycling; no masks, 6-feet distance, doors and windows closed, fans, instructor on pedestal facing participants and shouting; 10 participants of which 6 who also had exposure to instructor the next day tested positive – no secondary cases within the 4 with unique exposure (negative RT-PCR tests) • 29 June (4 hours before primary symptom onset): 1-hour static cycling class with same location/conditions as previous day (above); 10 participants, all symptomatic and with positive RT-PCR between 2-6 July – one of them was also a fitness instructor ('fitness instructor B'). No information on whether close contact may have happened before or after the classes; fomite transmission cannot be ruled out (no information on cleaning procedures) - Fitness instructor B: symptom onset on 2 July 2020. 21 participants were exposed to instructor B in the 2 days before symptom onset, of which 10 tested positive. However, physical distancing was not maintained in these personal training or small-group kickboxing sessions so these transmissions not relevant to this study.	<u>Insufficient air replacement</u> - Doors and windows closed <u>Directional air flow</u> - 3 large floor fans directed towards participants <u>Increased aerosol emission (shouting)</u> - Primary cases was speaking loudly ("shouting") while facing towards participants	community transmission at the time of the event was low (7-day average: 2-3 cases/100,000 persons per day) - Only symptomatic testing - Limited information provided on the results of the investigation or on what was asked in the questionnaire; possibility of close-contact transmission before or after the fitness classes not considered but airborne transmission >2m deemed possible for some cases due to high SAR
Gunther et al, 2020 [5] <u>Setting</u>: beef and pork processing complex in	<u>Participants</u>: n=6289 employees, of which more than 1400 tested positive	- Two staff members (asymptomatic) tested positive on 21 May 2020, one of which considered as the primary case of the cluster	<u>Insufficient air replacement</u> - Re-circulation of cooled air with low rate of exchange	<u>Quality rating</u>: medium <u>Key limitations</u>

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Rheda-Wiedenbrück, Germany Transmission period: May-June 2020 Investigation period: testing May-June 2020. Onsite visit 2 June, search of genotype database 6 July 2020 Objective: to report on an outbreak that occurred at a meat processing complex	between May and June 2020; outbreak started in one of the processing lines where 31 of the 140 employees of the same shift ('early shift') tested positive Outcome assessment - COVID-19 test (oropharyngeal swab; RT-PCR) for all workers of the early shift - Genome sequencing of 20 positive cases Exposure assessment - Information on housing, commuting and workplaces of employees provided by employer - On-site visit during working hours to assess work conditions, including inspection of ventilation system	(supported by genome analysis). Between 27 May and 3 June, 29 of 140 other staff members on the same shift tested positive. Genome analysis showed cases related to the same sub-branch of the virus. - Production line staff have fixed position in a conveyer belt processing line, with exception of supervisors. COVID-19 measures were in place (including hand hygiene, one-way traffic, increased distance between workers, one-layer mask mandatory and reduced physical contact in the canteen) but adherence not reported. - Mapping of the positions of 86 employees (28 cases and 58 non-cases) in function of distance to the primary case suggests a spatial clustering around the suspected primary case; p-values for the cumulative probability of infection rates among employees working at fixed positions were calculated (null-hypothesis: random spatial distribution), showing that the probability for spatial over-representation of cases was significant at 5 to 12m from the primary case and reaches a maximum significance level at 8m (p=2.3x10-5.); only 3 of the cases were within 2m of the primary case. - Some workers shared accommodation (11 shared flats and 16 shared bedrooms) and carpools (n=6), where close contact or fomite transmission may have happened. However, comparison of infection rates in shared accommodation and carpools with	with fresh air (air exchange rate <1; more than 1h needed to have the air replaced with fresh air); no filter Directional air flow - Eight cooling fans projected air in lateral direction Increased aerosol emission (physical work) - Some staff were said to be doing demanding physical work	- Close contact and fomite transmission during the 2 hours of breaks, during which staff visited the canteen, cannot be ruled out - No interviews with employees conducted, no information on whether transmission within employees outside work and housing settings (e.g. during social events) was provided - Data on housing and carpooling were anonymised, which limits assessment of chain of transmission - Statistical analysis comparing probability of infections only based on spatial distribution, without taking into account transmission modes or whether transmission risk is higher at short range than at long-distance - Airflow direction and speed assessment were qualitative, no experiments conducted

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		infection rates within the 8-meter radius on the processing line suggests that most transmission events are more likely to have happened on the processing line (p-values for infection rates among employees sharing one or more unit under the null-hypothesis of a random distribution significant for only 3 of the units [8 positive cases], which also corresponds to a positive correlation between these units' infection rates and percentage of staff working within 8 metres of primary case; average Pearson correlation coefficient r = 0.67). - Results suggested most transmission events occurred in the processing plant. Close contact or fomite transmission in other areas of the plant, such as canteens or toilets, is possible although the spatial distribution of cases suggest transmission was likely to have occurred on the processing line.		
Hamner et al, 2020 [6] Additional evidence from Miller et al, 2020[7] which reported on the same outbreak Setting: choir practice in Washington, United States	Participants: n=61 (median age: 69 years) Outcome assessment - COVID-19 diagnostic: confirmed if RT-PCR positive (type of swab not specified); suspected if based on symptoms Exposure assessment - Telephone interviews with all choir members, focusing on	- One suspected primary case (symptomatic since 7 March 2020); estimated secondary attack rates of 53% for confirmed cases (n=32) and of 87% if including suspected cases (n=52) during the choir practice on the 10 March. - Symptom onset for secondary cases: median of 3 days; range 1-12 days (3 confirmed cases on 11 March; 5 confirmed and 2 probable on 12 March; 1 probable on 22	Insufficient air replacement - External doors were closed - Ventilation system and heated system (with filter >1 micron) that can both provide outdoor air intake as well as recirculating air. It is not known whether it operated continually or how much external air was supplied	Quality rating: low Key limitations: - Suspected cases were not confirmed with a COVID-19 test and no asymptomatic testing - Genomic sequencing not performed, transmission outside this event cannot be ruled out

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Transmission date: rehearsal on 10 March 2020 Investigation period: 18-20 March 2020, with follow-up interviews on 7-10 April 2020 Objective: to investigate an outbreak that occurred at choir practice	rehearsal attendance, other possible exposures, symptoms and seating arrangement	March; all other cases had symptom onset 3-7 days after event). - The choir practice lasted 2.5 hours: 2 sessions of 40-45 minutes with all attendees, a 50-minute session where attendees were split into 2 groups, 1 of which participants sat next to each other (but the other group contained the suspected primary), and a 15-minute break. - Seating arrangement: for the sessions with all attendees, some empty seats but no specific spatial patterns (estimated space between attendees: 0.75m lateral and 1.4m longitudinal distance); for the session in 2 groups, one group was in a smaller room where they sat next to each other. - Close contact or fomite transmission during the 15-minute break, chair stacking at the end of the practice, and use of bathroom deemed unlikely by study authors. - The primary case spoke minimally with other participants. Many participants arrived shortly before the rehearsal and left as soon as it had finished. - The high rate of cases suggests that some airborne infection >2m may have occurred.	- The modelled air-change rate range estimated by Miller et al was 0.3-1.0/hr Directional air flow - A choir spokesperson indicated that the heating was turned on initially, but was not turned on during rehearsal, so there was no recirculating air Increased aerosol emission (singing) - May have increased the amount of aerosols generated by the primary case	- 10 of the secondary cases developed symptoms in the two days following the rehearsal (3 on 11 March and 7 on 12 March) therefore potential for multiple primary cases - Risk of recall bias as mainly based on telephone interviews - Singing as a modifying factor for airborne transmission was presented as a hypothesis, no data presented to support it.
Han et al, 2022[8] Setting: apartment complex in South Korea	Participants: initial cluster was 19 confirmed COVID-19 cases throughout a complex consisting of 260 apartments. Further epidemiological	- Initial cluster of 19 confirmed COVID-19 cases reported 10-27 January 2021, 14 of these were found to have likely occurred as a result of close social contact. These were	Insufficient air replacement - The only way to ventilate the apartments was by opening windows (no mechanical ventilation systems).	Quality rating: low Key limitations: - Close contact between cases of the cluster ruled out following interviews with

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Transmission dates: ~3-9 January 2021 (primary); ~6-16 January (secondary) Investigation period: cluster of COVID-19 cases reported 10-27 January 2021; investigation 27 January – 1 February 2021 Objective: to investigate a cluster of COVID-19 cases in an apartment block, who had reported no direct contact with other COVID-19 cases	investigations and testing of residents from 10 apartments along 2 vertical lines Outcome assessment: - COVID-19 testing by RT-PCR - Molecular genomic sequencing and phylogenetic analysis of only 3 cases, one from each apartment located in the vertical line studied Exposure assessment - Contact history determined with mobile phone location tracking - Epidemiological investigations (interviews with cases 1-5) - Field and environmental investigations of the apartments (air/surface sampling and smoke tests)	identified through voluntary testing of those with symptoms. - Epidemiological investigations focussed on the remaining 5 COVID-19 cases who reported no close contact with each other, and mobile phone GPS tracking indicated no direct contact with other previously confirmed cases. - The 5 cases were from 3 apartments located in the same vertical line. On 27 January all residents from that vertical line were tested. - The likely primary case resided in apartment 202 of the building from 3-9 Jan 2021 during a business visit (symptom onset 5 Jan, tested positive 9 Jan). A secondary case occurred within the same vertical line, residing in apartment 502 (symptomatic, tested positive 11 Jan), followed by a (possible tertiary) household cluster of 3 who resided in apartment 402 (earliest symptom onset 20 Jan, positive test 26 Jan). - Genomic sequencing of one sample from each of the 3 apartments indicated the cases were from the same origin. - All residents from an adjacent vertical line were tested, with no positive cases found. The 2 vertical lines investigated share a single entrance and staircase, yet face masks were worn on stairs, and all cases were in line 2, with none in line 1. This suggests fomite transmission at the door/handrail unlikely.	Residents were reported to rarely open windows during the period of the outbreak (winter; average outside air temperature -3.9°C) Directional air flow - Low outdoor air temperature could have caused upward air movement in the pipes, which could have been accelerated by use of a kitchen hood fan	positive cases, at risk of recall bias - Only 2 possible events relevant to long-distance airborne transmission (as 3 are from the same household), which could have been a chance finding; transmission could have been due to another route (fomite/close contact transmission in the entrance/stairwell) or asymptomatic transmission from an unknown case; this was not discussed in the investigation

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		- The apartment building has 5 floors with 6 apartments on each floor, thus 6 vertical lines of 5 apartments. Each vertical line has its own drainpipe and ventilation duct for the bathrooms. - The field investigation revealed most likely route to be through bathroom drains: smoke experiments revealed traps in floor drains were malfunctioning. Additionally, a floor drain sample from apartment 402 was positive and related phylogenetically to the 5 cases.		
Hwang et al, 2020 [9] Setting: apartment block in Seoul, South Korea Transmission dates: line A ~11-23 August 2020; line B ~16-23 August 2020 Investigation period: investigation started on 25 August 2020 after 5 cases tested positive 23-25 August Objective: to investigate an outbreak that occurred along two vertical lines in an apartment block	Participants: 10 COVID-19 cases (7 households); 437 residents (267 households) were tested Outcome assessment - COVID-19 test (nasopharyngeal swab; RT-PCR) for all residents Exposure assessment - Epidemiological data, including potential source of exposure and contact with other cases in the building (not clear how collected) - Surface sampling of ventilation grills and drains - Assessment of the structure of the building and air ducts	- All infected households were located within 2 vertical lines. Each line has a ventilation shaft which runs from the bottom to the rooftop (covering 17 floors) and connects to 17 apartments through the blowhole in the bathroom. - 10 cases from 7 households, spanning over 10 floors, tested positive for COVID-19; all symptomatic but one. The suspected primary case had symptom onset on 16 August, and the other cases between 18 and 25 August 2020. - Epidemiological investigation showed that cases reported no close contact between them and that all cases reported having used masks outside their apartments. - All households used the same elevators (except 2 cases) and entrance halls, so transmission via elevator (fomites or	Directional air flow - Airborne transmission of SARS-CoV-2 through the vertical air duct or floor drain connecting the apartments hypothesised - There were no bathroom exhaust fans and so no physical block of the air from the ventilation shafts moving into the apartment Insufficient air replacement - Cannot be assessed based on the information provided in the study	Quality rating: low Key limitations - No genomic testing performed, transmission from cases outside the apartment block cannot be ruled out - Very limited details provided on the epidemiological investigation - Transmission may have occurred within or across line A and B, presumably via close contact/other transmission route in shared areas. - Surface sampling likely to have been carried out after 25 August (10 days after symptom onset of the first case)

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		droplets) thought to have been randomly scattered rather than within 2 vertical lines. - All infected households located within 2 vertical lines (8 cases within 1 line, over maximum distance of 6 floors (furthest definite distance of 4 floors), 2 within another line, separated by 9 floors). Cases within line A, symptom onset 18-25 August. Cases within line B symptom onset 21 and 24 August. Each line has a ventilation shaft which runs from the bottom to the rooftop and connects to the apartments through the blowhole in the bathroom, which could have promoted airborne transmission between apartments. - Surface samples all negative (RT-PCR).		- No information on possible follow-up: symptom onset of cases: 16-25 August, testing of all residents: ~26-27 August; cannot be ruled out that some cases would have been within incubation period at that time - No tracer gas experiments conducted to support the hypothesis of transmission through air duct or floor drain - The possibility of positive cases distributed within the same line by chance not discussed. Particularly relevant for line B, where there are only 2 cases
Jiang et al, 2021[10] Setting: Baodi department store in Tianjin, China Transmission dates: 20–25 January 2020 Investigation period: after 3 staff tested positive, store closed and investigation started on January 26 2020	Participants: 24 confirmed COVID-19 cases who worked at (6) or had visited (18) the department store Outcome assessment - COVID-19 test (nasopharyngeal swab; RT-PCR) Exposure assessment - Surveillance video of the store (20-25 January) - Interviews with cases and contacts, including contact history	- Primary case thought to be a staff member, with symptom onset on 21 January 2020. - Two other staff members, with symptom onset on 22 and 25 January, likely to have been infected by primary case. No relationship reported between any of the 3 staff, and no close contact behaviours (video surveillance). Most departments of the store were separated by a 1.5m wide corridor and salespersons worked in a specific area; long-distance airborne transmission considered most likely route of transmission. - Similarly, for 10 other cases (3 staff and 7 customers), airborne transmission was	Insufficient air replacement - Doors were closed with draft excluders to keep the store warm in the winter conditions - No air conditioning system in use	Quality rating: low Key limitations: - No genomic sequencing, transmission outside the event cannot be ruled out - The 24 cases were part of a wider investigation of 131 cases. Epidemiological results traced back these 24 cases to the store. Unclear whether other customers had been contacted, so other primary cases and asymptomatic/mild cases potentially missed

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Objective: to investigate an outbreak that occurred in a department store	- Map of the department store and assessment of ventilation conditions (not specified how this was obtained)	deemed as the most likely route of transmission. - For 5 customers, droplet or contact transmission most likely. - For 6 customers, transmission route could not be determined.		- Transmission before the 20 January cannot be ruled out, especially between the 2 cases who developed symptoms on 21-22 January - Very little information provided on the methods and results of the investigations, only conclusions. Not specified when the investigation was conducted - Fomite transmission in bathrooms was not considered
Katelaris et al, 2021[11] Setting: church singing in Sydney, Australia Transmission dates: 15-17 July 2020 Investigation period: public health authorities notified on 20 July, investigation started on 21 July 2020 Objective: to investigate the outbreak and assess the possibility of airborne transmission of SARS-CoV-2	Participants: 1 primary case and 508 close contacts across the 4 church services (12 secondary cases) Outcome assessment - COVID-19 test (nasopharyngeal swab; RT-PCR) of all participants (85% uptake) - Close contacts asked for symptoms every 2/3 days during quarantine - Genomic sequencing for the primary case and 10 secondary cases Exposure assessment - Interviews with cases	- Primary case: 18-year-old choir member who, following SARS-CoV-2 exposure on 11 July 2020, reported symptom onset on 16-17 July. Sang at 4 1h church services: 15, 16, and twice on 17 July 2020, all at the same church. - All attendees to the 4 services were considered close contacts (n=508) and required to self-isolate and be tested (85% uptake of testing). The first two cases had been notified on 20 July, and most contacts were tested 2-7 days after exposure. - 12 secondary cases were identified (SAR 2.4%). All had attended services on 15 and/or 16 July, none had attended services only on 17 July.	Insufficient air replacement - Lack of ventilation and aeration (ventilation system and fans not in operation; windows and doors closed, except for entrance and exit) Increased aerosol emission (singing) - May have increased the amount of aerosols generated by the primary case	Quality rating: high Key limitations - Singing as a modifying factor for airborne transmission was presented as a hypothesis, no data presented to support it - Testing performed within one week of exposure, some cases might have been missed

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	- Video recording - Site visits with building managers to understand ventilation	- Video analysis found all secondary cases sat in the same section, 1-15m from the primary case, who was located in a choir loft 3.5m above the congregation, facing away from the secondary cases. No cases were detected in other sections of the church. - Except for 5 of the secondary cases who were from the same household, close contact and fomite transmission unlikely as primary case denied mixing with attendees or touching objects (confirmed by video analysis). - Transmission outside the outbreak deemed unlikely as community transmission was low at the time and genome sequencing suggested single cluster. - No secondary cases identified within participants who only attended service on 17 July. Hypothesised reasons being cases were not detected, or that air flow on that day was different, or the primary had passed infectiousness peak.		
Kwon et al, 2020[12] Setting: restaurant in Jeonju, Korea Transmission date: 12 June 2020 Investigation period: epidemiological field investigation took	Participants: 14 participants, including 1 primary case (case B) and their 13 close contacts at the restaurant (11 visitors and 2 employees) Outcome assessment - COVID-19 test (nasopharyngeal swab, RT-PCR) for all close contacts	- Case B (primary case) visited the restaurant on 12 June 2020, 1 day before symptom onset. - 13 persons identified as close contacts, of which 2 tested positive: case A (symptom onset 16 June, positive test 17 June) and case B (symptom onset 18 June, positive test 20 June); link to primary case confirmed by	Directional air flow - Environmental investigation, including air flow velocity and direction showed air conditioner units directed air from the primary case B diagonally across the restaurant to secondary cases A (maximum speed 1.0m/s)	Quality rating: high Key limitations - The authors ruled out close contact and fomite transmission; however they did not report results of CCTV analysis for interaction between cases B and C

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place 19 June – 2 July 2020 Objective: to investigate how transmission of SARS-CoV-2 occurred in a restaurant	- Genome sequencing for positive cases Exposure assessment - Contact tracing - Personal interviews - Credit card records - CCTV images - Mobile phone location data - On-site visits for environmental sampling (RT-PCR, 39 samples from air conditioning units, tables and chairs) and to assess restaurant structure, seating arrangement and air flow (anemometer)	genomic analysis. Secondary attack rate: 15.4% (2/13). - Cases B and A: in the restaurant at the same time for 5min, 6.5m apart (without mask). Close contact and fomite transmission unlikely as they did not use the same door and case A did not leave their table (CCTV). - Cases B and C: in the restaurant at the same time for 21min, 4.8m apart. Fomite transmission through door handle unlikely as they did not use the same door. - All environmental samples tested negative (qRT-PCR).	and C (maximum speed 1.2 m/s) - The other visitors (and staff) present in the restaurant (including some that were closer to case B and for a longer time) but not in the air flow path from case B did not get infected. Visitors sitting at tables with cases A and C but facing away from primary case did not get infected. Insufficient air replacement - No windows and no outside ventilation system	- One additional visitor tested positive for COVID-19 (case D, who was with case B at the restaurant) on 16 June (symptom onset 15 June); not included in the investigation as believed to be part of a different cluster (supposedly infected on 11 June); however, no information provided on genomic analysis - Environmental sampling conducted on 23 June 2020, 11 days after event
Li et al, 2021[13] Outbreak originally reported by Lu et al[14] and additional analysis of CCTV recording by Zhang et al[15] Setting: restaurant in Guangzhou, China Transmission date: 24 January 2020 (Chinese New Year's Eve) Investigation period: soon after secondary cases with no travel history notified on 6	Participants: 89 visitors (10 positive cases) and 8 staff Outcome assessment - COVID-19 test (throat swab, RT-PCR) for all participants Exposure assessment - Epidemiological data (including travel and exposure history) and seating arrangement from Li et al[14] - CCTV recording (of restaurant and elevator), with detailed analysis from Zhang et al[15]	- 9 potential secondary and tertiary cases (symptom onset up to 6 Feb) at tables A, B and C situated at the back of the restaurant; potential primary case (symptom onset later on 24 Jan) sat at table A. None of the other 79 visitors or 8 staff tested positive or developed symptoms of COVID-19 within 14 days. - Table A located between tables B and C; overlap time between tables A and B was 53min and 75min between tables A and C. Distance between primary case and potential secondary cases was 1.4m-4.6m. - Table A: (visiting from Wuhan) 10 people from 4 households, 5 infected (including	Directional air flow by air circulation units - 5 fan coil air conditioning units, one of which was at the back of the restaurant directed towards tables A, B and C - CFD simulation predicted a relatively isolated air recirculation zone around tables A B and C, which was supported by tracer gas experiments, thought to have promoted long distance airborne transmission. Those on tables next to table A, but	Quality rating: medium Key limitations - Genomic sequencing not performed, transmission outside this event cannot be ruled out. Cases in table B had symptom onset between 1 and 5 Feb (≥8 days after event); could have been infected elsewhere - All members of 3 tables used the bathroom. Whilst there was no overlap with the primary case, fomite transmission is unlikely, but

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February 2020. Tracer gas study, 19-20 March 2020 Objective: to investigate an outbreak involving 3 families that occurred at a restaurant and evaluate airborne transmission and associated environmental conditions	- Design of air conditioning and ventilation system - Hourly weather data - Computational fluid dynamics (CFD) simulation and tracer gas measurements (on-site visit) to study airflow and respiratory particles dispersion	primary case); but transmission between primary and secondary cases could have happened outside restaurant. - Table B: 4 people from 2 households, 3 infected. Table C: 7 people from 3 households, 2 infected. No contact with any known COVID-19 patients or visitors from Hubei Province 14 days prior to symptom onset. Unclear whether all had been infected at the restaurant, but likely that transmission happened at the restaurant for at least 1 member of each table. - Extensive CCTV analysis (3 camera) of surface touching and close contacts ruled out other transmission routes: no risk of fomite transmission or close contact during lunch or in elevator (apart from some seating back-to-back); table A was active (standing up, speaking right and left, but primary case never turned their head towards table B) while tables B and C were rather inactive in comparison.	not in the circulating air stream, did not get infected Insufficient air replacement - Air-conditioning units without outdoor air supply and exhaust fans not in use (except 1 in the bathroom providing occasional natural ventilation); door used approximately every 2 minutes, but no windows opened - 2 tracer gas decay experiments showed the air exchange rate was only 0.77 air changes/hour and ventilation rate 0.75–1.04 L/s fresh air/person	cannot be completely ruled out
Lin et al, 2021 [16] Setting: 29-storey apartment with 3 units in Guangzhou, China Transmission dates: ~21 January – 1 February 2020, unit	Participants: 9 symptomatic cases from 3 flats in unit B; total number of residents not specified Outcome assessment - COVID-19 test (nasopharyngeal swab; RT-PCR) of the 9 symptomatic cases	- Apartment block consisting of 3 side-by-side units (A, B, C), with shared entrance and lifts. - All 9 cases were symptomatic and infected by the same strain of SARS-CoV-2. 5 cases from flat 15b (tested positive 26-29 January), 2 from 25b (tested positive 1 February) and 2 from 27b (tested positive 6-13 February).	Insufficient air replacement - Ventilation efficiency lower in unit b than in unit a and c due to a modification of the ventilation pipe (narrower and bent at a right angle). Tracer gas experiment showed gas remained for longer in the	Quality rating: low Key limitations - Only symptomatic testing, asymptomatic cases in other flats and units might have been missed - Transmission from outside the apartments cannot be ruled out as no whole genome

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evacuated on 8 February Investigation period: not specified, but field measurements likely to be while residents had been moved to a separate hotel between 8-22 February 2020 Objective: to investigate a community outbreak in apartments and evaluate airborne transmission	- Partial S-gene sequencing Exposure assessment - Interviews with cases - CCTV of the elevator - Simulated experiments within the apartments with tracer gas and measurement of air flow	- 4 of the 5 members of flat 15b had travel history to Wuhan; flats 25b and 27b did not. - Elevator disinfected immediately after diagnosis of the primary case. Elevator CCTV showed no close contacts within the elevator between 25 and 27 January 2020, and that family 15b wore masks every time but once when in the elevator; families 25b and 27b did not. - Elevator used by residents of all 3 units. However, significant difference in chance of testing positive for residents from unit b compared to residents not from unit b ($p<0.05$; Fisher's exact test): location of positive cases was unlikely to be due to chance alone, or due to transmission in the elevator. - Families 25b and 27b reported no close contacts with family 15b or with other cases. - All cases located in unit b, sharing a common pipe system. Wind speed and tracer-gas experiments showed that long-distance airborne transmission through pipe system was possible.	pipes compared to unit A (>60min vs <30 min) - Windows were closed (winter, cold weather) Directional air flow - Wind speed experiment showed that on flushing a toilet, strong airflow could drive virus through drainage and exhaust system for vertical line transmission between connected apartments on different floors	sequencing performed (only partial S-gene which provided evidence on variant) - CCTV analysis of elevator limited to 25-27 January, close contact or fomite transmission before or after this period cannot be ruled out - Unclear whether possibility of close contacts in building entrance and corridors was considered - The authors reported in the discussion that residents generally wore masks outside of their apartments and avoided going outside, but it is unclear whether this started before or after the outbreak had been detected
Luo et al, 2020 [17] Additional investigations from Ou et al, 2022[18] Setting: public transport (coach and	Participants: primary case and 243 potential contacts; up to 9 secondary cases identified who had travelled with primary case Outcome assessment	- Primary case (symptom onset 22 January; tested positive 29 January) travelled on 2 buses on 22 January 2020: • First journey (coach, 2.5h): of the 48 passengers (including driver), 7 tested positive (symptom onset: 23 January - 4 February, 1 asymptomatic).	Insufficient air replacement - Coach: all windows closed; air conditioning system turned off - Minibus: driver recalled that his small window and 2 other windows were opened occasionally (although	Quality rating: low Key limitations - Genomic sequencing not performed so transmission outside this event cannot be ruled out, although

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minibus), Hunan province, China Transmission date: bus trips on 22 January 2020 Investigation period: epidemiological investigation not specified; tracer gas experiments on minibus 5-7 April and on coach 7-11 April 2020 Objective: to investigate transmission from a single primary case who travelled on a public coach and minibus	- COVID-19 test (nasopharyngeal swab; RT-PCR) for all participants Exposure assessment - Epidemiological survey/interview of drivers and passengers (travel history and close contacts of suspected cases) - Bus seating layouts from video screenshots and loading and unloading stops of all passengers (obtained from public transportation authority) - Details of the air conditioning and ventilation systems on the buses and hourly weather data from 22 Jan - Ventilation and dispersion measurements on both buses with the original drivers on the original route	• Second journey (minibus, 1h): of the 12 passengers (including driver), 2 tested positive (symptom onset: 24 January and 31 January). - Majority of secondary cases >2m from primary case, up to 4.5m. On the minibus, the farthest infected seat was 2.3m from the primary case (the other was within 2m). - None of the cases wore face coverings on the buses, but some non-cases did. - Fomite transmission and close contact transmission cannot be ruled out, although deemed unlikely for at least some cases (e.g. who had used different doors and did not report direct contact with primary case). - None of the infected passengers had been in contact with a COVID-19 case in the two weeks prior to symptom onset. Very few cases reported in the Hunan Province before 22 January 2020. - Distribution of tracer gas from simulation of exhalation from the primary case was measured to be relatively uniform. On both buses, contaminated supply air spread slightly more to the driver side than to the opposite side. These findings were thought to explain the relatively uniform distribution of secondary cases front-to-back on both buses, but a higher AR on the driver side.	weather was 6-9°C with light rain); air conditioning turned off - Tracer gas experiments showed both buses were poorly ventilated: average ventilation rate of 1.72L/s and 3.22L/s per person on the coach and minibus respectively (much lower than 8-10L/s per person often recommended) Directional air flow from ventilation system - The coach had a ceiling-mounted outdoor air supply inlet at the rear, and a ceiling exhaust at the front, possibly creating an air flow from the rear of the coach (where the primary case was seated) to the front (with the primary seated one row from the back) - Heating was from floor-level convective radiators along both sides of the coach, although this was not working on the side with the seat of the primary and most secondary cases (6 of the 7 secondary cases from the	community levels were thought to be very low at the time - Due to potential for more than 1 primary case (up to 3 on the coach and up to 2 on the minibus), it is not possible to obtain exact distances for transmission, but likely to >2m from all potential primaries for some secondary cases - Unclear when the epidemiological investigation and the testing of the contacts took place - Interviews with passengers and drivers are at risk of recall bias - On the minibus, the farthest infected seat was 2.3m from the primary case, so close contact transmission may have occurred - There are some discrepancies in exact seating positions between the two reports, meaning exact distances cannot be determined for all secondary cases

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			coach were seated on the same side as the primary) - The minibus had an exhaust fan in the centre	
Sarti et al, 2021[19] Setting: workplace (office; 130m^2), Italy Transmission date: 23 November 2020 Investigation period: December 2020 (retrospective study of 20 November to 7 December 2020) Objective: to describe a COVID-19 outbreak in a small office	Participants: n=6 co-workers (5 days a week, 8h/day) Outcome assessment - COVID-19 test (RT-PCR) on days 7 and 14 from contact with primary case for all contacts Exposure assessment - Phone interview (protective measures in place, position in the office, contact history with co-workers as well as symptom history, test results and household status)	- 5 COVID-19 cases: 1 primary case (symptom onset on 24 November 2020; absent from the office from this date) and 4 secondary cases: symptom onset 28 November (1 case) and 2 December (3 cases). One other co-worker, not infected, was absent from the office on 23 and 24 November. - The office 130m^2 space on 1 floor included desk area (6 workers each had individual desk), archive room, meeting room, photocopier area and toilet. - COVID-19 measures in place: minimum 1m between each desk (distance between cases: 1.76 to 5.01m), Plexiglas panel between desks and hand disinfection; face coverings used in meetings (although no internal meetings held) or when moving in the office, but not when seated at desk. - No known contact with other positive cases for the 4 secondary cases. - Close contact and fomite transmission: cannot be ruled out despite the measures in place.	Insufficient air replacement and directional air flow - The office was not regularly ventilated: windows were not opened and had no air conditioning - heating system: vent convector using internal air; internal filter changed monthly	Quality rating: low Key limitations - Genomic sequencing not performed, transmission outside the event cannot be ruled out despite the contact tracing results - Very limited information provided on the interviews with participants, risks of fomite or close contact transmission not discussed
Shah et al, 2021 [20] **PREPRINT (v2, 6 July 2021)**	Participants: between 9 (event 5) and 21 (event 2); 78 in total	- National recommendations for singing event at the time of the study included physical	Insufficient air replacement - Doors or/and windows reported to be opened in all events. In addition: event 3:	Quality rating: medium Key limitations

Author, setting, study period, objective	Participants, methods	Results relating to transmission routes	Results relating to transmission modifying factors	Study quality and key limitations
Setting: 5 singing events, Netherlands Transmission dates: 5 unspecified dates in September and October 2020 Investigation period: retrospectively, unclear how long after the events Objective: to investigate whether singing increased SARS-CoV-2 transmission risk during singing events	(of which 48 confirmed and 2 probable cases) Outcome assessment - COVID-19 test (respiratory sample; RT-PCR) for all symptomatic cases (and for 4 asymptomatic cases); probable cases based on symptoms only - Genome sequencing for some of the cases from events 4 and 5 Exposure assessment - Phone/email conversations with spokesperson of each group, and questionnaire for all participants (81% response rate, ranging from 58% for event 1 to 100% for event 4), including data on possible exposure within and outside the event, and seating arrangements - National Notifiable Diseases Surveillance System data - Aerosol transmission model (AirCoV2)	distancing and ventilation. Rooms ranged between 320 to 3,000m^3. - Event 1: 90 min duration (50 min singing), 19 attendees, 14 confirmed cases (74% attack rate), no single primary case identified (7 had symptom onset in the 3 days following the event). Cases widely dispersed in the room (likely >2 metres). Some staff present in the venue but no information available. - Event 2: 120 min duration (80 min singing), 21 attendees, 13 confirmed cases, 1 probable case (67% attack rate), 2 possible primary cases identified. Cases widely dispersed in the room (likely >2 metres). - Event 3: 150 min duration (120 min singing), 15 attendees, 8 confirmed cases (53% attack rate). 1 possible primary case identified. Cases widely dispersed in the room (likely >2 metres). - Event 4: 120 min duration (90 min singing), 14 attendees, 7 confirmed cases, 1 probable (57% attack rate), 1 possible primary case identified. Cases widely dispersed in the room (likely >2 metres). Genome sequencing: 2 participants on opposite sides of room had identical strain. - Event 5: 60 min duration (20 min singing), 9 participants, 6 confirmed cases (67% attack rate), 1 possible primary case identified. Cases were positioned up to 3m from suspected primary case. Genome	ceiling ventilation; event 4: Possible mechanical ventilation - Not enough information provided to assess exact air exchange rates, but estimated to be about 3 air exchanges per hour (ACH) for events 1 and 5, and <1 ACH for the other events Directional air flow - Members in events 1, 3 and 4 reported feeling an air draft - Not enough information to assess whether air flow was a modifying factor, but cannot be ruled out: air flow could have been generated through opened doors or windows; and all events except event 2 had some mechanical ventilation systems (events 3 and 4) or heating systems (events 1 and 5) Increased aerosol emission (singing) - Possible modifying factors in all 5 events - AirCoV2 model suggests high virus concentration (eg presence of a supershedder with 10^{10} virus/mL of mucus)	- Epidemiological investigation mainly based on questionnaire and unclear how long after the events it was done (risk of recall bias) - Genomic sequencing not performed for 3 events, and for only 2 out of 8 cases for another event - Potential primary cases identified though symptom onset date (in all events, at least 1 participant had symptom onset in the 3 days following the event); asymptomatic transmission was not considered (no asymptomatic testing)

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		sequencing: 4 of 5 identical strains in participants sitting near one another. - Droplet transmission reported to be unlikely in events 2 and 5, but possible for some secondary cases in events 1, 3 and 4 (lack of social distance reported before, after or during the break, and some members travelled together to and from the events); 6 participants lived together, all tested positive. - Fomite transmission reported to be unlikely in events 1, 2, 3 and 5. Event 4: cannot be ruled out due to use of a coffee machine with a push button. - Most attendees did not report contact with confirmed cases before (n=3) or after (n=4) the event and only 3 of all attendees reported having participated in another singing event in the 14 days prior to the event.	required to explain high attack rates observed in these 5 events	
Shen et al, 2020[21] Setting: bus transport to an outdoor religious event in Zhejiang province, China Transmission date: bus ride 19 January 2020	Participants: 300 individuals attended religious event, of which 128 had travelled by bus (60 on bus 1 and 68 on bus 2; the 2 buses had similar design) Outcome assessment - COVID-19 test (throat swab; RT-PCR) for those involved in the outbreak and their close contact Exposure assessment	- 31 cases including primary case (first to develop symptoms and had close contact 2 days before event with 4 individuals with travel history to Hubei). Primary case considered presymptomatic as reported first symptoms after the event although a follow-up investigation suggested that they had a mild cough from the day before the event. - 23 secondary cases had travelled in the same bus (bus 2) as the primary case (50 min each way travel time). The remaining 7 did not	Insufficient air replacement - Bus air conditioning system was in indoor recirculation mode (warm air); no information provided on whether the 4 windows were opened - The driver and passengers seated near the door were not infected. Only 1 participant	Quality rating: medium Key limitations - Testing of all individuals "involved in the outbreak" may be only those who developed symptoms (and their close contacts) rather than all participants at the religious event - Genomic sequencing reported in methods but results not

Author, setting, study period, objective	Participants, methods	Results relating to transmission routes	Results relating to transmission modifying factors	Study quality and key limitations
Investigation period: 27 January – 23 February 2020 Objective: to investigate how transmission of SARS-CoV-2 occurred during bus travel	- Questionnaires and interviews (demographics, travel history, seating arrangement in bus, etc) - Contact tracing data - Bus design and ventilation system	travel in a bus but reported close contact with primary case during the religious event (150min duration; mainly outdoors). No secondary cases identified within the 60 individuals who travelled in bus 1. None of the participants wore masks and no IPC measures in place. - For the 23 secondary cases from bus 2, most transmission events likely to have happened during bus ride rather than during religious event as otherwise cases would have been randomly scattered between buses. The event included a 15-30min lunch with tables of 10 during which passengers from bus 2 were randomly mixed with others. Relative risk (RR) of infection for those on bus 2 compared to: • Bus 1: RR 42.2 (95%CI 2.6 to 679.3; p<0.01) • All participants but those in bus 2: RR 11.4 (95%CI 5.1 to 25.4; p<0.01) - Cases scattered within bus 2, no statistically significant association with being seated <2m from primary case. Severity of cases not associated either with proximity to primary case. Passengers remained seated during the ride and had same seats in on both journeys. - Fomite transmission e.g. from a pole on the bus cannot be ruled out, although unlikely to account for all 23 cases.	seated near openable window infected Directional air flow - 16 air vents across both sides of the bus, no information provided on whether these might have resulted in air flow	presented. It is likely that the genomic sequencing was used as case definition (see supplementary material of the paper) rather than to ensure cases belonged to the same genomic cluster - Some secondary cases had disease onset >14 days after the exposure - Authors commented on repartition of cases compared to position near windows, but not enough information provided to assess its significance in relation to air replacement and air flow - Exposure assessments (travel history, seating arrangements etc) mainly based on questionnaires and interviews
Vernez et al, 2021[22]	Participants: n=10 Outcome assessment	- 5 COVID-19 cases: 1 suspected primary case (symptom onset on the day of the event;	Insufficient air replacement	Quality rating: low Key limitations

Author, setting, study period, objective	Participants, methods	Results relating to transmission routes	Results relating to transmission modifying factors	Study quality and key limitations
Setting: courtroom (150m^3), Switzerland Transmission period: 2-5pm on 30 September 2020 Investigation period: October-December 2020 Objective: to address the hypothesis of aerosol contamination in a COVID-19 outbreak that occurred in a poorly ventilated courtroom	- COVID-19 test (RT-PCR) for the 5 participants who developed symptoms; unclear whether the 5 other participants were tested Exposure assessment - Hearing records - Contact tracing data - Schematic view of the courtroom with positions of the participants, including distance between them - Field measurements: CO2 injections and lactose aerosol generation to assess ventilation rate and fine aerosol dispersion	positive test the day after); 3 likely secondary cases (no known contact with other positive cases; symptom onset 3 days after the event for 2 of them, unknown for the third) and 1 possible secondary case (symptom onset 2 days after the event but had contact with another positive case on the 26/09/2020). - Event lasted 3 hours (9 of the 10 participants were present for the 3 hours of the event, 1 only for 34 minutes); 3 breaks (7min, 15min and 24min). - COVID-19 measures in place: minimum 1.5m between each seat; mask use mandatory indoor except while seated; disinfectant available for hand hygiene. - The index case and the 3 likely secondary cases were all seated behind the same table (2 at 1.5m of the index case, 1 at 3m of the index case); they remained in the room during the break although no information was available on whether they went to the bathroom or on possible close contact before or after the event. The possible secondary case was at 3.3m of the index case and leaved the room during the breaks. - Fomite transmission deemed unlikely as there was limited exchange of objects between participants, except for a paper document circulated between 4 participants (including index case and 2 likely secondary cases).	- Room poorly ventilated: no mechanical ventilation, door closed, window closed except during breaks; results confirmed by field measurements which found that air renewal was of 0.23/h (closed window) and 1.23/h (open window) and that the event conditions may have resulted in a homogeneous distribution of aerosols throughout the room Increased aerosol emission (speaking loudly) - 3 participants reported to have spoken for long period of time and loudly, but not the index case	- Genomic sequencing not performed, transmission outside this event cannot be ruled out (14-day incidence at time of event: 100 cases/100,000 habitants) - No information provided about what happened during the breaks - Field measurements done 3 months after the event, without participants in the room and with dividers of Plexiglas between each seat which were not present when outbreak occurred - Study mainly based on field measurements and modelling; limited information provided on the results of contact tracing and no mention of interviews with participants

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