Centers for Disease Control and Prevention

COVID-19

Science Brief: Transmission of SARS-CoV-2 in K-12 Schools and Early Care and Education Programs – Updated

Updated July 9, 2021 Print

Summary of Recent Changes

Updates as of July 9, 2021

- Modified the background to reflect the current state of the pandemic and to clarify that studies in the review pre-date the approval of vaccinations for adults and adolescent 12 years and older
- Condensed and updated information in section on COVID-19 in children and adolescents
- Added section on early care and education settings
- Added section on masking
- Added section on screening testing
- Added information on the updated CDC Guidance for COVID-19 Prevention in Kindergarten (K)-12 Schools and COVID-19 Guidance for Operating Early Care and Education/Child Care Programs

View previous updates

Background

Schools and early care and education (ECE) programs are an important part of the infrastructure of communities. They provide safe, supportive learning environments for children and adolescents and employ teachers and other staff.[1, 2] Schools and some ECE programs also provide critical services, including school meal programs and social, physical, behavioral, and mental health services.[1, 3] Schools and ECE programs have other benefits for the community, including enabling parents, guardians, and caregivers to work.[1, 2, 4] In the spring of 2020, kindergarten to grade 12 (K-12) schools and many ECE programs in the United States closed for in-person instruction or care as a strategy to slow the spread of SARS-CoV-2, the virus that causes COVID-19. Reports suggest that the limited in-person instruction during the pandemic may have had a negative effect on learning for children[5] and on the mental and emotional well-being of both parents and children.[6, 7] For schools and ECE programs, the benefits of in-person school and caregiving need to be balanced against the risk of acquiring and spreading SARS-CoV-2 in these settings.

Globally, K-12 schools and ECE programs used various, layered COVID-19 prevention strategies with in-person, hybrid, and virtual models of instruction and care during the 2020-2021 academic year. Their experiences have contributed to our knowledge of the nature of SARS-CoV-2 transmission in schools, ECE programs, and their surrounding communities.

Given the rapid developments of the pandemic response and the time needed to collect, analyze, and report new data, the studies in this updated science brief primarily describe experiences before widespread availability of COVID-19 vaccines. The availability of safe and effective vaccines for people ages 12 years and older and subsequent decreases in COVID-19 cases,

hospitalizations, and deaths mark progress against COVID-19.[8] Increasing COVID-19 vaccination rates will likely affect patterns of transmission in schools and communities. As of July 4, 2021, approximately 55% of those 12 years and older in the United States were fully vaccinated.[8]

In addition, the studies in this review describe school operations when multiple, layered prevention strategies were in use including universal masking policies, limited class sizes, and cohorting. The studies are also not limited to experiences in the United States and do not account for new variants of the virus. This context is important to consider when reviewing this summarized science.

Many state, tribal, local, and territorial agencies are planning to or already have reduced prevention strategies, such as physical distancing and masking, for community settings including schools. Therefore, the 2021-2022 school year will not be directly comparable to the 2020-2021 school year. Evaluation and sharing of the 2021-2022 experiences will be needed to understand SARS-CoV-2 transmission risk in this new stage of the pandemic and to add to the science on this topic. Regardless, it has been established, as described by the evidence in this document, that layered COVID-19 prevention strategies help to prevent SARS-CoV-2 transmission.

Transmission of SARS-CoV-2 in schools and ECE programs depends on the local transmission rates; the types of variants circulating; the epidemiology of COVID-19 among children, adolescents, and staff; vaccine coverage for those eligible; and mitigation measures in place to prevent transmission.

COVID-19 among children and adolescents

Children and adolescents can be infected with SARS-CoV-2, can get sick with COVID-19, and can spread the virus to others.[9-15] In the United States through March 2021, the estimated cumulative rates of SARS-CoV-2 infection and COVID-19 symptomatic illness in children ages 5-17 years were comparable to infection and symptomatic illness rates in adults ages 18-49 and higher than rates in adults ages 50 and older.[16] Estimated cumulative rates of infection and symptomatic illness in children ages 0-4 years are roughly half of those in children ages 5-17 years, but are comparable to those in adults ages 65 years or older. These cumulative rates were estimated from CDC models that account for under-detection among reported cases.[17]

Several studies conducted early during the COVID-19 pandemic suggested that the incidence rate among children and adolescents was lower than among adults.[9, 10, 18-23] However, the lower incidence rates may have been due in part to children, when compared to adults, having fewer opportunities for exposure (due to school, daycare, and activity closures) and a lower probability of being tested.[17] Studies that have systematically tested children and adolescents, irrespective of symptoms, for acute SARS-CoV-2 infection (using antigen or RT-PCR assays) or prior infection (through antibody testing) have found their rates of infection can be comparable, and in some settings higher, than in adults.[12, 15, 24-29]

Children and adolescents can also transmit SARS-CoV-2 infection to others. Early during the COVID-19 pandemic, children were not commonly identified as index cases in household or other clusters[9, 10] largely because schools and extracurricular activities around the world were closed or no longer held in-person. However, outbreaks among adolescents attending camps, sports events, and schools have demonstrated that adolescents can transmit SARS-CoV-2 to others.[11, 14, 30] Furthermore, transmission studies that have examined secondary infection risk from children and adolescents to household contacts who are rapidly, frequently, and systematically tested demonstrate that transmission does occur.[29, 31]

Compared with adults, children and adolescents who are infected with SARS-CoV-2 are more commonly asymptomatic (never develop symptoms) or have mild, non-specific symptoms (e.g. headache, sore throat).[32-36] Similar to adults with SARS-CoV-2 infections, children and adolescents can spread SARS-CoV-2 to others when they do not have symptoms or have mild, non-specific symptoms and thus might not know that they are infected and infectious. Children are less likely to develop severe illness or die from COVID-19.[23, 37-39] Nonetheless, 271 COVID-19 deaths among persons ages 5-17 years and 120 deaths among those 0-4 years have been reported to the National Center for Health Statistics through July 7, 2021.[8] The extent to which children suffer long-term consequences of COVID-19 is still unknown.[40] Although rates of severe outcomes (e.g. hospitalization, mortality) from COVID-19 among children and adolescents are low,[41, 42] youth who belong to some racial and ethnic minority groups are disproportionately affected similar to adults. For example, a higher proportion of COVID-19 cases in school-aged children who are Hispanic or Latino or are Black or African American were hospitalized or required intensive care unit (ICU) admission than reported among White school-aged children.[41] Underlying medical conditions are also more commonly reported among children who are hospitalized or admitted to an ICU than those not.[41, 43] CDC's COVID Data Tracker provides up-to-date information on Demographic Trends of COVID-19 cases and deaths in the US reported to CDC.

The evidence that children and adolescents can be infected with, get sick from, and transmit SARS-CoV-2 continues to evolve. As with the studies from early during the COVID-19 pandemic, the quality and comparability of reported studies is affected by the study design, the method used to detect SARS-CoV-2 infection, the prevention measures in place during the study period, and the background rate of infection in the community.[33, 44, 45] The introduction of new variants of the virus into the population likely will further affect the evolving epidemiology and interpretation of future studies as will understanding how transmission varies by the age of the child. COVID-19 vaccination of adults and adolescents could also impact the incidence of COVID-19 in the United States, as young children will comprise a greater proportion of the population who are unvaccinated and therefore at risk.

Schools and SARS-CoV-2 transmission

National COVID-19 case incidence rates among children and adolescents increased during fall 2020 until about mid-January 2021 and then declined, paralleling trends observed among adults.[8] Neither increases in case incidence among school-aged children nor school reopenings for in-person learning appear to pre-date increases in community transmission.[42, 46-48] Schools should consider levels of community transmission as they assess the risk of transmission within their school.[46] If community transmission is high and community vaccination level is low, students and staff are more likely to come to school while infectious, and introduce SARS-CoV-2 into the schools.

A study comparing COVID-19 hospitalizations between counties with in-person learning and those without in-person learning found no effect of in-person school reopening on COVID-19 hospitalization rates when baseline county hospitalization rates were low or moderate.[49] The association between COVID-19 incidence, the transmission of the virus in school settings, and levels of community transmission underscores the importance of controlling disease spread in the community to protect teachers, staff, and students in schools.[46]

Some outbreaks have occurred in schools, leading to closures.[50, 51] Significant secondary transmission of SARS-CoV-2 infection has occurred in school settings when prevention strategies are not implemented or are not followed.[50] In Israel, prior to vaccine introduction, a school was closed less than two weeks after reopening when two symptomatic students attended in-person learning, leading to 153 infections among students and 25 among staff members, from among 1,161 students and 151 staff members that were tested.[50] Importantly, prevention strategies were not adhered to – including lifting of a mask requirement because of a heat wave, classroom crowding, and poor ventilation.

Although outbreaks in schools can occur, multiple studies have shown that transmission within school settings is typically lower than – or at least similar to – levels of community transmission, when prevention strategies are in place in schools. Findings from these studies include:

- National surveillance data from the United Kingdom (UK) showed an association between regional COVID-19 incidence and incidence in schools. For every five additional cases per 100,000 population in regional incidence, the risk of a school outbreak increased by 72%.[46]
- Few cases in Australian schools were reported when community transmission levels were low, and cases in schools increased when community transmission increased.[2]
- In Michigan and Washington state, delivery of in-person instruction was not associated with increased spread of SARS-CoV-2 in schools when community transmission was low, but cases in schools did increase at moderate-to-high levels of community transmission.[52] When community transmission was low, there was no association between in-person learning and community spread.[52]
- A combined cross-sectional and cohort study in Italy between September 2020 and February 2021 found that reopening schools for in-person learning did not contribute to the second wave of SARS-CoV-2 infections.[47]

SARS-CoV-2 transmission in schools among students, families, teachers, and school staff

With approximately one quarter of teachers at higher risk of serious consequences of COVID-19 because of their underlying medical conditions,[53] reasonable concerns have been raised about the occupational risk of SARS-CoV-2 infection for teachers and school staff. Evidence from studies primarily done before vaccine approval for those 12 years of age and older suggests that staff-to-staff transmission is more common than transmission from students to staff, staff to student, or student to student.[46, 50, 54] For example, in the large UK study, most outbreak cases were associated with an index case (initial case) in a staff member.[46] Therefore, school interventions should include prevention strategies to reduce the transmission potential of

staff members. Detection of cases in schools does not necessarily mean that transmission occurred in schools. The majority of cases that are acquired in the community and are brought into a school setting result in limited spread inside schools when multiple layered prevention strategies are in place.[38, 55-57]

Findings from several studies suggest that SARS-CoV-2 transmission among students is relatively rare, particularly when prevention strategies are in place. An Australian study of 39 COVID-19 cases among 32 students and seven staff traced contacts across 28 schools and six early childhood centers and found only 33 secondary positive cases (28 students and five staff members) out of 3,439 close child contacts and 385 close staff contacts.[58, 59] Several contact tracing studies have found limited student-to-student transmission in schools.[47, 54, 60, 61] A study of factors associated with SARS-CoV-2 infection among children and adolescents in Mississippi found that school attendance was not associated with a positive SARS-CoV-2 test result. However, close contacts with persons with COVID-19, attending gatherings, and having visitors in the home were associated with SARS-CoV-2 infections among children and adolescents.[26] The evidence to date suggests that staff-to-student and student-to-student transmission are not the primary means of exposure to SARS-CoV-2 among infected children. Several studies have also concluded that students are not the primary sources of exposure to SARS-CoV-2 among adults in school setting.[47, 54, 59]

There is some evidence to indicate that SARS-CoV-2 might spread more easily within high school settings than in elementary school settings.[9] For example, researchers in Italy identified and tested nearly all (99.8%) contacts of 1,198 cases in school settings and reported a lower attack rate in elementary schools (one secondary case; 0.38% attack rate) than in middle and high schools (37 secondary cases; 6.46% attack rate).[62] This pattern was consistent with findings from a study in New South Wales, Australia, that reported higher attack rates in high schools than in elementary/primary schools.[58] The apparent increased risk of SARS-CoV-2 transmission among adolescents may be in part attributable to more social interactions with non-household members outside schools.[63] Nonetheless, evidence for greater transmission in middle schools and high schools compared with elementary schools suggests that the former may need to move more quickly to virtual instruction when community transmission is high. Uptake of COVID-19 vaccines in adolescents will likely alter these transmission dynamics.

Transmission in the ECE setting

Although the data are more limited in ECE settings,[58, 64-69] several findings are noteworthy. First, higher numbers of cases are observed when community rates are higher.[66, 67] Second, children can acquire SARS-CoV-2 in ECE settings[65, 70] and transmit it to household and non-household members.[70] Third, when prevention strategies are in place, secondary transmission appears uncommon.[66, 67] Findings from some of these studies include:

- In a study of Rhode Island child care centers shortly after reopening between June 1, 2020 and July 31, 2020, 29 of 666 programs had one or more cases of COVID-19 among children or staff. However, only four had possible secondary transmission.[66] During this time period, licensed child care facilities were required to follow multiple prevention strategies including reduced enrollment, cohorting in the same group, masks for adults, and enhanced cleaning. Data from periodic inspections demonstrated high compliance with the strategies.
- In a study of licensed childcare centers in Washington, D.C., between July and December of 2020 that had multiple prevention strategies in place, a quarter of facilities reported at least one case. However, facility-associated outbreaks only occurred in 5.8% of facilities.[67] Risk factors for an outbreak in a facility included having been in operation less than three years, having people who are symptomatic in the facility who first sought testing three or more days after illness onset, or having people with asymptomatic infection present in the facility.
- Another study found that child care providers who worked in ECE facilities open during April and May 2020 were not more likely to get COVID-19 than those who did not work in ECE facilities during those two months, a finding suggesting that working in the ECE facilities did not increase their risk of infection.[68]

Additional information on ECE programs can be found in CDC's COVID-19 Guidance for Operating Early Care and Education/Child Care Programs.

Prevention strategies and school in-person learning

CDC guidance identifies multiple prevention strategies that schools can implement in a layered approach to promote safer in-person learning and care. These include promoting vaccination, consistent and correct use of masks for people who are not fully vaccinated, physical distancing, screening testing in schools to promptly identify cases, improved ventilation,

handwashing and respiratory etiquette, staying home when sick and getting tested, contact tracing in combination with isolation and quarantine, and routine cleaning with disinfection under certain conditions.

When prevention strategies are consistently and correctly used, the risk of SARS-CoV-2 transmission in the school environment is decreased.[71] Use of multiple strategies – also called layered prevention – provides greater protection in breaking transmission chains than implementing a single strategy.[72] CDC guidance recommends layering multiple prevention strategies, especially in areas with moderate to high community transmission, low vaccination rates, and for people who are not fully vaccinated.

Studies of SARS-CoV-2 transmission in schools that consistently implemented layered prevention strategies have shown success in limiting transmission in schools, even when testing of close contacts has been incomplete.[38, 46, 49, 73-77] For example:

- A study of 11 school districts in North Carolina with in-person learning for at least nine weeks during the fall 2020 semester reported minimal school-related transmission even while community transmission was high.[38] These schools implemented and strictly adhered to multiple prevention strategies, including universal mask use and physical distancing. Breaches in mask use likely explained the few instances of in-school spread of SARS-CoV-2.
- A study of elementary schools in Utah who implemented layered prevention strategies, such as mask wearing and cohorting, found very low transmission (secondary attack rate 0.7%) in December 2020-January 2021.[74]
- In a study of K-12 schools in St. Louis with multiple layered prevention strategies in place, only 2% of contacts of COVID-19 cases in the schools tested positive for the virus; this was despite high community transmission rates.[76]
- A study of Italian schools, which implemented a comprehensive prevention approach that included masking, distancing, cleaning, increased ventilation, and cancellation of extracurricular activities, found that school reopening was not associated with the second wave of COVID-19 in Italy.[47]
- Similarly, a surveillance study of symptomatic and asymptomatic cases among children in Swiss schools found limited secondary transmission when multiple protective measures were used in schools,[56] including mask use, physical distancing, and other interventions.
- Data from surveillance of German school outbreaks detected outbreaks before any prevention strategies were implemented. After schools reopened with prevention strategies in place, the average number of outbreaks per week after the reopening (2.2) was smaller than before the school closed earlier in the pandemic (3.3), suggesting that prevention strategies had some protective effect.[51]
- A study of private schools that reopened for in-person instruction in Chicago with the implementation of layered prevention strategies found minimal in-school transmission.[57]

When a combination of effective prevention strategies is implemented and strictly adhered to in the K-12 in-person learning environment, the risk of transmission in the school setting appears to be lower than or equivalent to the transmission risk in other community settings.[47]

Specific strategies

CDC guidance includes multiple strategies that schools can use to reduce the risk of COVID-19 transmission. Many of these are broadly applicable for the prevention of infectious disease (e.g., hand hygiene and improved ventilation [including air cleaning]). This section focuses on three strategies that schools and ECE programs might specifically implement for COVID-19 prevention.

Mask use

Consistent and correct use of face masks reduces the spread of SARS-CoV-2[78] and, with some exceptions, is recommended for use indoors among people aged 2 and older who are not fully vaccinated. In general, people do not need to wear masks when outdoors. However, particularly in areas of substantial to high transmission, CDC recommends that people who are not fully vaccinated wear a mask in crowded outdoor settings or during activities that involve sustained close contact with other people who are not fully vaccinated. Masks work through the combination of source control and protection for the mask wearer. Most studies that have shown success in limiting transmission in schools have required that staff only or staff and students wear masks as one of the school's prevention strategies.[38, 47, 57, 66, 67, 75] Inconsistent mask use may have contributed to school-based outbreaks.[50, 79]

Physical distancing

Physical distancing is a recommended prevention strategy in schools and other settings. In many settings, physical distancing has been defined as at least 6 feet. This recommendation was based on historical studies of other contagious diseases such as SARS-CoV-1 in a hospital setting.[80] However, emerging international and United States evidence suggests layering of other prevention strategies is effective at reducing SARS-CoV-2 transmission risk even with physical distances of less than 6 feet between students in classrooms.

Several studies from international settings published in the fall of 2020 reported low levels of transmission with one meter (approximately 3.28 feet) between students in schools – consistent with the 1-meter recommendation for physical distancing of students from the World Health Organization (WHO).[81] A summary of findings from these studies is described below.

- K-5 schools in Norway had minimal child-to-child and child-to-adult transmission with masks only required for adults one meter between all individuals, and two meters between student cohorts (a cohort is a distinct group that stays together throughout the entire school day during in-person learning, or over the course of any pre-determined period of time, so that there is minimal or no interaction between groups).[73]
- Studies from Switzerland,[56] Australia,[59] Italy,[47] the U.K,[46] and Germany[51, 61] similarly found limited transmission for K-12 schools, using 1-meter distance between individuals (students, teachers, and staff).
- An outbreak investigation in an Israeli school among students in grades 7-12 highlighted the importance of multiple prevention measures, especially when physical distance cannot be achieved. In this case, already increased transmission risk from classroom crowding (35–38 students per class) and reduced distancing (1-1.3 m^2) was likely increased more by reduced ventilation (conditioned indoor air was recirculated) and an exemption from mask requirements due to a heat wave.[50]

Several United States studies also showed low transmission among students in schools even when student physical distancing is less than 6 feet, but other prevention strategies are in place. For example:

- A North Carolina study[38] found low transmission in schools and no instances of child-to-adult transmission of SARS-CoV-2 during a time when community transmission was high. Students were required to wear masks, and the schools implemented routine handwashing, daily symptom monitoring and temperature checks, contact tracing, and 14-day quarantine for close contacts. Although this study did not report the specific distances maintained between students, verbal reports from school officials indicated that in participating districts, students were placed less than 6 feet apart in classrooms.
- A study of the 94 pre-K-12 schools in the Chicago Archdiocese, the largest private school system in the United States, reported that the attack rate for students and staff participating in in-person learning was lower than the rate for the community overall: 0.2% among these students compared to 0.4% among all Chicago children.[57] The COVID-19 reopening guidelines for the Chicago Archdiocese schools required 6 feet between cohorts but not for students within cohorts, as well as masking, hand hygiene, cleaning and disinfection, daily symptom monitoring, contact tracing, and 14-day quarantine for close contacts of a case.[82]
- A study of 17 rural Wisconsin K-12 schools that were using full in-person instruction found only seven cases among students that were linked to in-school spread; the study noted limited spread among children in cohorts and observed no documented transmission to or from staff members.[55] These Wisconsin schools required mask use (92% observed compliance), placed students less than 6 feet apart in classrooms, and used cohorting at a time of high community transmission.
- A study of 20 K-6 schools in Utah at a time of high community transmission (>100 cases per 100,000 persons in the past seven days) found low in-school transmission (secondary attack rate of 0.7%) with mask requirements, a median of 3 feet between students, and use of cohorting.[74]
- A statewide analysis of Florida K-12 schools, where not all schools had mask requirements or physical distancing requirements between desks, also found low rates of school-associated transmission. Resumption of in-person education was not associated with a proportionate increase in COVID-19 among school-aged children.[83] Higher rates among students were observed in districts without mandatory mask-use policies and those with a higher proportion of students attending in-person learning. These findings provide further evidence for the effectiveness of universal masking, especially when physical distancing cannot be achieved.[83]
- A study of 58 K-12 schools conducting full in-person instruction in Missouri, where mask use was required and 73% of schools used distances of 3-6 feet between students, found that secondary transmission was rare.[76]
- A large evaluation of nine school districts in Ohio at a time of high community transmission found limited in-school transmission. Children who had in-school exposure to a student who was infected had rates of COVID-19 similar to

those of children with no known exposure in school.[84] This evaluation included K-12 schools that were using full in-person instruction and others that were using hybrid instruction; 12 schools used 3-5 feet of distance, while 17 used 6 feet. Because findings were not stratified by learning mode or distancing, it was not possible to determine the differential effects of these two factors.

- In a report using data from Michigan and Washington state, in-person schooling was not associated with increased spread of SARS-CoV-2 among students at schools located in areas with low or moderate levels of community transmission.[52] At the time, schools varied in how they held classes (full in-person, hybrid, and virtual). In Michigan, 6 feet of distance was recommended but not required, and in Washington, the recommended distance varied over time. The combination of learning modes and distancing definitions in this analysis did not allow investigators to draw conclusions about the effectiveness of 6 feet or shorter distances in terms limiting transmission in schools.

In summary, the preponderance of the available evidence from United States schools indicates that even when students were placed less than 6 feet apart in classrooms, there was limited SARS-CoV-2 transmission when other layered prevention strategies were consistently maintained; notably, masking and student cohorts.[34, 55, 74, 85] International studies further support these conclusions.[46, 47, 51, 73] However, greater physical distancing (at least 6 feet) between people who are not fully vaccinated should be prioritized whenever masks cannot be used (for example, while eating indoors).

Consistent with recommendations from WHO[81] and the American Academy of Pediatrics,[86] using a distance of at least 3 feet between students in classrooms could provide a feasible definition of physical distancing so long as other prevention strategies are maximized. These include mask requirements for children aged 2 years and older, adolescents, and staff who are not fully vaccinated, ensuring good ventilation that includes air cleaning, frequent hand hygiene, and encouraging children, adolescents, and staff to stay home when they have symptoms of COVID-19 or, for those not fully vaccinated, when they have been in close contact with someone who has known or suspected COVID-19.

There are insufficient data on the optimal distance recommended in ECE settings to reduce transmission risk, and feasibility of distancing between children and adults remains an issue.

Screening testing in K–12 schools

Screening testing is intended to identify persons who are infected but without symptoms (or before development of symptoms) who may be contagious so that measures can be taken to prevent further transmission. This can be used as a prevention strategy in schools.

Because many children with COVID-19 are asymptomatic, their infections may be difficult to detect without regular testing.[87] Several factors influence the yield of screening testing programs, including the accuracy of the test (sensitivity and specificity) and the prevalence of the infectious disease.[88] As previously stated, community transmission is correlated with the introduction of SARS-CoV-2 in the school. Depending on the characteristics of selected SARS-CoV-2 tests, conducting screening testing when community incidence is low is likely to result in identifying more false positives than true cases. Currently, CDC recommends that screening testing in schools be offered at least weekly for students who are not fully vaccinated in communities with moderate, substantial, or high transmission and for teachers and staff who are not fully vaccinated regardless of the levels of community transmission of SARS-CoV-2.

School-based screening testing programs may be particularly useful when other prevention strategies are not in place. In a modeling study that examined the effect of different prevention strategies on COVID-19 rates once a case was introduced into the school, weekly screening testing was projected to reduce secondary cases by a large extent in both elementary and high schools. Screening testing was estimated to be most effective in settings where other prevention strategies such as physical distancing and wearing masks were used less.[87]

In the field, screening testing programs have often been implemented along with other prevention strategies.[69, 75, 89] Screening testing programs have allowed some schools to identify and isolate students with asymptomatic infections and to address potential deficiencies in mitigation protocols, both of which can help reduce transmission of SARS-CoV-2.[69, 75, 89, 90] One study found that among five programs with regular screening testing (at least weekly) of most students and staff in the fall of 2020, one-third to two-thirds of total COVID-19 cases identified in the schools were identified through screening.[90] Being able to reassure parents and staff about the safety of in-person learning is one reported benefit of screening testing programs.[90] However, schools with screening testing programs also identify barriers such as privacy concerns, operational complexity, and financial concerns.[89, 90]

Sports and other extracurricular activities

Team sports or other types of group extracurricular activities can increase the risk of SARS-CoV-2 transmission for participants, coaches, and spectators[11, 91-93] as well as among other students, teachers, and staff.[11, 94, 95] Close contact team sports and indoor sports such as wrestling appear to represent particularly high-risk activities, because participants cannot maintain distance from others and ventilation options may be limited.[11, 93] Intense exercise causes participants to breathe heavily, which can cause potentially infected respiratory droplets to travel further than they would from persons upon exhaling at rest.[96] Other extracurricular activities, especially ones that occur indoors and involve shouting or singing, also increase the risk of transmission if a participant is infectious, because respiratory droplets may be generated at higher rates and potentially travel greater distances.[97, 98] For these reasons, strategies to control SARS-CoV-2 transmission in schools and ECE programs should take into account the role of sports and extracurricular activities that might be higher risk in increasing transmission. Differences in transmission dynamics for these activities compared with in-person instruction should also be considered. Relocation of activities to outdoors or other well-ventilated venues, as well as vaccination of eligible students and adults who support these activities (such as coaches, volunteers, teacher advisors), will be important contributors to reducing the risk of COVID-19 for those who play sports or engage in higher risk extracurricular activities.

Conclusions

SARS-CoV-2 transmission in the community is correlated with the amount of infections in schools. When community rates of COVID-19 are high, there is an increased likelihood that SARS-CoV-2 will be introduced to, and potentially transmitted within, a school or ECE setting.

Evidence to date suggests that when prevention strategies are layered and implemented with fidelity, transmission within schools and ECE programs can be limited. Information on transmission patterns following the uptake of COVID-19 vaccines and the experiences of schools as they use different mixes of effective prevention strategies to address COVID-19 will help refine guidance.

Reducing SARS-CoV-2 transmission in schools and ECE programs is a shared responsibility. Schools and ECE programs can limit transmission by layering the following effective prevention strategies:

- Promoting COVID-19 vaccination for those eligible
- Consistent and correct use of masks by people who are not fully vaccinated
- Physical distancing among people who are not fully vaccinated
- Screening testing in K-12 schools
- Improving ventilation
- Handwashing and respiratory etiquette
- Staying home when sick and getting tested
- Testing and contact tracing in combination with isolation and quarantine
- Routine cleaning with disinfection under certain conditions.

Implementing these strategies is particularly important in areas with moderate, substantial, or high transmission rates and low vaccination coverage, and to protect people who are not fully vaccinated. CDC has developed guidance that administrators in K-12 schools and ECE programs can use to help protect students, teachers, and staff; slow the spread of SARS-CoV-2; and support in-person learning and care.

Previous Updates

As of March 19

- Added a section on physical distancing in schools that includes a summary of evidence on physical distancing and updated references and citations.

References

1. National Academies of Sciences, Engineering, and Medicine (NASEM). Reopening K-12 Schools During the COVID-19 Pandemic: Prioritizing Health, Equity, and Communities. *Consensus study report from The National Academies Press* 2020. doi:10.17226/25858
2. Russell FM, Ryan K, Snow K, et al. COVID-19 in Victorian Schools: An analysis of child-care and school outbreak data and evidence-based recommendations for opening schools and keeping them open. *Report from Murdoch Children's Research Institute and the University of Melbourne*. 2020; Published 2020 September 25.
3. Donohue JM, Miller E. COVID-19 and School Closures. *JAMA* 2020;324(9):845-847. doi:10.1001/jama.2020.13092
4. Powell A, Thomason S, Jacobs K. Investing in Early Care and Education: The Economic Benefits for California. May 2019. Accessed June 30, 2021. https://laborcenter.berkeley.edu/investing-early-care-education-economic-benefits-california
5. Engzell P, Frey A, Verhagen MD. Learning loss due to school closures during the COVID-19 pandemic. *Proc Natl Acad Sci* 2021;118(17). doi:10.1073/pnas.2022376118
6. Barnett WS, Jung, K. Seven Impacts of the Pandemic on Young Children and their Parents: Initial Findings from NIEER's December 2020 Preschool Learning Activities Survey. 2021. New Brunswick, NJ: National Institute for Early Education Research.
7. Verlenden JV, Pampati S, Rasberry CN, et al. Association of Children's Mode of School Instruction with Child and Parent Experiences and Well-Being During the COVID-19 Pandemic — COVID Experiences Survey, United States, October 8–November 13, 2020. *MMWR Morb Mortal Wkly Rep* 2021;70:369–376. doi:10.15585/mmwr.mm7011a1
8. Centers for Disease Control and Prevention. COVID Data Tracker. Accessed June 30, 2021. https://covid.cdc.gov/covid-data-tracker/#datatracker-home
9. Goldstein E, Lipsitch M, Cevik M. On the Effect of Age on the Transmission of SARS-CoV-2 in Households, Schools, and the Community. *J Infect Dis* 2021;223(3):362-369. doi:10.1093/infdis/jiaa691
10. Zhu Y, Bloxham CJ, Hulme KD, et al. A Meta-analysis on the Role of Children in Severe Acute Respiratory Syndrome Coronavirus 2 in Household Transmission Clusters. *Clin Infect Dis* 2021;72(12):e1146-e1153. doi:10.1093/cid/ciaa1825
11. Atherstone C, Siegel M, Schmitt-Matzen E, et al. SARS-CoV-2 Transmission Associated with High School Wrestling Tournaments – Florida, December 2020-January 2021. *MMWR Morb Mortal Wkly Rep* 2021;70(4):141-143. doi:10.15585/mmwr.mm7004e4
12. Lewis NM, Chu VT, Ye D, et al. Household Transmission of SARS-CoV-2 in the United States. *Clin Infect Dis* 2020. doi:10.1093/cid/ciaa1166
13. Szablewski CM, Chang KT, Brown MM, et al. SARS-CoV-2 Transmission and Infection Among Attendees of an Overnight Camp – Georgia, June 2020. *MMWR Morb Mortal Wkly Rep* 2020;69(31):1023-1025. doi:10.15585/mmwr.mm6931e1
14. Chu VT, Yousaf AR, Chang K, et al. Transmission of SARS-CoV-2 from Children and Adolescents. *medRxiv* 2020. doi:10.1101/2020.10.10.20210492
15. Fontanet A, Tondeur L, Grant R, et al. SARS-CoV-2 infection in schools in a northern French city: a retrospective serological cohort study in an area of high transmission, France, January to April 2020. *Eurosurveillance* 2021;26(15):2001695. doi:10.2807/1560-7917.ES.2021.26.15.2001695
16. Centers for Disease Control and Prevention. Estimated Disease Burden of COVID-19. Accessed June 30, 2021. /coronavirus/2019-ncov/cases-updates/burden.html
17. Reese H, Iuliano AD, Patel NN, et al. Estimated Incidence of Coronavirus Disease 2019 (COVID-19) Illness and Hospitalization—United States, February–September 2020. *Clin Infect Dis* 2020;72(12):e1010-e1017. doi:10.1093/cid/ciaa1780
18. Gudbjartsson DF, Helgason A, Jonsson H, et al. Spread of SARS-CoV-2 in the Icelandic Population. *N Engl J Med* 2020;382(24):2302-2315. doi:10.1056/NEJMoa2006100
19. Madewell ZJ, Yang Y, Longini IM, et al. Household Transmission of SARS-CoV-2: A Systematic Review and

Meta-analysis. *JAMA Netw Open* 2020;3(12):e2031756. doi:10.1001/jamanetworkopen.2020.31756

20. Zhang J, Litvinova M, Wang W, et al. Evolving epidemiology and transmission dynamics of coronavirus disease 2019 outside Hubei province, China: a descriptive and modelling study. *Lancet Infect Dis* 2020;20(7):793-802. doi:10.1016/s1473-3099(20)30230-9
21. Viner RM, Mytton OT, Bonell C, et al. Susceptibility to SARS-CoV-2 Infection Among Children and Adolescents Compared With Adults: A Systematic Review and Meta-analysis. *JAMA Pediatr* 2021;175(2):143-156. doi:10.1001/jamapediatrics.2020.4573
22. Somekh E, Gleyzer A, Heller E, et al. The Role of Children in the Dynamics of Intra Family Coronavirus 2019 Spread in Densely Populated Area. *Pediatr Infect Dis J* 2020;39(8):e202-e204. doi:10.1097/inf.0000000000002783
23. Choi SH, Kim HW, Kang JM, et al. Epidemiology and clinical features of coronavirus disease 2019 in children. *Clin Exp Pediatr* 2020;63(4):125-132. doi:10.3345/cep.2020.00535
24. Centers for Disease Control and Prevention. National Commerical Laboratory Seroprevalence Survey. Accessed June 30, 2021. https://covid.cdc.gov/covid-data-tracker/#national-lab
25. Bajema KL, Wiegand RE, Cuffe K, et al. Estimated SARS-CoV-2 Seroprevalence in the US as of September 2020. *JAMA Intern Med* 2021;181(4):450-460. doi:10.1001/jamainternmed.2020.7976
26. Hobbs CV, Drobeniuc J, Kittle T, et al. Estimated SARS-CoV-2 Seroprevalence Among Persons Aged <18 Years – Mississippi, May-September 2020. *MMWR Morb Mortal Wkly Rep* 2021;70(9):312-315. doi:10.15585/mmwr.mm7009a4
27. Smith BK, Janowski AB, Danis JE, et al. Seroprevalence of SARS-CoV-2 Antibodies in Children and Adults in St. Louis, Missouri, USA. *mSphere* 2021;6(1). doi:10.1128/mSphere.01207-20
28. Riley S, Ainslie KEC, Eales O, et al. Resurgence of SARS-CoV-2: Detection by community viral surveillance. *Science* 2021;372(6545):990-995. doi:10.1126/science.abf0874
29. Grijalva CG, Rolfes MA, Zhu Y, et al. Transmission of SARS-COV-2 Infections in Households – Tennessee and Wisconsin, April-September 2020. *MMWR Morb Mortal Wkly Rep* 2020;69(44):1631-1634. doi:10.15585/mmwr.mm6944e1
30. Schwartz NG, Moorman AC, Makaretz A, et al. Adolescent with COVID-19 as the Source of an Outbreak at a 3-Week Family Gathering – Four States, June-July 2020. *MMWR Morb Mortal Wkly Rep* 2020;69(40):1457-1459. doi:10.15585/mmwr.mm6940e2
31. Park YJ, Choe YJ, Park O, et al. Contact Tracing during Coronavirus Disease Outbreak, South Korea, 2020. *Emerg Infect Dis* 2020;26(10):2465-2468. doi:10.3201/eid2610.201315
32. CDC COVID-19 Response Team. Coronavirus Disease 2019 in Children – United States, February 12-April 2, 2020. *MMWR Morb Mortal Wkly Rep* 2020;69(14):422-426. doi:10.15585/mmwr.mm6914e4
33. Davies NG, Klepac P, Liu Y, et al. Age-dependent effects in the transmission and control of COVID-19 epidemics. *Nat Med* 2020;26(8):1205-1211. doi:10.1038/s41591-020-0962-9
34. Laws RL, Chancey RJ, Rabold EM, et al. Symptoms and Transmission of SARS-CoV-2 Among Children – Utah and Wisconsin, March-May 2020. *Pediatrics* 2021;147(1). doi:10.1542/peds.2020-027268
35. Ludvigsson JF. Children are unlikely to be the main drivers of the COVID-19 pandemic – A systematic review. *Acta Paediatr* 2020;109(8):1525-1530. doi:10.1111/apa.15371
36. Munro APS, Faust SN. COVID-19 in children: current evidence and key questions. *Curr Opin Infect Dis* 2020;33(6):540-547. doi:10.1097/qco.0000000000000690
37. Dong Y, Mo X, Hu Y, et al. Epidemiology of COVID-19 Among Children in China. *Pediatrics* 2020;145(6). doi:10.1542/peds.2020-0702
38. Zimmerman KO, Akinboyo IC, Brookhart MA, et al. Incidence and Secondary Transmission of SARS-CoV-2 Infections in Schools. *Pediatrics* 2021;147(4). doi:10.1542/peds.2020-048090
39. Castagnoli R, Votto M, Licari A, et al. Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) Infection in Children and Adolescents: A Systematic Review. *JAMA Pediatr* 2020;174(9):882-889. doi:10.1001/jamapediatrics.2020.1467
40. Salamanna F, Veronesi F, Martini L, et al. Post-COVID-19 Syndrome: The Persistent Symptoms at the Post-viral Stage of the Disease. A Systematic Review of the Current Data. *Front Med (Lausanne)* 2021;8:653516. doi:10.3389/fmed.2021.653516
41. Leeb RT, Price S, Sliwa S, et al. COVID-19 Trends Among School-Aged Children – United States, March 1-

September 19, 2020. *MMWR Morb Mortal Wkly Rep* 2020;69(39):1410-1415. doi:10.15585/mmwr.mm6939e2

42. Leidman E, Duca LM, Omura JD, et al. COVID-19 Trends Among Persons Aged 0-24 Years – United States, March 1-December 12, 2020. *MMWR Morb Mortal Wkly Rep* 2021;70(3):88-94. doi:10.15585/mmwr.mm7003e1
43. Kompaniyets L, Agathis NT, Nelson JM, et al. Underlying Medical Conditions Associated With Severe COVID-19 Illness Among Children. *JAMA Netw Open* 2021;4(6):e2111182. doi:10.1001/jamanetworkopen.2021.11182
44. Accorsi EK, Qiu X, Rumpler E, et al. How to detect and reduce potential sources of biases in studies of SARS-CoV-2 and COVID-19. *Eur J Epidemiol* 2021;36(2):179-196. doi:10.1007/s10654-021-00727-7
45. Kahn R, Kennedy-Shaffer L, Grad YH, et al. Potential Biases Arising From Epidemic Dynamics in Observational Seroprotection Studies. *Am J Epidemiol* 2021;190(2):328-335. doi:10.1093/aje/kwaa188
46. Ismail SA, Saliba V, Lopez Bernal J, et al. SARS-CoV-2 infection and transmission in educational settings: a prospective, cross-sectional analysis of infection clusters and outbreaks in England. *Lancet Infect Dis* 2021;21(3):344-353. doi:10.1016/s1473-3099(20)30882-3
47. Gandini S, Rainisio M, Iannuzzo ML, et al. A cross-sectional and prospective cohort study of the role of schools in the SARS-CoV-2 second wave in Italy. *Lancet Reg Health Eur* 2021;5:100092. doi:10.1016/j.lanepe.2021.100092
48. Mossong J, Mombaerts L, Veiber L, et al. SARS-CoV-2 transmission in educational settings during an early summer epidemic wave in Luxembourg, 2020. *BMC Infect Dis* 2021;21(1):417. doi:10.1186/s12879-021-06089-5
49. Harris DN, Zieden E, Hassig SN. The Effects of School Reopenings on COVID-19 Hospitalizations. Technical Report from the National Center for Research on Education. Accessed June 30, 2021. https://www.reachcentered.org/publications/the-effects-of-school-reopenings-on-covid-19-hospitalizations
50. Stein-Zamir C, Abramson N, Shoob H, et al. A large COVID-19 outbreak in a high school 10 days after schools' reopening, Israel, May 2020. *Euro Surveill* 2020;25(29)doi:10.2807/1560-7917.Es.2020.25.29.2001352
51. Otte Im Kampe E, Lehfeld AS, Buda S, et al. Surveillance of COVID-19 school outbreaks, Germany, March to August 2020. *Euro Surveill* 2020;25(38). doi:10.2807/1560-7917.Es.2020.25.38.2001645
52. Goldhaber D, Imberman SA, Strunk KO, et al. To What Extent Does In-Person Schooling Contribute to the Spread of COVID-19? Evidence from Michigan and Washington. 2020. CALDER Working Paper No. 247-1220-2
53. Claxton C, Levitt L, Kamal R. How many teachers are at risk of serious illness if infected with the Coronavirus? 2020. Accessed June 30, 2021. https://www.kff.org/coronavirus-covid-19/issue-brief/how-many-teachers-are-at-risk-of-serious-illness-if-infected-with-coronavirus/
54. Yung CF, Kam KQ, Nadua KD, et al. Novel Coronavirus 2019 Transmission Risk in Educational Settings. *Clin Infect Dis* 2021;72(6):1055-1058. doi:10.1093/cid/ciaa794
55. Falk A, Benda A, Falk P, et al. COVID-19 Cases and Transmission in 17 K-12 Schools – Wood County, Wisconsin, August 31-November 29, 2020. *MMWR Morb Mortal Wkly Rep* 2021;70(4):136-140. doi:10.15585/mmwr.mm7004e3
56. Kriemler S, Ulyte A, Ammann P, et al. Surveillance of Acute SARS-CoV-2 Infections in School Children and Point-Prevalence During a Time of High Community Transmission in Switzerland. *Front Pediatr* 2021;9:645577. doi:10.3389/fped.2021.645577
57. Fricchione MJ, Seo JY, Arwady MA. Data-Driven Reopening of Urban Public Education Through Chicago's Tracking of COVID-19 School Transmission. *J Public Health Manag Pract* 2021;27(3):229-232. doi:10.1097/phh.0000000000001334
58. National Centre for Immunisation Research and Surveillance. COVID-19 in schools and early childhood education and care services – the Term 3 experience in NSW. Report from National Centre for Immunisation Research and Surveillance. October 9, 2020. Accessed June 30, 2021. https://www.ncirs.org.au/sites/default/files/2020-10/COVID-19%20Transmission%20in%20educational%20settings%20in%20NSW%20Term%203%20report_0.pdf
59. Macartney K, Quinn HE, Pillsbury AJ, et al. Transmission of SARS-CoV-2 in Australian educational settings: a prospective cohort study. *Lancet Child Adolesc Health* 2020;4(11):807-816. doi:10.1016/s2352-4642(20)30251-0
60. Dub T, Erra E, Hagberg L, et al. Transmission of SARS-CoV-2 following exposure in school settings: experience from two Helsinki area exposure incident. *medRxiv* 2020. doi:10.1101/2020.07.20.20156018

61. Ehrhardt J, Ekinci A, Krehl H, et al. Transmission of SARS-CoV-2 in children aged 0 to 19 years in childcare facilities and schools after their reopening in May 2020, Baden-Württemberg, Germany. *Euro Surveill* 2020;25(36). doi:10.2807/1560-7917.Es.2020.25.36.2001587
62. Larosa E, Djuric O, Cassinadri M, et al. Secondary transmission of COVID-19 in preschool and school settings in northern Italy after their reopening in September 2020: a population-based study. *Euro Surveill* 2020;25(49). doi:10.2807/1560-7917.Es.2020.25.49.2001911
63. Murillo-Llorente MT, Perez-Bermejo M. COVID-19: Social Irresponsibility of Teenagers Towards the Second Wave in Spain. *J Epidemiol* 2020;30(10):483. doi:10.2188/jea.JE20200360
64. Russell FM, Ryan K, Snow K, et al. COVID-19 in Victorian Schools: An analysis of child-care and school outbreak data and evidence-based recommendations for opening schools and keeping them open. Report from Murdoch Children's Research Institute and the University of Melbourne September 25, 2020.
65. National Centre for Immunisation Research and Surveillance. COVID-19 in schools and early childhood education and care services-the Term 4 experience in NSW: Report from National Centre for Immunisation Research and Surveillance. March 9, 2021. Accessed June 30, 2021. https://www.ncirs.org.au/sites/default/files/2021-03/NCIRS%20NSW%20Schools%20COVID_Summary_Term%204%202020%20Report.pdf
66. Link-Gelles R, DellaGrotta AL, Molina C, et al. Limited Secondary Transmission of SARS-CoV-2 in Child Care Programs – Rhode Island, June 1-July 31, 2020. *MMWR Morb Mortal Wkly Rep* 2020;69(34):1170-1172. doi:10.15585/mmwr.mm6934e2
67. Kim C, McGee S, Khuntia S, et al. Characteristics of COVID-19 Cases and Outbreaks at Child Care Facilities – District of Columbia, July-December 2020. *MMWR Morb Mortal Wkly Rep* 2021;70(20):744-748. doi:10.15585/mmwr.mm7020a3
68. Gilliam WS, Malik AA, Shafiq M, et al. COVID-19 Transmission in US Child Care Programs. *Pediatrics* 2021;147(1). doi:10.1542/peds.2020-031971
69. Gillespie DL, Meyers LA, Lachmann M, et al. The Experience of 2 Independent Schools With In-Person Learning During the COVID-19 Pandemic. *J Sch Health* 2021;91(5):347-355. doi:10.1111/josh.13008
70. Lopez AS, Hill M, Antezano J, et al. Transmission Dynamics of COVID-19 Outbreaks Associated with Child Care Facilities – Salt Lake City, Utah, April-July 2020. *MMWR Morb Mortal Wkly Rep* 2020;69(37):1319-1323. doi:10.15585/mmwr.mm6937e3
71. Honein MA, Barrios LC, Brooks JT. Data and Policy to Guide Opening Schools Safely to Limit the Spread of SARS-CoV-2 Infection. *JAMA* 2021;325(9):823-824. doi:10.1001/jama.2021.0374
72. Honein MA, Christie A, Rose DA, et al. Summary of Guidance for Public Health Strategies to Address High Levels of Community Transmission of SARS-CoV-2 and Related Deaths, December 2020. *MMWR Morb Mortal Wkly Rep* 2020;69(49):1860-1867. doi:10.15585/mmwr.mm6949e2
73. Brandal LT, Ofitserova TS, Meijerink H, et al. Minimal transmission of SARS-CoV-2 from paediatric COVID-19 cases in primary schools, Norway, August to November 2020. *Euro Surveill* 2021;26(1). doi:10.2807/1560-7917.Es.2020.26.1.2002011
74. Hershow RB, Wu K, Lewis NM, et al. Low SARS-CoV-2 Transmission in Elementary Schools – Salt Lake County, Utah, December 3, 2020-January 31, 2021. *MMWR Morb Mortal Wkly Rep* 2021;70(12):442-448. doi:10.15585/mmwr.mm7012e3
75. Volpp KG, Kraut BH, Ghosh S, et al. Minimal SARS-CoV-2 Transmission After Implementation of a Comprehensive Mitigation Strategy at a School – New Jersey, August 20-November 27, 2020. *MMWR Morb Mortal Wkly Rep* 2021;70(11):377-381. doi:10.15585/mmwr.mm7011a2
76. Dawson P, Worrell MC, Malone S, et al. Pilot Investigation of SARS-CoV-2 Secondary Transmission in Kindergarten Through Grade 12 Schools Implementing Mitigation Strategies – St. Louis County and City of Springfield, Missouri, December 2020. *MMWR Morb Mortal Wkly Rep* 2021;70(12):449-455. doi:10.15585/mmwr.mm7012e4
77. Varma JK, Thamkittikasem J, Whittemore K, et al. COVID-19 Infections Among Students and Staff in New York City Public Schools. *Pediatrics* 2021;147(5). doi:10.1542/peds.2021-050605
78. Centers for Disease Control and Prevention. Science Brief: Community Use of Cloth Masks to Control the Spread of SARS-CoV-2. Accessed June 15, 2021. /coronavirus/2019-ncov/science/science-briefs/masking-science-sars-cov2.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-ncov%2Fmore%2Fmasking-science-sars-cov2.html
79. Gold JA, Gettings JR, Kimball A, et al. Clusters of SARS-CoV-2 Infection Among Elementary School Educators

and Students in One School District — Georgia, December 2020–January 2021. *MMWR Morb Mortal Wkly* 2021;70:289-292. doi:10.15585/mmwr.mm7008e4

80. Wong TW, Lee CK, Tam W, et al. Cluster of SARS among medical students exposed to single patient, Hong Kong. *Emerg Infect Dis* 2004;10(2):269-76. doi:10.3201/eid1002.030452
81. World Health Organization United Nations Children's Fund and United Nations Educational Scientific and Cultural Organization. Considerations for school-related public health measures in the context of COVID-19: annex to considerations in adjusting public health and social measures in the context of COVID-19. September 2020. Accessed June 30, 2021. https://apps.who.int/iris/handle/10665/334294
82. Archdiocese of Chicago Office of Catholic Schools. Reopening with Trust: A Planning Framework for the 2020/21 School Year. July 2020. Accessed June 30, 2021. https://schools.archchicago.org/documents/80540/2983414/ABRIDGED_Reopening+Planning+Framework.pdf/b451f470-68da-45e7-b591-485191cc0558
83. Doyle T, Kendrick K, Troelstrup T, et al. COVID-19 in Primary and Secondary School Settings During the First Semester of School Reopening – Florida, August-December 2020. *MMWR Morb Mortal Wkly Rep* 2021;70(12):437-441. doi:10.15585/mmwr.mm7012e2
84. Ohio Schools COVID-19 Evaluation Research Team. Ohio Schools COVID-19 Evaluation Final Report. January 2021. https://coronavirus.ohio.gov/static/responsible/schools/OSCE_evaluation.pdf
85. van den Berg P, Schechter-Perkins EM, Jack RS, et al. Effectiveness of 3 versus 6 ft of physical distancing for controlling spread of COVID-19 among primary and secondary students and staff: A retrospective, state-wide cohort study. *Clin Infect Dis* 2021. doi:10.1093/cid/ciab230
86. American Academy of Pediatrics. COVID-19 Guidance for Safe Schools. January 5, 2021. https://services.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/clinical-guidance/covid-19-planning-considerations-return-to-in-person-education-in-schools/external.
87. Bilinski A, Salomon JA, Giardina J, et al. Passing the Test: A Model-based analysis of safe school-reopening strategies. *medRxiv* 2021. doi:10.1101/2021.01.27.21250388
88. Maxim LD, Niebo R, Utell MJ. Screening tests: a review with examples. *Inhal Toxicol* 2014;26(13):811-28. doi:10.3109/08958378.2014.955932
89. Doron S, Ingalls RR, Beauchamp A, et al. Weekly SARS-CoV-2 screening of asymptomatic students and staff to guide and evaluate strategies for safer in-person learning. *medRxiv* 2021. doi:10.1101/2021.03.20.21253976
90. Vohra D, Rowan P, Goyal R, et al. Early Insights and Recommendations for Implementing a COVID-19 Antigen Testing Program in K-12 Schools: Lessons Learns from Six Pilot Studies. 2021. Oakland, CA: Mathematica. Accessed June 30, 2021. https://www.maineaap.org/assets/docs/US-K12-early-recommendations.pdf
91. Jang S, Han SH, Rhee JY. Cluster of Coronavirus Disease Associated with Fitness Dance Classes, South Korea. *Emerg Infect Dis* 2020;26(8):1917-1920. doi:10.3201/eid2608.200633
92. Bae S, Kim H, Jung TY, et al. Epidemiological Characteristics of COVID-19 Outbreak at Fitness Centers in Cheonan, Korea. *J Korean Med Sci* 2020;35(31):e288. doi:10.3346/jkms.2020.35.e288
93. Atrubin D, Wiese M, Bohinc B. An Outbreak of COVID-19 Associated with a Recreational Hockey Game – Florida, June 2020. *MMWR Morb Mortal Wkly Rep* 2020;69(41):1492-1493. doi:10.15585/mmwr.mm6941a4
94. Hamner L, Dubbel P, Capron I, et al. High SARS-CoV-2 Attack Rate Following Exposure at a Choir Practice – Skagit County, Washington, March 2020. *MMWR Morb Mortal Wkly Rep* 2020;69(19):606-610. doi:10.15585/mmwr.mm6919e6
95. Charlotte N. High Rate of SARS-CoV-2 Transmission Due to Choir Practice in France at the Beginning of the COVID-19 Pandemic. *J Voice* 2020. doi:10.1016/j.jvoice.2020.11.029
96. Buonanno G, Stabile L, Morawska L. Estimation of airborne viral emission: Quanta emission rate of SARS-CoV-2 for infection risk assessment. *Environ Int* 2020;141:105794. doi:10.1016/j.envint.2020.105794
97. Bahl P, de Silva C, Bhattacharjee S, et al. Droplets and Aerosols Generated by Singing and the Risk of Coronavirus Disease 2019 for Choirs. *Clin Infect Dis* 2021;72(10):e639-e641. doi:10.1093/cid/ciaa1241
98. Mürbe D, Kriegel M, Lange J, et al. Aerosol emission of adolescents voices during speaking, singing and shouting. *PLoS One* 2021;16(2):e0246819-e0246819. doi:10.1371/journal.pone.0246819

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