



SARS-CoV-2 Incidence and Transmission in 48 K-12 Virginia Public Schools During Community Surge

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Among 20 681 students and 4282 staff, the in-school transmission of SARS-CoV-2 appeared low during highest community spread and at 3- to 6-foot distancing. Nine of 820 school cases (1.1%) resulted in spread, with only one student-to-staff transmission. A school epidemiologist and mitigation audit teams were useful.

Key words. children; COVID-19; SARS-CoV-2; school; transmission.

School closures due to the COVID-19 pandemic have had grave effects on the mental and physical health of children, negatively impacting socialization, academics, family finances, and widening inequities [1, 2]. The risk of acquiring severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in school settings appears low [3], but there is a need to further understand transmission within schools, especially during high community spread and at physical distancing less than 6 feet. Among 20 elementary schools in Utah during community surge from December 2020 to January 2021, in-school SARS-CoV-2 spread was found to be low, but middle and high schools were not included [4]. Analysis of transmission of SARS-CoV-2 in Florida schools from August to December 2020 indicated that fewer than 1% of registered students acquired COVID-19 infection from school, however, thorough contact tracing and determination of school rates of COVID-19 infection were not available [5]. Researchers found low in-school spread in Washington and Michigan during times of low to moderate community trans-

mission, but details were lacking about mitigations used within schools that could help explain changes in transmission [6].

The following study offers a comprehensive investigation of in-school transmission in the context of a large public school district where mitigation was documented and monitored closely. Learners of all ages were in-person during a time of highest community transmission, and a novel partnership between school health staff and an epidemiologist assigned to schools allowed the rapid tracking of in-school transmission through traditional epidemiological methods. Schools utilized mitigation audit teams to optimize and monitor the layering of practical, affordable mitigation methods, including distancing of 3-6 feet.

METHODS

During the study period from September 14, 2020 to January 29, 2021, there were 20 681 students and 4282 staff who chose in-person instruction for public schools in the city of Chesapeake, VA. Reopening was instituted in a phased approach. Chesapeake Public Schools brought back their most vulnerable students first, including English learners, all students receiving significant special education services, and preK-grade 3 in the first 3 weeks. While monitoring in-school transmission, additional grades were returned every 2 weeks using a hybrid model (2 days in-person, 3 days virtual). Re-introduction of all learners was completed by November 16, 2020, with preK-grade 5 attending 5 days per week and grades 6-12 on a hybrid schedule, such that approximately 15 250 students were in buildings each day.

Chesapeake Public Schools partnered with the Chesapeake Health Department that assigned an epidemiologist to monitor, advise, collaborate, and maintain SARS-CoV-2 transmission data. The epidemiologist monitored SARS-CoV-2 transmission among city public and private schools and daycare centers. This facilitated early identification of transmission across settings where children were being supervised. School health officials investigated COVID-19 cases in the district and oversaw mitigation strategies. School-based mitigation audit teams were sent to schools unannounced when a complaint was filed by students, parents, staff, or anonymously through the district's reporting system; when in-school SARS-CoV-2 transmission occurred; and at regular intervals, no more than 3 months apart. Teams made reports based on adherence to extensive mitigations (Table 1). Surveys and focus groups were utilized to assess the perception of safety by students, families, and staff.

A COVID-19 case was defined as a positive SARS-CoV-2 reverse transcription-polymerase chain reaction (RT-PCR) test; positive SARS-CoV-2 antigen test; or a probable case based on symptoms. Contact tracing was done within the school immediately so quarantine of close contacts [7] could be aggressively

Received 18 March 2021; editorial decision 23 July 2021; accepted 26 July 2021; Published online August 26, 2021.

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Journal of the Pediatric Infectious Diseases Society 2021;XX(X):1-5

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<https://doi.org/10.1093/jpids/piab075>

Table 1. Mitigations and Strategies Used to Prevent In-School Transmission of SARS-CoV-2

Mitigation/Strategies	Implementation Details
Masking	<ul style="list-style-type: none"> • Universally required for all, unless eating 6 feet apart • Partnered with local physicians to minimize medical mask exemptions, which were tracked • KN95 masks for therapists during close contact • KN95 masks for bus aides and nutrition workers^a • Mask and face shield for staff moving between rooms^a • Face shields available for students and staff by request and for students for small group work • Spare masks available for all
Distancing	<ul style="list-style-type: none"> • Staff encouraged to distance 6 feet when indoors • Eating locations spaced 6 feet apart • 3-6 ft between desks • Desks facing one direction • Locker and mailbox use limited or discontinued • No large gatherings • Chorus and band spaced 10 ft apart
HVAC/air quality efforts	<ul style="list-style-type: none"> • Stress on HVAC systems limited door and window openings (done on case-by-case basis) • HVAC flow not increased, but systems were run for longer periods of time daily • Filter changes every 90 days, MERV 8 used per manufacturer instructions • Classes indoors, but electives allowed to be outside
Hand sanitizing	<ul style="list-style-type: none"> • Sanitizing stations strategically located (food serving/prep, restrooms, recess entrances/exits, high touch/traffic areas) • Handwashing before/after eating and recess • Soap/supplies maintained regularly • Gloves available for staff
Surface disinfection	<ul style="list-style-type: none"> • Touch points frequently disinfected • Wipes available for staff • Supplies disinfected between use
Symptom screening	<ul style="list-style-type: none"> • Temperature checks required to enter the office area • Compliance monitoring of completion of daily symptom checklists • Positive daily COVID-19 screening questions followed up by school staff
Barriers	<ul style="list-style-type: none"> • Plexiglass for separation when <6-foot distancing • Sneeze guards installed at security desks, front offices, and clinics • Isolation room established for symptomatic persons
Cohorting	<ul style="list-style-type: none"> • High school placed on 4 × 4 schedule (fewer classes) • Elementary classes strictly cohorted • Seating charts for classrooms and buses • Minimized movement of students during the day
Education	<ul style="list-style-type: none"> • Virtual community outreach to the entire district • All school staff completed virtual COVID-19 educational modules with follow-up • All school nurses trained as contact tracers • Administrators reported individuals failing to follow mitigation strategies
Asymptomatic screening for SARS-CoV-2	<ul style="list-style-type: none"> • None
Mitigation audits	<ul style="list-style-type: none"> • Regular audits performed in instructional and noninstructional settings to track compliance with all of the above

Abbreviations: HVAC, heating, ventilation and air conditioning; MERV, minimum efficiency reporting value; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

^aImplemented after a staff-to-student transmission occurred while masked.

applied as a mitigation measure. Case surveillance involved school health officials following reports of SARS-CoV-2 test results, conducting case investigation interviews, monitoring close contacts, and surveillance of symptoms to determine probable cases. When a student was excluded from in-person school due to symptoms or a positive test, other household members were also excluded. Asymptomatic COVID-19 testing was not conducted.

The study protocol was reviewed by the Eastern Virginia Medical School Institutional Review Board and determined not to involve human subjects; therefore, it was not subject to IRB approval.

RESULTS

During the study period, weekly COVID-19 incidence ranged from 40 to 563 per 100 000 persons in Chesapeake City and 4

to 465 cases per 100 000 among in-person students and staff (Figure 1). Positive SARS-CoV-2 tests in Chesapeake City ranged from 3.1% to 24.2%. Among 20 681 in-person students and 4282 in-person staff, 820 individuals were confirmed to be present in school buildings during their SARS-CoV-2 infectious period.

In-school transmission was linked to only 33 of 820 cases (4.0%), defined by 2 or more connected in-school cases including the source. Of the 820 individuals who entered the building during the infectious period, all were immediately quarantined or isolated as soon as they were recognized to have had exposure or symptoms. Of 33 staff and student COVID-19 cases connected to in-school transmission, 32 individuals agreed to testing. Results showed 16 (11 staff, 5 students) were confirmed by positive SARS-CoV-2 RT-PCR tests and 16 (12 staff, 4 students) by SARS-CoV-2 Ag tests. There were no hospitalizations

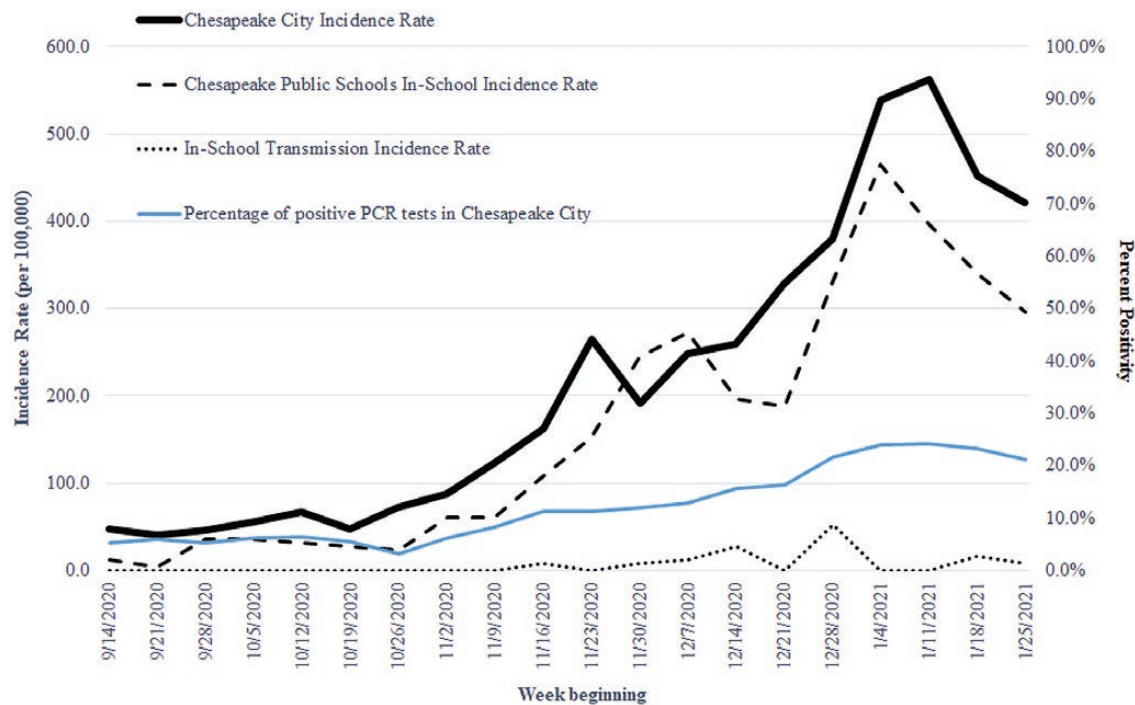


Figure 1. Chesapeake City and Chesapeake Public School associated COVID-19 incidence (cases per 100 000) and percentage of positive test results by week—September 14, 2020–January 29, 2021.

or significant morbidity among the 33 cases associated with in-school transmission, but 36 staff and 120 students were quarantined for 14 days as a result of exposure. Index cases (sources) included 7 staff and 2 students, resulting in transmission to 24 other people. Staff to staff were 66.7% (16/24) of transmissions: 20.8% (5/24) were staff-to-student, 8.3% (2/24) were student-to-student, and 4.2% (1/24) was student-to-staff transmission.

There was no spread between cohorts. One case of student-to-student transmission was thought to have occurred at 3-feet and the other at 6-feet distancing, both masked, in small learning groups within elementary cohorts. Five cases of staff-to-student transmission occurred among elementary cohorts within small groups at <3 feet, while masked. Sixteen cases of staff-to-staff transmission occurred during times of lapsed mitigation with students out of the building or at meals without masks and at less than 6 feet of distancing. Eleven of sixteen staff-to-staff transmissions were traced to a single in-school holiday party, where masking and distancing were not consistently upheld. One staff-to-staff transmission occurred while eating without distance, and possible mitigation failures with the remaining cases were unknown.

There were no cases of transmission in middle and high school students who were mostly at 6-feet distancing, with some spaced 3-6 feet. The single student-to-staff transmission was probable but not proven, while masked in a small group <3 feet without a face shield, based on timing of the infection onset.

Peak absenteeism occurred the week of December 7, 2020, when 762 staff and students were in quarantine or isolation.

Community transmission as related to the study population was more difficult to track but it was observed that mitigation methods were not consistently employed. All 820 cases entering school buildings were investigated by school health staff who determined that 76/820 (9.2%) cases were community-acquired, 490/820 (59.8%) were related to household contacts and 221/820 (27.0%) were unable to be determined. Two additional index cases within school staff support facilities led to 6 cases, but these transmissions were excluded from analysis because students do not enter these buildings. Cases totaling 289 among 19 014 virtual students and staff were monitored but are excluded from this analysis. Rising cases after November 27, 2020, over Thanksgiving break, increased school burden including staff quarantine and the need for more extensive contact tracing. Contact tracing by school staff revealed these cases were all associated with travel and informal gatherings. In-school transmission did not surge, but all students were placed into virtual learning for 2 weeks following a scheduled break to prevent a repeated increase of school burden. Of all cases among in-person staff and students during the study period, 42% (345/820) occurred from December 21, 2020 to January 17, 2021, while students were not in buildings. No additional information was available on mitigation strategies used among students and staff when outside school. The temporary use of virtual instruction served to keep cases out of schools

during a community surge when staff and students were anticipated to experience decreased mitigation due to increased community exposure as a result of holiday activities. Peak incidence of positive staff and student cases occurred the week of January 4, 2021 with 171 reported cases, but most never entered schools due to extended virtual instruction.

During peak community case incidence, contact tracing for the community was burdensome for the health department. Of note, the school epidemiologist and school nurses were able to complete contact tracing for school cases 3-5 days earlier than the health department.

Despite widespread community spread, a district survey of parents, students, and staff received 4700 responses with 75% stating that they agreed or strongly agreed with the statement “I <or my child> feel/s safe at school,” and focus groups of 200 stakeholders found that most individuals felt safe in buildings.

DISCUSSION

In-school transmission appeared low among these 29 elementary, 10 middle, 7 high schools, and 2 career and alternative centers. Of 820 cases during the study period, 9 (1.1%) resulted in a transmission, with only 1 student-to-staff transmission. Cases resulting from an in-school source represented 2.9% of total cases (24/820), and the incidence rate was lower in schools than the community. Our findings correspond to other studies including Falk et al [8] who found 3.7% of school cases in Wood County, WI resulted from in-school transmission, and aligns well with van den Berg et al [9] who found no difference in incidence between 3- and 6-foot distancing in Massachusetts’ schools. Furthermore, mitigation audits revealed that most transmission occurred when adults’ face coverings were absent, as appreciated elsewhere [10]. The two cases of student-to-student transmission did occur with masking, but these were the only two mitigation failures among students leading to spread in a population of 20 681 students and 4282 staff, a very low rate. Additionally, to our knowledge, this is the first school system to report partnership with an epidemiologist. This novel model increased the speed of contact tracing during times of highest community transmission which may have decreased in-school transmission as exposed students and staff were able to be quarantined quickly.

Audits led to implementation of new measures, including the utilization of face shields with masks when >3 ft distancing was not possible such as during physical therapy, occupational and speech therapy, and small groups. At the time of the study, vaccination for school staff was not available. Our findings imply that at distances <3 ft, it may be prudent to use face shields for unvaccinated adults.

Interestingly, over half of the identified cases in our study population were traced back to household transmission. This indicates that the prompt quarantining of siblings of students

confirmed or suspected to be infected with SARS-CoV-2 may be prudent to decreasing cases in schools.

If children were present in schools with asymptomatic SARS-CoV-2 infection, evidence that students spread infection to others was lacking. School case incidence mirrored community incidence (Figure 1), which is consistent with data indicating that schools do not contribute significantly to transmission of SARS-CoV-2 in a community in the absence of complete societal shutdown[11]. The majority of cases (99%) entering schools were linked to community activities out of school with likely suboptimal mitigation despite a statewide mandated mask policy in effect. Schools may actually offer mitigation for a community, especially during high levels of SARS-CoV-2 spread and when children and staff are in non-mitigated settings elsewhere.

Our report had several limitations. First, there was no routine screening within schools to determine the prevalence of asymptomatic spread. However, there were no apparent large outbreak clusters, continual transmission chains, or significant student-to-staff spread, which supported previous findings that asymptomatic spread in school settings is minimal [12, 13]. Second, genomic sequencing was not available so connected cases were determined through contact tracing alone. Third, it was unknown which mitigation measure was most beneficial given the diversity of school buildings, ventilation, and physical distancing, but audits indicated that masking was key. Fourth, the study period included time when students were not physically present in the building consisting of 2 weeks of winter break and 2 weeks of virtual learning. However, inclusion of this time in the analysis was necessary to account for possible transmission during the 14-day incubation period of SARS-CoV-2; also, there were 66 cases in staff who were working in buildings during the virtual period and were followed for transmission.

Community metrics were initially used to inform school re-openings, but monitoring in-school transmission and school burden can be used to keep schools open [14, 15]. Low in-school transmission is facilitated by extensive planning, execution, and auditing of multiple mitigation strategies to create safe in-person instruction. Partnership with a school epidemiologist, on-site rapid contact tracing by school nurses, and mitigation audits offer extra protective layers to reduce in-school transmission. This study provides a model for maintaining the safety of school opening through mitigation methods during the COVID-19 pandemic.

Notes

Acknowledgments. Muge Akpınar-Elci, MD, MPH; Michele A. Kekeh, PhD; Martin Klinkhammer, MD, MPH; and Turaj Vazifedan, MS assisted in the preparation of this manuscript. The school nurses and clinic assistants of Chesapeake Public Schools dedicated countless hours promoting the health and safety of the students and staff, making school reopening possible.

Financial support. The authors received no financial support for the research, authorship, and/or publication of this article.

Potential conflicts of interest. All authors: No reported conflicts. All authors have submitted the ICMJE Form for Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

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