

Insights on transmission of COVID-19 with a focus on the hospitality, retail and leisure sector

Purpose of the paper

This paper is a summary of the best available evidence at the time of writing with respect to the risks of COVID-19 transmission in the retail, leisure and hospitality sector.

The paper synthesises multiple strands of evidence taking into consideration outbreak surveillance, contact tracing and case-control studies and published evidence from international research studies. This report also complements the previous NERVTAG/EMG paper on transmission routes and environments (dated 22 October 2020) and Transmission group paper on Factors contributing to risk of SARS-CoV2 transmission in various settings (dated 26 November 2020).

Key considerations when reviewing the data are:

- The risk of transmission of SARS-CoV-2 in hospitality, retail and leisure sectors described in this paper is based on entirety of evidence;
- This paper synthesises international and UK evidence using different approaches, including ONS mobility data, and PHE case-control, secondary attack rates, outbreak investigations and cluster concordance (shows the transmission from the same source) studies;
- Each source of evidence has its own associated caveats, limitations and biases and therefore there are a number of uncertainties involved in drawing conclusions solely from individual data sources. With this in mind, this paper draws out where a combination of evidence indicates a pattern of increased risk of transmission in certain settings. The majority of evidence describes associations rather than causation;
- Contact tracing applies a definition of a close contact which could result in some potential contacts being missed and may underestimate the risk in a given setting. There are other strands of evidence such as outbreak investigations and concordance studies that complement these studies;
- Numbers of outbreaks should be interpreted with caution, due to how information can be reported to PHE, but reflect ongoing risk in a number of settings. It is extremely difficult to determine how much of the transmission of SARS-CoV-2 takes place within a sector, and how much is associated with related social, household or transport exposures. However, this paper highlights where the combination of evidence indicates that particular sectors that have an increased risk of transmission overall;
- While transmission is a continuous risk which can occur in any setting, some settings facilitate greater risk of transmission due to a combination of environmental and behavioural factors and some settings act as a connection hub bringing non-household members together either through the setting or associated activities;
- There is variation in the extent, quality and level of adherence to COVID secure measures within and between retail, leisure and hospitality settings. Detailed analysis of these variations cannot be readily drawn out from available data. In addition, the effect of these variations on the level of transmission within and between retail, leisure and hospitality settings cannot be readily drawn out;

- The data collected via contact tracing offers an opportunity to understand the environments where people spend time, but does not give definitive information on where, when and how transmission occurred;
- Transmission linked to a setting may go beyond the physical venue and the activities that happen within that space. Many settings will facilitate other interactions and behaviours including travel and social interactions that happen outside of a particular venue or event;
- We are not comparing the leisure, hospitality and retail settings in relation to risk associated with other settings, any risk associated with other settings is beyond the scope of this paper;
- In these analyses, different methodologies used different comparator groups as a baseline (see methodology section for each study).

Executive summary

- Transmission is strongly associated with proximity, duration and frequency of contact and community prevalence. The highest risks of transmission are associated with poorly ventilated and crowded indoor settings. (high confidence)
- The contribution of different settings on the population infection rates will depend on both the likelihood of transmission occurring within a particular environment and the frequency with which people visit that setting. Settings that are associated with higher risk factors and are visited frequently by many people are likely to have a much bigger impact on population level transmission than those that may have a higher risk but are visited infrequently by smaller numbers of people. (high confidence)
- According to ONS mobility data, among adults, the number of socially distanced contacts of all ages has decreased over time since September/October 2020. In December, socially distanced contacts may have risen slightly as the November lockdown ended, but remains low since December lockdown. Overall, the number of social contacts in relation to leisure activities have remained low. The highest social contacts reported are in relation to leaving home for work related purposes. (medium confidence)
- It is difficult to ascertain the individual contribution of these sectors to the overall transmission rates as they are closely linked to other activities and occupations, such as warehouses, delivery workers, food production, transport. Once hospitality and retail services are open, it leads to greater mixing and mobility across the population. (medium confidence)
- Overall, data suggest that the hospitality sector, compared to leisure and retail sectors seems to be associated with greater risk of transmission. But, overall, population attributable fractions (fraction of all cases in a population that is attributable to the setting) associated with transmission in hospitality, retail and leisure are relatively low. Thus, transmission happens in more than one setting and activity. (high confidence)
- The secondary attack rate among contacts of confirmed cases from leisure and hospitality activities outside the home (not work or education) was highest among people exposed at private events and celebrations. However, four case-control studies provided no statistical evidence that these were associated with increased odds of infection. (medium confidence)

- Shopping has consistently been one of the most commonly reported exposures among cases; however, four case-control studies have not shown any indication that shopping is associated with increased odds of becoming a COVID-19 case. (high confidence)
- Three case-control studies provided no statistical evidence that personal exercise activities were associated with increased odds of becoming a COVID-19 case, although indoor gyms show the highest attack rate in the exercising category and smaller numbers of events at swimming pools show a lower risk. (high confidence)
- Staff working in these sectors are shown to be at significantly higher risk of infection than customers, consistently demonstrated in all studies. Close contact service staff, in particular those working in restaurants, bars, and pubs, had the highest risk observed. (high confidence)
- Staff working in these settings are likely to have numerous and frequent daily contacts, long working hours, working in settings where adherence to mask use or social distancing may be challenging, and workers may also share living spaces or live in large/multiple occupancy households or may share transport or use public transport. (high confidence)
- Requiring more people to come to a workplace is likely to increase the risk of transmission associated with that environment, either retail, hospitality or leisure. (high confidence)
- Staff attending the workplace while unwell (which may be more likely if not provided with sick leave or financial compensation) increases the risk of transmission in the environment, which increases risk for customers and other staff members. (high confidence)
- Supporting staff to self-isolate while unwell or with positive test (through provision of sick leave or sufficient financial compensation) is important in reducing the risk of transmission in the environment. (high confidence)
- Regardless of the source of the initial infection, the risk of onward transmission also relates to both working conditions and living conditions. For many occupations, it may be difficult to disentangle these effects of 'working conditions' and 'living conditions'. (high confidence)
- These findings suggest that while mitigation measures implemented in these settings primarily aimed at preventing infections among customers, staff are at much higher risk of infection, increasing the infection risk of a given setting. This suggests that mitigation measures to reduce the risk of infection among staff working in these settings are needed. (high confidence)
- Mitigation measures aim to decrease the likelihood of transmission in a given setting; however, they do not completely eliminate the risk. Regardless of mitigation measures in place, several people gathering together in an environment likely increases the risk of transmission, either in that environment or via associated activities (e.g. transport). (medium confidence)
- These conclusions are in line with international and national analyses showing higher cumulative infection rates observed in those areas that continued to engage in mobility behaviours consistent with commuting for work. Public facing occupations involve greater social mixing and greater exposure risk owing to factors such as prolonged working hours and reduced opportunities to practise physical distancing. (high confidence)
- As community businesses reopen, prevention measures should be emphasized, including limiting building occupancy, improving ventilation, prioritizing outdoor seating, enforcing correct mask

wearing and physical distancing, staying home when ill, and encouraging COVID-19 vaccination to reduce transmission on site and within the community.

UK Research studies

Coronavirus outbreaks worldwide have been associated with restaurants, pubs, cafes and gyms. We have analysed the risk of transmission of SARS-CoV-2 in these settings in the UK using several approaches: social contacts over time, case-control studies, secondary attack rates, and cluster concordance.

The details of the outcomes of these investigations are shown in Table 1. As many hospitality and leisure environments will be utilised with friends and family, risk measures associated with visiting friends and relatives at home are also shown for comparison. In addition, Table 2 shows a breakdown of outbreaks with the data stratified by lockdown or tiering interventions in place. Table 3 provides summary of Population Attributable Fraction (PAF) for selected leisure and hospitality exposures.

Definitions used in the PHE analyses in this report:

- **Cluster (used for the literature survey):** two or more test-confirmed cases of COVID-19 among individuals associated with a specific non-residential setting with illness onset dates within a 14-day period (in the absence of detailed information about the type of contact between the cases).
- **Outbreak (used in outbreak surveillance section):** two or more test-confirmed cases of COVID-19 among individuals associated with a specific non-residential setting with illness onset dates within 14 days, and one of:
 - Identified direct exposure between at least 2 of the test-confirmed cases in that setting (for example under one metre face to face, or spending more than 15 minutes within 2 metres) during the infectious period of one of the cases
 - When there is no sustained local community transmission - absence of an alternative source of infection outside the setting for the initially identified cases

Case-control study

There was strong evidence that working in hospitality was associated with increased odds of being a COVID-19 case (aORs 2.87, 2.93 2.14, for studies 1-3 respectively). In particular, working in restaurants, bars, and pubs was strongly associated with increased odds of becoming a COVID-19 case (aORs 3.52, 2.92, 2.41 for studies 1-3 respectively). There was some evidence that working in retail and close contact services was associated with increased odds of infection. There was evidence that engaging in entertainment (other) activities was associated with increased odds of becoming a COVID-19 case in the first study (aOR 8.47, 95% C.I. 3.09-23.24, $p < 0.001$), the second study (aOR 4.13, 95% C.I. 1.51-11.29, $p < 0.006$), and the third study (aOR 7.12, 95% C.I. 1.69-30.04, $P = 0.008$). The population attributable fraction (PAF) for other entertainment activities was 0.9%, 1.8%, and 0.9%, for studies 1-3 respectively (Table 3). There was also evidence that going to a pub or bar was associated with increased odds of becoming a case in the second study (aOR 2.20, 95% C.I. 1.23-3.91, $p < 0.007$). The PAF for going to a pub or bar was 0.8%, 1.0%, and 0.2%, for studies 1-3 respectively. It is important to note that population attributable fractions for sectors do not indicate the overall proportion of cases that would be prevented by closing these venues as they do not account for the effect of other exposures elsewhere in the community. In particular, no account is taken of the effect of any potential onward transmission. Variation in restrictions for such venues across England during these periods should also be noted. Hence, these estimates may be confounded by multitude of factors, and should be interpreted with these caveats in mind. They indicate how much transmission can be attributed to the association observed, and that transmission is associated with multiple settings and activities.

The fourth case-control study was conducted during the second England-wide lockdown when non-essential shops and most hospitality and other entertainment venues were closed. The fourth study showed no evidence of an association between working or visiting hospitality settings and becoming a COVID-19 case. It is most plausible that this finding reflects a decreased opportunity to visit these venues

rather than a true decrease in the risk of infection associated with these settings. The fourth study did show some evidence that cases were more likely to visit a family or friend than controls (aOR 1.42, 95% C.I. 1.02-2.09, P=0.041).

Secondary attack rates

The secondary attack rate calculated among named close contacts of people with COVID-19 in NHS Test and Trace, from 23 October 2020 to 31 January 2021, was 10.2% (10.1% - 10.2%), with the majority of contacts named as household contacts. Secondary attack rates for named close contacts in hospitality and leisure settings or events were lower at 5.3% (5.2% - 5.5%), but it should be noted that not all contacts in these settings may be known contacts. Secondary attack rates in hospitality settings were overall higher (6.6% (6.3% - 6.8%)) than those in leisure activities (4.4% (4.2% - 4.6%)) during the period studied, despite the fact that 53% of leisure events were reported in the 2 Dec – 4 Jan period when the Kent variant was circulating, compared to 40% of hospitality events falling in the same period. Overall secondary attack rates in these sectors were depressed during periods of lockdown: 4.1% (3.6% - 4.6%) for 5 Nov – 1 Dec and 4.0% (3.6% - 4.6%) for 4 Jan – 31 Jan compared to 5.6% (5.3% - 5.9%) observed over 23 Oct – 4 Nov and 5.6% (5.4% - 5.8%) for 2 Dec – 4 Jan when there were fewer restrictions.

Cluster concordance

Groups of cases that reported attending the same place, on the same day, during the time when they may have acquired the infection, were compared using a genomic marker (S-Gene Target Failure, SGTF). This compares the level of concordance in events of a type we are studying to the level of concordance we would observe if the participants had been infected randomly with strains prevalent in their region, and compute an odds ratio indicating how much higher the observed level of concordance is than the expected. The odds of the cases having the same marker, which means that transmission may have occurred, compared to discordant markers which shows the transmission from the same source could not have occurred were calculated for different settings.

Higher odds ratios imply more likelihood of transmission from a common source, consistent with higher transmission rates in these settings.

The overall odds ratio relative to the random chance of cases having the same marker was OR 2.85 (2.53-3.2) among leisure settings and OR 6.2 (5.25 – 7.32) in hospitality settings. 96% of such groups were recorded during the tiers regime from 2 December 2020 – 4 January 2021. This is lower than odds ratios reported for staying with friends and relatives (OR 19.9 (11.4 - 34.8)) or visiting friends and relatives (OR 35.6 (19.7 - 64.2)).

Among leisure activities reported, risk was higher in indoor exercising (OR 3.83 (3.1 - 4.72)), including gyms and swimming pools, and personal care (OR 29 (3.6 - 234)) such as barbers and hairdressers, but numbers are small for the personal care category. Staff working in non-essential retail (OR 3.47 (2.6 - 4.63)) and close contact services (OR 45.6 (5.77 – 360)) had higher risks for leisure settings, with small numbers for the close contact services.

Odds of concordance in hospitality settings for the public were higher in holiday stays (OR 11.7 (6.96 - 19.6)) and eating out (OR 5.42 (4.29 – 6.85)). Staff working in hospitality had an overall odds ratio of 6.09 (4.64 – 7.98).

Outbreak surveillance

Public Health England monitors acute respiratory infection (ARI) outbreaks and situations reported to Health Protection Teams. Information on ARI relating to hospitality venues, by type of setting, was extracted from the HPZone case management system. ARI situations are categorised into Primary Contexts (for example Workplace, Food Outlet/Restaurant, Care Homes, Educational settings, Hospital, and Prison). A manual investigation of these situations was conducted to identify situations associated with hospitality venues. These occurred within the Workplace, Food Outlet/Restaurant, and Other Primary Contexts. The situations are further classified into Secondary Contexts (e.g. Workplace ->

Restaurant and Caterers) and Tertiary Contexts (e.g. Workplace -> Restaurant and Caterers -> Pub/Club), which are presented in the table 2.

The situations captured on HPZone represent a subset of all ongoing clusters and outbreaks in England rather than an exhaustive listing. As a result, the number of outbreaks reported for some of the regions are underestimates.

ONS Survey results

This analysis looks at how often individuals are reporting social contact (either socially distanced or physical contact) with other people outside their own household. We asked individuals how many people aged 17 years and under, 18 to 69 years, and 70 years and over, outside their household, they have had contact with up to seven days prior to each visit. "Contact" refers to either of the following:

- socially distanced contact – direct contact with social distancing only
- physical contact – physical contact, such as a handshake or personal care, including wearing Personal Protective Equipment (PPE)

This analysis covers the time period between 27 July 2020 and 8 February 2021. We have produced estimates that have been weighted to be representative of the total population in England.

Among adults, the number of socially distanced contacts of all ages has decreased over time since September/October 2020. In December, socially distanced contacts may have risen slightly as the November lockdown ended. The number of socially distanced contacts has decreased again in January and remains low in February, which could reflect the lockdown measures in place.

Overall, the number of social contacts in relation to leisure activities including eating at a restaurant or pub have remained low. The highest social contacts reported are in relation to leaving home for work related purposes.

These data allow us to track behaviours related to hospitality and leisure over time, including changes in behaviours across different lockdowns. A summary data table from 14th May 2020 to 31st January 2021 is available in [Table 3 here](#). These data are available up to and including the most recent weekly OPN release ([Table 6 here](#)) and will continue to be available going forward.

Table 1 Risks associated with particular activities

Events / Activities	Cluster concordance	Secondary attack rates	Case-control study
Visiting and being visited by friends and family (comparison)	Risks of transmission in this comparison group – OR 19.9 (11.4 - 34.8) for staying with friends and relatives and OR 35.6 (19.7 - 64.2) for visiting friends and relatives – were higher than most risks found in hospitality or leisure settings. Hospitality and leisure activities reporting higher risks tended to have small underlying counts.	Risks of activities of customers in leisure and hospitality settings may be compared to those of visiting friends and family at home. Secondary attack rates for contacts who visit or are visited by the case are around 8%; 8.5% (8.5%-8.7%) for visits to the case's home, and 7.7% (7.5% - 7.9%) for visits of the case to the contact's home. These are higher than for the majority of leisure and hospitality settings.	The first three case-control studies provided no statistical evidence of cases being more likely to visit friends or family. However, the fourth study did show some evidence that cases were more likely to visit a family or friend than controls (aOR 1.42, 95% C.I. 1.02-2.09, P=0.041).
Eating out	Eating out activities reported OR 5.42 (4.29 – 6.85) as a measure of risk of transmission.	Higher secondary attack rates observed were: pubs 7.6% (7.1% - 8.2%), restaurants 8.0% (7.3% - 8.9%) and cafés 5.4% (4.8% - 6.2%).	Eating out in any food outlet or restaurant was not associated with increased odds of becoming a COVID-19 in any of the case-control studies. However, analysing the data on more granular level provided evidence information eating in café/restaurant (other) was associated with increased odds of becoming a COVID-19 case in the first (aOR 4.56, 95% C.I. 2.75-7.56, p<0.001), the second (aOR 2.78, 95% C.I. 1.67-4.64, p<0.001), and the third case-control study (aOR 2.62, 95% C.I. 1.37-5.02, P=0.004). However, it is important to interpret this finding with caution as this category may represent a heterogenous set of restaurants and food outlets. The population attributable fraction (PAF) for eating out in a

			restaurant café (other) was 0.9%, 1.5%, 0.7%. 0.1%% for studies 1-4 respectively.
Entertainment and day trips	Risks of transmission OR 3.56 (2.03 – 6.25) for entertainment and day trip activities were slightly higher than the overall risk for leisure activities OR 2.85 (2.53 - 3.2).	An overall attack rate of 6.5% (5.8% - 7.2%) was observed across all entertainment and day trip events, with notably higher attack rates in pubs 10.0% (8.3% - 11.9%). This is a contrast to pubs as a venue for eating out 7.6% (7.1% - 8.2%).	<p>There was evidence that engaging in entertainment (other) activities was associated with increased odds of becoming a COVID-19 case in the first (aOR 8.47, 95% C.I. 3.09-23.24, p<0.001), the second study (aOR 4.13, 95% C.I. 1.51-11.29, p<0.006), and the third study (7.12, 95% C.I. 1.69-30.04, P=0.008). The PAF for other entertainment activities was 0.9%, 1.8%, 0.9% for studies 1-3 respectively.</p> <p>There was also evidence that going to a pub or bar was associated with increased odds of becoming a case in the second study (aOR 2.20, 95% C.I. 1.23-3.91, p<0.007). There was also some weak evidence in the first study (aOR 1.54, 95% C.I. 0.93-2.57, p<0.10), however, the third study showed no evidence that going to pubs and bars was associated with increased odds of becoming a COVID-19 case. The PAF for going to a pub or bar was 0.8%, 1.0%, and 0.2%, for studies 1-3 respectively.</p>

Exercising	The risk of transmission for exercising OR 3.83 (3.1 - 4.72), including exercise classes OR 7.01 (2.14 - 23), gyms OR 3.19 (2.51 - 4.06) and swimming OR 19.2 (2.26 - 164) (but small numbers), is slightly higher than the overall risk for leisure activities OR 2.85 (2.53 - 3.2).	Gyms show the highest attack rate in the exercising category 8.5% (7.0% - 10.3%). Smaller numbers of events at swimming pools show a potentially lower attack rate 5.1% (3.1% - 8.5%). Casual exercise with friend(s) were about 50% of the events studied in the exercising category and showed an attack rate of 3.6% (3.2% - 4.0%), perhaps indicating an outdoor setting for such activities.	The three studies provided no statistical evidence that personal exercise activities were associated with increased odds of becoming a COVID-19 case.
Personal care	Risk among people attending personal care settings was OR 29 (3.6 - 234), in barbers and hairdressers all clusters were concordant, however numbers were relatively small.	Contacts associated with attending a personal care setting (such as a hairdresser or nail bar) showed a relatively low attack rate of 3.6% (3.0% - 4.2%) among the sector.	The four studies provided no statistical evidence that personal care settings were associated with increased odds of becoming a COVID-19 case.
Private events and celebrations	Insufficient clusters were identified for this type of activity in the time period studied to assess risks.	Only parties were studied here, among ~500 events the attack rate was 8.6% (6.5% - 11.3%).	The four studies provided no statistical evidence that private events were associated with increased odds of becoming a COVID-19 case.
Public events and mass gathering	Insufficient clusters were identified for this type of activity in the time period studied to assess risks.	A secondary attack rate of 6.9% (4.8% - 9.8%) was observed amongst ~400 such events.	The four studies provided no statistical evidence that public events were associated with increased odds of becoming a COVID-19 case.

Shopping	Risks observed among people participating in non-essential shopping activities was OR 1.83 (1.51 - 2.22), one of the lowest of the categories studied, with slightly elevated risk in clothes shopping 1.96 (1.5 - 2.56) which also had the greatest number of clusters and garden centres 3.99 (1.29 - 12.3). The risks observed here are lower than those for leisure activities.	Contacts from non-essential shopping events showed an overall attack rate of 6.8% (6.0% - 7.8%). Some mitigating effect of outdoor settings may be indicated by these counts with low confidence as this is based on small counts of events. For indoor/covered markets (~200 events) the attack rate was 8.5% (5.2% - 13.6%) and for garden centres (~300 events) it was 4.9% (3.0% - 8.1%).	The four case-control studies provided no statistical evidence that shopping activities were associated with increased odds of becoming a COVID-19 case.
Sport events	Insufficient data to conclusively show a risk for these activities OR 2.19 (0.769 - 6.22) that was significantly different from overall leisure activities.	Attending sport events in the earlier period of tier restrictions (23 Oct - 4th Nov) showed a significantly higher attack rate of 5.9% (4.8% - 7.1%) compared to a later period (2 Dec - 4 Jan) when attack rates were 3.3% (2.5% - 4.3%).	
Household or accommodation Holiday accommodation	When looking at people staying in holiday accommodation outside their primary residence, risks of transmission OR 11.7 (6.96 - 19.6) are higher than overall for hospitality OR 6.2 (5.25 - 7.32). All clusters in private holiday homes were concordant. Hotels with OR 10.1 (5.82 - 17.5) were the setting with most clusters.	Spending time in holiday accommodation was associated with a secondary attack rate of 11.2% (9.7% - 13.0%), comparable to that of household transmission 10.9% (10.9% - 10.9%), but there was insufficient data to report on holiday accommodation events after 1st Dec 2020.	

<p>Work in Arts, entertainment or recreation</p>	<p>For staff working in general leisure settings the risk was OR 4.17 (2.05 - 8.5).</p>	<p>Events reported in workplaces in the arts, entertainment and recreation sector showed an attack rate of 5.6% (4.8% - 6.6%); for theatre/dance this was 8.7% (6.7% - 11.3%) and much lower in gyms and sports and leisure facilities 3.7% (2.5% - 5.5%).</p>	<p>The four case-control studies provided no statistical evidence that working in arts, entertainment or recreation was associated with increased odds of becoming a COVID-19 case.</p>
<p>Work in Close contact services</p>	<p>Close contact services staff had a risk observed of OR 45.6 (5.77 – 360). This includes those working as barbers or hairdressers OR 25.8 (3.15 – 212), this is higher than the overall risk for leisure settings but based only on 41 groups observed.</p>	<p>Secondary attack rates amongst contacts of cases working in these close contact settings were low for this sector and similar to those among customers (see ‘personal care’) at 3.1% (2.7% - 3.6%).</p>	<p>There was some evidence that working in close contact services was associated with increased odds of becoming a COVID-19 case in the first study period (aOR 2.92, 95% C.i. 1.11-7.68, p=0.03).</p>
<p>Work in Hospitality</p>	<p>The risk observed among staff working in hospitality was OR 6.09 (4.64 – 7.98), most groups observed were in food and drink services OR 6.13 (4.61 - 8.15) and a few in providing accommodation for instance in hotels and bed and breakfasts OR 10.1 (3.06 – 33.2).</p>	<p>Secondary attack rates for events in hospitality workplaces were observed to have an attack rate of 4.4% (4.1% - 4.8%); this was consistent among the subcategories of food and drink venues 4.4% (4.0% - 4.8%) and lodging 4.4% (3.3% - 5.8%).</p>	<p>The studies provided statistical evidence that working in hospitality (aORs 2.87, 2.93, 2.14, for studies 1-3 respectively) was associated with increased odds of becoming a COVID-19 case. In particular, there was statistical evidence across all studies that working in bars, restaurants and pubs was associated with elevated odds of being a case (aORs 3.52, 2.92, 2.41, for studies 1-3 respectively). The PAF for working in hospitality (any) was 2.3%, 2.8%, 2.1%, for studies 1-3 respectively. The PAF for working in restaurants, bars or pubs was 2.7%, 2.6%, 2.1%, for studies 1-3 respectively.</p>

Work in the retail sector	Staff working in non-essential retail had a risk of OR 3.47 (2.6 - 4.63), higher in health and beauty OR 10.6 (3.31 - 33.7) and sports and leisure where all clusters were concordant.	Staff in non-essential retail settings reported contacts with an attack rate of 4.3% (3.7% - 4.9%).	Working in retail was associated with increased odds of becoming a COVID-19 case in the 4th study (aOR 1.73, 95%C.I. 1.12-2.67, P=0.013). The PAF for working in retail was 0.3% in study 4.
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Table 2. Outbreaks in hospitality and leisure settings

Setting	Before Tiers	Tiers Autumn	Second Lockdown	Tiers Winter	Third Lockdown	Grand Total	Grand Total %
	29/6/20 - 11/10/20	12/10/20 - 1/11/20	2/11/20 - 29/11/20	30/11/20 - 3/1/21	4/1/21 - 14/2/21		
Food Outlet/Restaurant	219	73	21	13	17	343	53%
Food Outlet/Restaurant	219	73	21	13	17	343	53%
Bar	17	1	1	1	0	20	3%
Café	10	8	1	3	0	22	3%
Catered Event	1	0	1	0	0	2	0%
Fast Food	30	5	8	6	14	63	10%
Members club	9	1	0	0	0	10	2%
Pub	78	24	3	2	0	107	16%
Restaurant	74	34	7	1	3	119	18%
Other	84	30	12	12	24	162	25%
Congregation	2	0	0	0	0	2	0%
Social club	2	0	0	0	0	2	0%
Educational setting	9	0	1	0	0	10	2%
Halls of residence	9	0	1	0	0	10	2%
Foreign Travel	13	0	0	0	4	17	3%
Hotel	23	14	5	6	10	58	9%
Other	25	11	3	4	8	51	8%
Hotel/ Guest house	0	0	0	0	6	6	1%
Leisure Centre/ Gym	8	2	1	2	0	13	2%
Probation Hostel	0	0	0	0	1	1	0%
Restaurant/Café/Canteen	17	9	2	2	0	30	5%
Youth club	0	0	0	0	1	1	0%
Visitor Attraction	12	5	3	2	2	24	4%
Workplace	74	38	17	11	5	145	22%
Close Contact Services	1	0	1	0	0	2	0%
Spas and wellness businesses	1	0	1	0	0	2	0%
Office	1	1	0	0	0	2	0%
Housing association	1	1	0	0	0	2	0%
Other	27	12	5	6	3	53	8%
Leisure Centre/ Gym	16	9	3	2	1	31	5%
Visitor attraction	11	3	2	4	2	22	3%
Restaurant and Caterers	45	25	11	5	2	88	14%
Hotel/ Guest house	2	1	1	0	0	4	1%
Pub	16	10	1	1	0	28	4%
Restaurant/Café/Canteen	27	14	9	4	2	56	9%
Grand Total	377	141	50	36	46	650	100%

Table 3. Population Attributable Fraction (PAF)* for selected leisure and hospitality exposures by PHE case-control study period

Leisure or work activity	Period 1	Period 2	Period 3	Period 4
Eating out - other	0.9%	1.5%	0.7%	0.1%
Entertainment and day trips	0.9%	1.8%	0.9%	N/A
Going to a pub or bar for entertainment	0.8%	1.0%	0.2%	N/A
Working in a restaurant, café, or a bar	2.7%	2.6%	2.1%	N/A
Working in retail	N/A	N/A	N/A	0.3%
Working in hospitality (any)	2.3%	2.8%	2.1%	N/A
Visiting family or friends	N/A	N/A	N/A	<0.1%

* PAFs only calculated when the effect measure (OR) is above 1.0

Methodology

Case-control study

The four case-control studies were conducted in late August 2020 (1st study), late September (2nd study), late October (3rd study) and late November/early December (4th study).¹ The data for the cases was collected through NHS T&T, where cases provided the information either through a digital route (self-completed) or through being interviewed over the phone. Information was collected on workplace, education and leisure activities in the 2-7 day period before symptom onset (or date of test if onset date was not provided). Controls, who were recruited concurrently, completed an online survey with same activity questions. Controls were frequency matched by 3 age groups (18-29 years, 30-49, 50 and above) and by geography (London, South England, North England, Midlands) to take into account the distribution of the infection and the regional implementation of NPIs. Crude odds ratios (cORs) were obtained for each main exposure. Adjusted odds ratios (aORs) were obtained through multivariable analyses using penalised regression methods. All multivariable analyses were adjusted for age, sex, ethnicity, socioeconomic deprivation (using index for multiple deprivation (IMD)), geographical region, and work and leisure activities.

Secondary attack

Contacts with exposure dates within 23 October 2020 to 31 January 2021 were included in secondary attack rate analyses. Analyses were restricted to these dates due to a change in setting categories on 23 October 2020. CTAS data contains information collected from individuals with a positive test for SARS-CoV-2 referred to NHS Test and Trace ('cases') and individuals named by them as having been in contact with them between 2 days prior to symptom onset or test date and the date of tracing ('contacts').

Persons can arise multiple times as cases and/or contacts in the data and are matched with themselves via combination of name, NHS number, date of birth, address and contact information. Transmission is defined as a confirmed case (B) previously reported as a contact by a case (A), where the date for case (A) interacting with case (B) is between 2 and 14 days inclusive prior to the onset of symptoms (or test date) for case (B). Where there was more than one contact event within the transmission window leading to a case, one event is counted per case who was previously a contact, with priority given to household contacts and to later interactions. Hence leisure activities or visits to hospitality venues undertaken with members of one's household would not be considered as likely transmission events in this study.

Cluster concordance

Contact tracing information was used to identify clusters of cases which were in the same place on the same day up to 7 days prior to symptom onset. We assessed whether all cases in each cluster displayed positive or negative for SGTF (a specific genomic marker detectable via PCR). Baseline expected probabilities for concordance, positive or negative, are computed from the proportion of SGTF in cases developing symptoms on the date of the cluster. Assigning an odds ratio compared to the baseline to the proportion of such clusters, weighted by the number of cases, in each setting gives us an estimate of the risk that transmission may have occurred in a particular setting or group of settings.

¹ <https://www.medrxiv.org/content/10.1101/2020.12.21.20248161v1>

Caveats

Case-control study

It is not possible to determine how much of the transmission of SARS-CoV-2 took place within the settings described, and how much was associated with social, household or transport exposures not captured by the study. The study may be subject to selection bias as only cases who were tested are included and the controls were recruited from Market Research Panels and therefore may not represent accurately the general population of England. There is also differential misclassification of exposure. It is for example plausible that cases are under-reporting their activities potentially due to issues with questionnaire fatigue or being more likely to adhere to socially desirable reporting. Controls are less likely to be affected by questionnaire fatigue and were paid to complete the survey. However, it is difficult to determine whether the biases causing the misclassification led to under- or overestimation of specific effect measures. While multivariable models were adjusted for confounding of all the available demographic variables, some residual confounding is likely to persist.

Secondary attack

As links are only identified between named contacts, and rely on contacts accessing testing, secondary attack rates calculated here should be considered a minimum estimate. In leisure and hospitality venues, contacts between staff and customers may not be captured.

Cluster concordance

Only time periods in English regions where SGTF in cases developing symptoms was between 20% and 80% could be analysed, and very few clusters could be identified in lockdown periods so some regions (London, the South East, East of England and Yorkshire and Humber) are under-represented. This analysis only shows the setting-associated risk of multiple case exposures, not the underlying incidence of such multiple exposures in people attending such settings, and also neglects the exchange of disease between staff and customers in hospitality and leisure settings. Different activities were possible during different periods, and 96% of data on leisure and hospitality data was captured during the 2 December – 4 January tiers period, which may not have been the case for the comparison group of visiting friends and family.

International data

According to a recent analysis of non-pharmaceutical interventions worldwide, restriction of small gatherings was found to be the most effective of all approaches, while restriction of mass gatherings is within the top 10 most effective strategies. While this is not explicitly related to social and leisure settings many of which are expected to have better mitigation measures in place than in informal household gatherings, these are places which facilitate gatherings, and enable social mixing between different households.

Outbreak analysis studies have linked SARS-CoV-2 transmission to events such as parties and weddings as well as locations such as bars and restaurants. Studies have also highlighted clusters in fitness and sports settings. Poor ventilation and crowding have been suggested to be factors in numerous transmission clusters. However, most published studies are from early in the pandemic; it is not possible to establish whether transmission risk has changed over time, for example if mitigations have improved or behaviour has changed.

A selection of available literature

- **Community Transmission of SARS-CoV-2 Associated with a Local Bar Opening Event — Illinois, February 2021**
(https://www.cdc.gov/mmwr/volumes/70/wr/mm7014e3.htm?s_cid=mm7014e3_w)
 - 29 out of 46 cases were employee/patron working in the pub and there were 17 secondary cases.
 - 4 people had symptoms on the day of the event.
 - Event patrons were linked to secondary cases among household, long-term care facility, and school contacts, resulting in one hospitalization and one school closure affecting 650 students.
 - This supports the conclusions of this paper that staff working in these environments are at greater risk of infection, and the presence of symptomatic people in an environment increases the risk for the customers and other staff members.

- **COVID-19 Outbreak Associated with Air Conditioning in Restaurant, Guangzhou, China, 2020**
(<https://pubmed.ncbi.nlm.nih.gov/32240078/>)
 - January 2020, China, evidence of transmission between different families at the same air-conditioned restaurant

- **Evidence of Long-Distance Droplet Transmission of SARS-CoV-2 by Direct Air Flow in a Restaurant in Korea** (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7707926/>)
 - June 2020, South Korea, evidence of transmission between three cases associated with air flow at restaurant

- **Superspreading Event of SARS-CoV-2 Infection at a Bar, Ho Chi Minh City, Vietnam**
(<https://doi.org/10.3201/eid2701.203480>)
 - Description of a superspreading event associated with a bar resulting in symptomatic and asymptomatic infections

- **COVID-19 outbreaks in a transmission control scenario: challenges posed by social and leisure activities, and for workers in vulnerable conditions, Spain, early summer 2020**
(<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7472688/>)
 - In June-August 2020, in Spain, study investigated outbreaks reported to the national level with the following information: municipality, number of cases, date of symptom onset of the first and last cases, number of related contacts and transmission setting
 - Social settings comprised 35% (193/551) of all active outbreaks (vs occupational settings). Among these, the most frequent settings were those related to family gatherings or private parties (112 outbreaks including 854 cases), followed by those linked to leisure venues such as bars, restaurants, or clubs, with fewer outbreaks (n = 34) but involving more than 1,230 cases

- **Community and Close Contact Exposures Associated with COVID-19 Among Symptomatic Adults ≥18 Years in 11 Outpatient Health Care Facilities — United States, July 2020.**
(<https://www.cdc.gov/mmwr/volumes/69/wr/mm6936a5.htm>)
 - Findings from a case-control investigation of symptomatic outpatients attending 11 U.S. health care facilities found that close contact with persons with known COVID-19 or going to locations that offer on-site eating and drinking options were associated with COVID-19 positivity. Adults with positive SARS-CoV-2 test results were approximately twice as likely to have reported dining at a restaurant than were those with negative SARS-CoV-2 test result.

- **Coronavirus Disease Exposure and Spread from Nightclubs, South Korea**
(<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7510694/>)
 - In May 2020, in South Korea, at least 246 cases of coronavirus disease (COVID-19) have been linked to nightclubs in Seoul
 - They conducted contact tracing of persons who had visited any of the five major nightclubs in Itaewon during April 30–May 6, using cell phone location data, credit card records, and lists of nightclub visitors

- **Cluster of Severe Acute Respiratory Syndrome Coronavirus 2 Infections Linked to Music Clubs in Osaka, Japan** (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7499593/>)
 - In March 2020, in Japan, a cluster of 108 cases associated with a nightclub in Osaka

- **Subsidizing the spread of COVID19: Evidence from the UK's Eat-Out-to-Help-Out scheme**
(<wp.517.2020.pdf> (warwick.ac.uk))
 - This paper documents that a large-scale government subsidy aimed at encouraging people to eat out in restaurants in the wake of the first 2020 COVID19 wave in the United Kingdom has had a large causal impact in accelerating the subsequent second COVID19 wave.

- **Managing COVID-19 transmission risks in bars: an interview and observation study.**
(<https://www.jsad.com/doi/full/10.15288/jsad.2021.82.42>)
 - This paper describes a study using interviews of business practices and behaviours in licensed premises together with observations. Interviewees generally sought clarity, flexibility, and balance in government guidance on reopening, and they cited commercial and practical challenges to doing so safely. Alcohol consumption was perceived as an additional but potentially manageable challenge. Most observed premises had made physical and operational modifications; however, practices were variable. Observed incidents of concern included close physical interaction between customers and with staff, frequently featuring alcohol intoxication and rarely effectively stopped by staff.
 - Conclusions: Despite the efforts of bar operators and guidance from government, potentially significant risks of COVID-19 transmission persisted in a substantial minority of observed bars, especially when customers were intoxicated.

- **Cluster of Coronavirus Disease Associated with Fitness Dance Classes, South Korea**
(<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7392463/>)
 - In March 2020, in South Korea, 112 COVID-19 cases were identified as associated with fitness dance classes in 12 different sports facilities in Cheonan
 - A case was identified in Cheonan, active surveillance was conducted, all consecutive cases had participated in a fitness dance class (nationwide fitness dance instructor workshop).
 - Most (50.9%) cases were the result of transmission from instructors to fitness class participants; 38 cases (33.9%) were in-family transmission from instructors and students; and 17 cases (15.2%) were from transmission during meetings with coworkers or acquaintances.

- **Possible indirect transmission of COVID-19 at a squash court, Slovenia, March 2020: case report** (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7327185/>)
 - In late February/early March 2020, in Slovenia, cluster of five cases who all played squash at a sports venue in Maribor, Slovenia (prior to community spread of COVID-19 in Slovenia)

- **Recreational waters – A potential transmission route for SARS-CoV-2 to humans?**
(<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7287419/>)
 - Study from October 2020 highlighting lack of research into Covid-19 transmission linked to wastewater or recreational water but risk is predicted to be low in recreational water

- **High SARS-CoV-2 attack rate following exposure at a choir practice—Skagit County, Washington, March 2020** (<https://www.cdc.gov/mmwr/volumes/69/wr/mm6919e6.htm>)
 - Among 61 of 122 persons who attended a March 10 choir practice at which one person was known to be symptomatic, 53 cases were identified, including 33 confirmed and 20 probable cases (secondary attack rates of 53.3% among confirmed cases and 86.7% among all cases). The 2.5-hour singing practice provided several opportunities for droplet and fomite transmission, including members sitting close to one another, sharing snacks, and stacking chairs at the end of the practice. The act of singing, itself, might have contributed to transmission through emission of aerosols, which is affected by loudness of vocalization.

- **General acute respiratory infections, 2006-2010: Public activities preceding the onset of acute respiratory infection syndromes in adults in England - implications for the use of social distancing to control pandemic respiratory infections.**
(<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7194223/>)
 - From July 2006 – October 2010
 - Households randomly selected across England and Wales, contacted weekly, asked to report cold, sore throat or fever, and kept a symptom diary recording symptoms for any acute respiratory illness
 - Compared exposures in week before onset of acute respiratory infection and week before baseline survey. Eating out at a café, restaurant or canteen (AOR 1.65, 95% CI 1.20-2.26, p=0.002) was more common the week before illness than the baseline week.
 - There were no significant associations (in the week before respiratory illness) with playing team sports, visiting public houses, bars or nightclubs or going to the cinema or theatre.
 - Further analyses using the original 0–7 days per week classification of exposure frequencies as continuous variables within conditional logistic regression analyses (unimputed data) found that each additional day of exposure was associated with increased illness risk for: attending a theatre, cinema or concert (AOR 1.26, 95% CI 1.02-1.55, p=0.032), eating out at a café, restaurant or canteen (AOR 1.25, 95% CI 1.08-1.45, p=0.003)

- **COVID-19 clusters and outbreaks in occupational settings in the EU/EEA and the UK, 11 August 2020.** (<https://www.ecdc.europa.eu/sites/default/files/documents/COVID-19-in-occupational-settings.pdf>)
 - General description of clusters observed. Workers in occupations which bring them in close physical proximity to other people (co-workers, patients, customers, etc.), particularly when working in indoor settings or with shared transport or accommodation, are more exposed to and at higher risk of COVID-19 in the absence of mitigation measures.

- **What settings have been linked to SARS-CoV-2 transmission clusters?**
(<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7327724/>)

- June 2020. Review looking at 201 outbreaks/clusters/transmission events. Found most in household (36/201), worker dormitories (21/201), elderly care (17/201), meal with others at home/restaurant/café etc (17/201), religious (15/201), bar (12/201) – household most common route of transmission
- **Report 38: SARS-CoV-2 setting-specific transmission rates: a systematic review and meta-analysis** (<https://www.imperial.ac.uk/media/imperial-college/medicine/mrc-gida/2020-11-27-COVID19-Report-38.pdf>)
 - Imperial report/review included 45 studies and examined secondary attack rates. Greatest for households (21.1%), followed by social gatherings with family and friends (5.9%)
- **Settings of virus exposure and their implications in the propagation of transmission networks in a COVID-19 outbreak** ([https://www.thelancet.com/journals/lanwpc/article/PIIS2666-6065\(20\)30052-3/fulltext](https://www.thelancet.com/journals/lanwpc/article/PIIS2666-6065(20)30052-3/fulltext))
 - Surveillance data from Hong Kong analysed, January-June 2020. Households accounted for 63% of all clusters with half as primary setting, while entertainment accounted for the highest number of primary setting transmission cases.
- **Clusters of coronavirus disease in communities, Japan, January-April** (https://wwwnc.cdc.gov/eid/article/26/9/20-2272_article)
 - Analysis of over 3000 cases of coronavirus disease in Japan identified 61 case-clusters in healthcare and other care facilities, restaurants and bars, workplaces, and music events
- **Occupational exposures associated with being a COVID-19 case; evidence from three case-controls studies** (<https://doi.org/10.1101/2020.12.21.20248161>)
 - This describes three retrospective, frequency-matched case-control studies between August 2020 and October 2020 using case data from the NHS Test and Trace programme. Controls were obtained through Market Research Panels. Multivariable analyses provided adjusted odds ratios (aORs) for multiple community exposure settings. The results were analysed in meta-analyses using random effects models to obtain pooled odds ratios (pORs).
 - Across all study periods, there was strong statistical evidence that working in healthcare (pOR 2.87, aOR range 2.72-3.08), social care (pOR 4.15, aOR range 2.46-5.41) or hospitality (pOR 2.36, aOR range 2.01-2.63) were associated with increased odds of being a COVID-19 case.
- **Occupation- and age-associated risk of SARS-CoV-2 test positivity, the Netherlands, June to October 2020** (<https://doi.org/10.2807/1560-7917.ES.2020.25.50.2001884>)
 - This describes an analysis of weekly test positivity in public test locations by population subgroup between 1 June and 17 October 2020. Hospitality and public transport workers, driving instructors, hairdressers and aestheticians had higher test positivity compared with a reference group of individuals without a close-contact occupation.
- **Excess mortality associated with the COVID-19 pandemic among Californians 18–65 years of age, by occupational sector and occupation: March through October 2020** (<https://www.medrxiv.org/content/10.1101/2021.01.21.21250266v1.full.pdf>)
 - Using death records from the California Department of Public Health, we estimated excess mortality among Californians 18–65 years of age by occupational sector and occupation, with additional stratification of the sector

analysis by race/ethnicity. During the COVID-19 pandemic, working age adults experienced a 22% increase in mortality compared to historical periods

- Relative excess mortality was highest in food/agriculture workers (39% increase), transportation/logistics workers (28% increase), facilities (27%) and manufacturing workers (23% increase)
 - Risk ratio (the observed number of deaths/expected number of deaths – the risk ratio of mortality comparing pandemic time to non-pandemic time. The risk ratio was highest for food or agriculture workers (1.39 (1.32-1.48)), transportation or logistics (1.28 (1.24-1.33)), and facilities workers (1.27 (1.22-1.32)), bearing in mind the risk ratio was 1.22 (1.20-1.24) for the entire state.
 - Occupations in hospitality including cooks (RR 1.60) and bakers (RR 1.50), chefs and head cooks (RR 1.35) had higher risk ratios for mortality than the state as a whole. Bartenders (RR 1.28) also had a slightly higher risk.
- **COVID-19 Workplace Outbreaks by Industry Sector and their Associated Household 2 Transmission, Ontario, Canada, January – June, 2020**
<https://www.medrxiv.org/content/10.1101/2020.11.25.20239038v1.full.pdf>
- In Canada, analysed 199 workplace outbreaks between January – July 2020, with 1245 cases
 - Most outbreaks were in Manufacturing (89, 45%), Agriculture/Forestry/Fishing/Hunting (24, 12%), and Transportation and Warehousing (22, 11%)
 - Leisure and hospitality – Retail (13, 7%), Accommodation and food services (5, 3%)
- **Deaths in the Frontline: Occupation-specific COVID-19 mortality risks in Sweden**
https://su.figshare.com/articles/preprint/Deaths_in_the_frontline_Occupation-specific_COVID-19_mortality_risks_in_Sweden/12816065
- Data from Swedish authorities on recorded COVID-19 deaths. Inequalities in COVID-19 mortality based on working in frontline occupations or degree of exposure. (bearing in mind Sweden didn't employ strong measures but relied on recommendations and compliance)
 - Found little evidence that frontline or essential workers that or older individuals are more likely to die from COVID-19 than other works from range of occupations. But analysed mortality rather than just transmission (bus and taxi drivers did have a heightened mortality risk).
- **Situation Room Report: Coronavirus and Health Inequalities - In which socio-economic groups have COVID-19 infections been most prevalent in Finland?**
<https://www.helsinkigse.fi/corona/tilannehuoneen-raportti-koronavirus-ja-terveyserot-missa-sosioekonomisissa-ryhmissa-koronatartuntoja-on-suomessa-havaittu-eniten/>
- The GSE Helsinki has formed a joint academic group that provides reports on the impact of COVID-19 pandemic in Finland. A recent analysis compared the total working population of Finland and their likelihood to be infected with those not registered to be employed or have any occupation. The analysis provided estimates on how much more likely people working in particular occupational groups were to become a COVID-19 case compared to those who are not working at all. The data on COVID-19 infections was taken from the national Infectious Disease Register covering the weeks 1-47 in 2020. The information on occupation was from the National Income Register (Statistics Finland).

- The study population therefore was the total population of Finland. In the control group, the prevalence of COVID-19 was 0.38%. The multivariable analyses were adjusted for age, sex, ethnicity and geographical region.
 - The multivariable analyses showed that working in sports (athletes or coaches), health and social care, cleaning services and construction and renovation were associated with increased odds of infection. There was also some suggestion that working in travel services and working as kitchen or restaurant assistance (people facing, cleaning tables etc) were associated with increased odds of becoming a COVID-19 case.
- **Prevalence of covid-19 in different occupational groups - sub-report 1**
<https://www.folkhalsomyndigheten.se/contentassets/5e248b82cc284971a1c5fd922e7770f8/for-ekomst-covid-19-olika-yrkesgrupper.pdf>
- An analysis by Public Health Agency of Sweden (Folkhälsomyndigheten) from the national data from March – May 2020, during the time when testing was based on need for clinical management, and wider testing regimes were not yet in place. Altogether 3188 cases were notified this period of time, and relative risk (RR) was calculated. The denominators were calculated based on information on the number of people working in certain occupations recorded in the national registry. The relative risk is calculated by dividing the proportion of all cases for each occupational group with the proportion of those who have each occupation based on population figures.
 - There was evidence that taxi drivers (RR 4.8, 95% C.I. 3.9-6.0), bus drivers (RR 4.3, 95% C.I. 3.6-5.1) and people working pizza restaurants in food preparation (RR 4.5, 95% C.I. 3.2-6.3) had increased relative risk compared to other occupational groups. There was also some suggestion as restaurant and industrial kitchen chefs (RR 2.5, 95% C.I. 1.7-3.8) and as kitchen or restaurant assistants (RR 1.4, 95% C.I. 1.2-1.7) were more at risk of infection compared to other occupational groups.
- **Identifying COVID-19 Risk Through Observational Studies to Inform Control Measures** (<https://jamanetwork.com/journals/jama/fullarticle/2776937>)
- In this investigation using a case-control study, an association was identified between SARS-CoV-2 infection and dining at restaurants and going to bars or coffee shops.

Research questions

As different age groups receive vaccination, risk of transmission in a given setting may change according to age related transmission dynamics; therefore, it is important to continue monitoring risk associated with different settings.

Studies using contact tracing data take into account strict contact definition, therefore may miss some unreported contacts and underestimate the risk in a given setting.

The gap in our understanding from contact tracing studies largely is complemented by outbreak investigations and concordance studies. Especially, concordance studies and backward contact tracing might be helpful in understanding risk associated with settings.

Studies using contact tracing data mainly follow symptomatic cases and their contacts, and while this overall provides important information, it may miss symptomless spread in these environments. International data suggests that truly asymptomatic cases (those who never show symptoms throughout the infection) make approximately 20% of all infections and are three times less likely to transmit to their contacts compared to symptomatic cases; however infected people can be highly infectious before developing symptoms. Expanding definition of symptoms could capture paucisymptomatic cases which may be missed with current case definition. This may also help understand spread from truly symptomless and pre symptomatic cases in these settings.

Figure 1: Summary results from epidemiological studies conducted by PHE, NHS T&T data, Aug 2020 – Jan 2021



