Public Health England

Protecting and improving the nation's health

Transmission of COVID-19 in school settings and interventions to reduce the transmission

A rapid review (update 1)

Contents

Main messages

1. This is an update of an existing review, in which 9 studies (including 4 preprints) had been identified (search: 1 January to 18 June 2020) (1). In this update, 13 new studies have been identified (including 6 preprints), of which 9 were observational and 4 were modelling studies (search up to 27 July 2020).

2. Evidence based mainly on antibody testing suggests that COVID-19 transmission may happen within school settings, however the results are influenced by community transmission (high or low COVID-19 prevalence) and local factors (such as likely contact with the index case and the physical school environment).

3. Limited evidence from 2 observational studies suggests that keeping schools open for children younger than 15 years old is not associated with higher infection rates in these children.

4. Consistent with our previous review, evidence from modelling studies suggests that the reopening of schools at reduced capacity is not associated with a second epidemic wave; and that contact tracing strategies are required to control community transmission in case of full return to school.

5. It is essential to closely monitor the transmission of COVID-19 via school-based surveillance such as the Public Health England sKID study, and further research is needed on the transmission of COVID-19 in schools and on the effectiveness of school-based interventions.

Background

School closures were implemented globally to slow the spread of COVID-19, with an estimated 91% or 1.5 billion students worldwide affected (2). A variety of approaches have been adopted in relation to both closing and re-opening of schools: for instance, schools remained open in Sweden over the course of the pandemic for children younger than 15 years old, while in Spain schools will remain closed until September 2020 (1).

The difference in approaches could partially be explained by the fact that evidence surrounding the role of children in the transmission of COVID-19 was inconclusive and the quality of studies was generally low. A systematic review conducted by the office of the Chief Medical Officer for England in the early stage of the epidemic (search up to 9 March 2020) identified mainly low-quality evidence from Asia that reported conflicting results, with some studies suggesting that children were less affected by COVID-19 than adults and other studies showing similar rates (3). This review also reported that data on clinical outcomes in children were scarce, and that children may mainly be asymptomatic or mildly infected (3).

Evidence from Europe was included in more recent reviews. A systematic review (preprint, search up to 16 May 2020) identified low and medium quality evidence, including studies from Iceland, the Netherlands, Spain and Italy which reported a lower prevalence of COVID-19 amongst children and young people, while studies from Stockholm, England, Switzerland and Germany showed no difference in prevalence between adults and children (4). The authors of the review concluded that there was ‘weak evidence’ that children and young people played a lesser role in transmission of COVID-19 at a population level and a meta-analysis of contact tracing studies suggested that children and young people had lower susceptibility to SARS-CoV-2, with a 0.56 (0.37, 0.85) lower odds of being an infected contact (4). An update of this review (search up to 3 July 2020) presented to the Scientific Advisory Group for Emergencies (SAGE) reported that for Norway, Denmark, Finland and the Netherlands the reopening of schools had not made a marked difference to community transmission (5).

A narrative rapid review conducted by the UNCOVER (COVID-19 evidence reviews) network in Edinburgh also concluded that ‘children may be less frequently infected or infect others’ (search up to 30 April) (6). Similar conclusions have been reached in other reviews, with one suggesting that children are ‘unlikely to be the main drivers of the pandemic’ (search up to 11 May 2020) (7) and another that children are ‘not transmitters to a greater extent than adults’ (search up to 28 May 2020) (8). Overall, these reviews highlighted an urgent need for higher quality studies to confirm these preliminary results.

In England, decisions around closures and re-opening of schools have been informed by evidence and advice via SAGE (see Annexe A for a list of relevant papers). After a phased reopening from June 2020, schools in England are planned to reopen in full in September (9).

To reduce the risk of transmission, children will be kept in ‘bubbles’ by class or year group (particularly for primary school aged children to maintain social distancing), social distancing measures will be encouraged, together with regular cleaning and hand washing, and face coverings will be required in communal areas of secondary schools in areas with high transmission. To support schools with COVID-19 risk management, detailed guidance has been produced (10).

Since the partial reopening of schools in England where 659,000 children were in attendance on 4 June 2020 (11), 256 possible school-based outbreaks had been notified to Public Health England (PHE), of which 122 were confirmed as SARS-CoV-2 positive (PHE surveillance reports, 1 June to 19 July 2020, weeks 23-29) (12). Outbreaks were defined as one index case plus at least one other case and it is unclear how many pupils were affected in each outbreak. In addition, schools-based surveillance studies such as the PHE COVID-19 Surveillance in Children attending preschool, primary and secondary schools (sKID) study are being conducted. The sKID study has captured data from 9,000 participants within preschool, primary and secondary school settings. As of 28 June 13,748 swab tests had been conducted, with 5 confirmed SARS-CoV-2 positive results (5).

Objective

The purpose of this rapid review was to identify and assess direct evidence on the extent to which transmission of COVID-19 has occurred within school settings, and on the effectiveness of school-based interventions in reducing transmission. This is an update of a previous version (1).

'School settings' refers to mainstream state schools and academies and includes preschool and nurseries only if they are attached to a school. It excludes boarding schools.

Review questions

1. What is the transmission of COVID-19 within school settings?
2. What is the effectiveness of interventions to reduce the transmission of COVID-19 within school settings?

Summary of methods

A literature search was undertaken to look for primary evidence related to the COVID-19 outbreak, published (or available as preprint) between 19 June 2020 and 27 July 2020 (24 July for Medline and Embase). The search dates of the previous version of this review were 1 January 2020 to 18 June 2020 (1).

Screening and data extraction were completed in duplicate (partially independently). Risk of bias appraisal considered study design and main sources of bias (for example, related to the sample, exposure, or outcome). Where evidence was considered 'limited' (due to the number of studies) or 'weak' (due to research design or quality) this is highlighted.

A detailed methodology is provided in Annexe B.

Evidence

The database search for this update returned 657 records and 9 additional records were identified through other sources. After removal of duplicates, 414 records were screened by title and abstract. Of these, 78 full-text articles were assessed for eligibility and 13 new papers were included in this review. A PRISMA diagram is provided in Figure B.1.

Of these 13 papers, 9 were observational and 4 were modelling studies. Eight of these 13 studies were not peer-reviewed (6 preprints and 2 reports). Data extraction tables are available in Annexe C.

When combined with the 9 papers included in the first version of this review (1) (5 were preprints and still have not been published, as per 28 July 2020) the total number of papers included in this review is 22 (13 of which were preprints and reports, not peer-reviewed).

Q1. What is the transmission of COVID-19 within school settings?

Evidence from previous version (1)
Three epidemiological studies reporting on transmission within school settings had been identified: one national report investigating all cases of COVID-19 in New South Wales (NSW) schools in Australia (13), one investigation from Ireland which included all known cases in children and adults within school settings (14) and one study from France which investigated a COVID-19 outbreak including a 9-year-old child that had attended schools (15). This body of evidence consistently suggested that transmission of COVID-19 within school settings might be low; however, this was based on a small number of studies and the evidence was considered to be weak due to study design, small numbers of index cases and the extent of school closures.

New evidence from observational studies
Seven new observational studies provided evidence on transmission of COVID-19 within school settings (16 to 22). Of these, 3 were preprints (16,17,22).

Two retrospective cohort studies (preprints) conducted in France, one in a high school (16) and one in primary schools (17), estimated the infection attack rate (IAR) in school settings in an area with high transmission of COVID-19. Both studies were conducted after schools had closed and anti-SARS-CoV-2 antibodies testing was implemented to detect previous infections among pupils, their relative and staffs of schools exposed to SARS-CoV-2 in February and

March 2020. In the high school, 326 of the 1,262 pupils, teachers and non-teaching staff participated in a serological survey (a questionnaire to assess symptoms and blood tests for antibody detection). The study reported an elevated IAR in pupils (38%) and staff (43% in teachers, 59% in non-teaching staff) compared to the IAR in parents and siblings of the pupils (11% and 10%, respectively) (16). These results shows that prevalence of anti-SARS-CoV-2 antibodies was elevated at the point of testing in pupils and school staff, suggesting that transmission might have occurred. A supplementary study was conducted approximately one month later, in primary schools in the same city. The same methodology was used and participation was higher (52% of the 1,047 pupils and 90% of the 51 teachers) (17). Contrary to the study conducted in the high school, the IAR was low in pupils (8.8%) and in teachers (7.1%), and the authors concluded that there was no evidence of onwards transmission from children in the school setting (17). However, this study was conducted one month later and the extent to which this may have influenced results is unclear. The evidence around immunity persistence (that is, the likely presence of antibodies) for mild and asymptomatic COVID-19 infection (as is expected in children) is still unclear, limiting the results of this study.

A serological study, conducted in a large community school (from preschool to high school) in Chile, aimed to assess the role of children and teachers in transmission of COVID-19 following an outbreak in the school using antibody testing (18). The overall antibody-positive rate was 9.9% in pupils and 17% in staff members. Positive rate was the highest in preschool pupils (12%) and the lowest in high school pupils (5.7%), although this may be due to the fact that index cases were teachers or parents from preschool. One of the main limitations of this study is that the antibody test was self-administrated.

A case report from Israel reported on a major outbreak in a high school in Jerusalem, where 13% of pupils and 17% of teachers tested positive for SARS-CoV-2 (viral RNA tested by PCR) (19). Infection rates were higher in younger pupils (17% to 33% in children aged 13 to 15 years old) than in older pupils (1.6% to 4.5% in children aged 16 to 18 years old). Difference in rates between these 2 cohorts can be partially explained by the fact that these 2 cohorts are located in two different wings of the school, reducing interaction between them. The investigation highlighted a number of risk factors, including crowded classes (35 to 38 students per class, making social distancing impossible) and air-conditioning functioning continuously and pupils not wearing masks (due to a heatwave) (19).

Results from a case report from the United States (US) suggested that close proximity interaction within class (walking and speaking) between an infected teacher and pupils might have resulted in virus transmission (20). A serological survey was conducted (questionnaire, antibody testing) of students involved in classes of a teacher with confirmed (via PCR test) COVID-19. However, this study is subject to several biases, including recall bias, selection bias (low participation: 21 out of 120 pupils) and bias in measurement of outcomes (only 14 days between exposure and antibody detection).

Results from case series from outbreaks in schools in Singapore (one secondary and 2 primary schools) suggest that transmission in these settings might be low, including when exposed to a major COVID-19 cluster in adult staff members (21). Testing used nasal swabs, and in 2 out of the 3 schools only symptomatic pupils were tested.

Only one study conducted in a low prevalence setting was identified. The SchoolCoviDD19 study is a German seroprevalence study (preprint) that started after reopening of school (18 May 2020), and aimed to assess the role of pupils and teachers in the transmission of COVID-19 (22). Thirteen secondary schools were included in the study; 1,538 pupils (median age 15 years) and 507 teachers completed a questionnaire and received an antibody test. The results show that prevalence of SARS-CoV-2 antibodies at the time of testing was low (0.7% in pupils and 0.2% in teachers), even in schools which had recorded cases prior lockdown (between 0% and 2.2% per individual schools). This suggests that pupils and teachers might not play a crucial role in COVID-19 transmission in a low prevalence setting. However, due to the period required to detect antibodies following infection, and to the short period between school reopening and the start of the studies, it is unclear whether transmission clusters following school reopening would have been detected.

In total, including the results from the previous version of the review, 10 studies were identified, of which 3 were preprints. They were mainly seroprevalence studies (prospective and retrospective) as well as case series and there was heterogeneity between studies (different prevalence settings, study design, outcomes, and testing methods). Testing is limited by uncertainty around COVID-19 immunity (and therefore the likely presence of antibodies at different time points), especially in asymptomatic cases and cases with mild symptoms (as is often reported for children). These studies are subject to a mixture of biases and confounding (for example, some have low participation, others may have been impacted by timing and context of the study) but overall the level of evidence is considered higher than in the previous version as there are more studies with stronger methodologies.

Main findings: the evidence on transmission within schools is mixed. Studies suggest that, in areas of high prevalence, COVID-19 may occur within school settings for both younger and older children, however local factors (such as likely contact with the index case and the physical school environment) may well have influenced results. There was no evidence of transmission within low prevalence areas. The results are limited by heterogeneity between studies and the reliance on antibody tests (which are constrained by uncertainties around COVID-19 immunity, especially in asymptomatic and mild cases).

Q2. What is the effectiveness of interventions to reduce the transmission of COVID-19 within school settings?

In the previous version of this review no observational or intervention studies were identified examining the effectiveness of specific interventions to reduce the transmission of COVID-19 within school settings (1).

New evidence from observational studies

Two new observational studies (23,24) provided evidence on the effectiveness of school closure on transmission within school settings, of which one was not peer-reviewed (23).

One study is a report from the Public Health Agency of Sweden (not peer-reviewed) that aimed to compare the effect of different approaches in regard to school closure between Finland (all schools closed) and Sweden (schools remained opened for children less than 15 years old) (23). By analysing cumulative incidence of reported cases by age groups (1 to 5 years, 6 to 15 years, 16 to 19 years, and total 1 to 19 years), the authors concluded that cumulative incidence by age was similar between the 2 countries, despite differences in measures implemented in relation to school closures and differences in COVID-19 prevalence (higher in Sweden than in Finland). The countries are described as ‘similar’ in many ways by the authors, although this study is limited by differences in testing and contact tracing policies between countries. The conclusions of ecological studies should be approached with caution regarding the certainty of their replication to other settings.

The second study also aimed to assess the impact of school closure in Sweden by comparing COVID-19 infection between children attending schools (less than 15 years old) and those whose schools were closed (over 15 years old) (24). To do so, the authors reviewed paediatric hospital admission, as at the time of the study (March to May 2020) nearly all patients were tested for SARS-CoV-2, independently of the reason for admission. The results did not show an association between age (less than 15 years versus over 15 years), suggesting that school closure and opening did not impact infection rates. However, this study is based on a low number of participants (n=63) and within a specific population group (those admitted to hospital) and might therefore not be representative.

One of the case reports identified for question 1 reported on the possible risk factors associated with a school outbreak in Israel: overcrowded classes, a lack of social distancing, and the continuous use of air-conditioning and no face masks used during a heatwave (19). While the study did not assess the effectiveness of these measures, it suggests that the limited use of non-pharmaceutical interventions (NPI) such might increase the risk of transmission within school settings.

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Main findings: limited evidence from 2 observational studies suggests that, in Sweden, keeping schools open for children younger than 15 years old was not associated with higher infection rates in these children. Anecdotal evidence from 1 case series suggest that not respecting NPI such as face masks and social distancing might increase the risk of transmission within school settings.

Evidence examining the impact of school opening and closures on community transmission

Evidence from previous version (1)
Due to the absence of evidence identified in the first version of this review on the effect of interventions within school settings, evidence on the effect of interventions (mainly school closure and opening) on COVID-19 transmission in the community had been included. Six modelling studies had been identified (25 to 30), of which 4 were preprints. Overall, the evidence suggested that the re-opening of schools at a reduced capacity, particularly for younger children, might not be associated with a second epidemic wave (1).

New evidence from modelling studies
Four new modelling studies (3 preprints and 1 working paper) provided evidence on the impact of school closure and opening on COVID-19 transmission in the community (31 to 34). Due to the rapid nature of this work, the modelling studies are described briefly here but a full evaluation of the methods and model's inputs are not provided.

Results from studies that assessed the impact of school reopening on COVID-19 transmission in the community are consistent with the results from the previous version of this review: reopening of schools might not be associated with an epidemic rebound (31 to 33), especially for younger children (31). Modelling using data from Germany suggests that the return to school of older pupils might be associated with increased transmission, and it was suggested that this might be due to a lack of social distancing (31).

For school reopening scenarios, results from a US modelling study found that the timetabling of pupil attendance for children of all ages (0 to 9 and 10 to 19 years) to alternative school days performed nearly as well as keeping the school closed, and slightly better than allowing only those under 10 years old to return to school (32). For a full return to school of all age groups, a UK study highlighted that social distancing and contact tracing strategies would be required to control transmission (33).

Modelling studies suggest that school closure is effective in reducing transmission (31) especially when initiated early in the epidemic (34). However, these results are confounded by the fact that, in most countries, other NPIs were simultaneously implemented (such as no large

gathering, working from home, amongst others) and it is not always possible to distinguish the individual effect of each measure. To fully assess the effectiveness of school closure during a growing epidemic, broader evidence should be assessed, including comparative analyses of the different NPI implemented. This has been addressed in systematic reviews which found that, overall, the evidence on the impact of school closure as a mitigation strategy during the COVID-19 pandemic was inconsistent (35,36).

Modelling studies, although increasingly based on data from the COVID-19 outbreak, are usually calculated as a controlled environment model and may not accurately reflect real-life behaviours. In addition, they often use population data which may not take into account individual or local variations. None of the 4 modelling studies identified here were peer-reviewed (3 preprints and 1 working document) and in the previous version of this review, 5 of the 6 modelling studies were also preprints. Therefore, 9 of the 10 studies identified on the impact of school closure and reopening on COVID-19 transmission in the community have not been peer-reviewed and should be considered with caution. As a result, this body of evidence was considered to be weak.

Main findings: evidence from modelling studies (all preprints) consistently reports that the reopening of schools at reduced capacity or on alternative day for all school ages might not be associated with a second epidemic wave. In case of full return to school of all age group, social distancing and contact tracing might be required to control transmission at community level.

Limitations

This is an update of a previous review. While a summary of the evidence identified in the previous version of the review has been provided for each review question, this update is mainly focused on the new evidence identified.

In terms of study design, the evidence identified for question 1 provides a higher level of evidence than the evidence identified in the previous version as observational studies are available. However, the heterogeneity between studies is important, especially in terms of prevalence (low vs high prevalence settings) and outcomes (antibody vs virus detection). The results are also limited by uncertainties around COVID-19 immunity, especially in asymptomatic and mild cases, and the reliance on antibody tests may have introduced biases.

Limited evidence was identified for question 2 (only 2 studies), from one setting (Sweden).

The evidence identified on the impact of school closure and opening on transmission in the community is, as in the first version of the review, mainly based on modelling studies which have not yet been peer reviewed. The results are also confounded by the impact of other

population level NPIs which were implemented around the same time. To fully assess the impact of school closures and reopening on community levels of COVID-19, broader evidence should be assessed, including comparative analyses of the different NPIs implemented.

None of the identified studies reported on subgroups such as gender, ethnicity and socio-economic status. The focus of this review was on the transmission of COVID-19 within school settings and as the risk of harms related to school closures was not included in the search strategy, a new search would be required to examine this evidence fully.

This review includes preprints, which should be treated with caution as they are not peer-reviewed, nor subject to publishing standards.

Conclusions

The evidence identified suggests that in areas of high prevalence, COVID-19 transmission can happen within school settings for both primary and secondary school-aged children. In one study from an area of low prevalence, there was no evidence of transmission from school settings. Limited observational evidence suggests that, in Sweden, keeping schools open for children younger than 15 years old was not associated with higher infection rates in these children. Evidence from modelling studies suggest that the reopening of schools at reduced capacity or on alternative day might not be associated with a second epidemic wave.

The evidence is heterogenous and has some inconsistencies. While schools on the whole do not appear to be associated with increased risk of transmission, outbreaks can happen in schools, especially in area of high transmission. It is therefore necessary to implement measures to reduce this risk, whether it is in relation to school attendance (such as alternative days, reduced capacity or only younger children) or in relation to contact tracing strategies.

It is essential to closely monitor the transmission of COVID-19 within school settings. Further enhanced surveillance and research is needed both on the role of schools in the transmission of COVID-19 and the effectiveness of school-based interventions to minimise transmission in schools.

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PHE’s rapid reviews aim to provide the best available evidence to decision makers in a timely and accessible way, based on published peer-reviewed scientific papers, unpublished reports and papers on pre-print servers. Please note that the reviews: i) use accelerated methods and

may not be representative of the whole body of evidence publicly available; ii) have undergone an internal, but not independent, peer review; and iii) are only valid as of the date stated on the review.

In the event that this review is shared externally, please note additionally, to the greatest extent possible under any applicable law, that PHE accepts no liability for any claim, loss or damage arising out of, or connected with the use of, this review by the recipient or any third party including that arising or resulting from any reliance placed on, or any conclusions drawn from, the review.

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Annexe A. Evidence published by SAGE on schools and COVID-19

Table A.1. List of documents on schools and COVID-19 discussed at SAGE meetings (Source)

Meeting date	Title
Meeting 46 9 July 2020	Risks associated with the reopening of education settings in September
	Reopening further education providers - analytical pack
	Introduction to higher education settings in England
	COVID-19 - further and higher education
Meeting 38 21 May 2020	GOS: Risk of COVID-19 amongst parents and grandparents of primary school children, 21 May 2020 (Paper prepared by the Government Office for Science)
Meeting 37 19 May 2020	Quick findings on age distributions of grandparents and parents of primary school aged children, 18 May 2020 (Paper prepared by the Office for National Statistics)
Meeting 31 1 May 2020	Technical briefing to Dutch Parliament: role of children in the COVID-19 outbreak (22 April 2020)
	Transmission and susceptibility in children
	Interdisciplinary Task and Finish Group on the Role of Children in Transmission: Modelling and behavioural science responses to scenarios for relaxing school closures (1 May 2020)
Meeting 30 30 April 2020	Susceptibility and Transmission in Children - updates from the last few weeks - 29-Apr-20
	Interdisciplinary Task and Finish Group on the Role of Children in Transmission: Modelling and behavioural science responses to scenarios for relaxing school closures (30 April 2020)
Meeting 26 16 April 2020	The role of children in transmission (16 April)
Meeting 23	UNCOVER Review: What is the evidence for transmission of COVID-19

7 April 2020	by children [or in schools]? (1 April 2020)
Meeting 17 18 March 2020	SPI-B: note on school closures (17 March 2020)
	SPI-M-O: Consensus view on the impact of school closures on Covid-19 (17 March 2020)
	Impact of school closures, 18 March 2020 (Paper prepared by the University of Warwick)
	Timing of the introduction of school closure for COVID-19 epidemic suppression, 18 March 2020 (Paper prepared by the MRC Centre for Global Infectious Disease Analysis (MRC GIDA), Imperial College)
	The impact of adding school closure to other social distance measures, 17 March 2020 (Paper prepared by the London School of Hygiene & Tropical Medicine)
Meeting 14 10 March 2020	PHE: SARS-CoV-2, SARS-CoV-1 and MERS-CoV: What do we know about children? 9 March 2020 (Paper prepared by Public Health England and the Chief Medical Officer)
	DHSC: SARS-CoV-2, SARS-Cov-1 and MERS-CoV: Epidemiology and clinical characteristics in children, 10 March 2020 (Paper prepared by the Department of Health and Social Care)
Meeting 13 5 March 2020	Timing & local triggering of non-pharmaceutical interventions (NPIs) to reduce COVID-19 mortality and healthcare demands, 5 March 2020 (paper prepared by Imperial College)
Meeting 12 03 March 2020	Adoption and impact of non-pharmaceutical interventions for COVID-19 (paper prepared by Imperial College and the London School of Hygiene & Tropical Medicine (LSHTM))
	Summary indicative effects of non-pharmaceutical interventions (NPIs) to reduce COVID-19 transmission & mortality, 2 March 2020 (paper prepared by Imperial College)
Meeting 11 27 February 2020	Potential effect of non-pharmaceutical interventions (NPIs) on a Covid-19 epidemic in the UK 26 February 2020
Meeting 10 25 February 2020	Potential effect of non-pharmaceutical interventions on a COVID-19 epidemic (paper prepared by Imperial College)
Meeting 09	SPI-M-O: Consensus view on the impact of mass school

20 February 2020	closures 19 February 2020
	Potential effect of school closure on a UK COVID-19 epidemic: annex to SPI-M-O consensus view, 20 February 2020 (paper prepared by Imperial College)
Meeting 06 11 February 2020	SPI-M-O: Consensus view on the impact of mass school closures on 2019 Novel Coronavirus (2019-nCoV) 10 February 2020
Meeting 04 04 February 2020	SPI-M-O's statement on the impact of possible interventions to delay the spread of a UK outbreak of 2019-nCov [includes closure of schools] 03 February 2020

Annexe B. Methods

Literature search

This report employed a rapid review approach to address the review question:

1. What is the transmission of COVID-19 within school settings?
2. What is the effectiveness of interventions to reduce the transmission of COVID-19 within school settings?

Notes
This is an update of the previous version of the review; the search dates of the previous version were 1 January 2020 to 18 June 2020. For this update, search was conducted up to 27 July 2020.

Due to the lack of evidence for the review question 2, evidence of the effectiveness of school closure and opening on the transmission of COVID-19 in the community (rather than within school settings) was included in the first version of this review. For consistency, similar evidence has been included in this update, but only if the objective of the study was primarily focused on schools. Studies assessing the effectiveness of school closing in combinations with other measures (such as lockdown or working from home) were not included.

Protocol

A protocol was produced by the project team before the literature search began, specifying the research question and the inclusion and exclusion criteria.

Sources searched

Medline, Embase, medRxiv preprints, WHO COVID-19 Research Database, Google scholar and Google.

Search strategy

Searches were conducted for papers published between 19 June 2020 and 27 July 2020. Note: our search was conducted on the 27 July, but the date of last update for Ovid Medline and Embase was 24 July 2020.

Transmission of COVID-19 in school settings and interventions to reduce the transmission: A rapid review (update 1)

Search terms covered main aspects of the research question, including terms related to the intervention. The search strategy for Ovid Medline is presented below.

Reference lists of relevant papers (including systematic reviews) were also searched.

Search strategy Ovid Medline

1. school*.tw,kw.
2. (primary adj2 educat*).tw,kw.
3. (secondary adj2 educat*).tw,kw.
4. (pre-school or preschool).tw,kw.
5. sixth form*.tw,kw.
6. (post-16 or post16).tw,kw.
7. teacher*.tw,kw.
8. teaching staff.tw,kw.
9. teaching assistant*.tw,kw.
10. early years practitioner*.tw,kw.
11. educat* setting*.tw,kw.
12. educat* workforce.tw,kw.
13. reception.tw,kw.
14. (privat* adj educat*).tw,kw.
15. (state adj2 educat*).tw,kw.
16. (mainstream adj2 educat*).tw,kw.
17. (pupil or pupils).tw,kw.
18. kindergarten*.tw,kw.
19. (pre-kindergarten* or prekindergarten*).tw,kw.
20. Schools/
21. Schools, Nursery/
22. School Teachers/
23. Nurses, Community Health/
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. covid*.nm.
30. (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.

31. (respiratory* adj2 (symptom* or disease* or illness* or condition*) adj10 (Wuhan* or Hubei* or China* or Chinese* or Huanan*)).ti,ab,kw.
32. ((seafood market* or food market* or pneumonia*) adj10 (Wuhan* or Hubei* or China* or Chinese* or Huanan*)).ti,ab,kw.
33. ((outbreak* or wildlife* or pandemic* or epidemic*) adj1 (Wuhan* or Hubei or China* or Chinese* or Huanan*)).ti,ab,kw.
34. or/25-33
35. 24 and 34
36. limit 35 to dt=20200619-20200725

Inclusion and exclusion criteria

Article eligibility criteria are summarised in Table B.1. The only difference with the previous version of this report is that systematic and rapid reviews are now excluded (due to an increased number of primary studies now being available).

Table B.1. Inclusion and exclusion criteria

	Included	Excluded
Population	• children aged 4 to 18 years • teachers, teaching assistants, school nurses, early years practitioners working in a school-attached service and other school settings workforce	• non-humans studies • children aged 0 to 3 years • pupils aged 19 years or older • early years practitioners working outside school settings
Settings	Schools; defined as: • mainstream provision • day attendance • primary • secondary • reception, preschool and nurseries that are attached to a school • Sixth form college • state and private funded day-attendance schools	• boarding schools • special schools • child minders, nannies and other home-based childcare • out of school settings for school age children, for example youth groups • universities and colleges
Context	COVID-19 outbreak	Other diseases, including Influenza
Intervention or exposure	• impact of schools re-opening in countries such as UK • impact of limited school closures in countries such as Iceland or Sweden	

	Included	Excluded
	• impact of other school social distancing measures • impact of infection prevention and control measures	
Outcomes	• SARS-CoV-2 infection rate in children and staff • transmission of COVID-19 within school settings • COVID-19 outbreaks in schools	
Language	English, French, Spanish, Italian	All other languages
Date of publication	19 June 2020 to 24 July 2020	
Study design	• experimental or observational studies • case series and case reports • modelling studies • if relevant, data from UK surveillance reports might be included.	• systematic and rapid reviews • guidelines • opinion pieces
Publication type	Published and preprint	

Screening

Title and abstract screening was completed by 2 reviewers: 10% of the eligible studies were screened in duplicate (disagreements were resolved by discussion) and the remainder were screened by one reviewer.

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

Figure B.1 illustrates this process.

Data extraction and quality assessment

Data extraction was done by one reviewer and checked by a second.

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

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

Variations across populations and subgroups, for example cultural variations or differences between ethnic, social or vulnerable groups will be considered, where evidence is available.

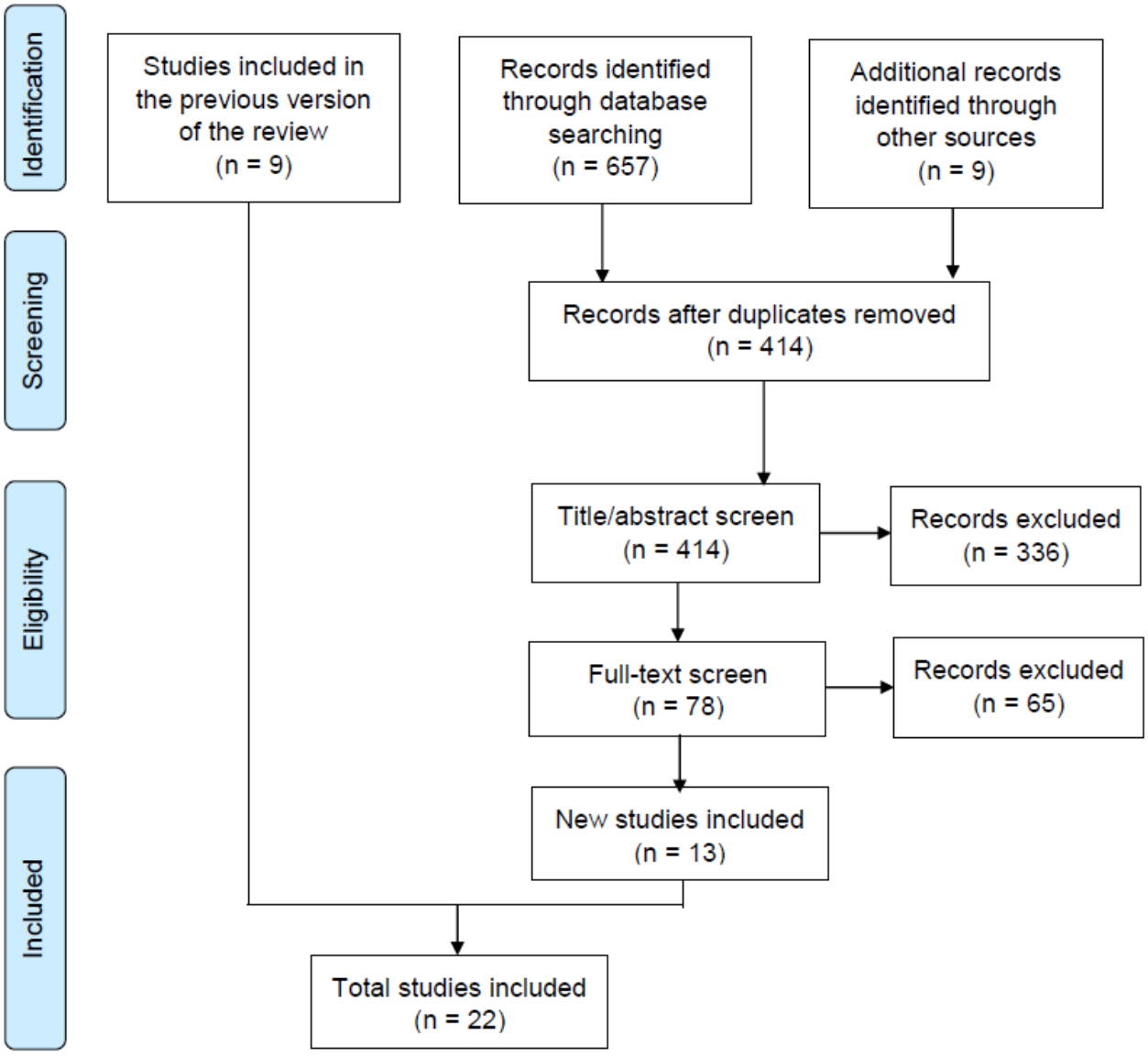

Figure B.1. PRISMA diagram

Figure B.1. PRISMA diagram alt text

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

There were n = 657 records identified through database searching and n = 9 records identified through other sources, reduced to n = 414 records after duplicates removed, which were screened on title and abstract.

Of these, n = 336 records were excluded, leaving n = 78 records which underwent full-text screening. Of these, n = 65 records were excluded, leaving n = 13 new included studies.

There were an additional n = 9 studies included in the previous version of this review, for a total of n = 22 studies included in this review.

Annexe C. Data extraction

Acronyms used: IAR = Infection attack rate, ICU = Intensive care unit, IQR = interquartile range, PHE = Public Health England, RT-PCR = reverse transcriptase polymerase chain reactino

Reference	Study design	Methods or description	Findings	Comments
Armann and others, 2020 (22) PREPRINT 'Anti-SARS-CoV-2 IgG antibodies in adolescent students and their teachers in Saxony, Germany (SchoolCoviDD 19): very low seropraevalenc e and transmission rates'	Study type Seroprevalence study Objective To assess the role of students and teachers in the SARS-CoV-2 transmission. Setting 13 secondary schools in eastern Saxony, Germany (low prevalence setting: 139 laboratory-confirmed infections per 100,000 inhabitants as of 13 July 2020). Period 25 May to 30 June 2020 Participants Students grade 8 to 11 (age 14 to 16 years) and their teachers.	After reopening of school on 18 May 2020, 2,020 students grade 8 to 11 and their teachers in 13 secondary schools were invited to participate to the SchoolCoviDD19 study. Participants completed: • questionnaire (symptom, contact history, sociodemographic, etc) • antibody detection (blood test, chemiluminescence immunoassay) All samples with a positive or equivocal test result, as well as all samples from participants with a reported personal or household history of a SARS-CoV-2 infection, were re-tested with two additional serological tests (chemiluminescent microparticle immunoassay and ELISA). Case definitions Positive serology = positive to the first test and to at least one of the additional tests.	1,538 students (median age 15 years; 14 to 16 years) and 507 teachers (median age 51 years; 37 to 57 years) participated in this study. Seroprevalence for SARS-CoV-2: • all: 0.6% (13 of 2,045) • students: 0.7% (11 of 1,538) • teacher: 0.2% (1 of 507) Seroprevalence ranged from 0% to 2.2% per individual school (even in schools with reported COVID-19 cases before lockdown). 23 of 24 participants with a household history of COVID-91 were seronegative. Authors conclusions Students and teachers do not play a crucial role in driving the SARS-CoV-2 pandemic in a low prevalence setting.	Author identified limitations None reported. Notes from the review team -This study was conducted during just over a month but started only one week after school reopened; depending on when exactly the samples were taken, it is unclear whether it could have detected outbreaks occurring since schools reopened. Efficacy testing by PHE of DiaSorin LIAISON (the primary antibody test the study used) indicates a required period of at least 14 days post symptom onset, to achieve a test sensitivity of 69.4%, and 21 days for 71.4% (37). Unclear applicability due to the differences in COVID-19 prevalence.
Brown and others, 2020 (20) 'Antibody Responses after Classroom Exposure to Teacher with Coronavirus Disease, March 2020'	Study type Case report Objective To assess potential SARS-CoV-2 transmission in a classroom setting. Setting US Period	After traveling to Europe, a teacher returned to school while being symptomatic (24 to 27 February). During this period, the teacher taught 16 classes, all in the same room, each with less than 30 students. Of the 16 classes, 10 were interactive (teacher walking in class and speaking directly with students) and 6 were noninteractive.	On 10 March, 120 students were contacted, of which 21 volunteered to participate in the serologic survey. Characteristics of the 21 students: • median age: 17 years (5 to 18 years) • 5 students (24%) had interactive contact (mean in-class time: 108 minutes) • 16 students (76%) had non-interactive contact (mean in-class time: 50 minutes) Out of the 5 students from interactive class, one tested positive (and was symptomatic) and one indeterminate	Author identified limitations Definition of classroom contact based on teacher report, do not consider contact variability for each student. Reported symptoms might have been affected by survey expectation (social desirability bias). Results might not be generalizable due to low participation.

Reference	Study design	Methods or description	Findings	Comments
	February 2020 to March 2020 <u>Participants</u> Students (aged 5 to 18 years old)	After the teacher tested positive to SARS-CoV-2 (oropharyngeal swab, RT-PCR), all students who attended his classes were asked to quarantine up to 12 March. Once the quarantine finished, a serologic survey was conducted, including: • questionnaire (symptoms) • antibody detection (blood test, ELISA)	(no symptoms). They were not in the classroom at the same period and they sat in different locations. The 3 other students tested negative, although 2 had reported limited symptoms. The 16 students from non-interactive classes all tested negative, although 7 of them (44%) reported symptoms. <u>Authors conclusions</u> These results suggest that classroom interaction between an infected teacher and students might result in virus transmission.	Participations might have been influenced by perceived risks and symptoms (selection bias). Not all potential infections might have been detected as the serological test was done only 14 days after exposure. The only known exposure to those who participated was the infected teacher, but other community transmission might have occurred. <u>Notes from the review team</u> Not enough details provided on total number of students who had been in contact with infected teacher and on which basis they had been contacted for serological survey. Outcome measure: as only 14 days between exposure & outcome measure, it is unclear why only antibodies and no virus detection was performed. As a result of the 2 points above, combined with the limitations reported by the authors, validity of the results is unclear. Case reports provide low-level evidence compared to other study designs.
Fontanet and others, 2020 (17) PREPRINT 'SARS-CoV-2 infection in primary schools in northern France: A retrospective cohort study in an area of high transmission'	<u>Study type</u> Retrospective cohort study <u>Objective</u> To investigate the extent of infection in younger children in a primary school. <u>Setting</u> 6 primary schools in Crépy-en-Valois, France <u>Period</u>	First case of COVID-19 was detected in this city on 24 February 2020; and the investigation led to an epidemic around a local high school, see (16). The present study report on a follow-up seroepidemiologic investigation across 6 primary schools from the same city. All pupils and staffs were invited to participate in the study, as well as parents and relatives over 5 years old leaving in the same household. Participants completed:	1,047 pupils and 51 teachers were invited to participate, of which 541 (51.5%) pupils and 46 (90.2%) teacher accepted. Infection attack rate (IAR): • primary school pupils: 8.8% (45 of 510) • teachers: 7.1% (3 of 42) • non-teaching staff: 3.6% (1 of 28) • parents: 11.9% (76 of 641) • relatives: 11.8% (14 of 119) The overall IAR was 10.4% and did not differ by gender, age categories or type of participants.	<u>Author identified limitations</u> Short timeframe between first case in a pupil and school closure (2 weeks). Incomplete sampling of classes and families. Information on symptoms was collected retrospectively, and other respiratory viruses were circulating concurrently in the study population. <u>Notes from the review team</u> The main limitations of the studies were highlighted by the authors.

Reference	Study design	Methods or description	Findings	Comments
	Study conducted on 28-30 April, reporting on the period February 2020 to March 2020 <u>Participants</u> Primary school pupils (6 to 11 years old), their parents and relatives, and staff.	• questionnaire (symptom and sociodemographic) • antibody detection (blood test, flow-cytometry-based assay) <u>Case definitions</u> Positive serology = having had SARS-CoV-2 infection. Symptomatic if participants reported symptoms up to 7 days prior to sample collection.	Prior to school closures (14 February), 3 pupils positive to SARS-CoV-2 had attended 3 separate schools with no secondary cases in the following 14 days. Familial clustering was observed: high proportion of antibodies among parents (61%; 36 of 59) and relatives (44%; 4 of 9) of infected pupils compared to non-infected pupils (6.9% for parents [p<0.0001] and 9.1% for relative [p=0.002]). In children, symptoms were mild and 41% (24 of 58) of infected children were asymptomatic. <u>Authors conclusions</u> In young children, SARS-CoV-2 infection was largely mild or asymptomatic and there was no evidence of onwards transmission from children in the school setting.	Still some knowledge gap on SARS-CoV-2 immunity, especially in relation to asymptomatic and mild-symptomatic. Validity of the results of the antibody detection in this case is therefore unclear. Study has potential applicability to an England context as the secondary case attended schools in a comparable country (that is, France).
Fontanet and others, 2020 (16) PREPRINT ‘Cluster of COVID-19 in northern France: A retrospective closed cohort study’	<u>Study type</u> Retrospective cohort study <u>Objective</u> To estimate the IAR and its determinants in an area affected by COVID-19. <u>Setting</u> One high school in Oise, France <u>Period</u> Study conducted on 30 March and 4 April <u>Participants</u> High school pupils, their parents and siblings, and staff.	As a follow-up to the initial case investigation and contact tracing, a retrospective closed cohort study was conducted in the high school. All pupils, teachers and non-teaching staff from the high school were invited to participate to the investigation, as well as parents and siblings of the pupils. Participants completed: • questionnaire (symptom and sociodemographic) • antibody detection (blood test, 3 different testing methods) <u>Case definitions</u> Positive serology = having had SARS-CoV-2 infection. Symptomatic if participants reported symptoms in since the 13 January	1,262 high school pupils, teachers and non-teacher staffs were invited to participate, of which 326 (37%) accepted. An additional 345 parents and siblings participated. Total participants: 661; median age: 37 years (16 to 47 years old). 68.4% (452 of 661) participants reported respiratory symptoms; 48.6% (321) experienced major symptoms; 19.8% (131) minor symptoms and 31.6% (209) had not noticed symptoms. 10 participants had been hospitalised; no fatalities were reported. Infection attack rate (IAR): • high school pupils: 38.3% (92 of 240) • teachers: 43.4% (23 of 53) • non-teaching staff: 59.3% (16 of 27) • parents: 11.4% (24 of 211) • siblings: 10.2% (13 of 127) The overall IAR was 25.9%. The IAR was higher in the high school staff, teachers and pupils, than in parents and siblings (p<0.001).	<u>Author identified limitations</u> Low participation rate. Information on symptoms was collected retrospectively, and other respiratory viruses were circulating concurrently in the study population. The chosen antibody test had very high sensitivity, but it is not clear whether time to seroconversion is longer in patients with asymptomatic or mild symptoms. <u>Notes from the review team</u> The main limitations of the studies were highlighted by the authors. The objective of this study was to assess the infection attack rate in an area that had been heavily affected by COVID-19 in early 2020, that is that it was not focus on assessing transmission in school settings. Nevertheless, as the studied cohort was directly linked to high school settings, the results are relevant to this

Reference	Study design	Methods or description	Findings	Comments
		2020 and up to 7 days prior to sample collection.	Participants who had experienced major symptoms were more likely to be infected, compared to those who had had minor or no symptoms (37.8%, 26.0%, and 13.9%, respectively, p<0.001). Of all symptoms considered, two had high positive predictive value for SARS-CoV-2 infection: anosmia (50 of 59 = 84.7%) and ageusia (52 of 59 = 88.1%).	review. Additional results of the study on comorbidities and other risk factors not reported here as outside the scope of this review. Study has potential applicability to an England context as the secondary case attended schools in a comparable country (France).
Hildenwall and others, 2020 (24) 'Paediatric COVID-19 admissions in a region with open schools during the two first months of the pandemic'	Study type Brief report of a retrospective study Objective To assess the impact of school closure on the incidence and severity of paediatric hospital admissions. Setting Stockholm, Sweden. Period 13 March to 14 May 2020 Participants Children aged 0 to 17 years	In Sweden, schools for children up to 15 years old remained opened. All paediatric hospital admissions were reviewed for the period covered by the study. During this period, a nasopharyngeal sample was collected from close to all paediatric hospital admissions. Patient files of all children who tested positive were reviewed to collect data on background characteristics, symptoms, outcomes, amongst others.	During the study period, 63 admitted children had tested positive, of which 30 had a primary COVID-19 diagnosis; 14 were admitted with another concurrent illness; 19 were incidentally found to be positive. Out of the 63 participants, 39 (62%) had fever and 32 (51%) had respiratory symptoms. Age of the 63 children who tested positive: • under 1 year: 33% (21 of 63) • 1 to 5 years: 17% (11 of 63) • 6 to 15 years: 33% (21 of 63) • 16 to 18 years: 16% (10 of 63) Median age: 4.7 years old. Authors conclusions Results point towards a low incidence of severe illness due to COVID-19 among Swedish children, even though day-care centres and primary schools remained open, and suggests that the pandemic for children in Sweden compared to countries with stricter lockdown measures.	Author identified limitations None reported. Notes from the review team -This study only considered hospital admissions, so might not be representative of all paediatric population. Low number of participants. Despite differences in the policies implemented, the study has potential applicability to an England context.
Public Health Agency of Sweden, 2020 (23) 'Covid-19 in schoolchildren - A comparison between Finland and Sweden'	Study type Country-level epidemiological study Objective To compare the effect of different approaches in regard to school closure, as a response to the COVID-19 pandemic. Setting Sweden and Finland	Finland and Sweden, two in many ways similar countries, applied different measures regarding schools during the covid-19 pandemic: • Sweden: day care and primary schools remained open during the pandemic (secondary schools and universities closed on 17 March 2020) • Finland: all schools were closed on 18 March until 13 May 2020 (except children in grades 1 to 3 whose parents were key workers)	Finland: • from school reopening on 14 May up to 31 May, 23 index cases were reported in 21 primary schools (16 pupils and 7 adults). 392 pupils and 54 adults were placed in quarantine up to 12 June; no secondary cases were reported during this period. • primary school closure and reopening did not have any significant impact on the weekly number of laboratory-confirmed cases in primary school aged children. Sweden:	Author identified limitations None reported. Notes from the review team This is a report from a national agency which has not undergone publishing process (for example, peer-review). Cases recorded in the study appear to be from notified infections. This potentially misses asymptomatic cases amongst children.

Reference	Study design	Methods or description	Findings	Comments
	Period Up to 14 June 2020 Participants Children aged 1 to 19 years old	Number of reported cases, number admitted in intensive care unit (ICU), number of deaths due to COVID-19 and cumulative incidence of reported cases up to 14 June 2020 were analysed for both countries.	• the percentage of reported cases among schoolchildren is only one tenth of their percentage of the population; changes in infection in children hard to assess due to changes in testing policies • compared to other professions, the relative risk among teachers in day care, primary and secondary school were close to one, indicating no increased risk of exposure and infection in this group. The overall cumulative incidence among school-aged children in Finland and Sweden is similar. Sweden has been much more affected by the pandemic than Finland but this does not show in the incidence among children. Authors conclusions Closure or not of schools had no measurable direct impact on the number of laboratory confirmed cases in school-aged children in Finland or Sweden.	Difference in testing and contact tracing policies between the two countries might impact the results. In addition, Sweden has changed its testing policies during the period of this study, confounding even further the results. Despite differences in the policies implemented, the study has potential applicability to an England context.
Stein-Zamir and others, 2020 (19) 'A large COVID-19 outbreak in a high school 10 days after schools' reopening, Israel, May 2020'	Study type Case report Objective To describe the investigation and epidemiological characteristics of the school's outbreak. Setting One regional public high school in Jerusalem, Israel Period May 2020 Participants High school students (13 to 18 years) and staff members	Schools in Israel were closed on 13 March 2020. Limited school reopening stated from 3 May 2020 and all classes reopened on 17 May, with requirement for daily health reports, hygiene, facemasks, social distancing and minimal interaction between classes. Due to an extreme heatwave, face masks were not mandatory on 19 to 21 May. 10 days after reopening, an outbreak emerged in a high school (1,190 students aged 12 to 18 years and 162 staff members): • first case notified on 26 May 2020, source unknown. Close contacts (4 household, 50 students, 14 teachers) were asked to self-isolate. • following the second case (27 May) an outbreak status was declared: school close and isolation instruction and testing of the school	Epidemiological investigation: both students attended school on 19 to 21 May (no masks) and reported mild symptoms. They were from different grades and were not epidemiologically linked. 1,161 students and 151 staff members were tested. Rates were higher in junior grades (7 to 9) than in high grade (10 to 12): • grade 7 (13 years): 20.3% (40 of 197) • grade 8 (14 years): 17.3% (34 of 197) • grade 9 (15 years): 32.6% (61 of 187) • grade 10 (16 years): 4.5% (9 of 200) • grade 11 (17 years): 3.1% (6 of 98) • grade 12 (18 years): 1.6% (3 of 87) • all students: 13.2% (153 of 1,161) • staff members: 16.6% (25 of 151) Peak rates observed in 4 classes: 9th grade (20 cases in one class; 13 cases in 2 other classes) and seventh grade (14 cases in one class). Of the cases in teachers, 4 taught all these 4 classes, 2 taught 3 of 4 classes and one taught 2 of 4 classes.	Author identified limitations None reported. Notes from the review team Not enough details provided on case definitions. No information on age and grades of the first two cases and on whether they were in the classes with high peak rates. Unclear applicability due to the differences in relation to population characteristics and school conditions. Case reports provide low-level evidence compared to other study designs.

Reference	Study design	Methods or description	Findings	Comments
		community (PCR in nasopharyngeal swabs).	57% of students and 24% of teachers who tested positive did not report symptoms. One emergency room visit was recorded and no hospitalisations. Environmental school inspection reported crowded classes, with 35 to 38 students per class in class area of 39 to 49 m^2, (1.1 to 1.3 m^2 per student), distancing not possible. Due to extreme heatwave, air-conditioning functioned continuously in all classes. Junior grades and high grades are located in 2 separate wings of the building. <u>Authors conclusions</u> The high school outbreak in Jerusalem displayed mass COVID-19 transmission upon school reopening.	
Torres and others, 2020 (18) 'SARS-CoV-2 antibody prevalence in blood in a large school community subject to a Covid-19 outbreak: a cross-sectional study'	<u>Study type</u> Cross-sectional survey <u>Objective</u> To assess the magnitude of a school outbreak and the role students and staff played using a self-administered antibody detection test and survey. <u>Setting</u> A large community school in Vitacura, Chile (2,616 students un 14 levels and 318 staff members, of which 195 are teachers) <u>Period</u> 4 to 19 May 2020 <u>Participants</u> Students and staff	After the outbreak was identified on 12 March, the school was closed and the entire community was placed in quarantine. As of 6 April, 52 members of the school community had been confirmed positive for SARS-CoV-2 (PCR), of which 17% were students, 35% staff and 52% parents. The school year had begun on 4 March, and during the first week of school parent-teacher meetings were held nearly every evening. The index case was a staff member who worked with the entire preschool and elementary school staff, and was present at all of the parent-teacher meetings for Prekinder through 4th grade. <u>Methods</u> To determine the overall SARS-CoV-2 antibody prevalence, a randomised	1,009 students and 235 staffs participated to the studies. Antibody positive rates: Students: 9.9% (95% CI 8.2 to 11.8) • preschool (n=147): 12.3% • elementary (n=286): 10.8% • middle school (n=295): 11.9% • high school (n=281): 5.7% Staff: 16.6% (95% CI 12.1 to 21.9) • teachers (n=165): 20.6% • support staff (n=70): 7.1% Among students, positivity was associated with younger age (p=0.01), lower grade level (p=0.05), prior RT-PCR positivity (p=0.03), and history of contact with a confirmed case (P<0.001). Among staff, positivity was higher in teachers (p=0.01) and in those previously RT-PCR positive (p<0.001). The median percent of antibody positive students per classroom was 8.3% (IQR: 1.6% to 14.3%). In 7 classrooms, over 25% of students were positive for antibodies, of which four had a primary teacher who was antibody positive or RT-PCR positive.	<u>Author identified limitations</u> The authors reported on the limitations of antibody detection tests and noted that a second test (for example, ELISA) would have been desirable for samples with discordant interpretations. (But not possible due to city-wide quarantine). Testing parents was not possible due to funding limitations. Symptoms were retrospectively reported (recall bias). <u>Notes from the review team</u> The main limitation of the study is related to the self-administrated test for antibody detection. Unclear applicability due to the differences in relation to population characteristics, COVID-19 incidence, R value and natural course of the virus.

Reference	Study design	Methods or description	Findings	Comments
		sample of students evenly distributed by classroom was invited to participate; all staffs were invited. A self-administrated IgG and IgM antibody test (finger-prick chromatographic-based) was sent to all selected participants 8 to 10 weeks after the start of the outbreak. Flyer, instruction and video were provided to demonstrate how to use the test. Quality check or verification of results performed, and duplicate opinion for any unclear results.	Antibody positive children had an average of 1.8 contacts with a confirmed RT-PCR COVID-19 case, while antibody negative children had 1.4 contacts (P=0.01). The greater the number of contacts, the greater the probability that the child was antibody positive (OR=1.4; p=0.05). Authors conclusions Teachers were more affected and younger children had higher infection rate, likely because index cases were teachers or parents from preschool.	
Yung and others, 2020 (21) 'Novel coronavirus 2019 transmission risk in educational settings'	Study type Case series Objective To describe the risk of SARS-CoV-2 transmission among children in educational settings (preschool and secondary school). Setting Preschool and secondary school in Singapore Period February 2020 to March 2020 Participants Students and	3 potential SARS-CoV-2 outbreaks were identified in 3 separate educational settings (2 preschools and 1 secondary schools). All close contacts were placed under quarantine, and one of the preschool was closed for 14 days following a rapid increase of staff members with COVID-19. Close contacts who developed symptoms were tested. All students and parents of the schools were advised to monitor for symptoms and were similarly admitted for COVID-19 evaluation if they were unwell within the 14-day incubation period. All admitted cases required at least 2 negative nasopharyngeal swabs to be taken on 2 separate days before being discharged from hospital. Clinical and epidemiological data of the confirmed cases and their contacts from school were extracted for analysis.	Secondary school Index case was a 12-year-old student, identified through contact tracing related to a community outbreak, and attended school on the first day of symptom. 8 students from the school developed symptoms (mean age: 12.8 years); all of them tested negative. Preschool 1 Index case was a 5-year-old student, identified through contact tracing related to a community outbreak, and attended school on the first day of symptom. 34 preschool students developed symptoms (mean age: 4.9 years); all of them tested negative. Preschool 2 Index case was a staff member, resulting in 16 staff members being infected (and 11 cases from their own households). 77 children (about 73% of total) were tested, of which 8 were symptomatic and 69 did not have symptoms. All of them tested negative. The remaining 27% of students did not develop symptoms. Authors conclusions The investigation found no evidence of COVID-19 transmission in secondary school and preschool students, including when exposed to a major COVID-19 cluster of adult staff members.	Author identified limitations No serology was performed, but it is unlikely that transmission was affected by high level of herd immunity in children (low number of paediatric cases in Singapore). Notes from the review team Only symptomatic participants were tested in 2 out of 3 of the included schools. In 2 out of 3 schools, it is unclear whether adult staff members were included in the investigation. Unclear applicability due to the differences in relation to population characteristics, COVID-19 incidence, R value and natural course of the virus. Case series provide low-level evidence compared to other study designs.

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