Public Health England

Protecting and improving the nation's health

Transmission of COVID-19 on Public Transport

A rapid review

Contents

Review question

What is the transmission of coronavirus (COVID-19) on public transport?

Main messages

1. Four studies identified reporting on the transmission of COVID-19 on trains (n= 3) and buses (n= 2) (search up to 24 August 2020).

2. There is weak and limited evidence from China and India that transmission on public transport may occur.

3. Further research is needed to examine the potential for transmission of COVID-19 on public transport.

Background

Lockdown restrictions implemented to reduce the spread of COVID-19 were implemented globally and often included limited use of public transport. While restrictions are being lifted, there is a need to understand the potential transmission of COVID-19 in public transport. For the purpose of this review, public transport was defined as a mode of transport that is used by general public, is scheduled and operated on established routes including city buses, underground, metro, trams, trains and coaches.

Although some studies were identified that reported on the transmission on planes, these studies were not included because additional risk factors might be associated with flights (longer duration, additional risk in airports and other transportation to airport) compared to other modes of public transport, and this should be considered separately.

Objective

The purpose of this rapid review was to identify and assess direct evidence from the COVID-19 outbreak on transmission of COVID-19 on public transport.

Methodology

A literature search was undertaken to look for primary evidence related to the COVID-19 outbreak, published (or available as preprint) between 1 January 2020 and 24 August 2020.

See Annexe A for details of the methodology.

Evidence

The search returned 1,059 records, and an additional publication was identified through a Google search at the scoping stage of this review. After removal of duplicates, 712 records were screened by title and abstract. Of these, 43 full-text articles were assessed for eligibility and 4 relevant studies were identified, of which 2 were preprints. A Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) diagram is provided in Figure A.1.

An epidemiological study (preprint) reported on the COVID-19 outbreak among lay Buddhists worshipping in the temple in Zhejiang province of China (n= 293) (1). Most participants (n=126) arrived by 2 buses and the index case, a 64-year-old female, was on bus 2 (n=67). The remaining individuals arrived by other modes of transportation. This study compared the attack rate (the number of diagnosed COVID-19 cases divided by the total number of people at risk) in the unexposed (bus 1; n= 59) and exposed (bus 2; n=67) buses. Compared to individuals in bus 1, those in bus 2 were 41.5 (95% confidence interval [CI]: 2.6 to 669.5) times more likely to

acquire COVID-19 infection. There was no statistically significant difference in the risk of transmission of COVID-19 between individuals seated in the high-risk (more than 2 metres from index patient) and low-risk zones (less than 2 metres), but it was observed that no passengers sitting near windows were infected apart from the person next to the index case. Other attendees at the temple were also infected with COVID-19 (so transmission could have occurred outside of the bus), and whilst the 2 buses were described as similar there could be important differences between the passengers or the that have not been accounted for.

A second epidemiological and modelling study (2) calculated attack rate by different seat locations referring to the seat occupied by an index patient on a fast G train in China, accounting for the effect of co-travel time. Participants were confirmed cases (n=2,568) reporting travel on this route between 19 December 2019 and 6 March 2020. The overall AR among contacts was 0.32% (234 out of 72,093) (95% CI: 0.29 to 0.37), with significant variation from 0% to 10.3% (8 out of 78, 95% CI: 5.3 to 19.0) depending on spatial distance and co-travel time on the train. The attack rate for contacts in the same row as an index case was 1.5%; 10 times higher than that in seats 1 or 2 rows away from the index case. Travel time was also associated with the attack rate, with an increase of 0.15% per hour of travel time, though this relationship strengthened after a contact travelled for more than 4 hours. The upper estimates of ARs may have been overestimated due to study limitations, including a lack of precise time of infection, a broad definition of ‘close contact’ and lack of consideration of social relationships between passengers. Additional factors such as ventilation and passenger density were not reported.

One case series (3) reported on a family of 4 patients with laboratory-confirmed COVID-19 who were admitted to a hospital in Beijing, China on 28 January 2020. After evaluating the history of contact, it was concluded that the infection might have been acquired during the 4-hour railway journey by one of the family members and then transmitted to other family members. This study is based on small numbers, the possible exposure via train journey was self-reported (the index case recalled another passenger coughing whilst not wearing a mask) and no follow up was carried out to ratify this.

A modelling study (preprint) (4) analysed the probability of COVID-19 infection and related secondary infections in public transport systems such as buses and train coaches in ‘Chennai-Metro-Merge’, a single geographical zone in India combining Chennai district with three bordering districts. The authors utilised a probabilistic model using data available from 7 March 2020 to 15 May 2020. The probability of acquiring a secondary infection from a single index case in an enclosed city bus, on a suburban train general coach and on a ladies-only train coach was found to be 0.192, 0.074 and 0.114 respectively (with an exposure time of 2 hours). The risk of infection was estimated to be lower in suburban train travel with a restricted occupancy of 50% as compared to bus travel with the same proportion of occupancy (0.19 vs 0.07), which the authors concluded may be due to the architecture of the train compartment providing more air volume for the travellers. Model parameters and data inputs for the study were based on a specific context and predictions were limited to a 6-week timeframe. This study is non-peer-reviewed, relies on certain assumptions and provides only theoretical evidence of transmission.

Main finding**:** transmission of COVID-19 on public transport may occur through close contact with an infected person, in the absence of physical barriers, but transmission risk may be lower when sitting next to doors and windows.

Limitations

The literature search was limited to evidence drawn from COVID-19 published between 1 January 2020 and 24 August 2020. Limitations with the included studies (for example, small sample sizes, use of self-reported exposure, and a lack of exploration of other routes of exposures to COVID-19) make it difficult to determine the extent to which transmission of COVID-19 might have occurred on public transport.

Conclusions

Two epidemiological studies (one partial modelling), a small case series and a modelling study conducted in China and India were identified that reported on the transmission of COVID-19 on trains (n=3) and buses (n=2). All studies reported potential for transmission of COVID-19 in those modes of transport however, there are limitations within studies that could have influenced this result and the applicability to the UK context is unclear. More evidence is needed to determine the risk of transmission and transmission dynamics of COVID-19 on public transport.

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References

1. Shen Y and others. 'Airborne transmission of COVID-19: epidemiological evidence from two outbreak investigations'. SSRN Electronic Journal 2020
2. Hu M and others. 'The risk of COVID-19 transmission in train passengers: an epidemiological and modelling study'. Clinical Infectious Diseases 2020
3. Qiu S and others. 'Familial cluster of SARS-CoV-2 infection associated with a railway journey'. International Society of Travel Medicine 2020
4. Krishnamurthy K and others. 'Prediction of the transition from sub-exponential to the exponential transmission of SARS-CoV-2 and epidemic nowcasting for metro-zones: Experiences from Chennai-Metro-Merge, India.'. JMIR Public Health and Surveillance 2020

Annexe A. Methods (Protocol)

Literature search

This report employed a rapid review approach to address the review question:
What is the transmission of COVID-19 on public transport?

Protocol

In view of our timeframe and of an expected lack of evidence, the protocol was finalised after the search had been conducted. While in the search strategy terms related to planes were included, after the screening on title and abstract it was agreed to exclude evidence on planes. This is because compared to other modes of transport the transmission on planes might occur differently and thus should be considered separately.

Sources searched

Ovid Medline (up to 24 August 2020), WHO Covid, medRxiv, ArXiv.

Search strategy

Searches were conducted for papers published between 1 January 2020 and 24 August 2020. Search terms covered key aspects of the research question. The search strategy for Ovid Medline is presented below.

Search strategy Ovid Medline

1. (public adj3 transport*).tw,kw.
2. (bus or buses).tw,kw.
3. (train or trains).tw,kw.
4. (flight or flights).tw,kw.
5. (plane or planes).tw,kw.
6. (aeroplane* or airplane*).tw,kw.
7. air travel*.tw,kw.
8. (rail* adj3 travel*).tw,kw.
9. (transport* and transmission).tw,kw.
10. ground transport*.tw,kw.
11. air transport*.tw,kw.
12. (transport* adj2 system*).tw,kw.
13. (passenger* adj2 transport*).tw,kw.
14. mass transport*.tw,kw.
15. underground.tw,kw.
16. metro.tw,kw.
17. coach.tw,kw.

18. (traveller* or traveler*).tw,kw.
19. transport* setting*.tw,kw.
20. exp Transportation Facilities/
21. Transportation/
22. exp Aviation/
23. Motor Vehicles/
24. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23
25. exp coronavirus/
26. exp Coronavirus Infections/
27. ((corona* or corono*) adj1 (virus* or viral* or virinae*)).ti,ab,kw.
28. (coronavirus* or coronovirus* or coronavirinae* or CoV or HCoV*).ti,ab,kw.
29. (2019-nCoV or 2019nCoV or nCoV2019 or nCoV-2019 or COVID-19 or COVID19 or CORVID-19 or CORVID19 or WN-CoV or WNCoV or HCoV-19 or HCoV19 or 2019 novel* or Ncov or n-cov or SARS-CoV-2 or SARSCoV-2 or SARSCoV2 or SARS-CoV2 or SARSCov19 or SARS-Cov19 or SARSCov-19 or SARS-Cov-19 or Ncovor or Ncorona* or Ncorono* or NcovWuhan* or NcovHubei* or NcovChina* or NcovChinese* or SARS2 or SARS-2 or SARScoronavirus2 or SARS-coronavirus-2 or SARScoronavirus 2 or SARS coronavirus2 or SARScoronovirus2 or SARS-coronovirus-2 or SARScoronovirus 2 or SARS coronovirus2).ti,ab,kw.
30. (respiratory* adj2 (symptom* or disease* or illness* or condition*) adj10 (Wuhan* or Hubei* or China* or Chinese* or Huanan*)).ti,ab,kw.
31. ((seafood market* or food market* or pneumonia*) adj10 (Wuhan* or Hubei* or China* or Chinese* or Huanan*)).ti,ab,kw.
32. ((outbreak* or wildlife* or pandemic* or epidemic*) adj1 (Wuhan* or Hubei or China* or Chinese* or Huanan*)).ti,ab,kw.
33. or/25-32
34. 24 and 33
35. limit 34 to yr="2020"

Inclusion and exclusion criteria

Article eligibility criteria are summarised in Table A.1.

Table A.1. Inclusion and exclusion criteria

	Included	Excluded
Population	Human	Non-human studies
Settings	Public transport	
Context	COVID-19 outbreak	Other diseases
Intervention/ exposure	COVID-19 transmission on public transport	
Outcomes	• SARS-CoV-2 infection rate in users of public transport • COVID-19 outbreaks in users of public transport	
Language	English	
Date of publication	From 1 January 2020 to 9 July 2020	
Study design	• experimental or observational studies • case series and case reports • modelling studies • laboratory studies	• systematic reviews • guidelines • ppinion pieces
Publication type	Published and preprint	

Screening

Title and abstract screening was done by 2 reviewers with a 100% agreement (disagreements were resolved by discussion).

Full text screening was done by one reviewer and checked by a second.

Figure A.1 illustrates this process.

Data extraction and risk of bias assessment

Data extraction was completed by one reviewer. Due to the rapid nature of the work, a validated risk of bias tool was not used to assess study quality. However, papers were evaluated based on study design and main source of bias (mainly population, selection, exposure, and outcome).

Strength of evidence

A formal grading of evidence was not undertaken, however if evidence was considered to be limited (due to the number of studies), weak, (either due to research design, research quality, or both), or both, this was highlighted. Preprint and publication status was also considered in determining this.

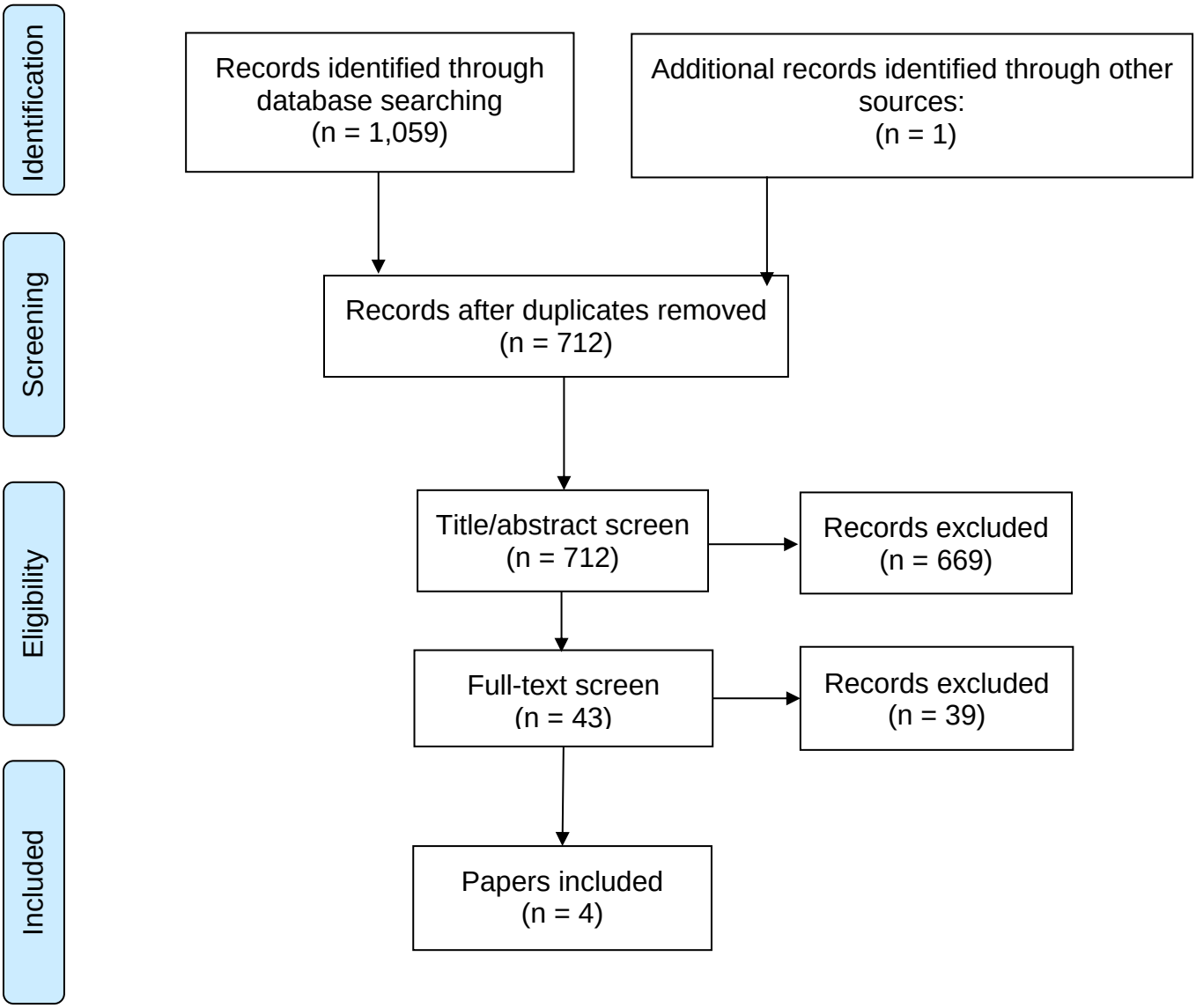

Figure A.1. PRISMA diagram

Figure A.1. PRISMA diagram alt text

A PRISMA diagram showing the flow of studies through this review.

From the original literature search (search conducted between 1 January and 24 August 2020), there were n = 4 papers included in the review.

From identification of studies via databases and registers, n = 1,060 records identified from databases.

From these, n = 347 duplicate records were removed before screening. This left n = 712 records screened, of which n = 669 were excluded, leaving n = 43 papers sought for retrieval. All identified reports were retrieved.

Of these n = 43 papers, n = 39 were excluded. This left n = 4 papers to be included in the review.

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