SARS-CoV-2 transmission in a Georgia school district — United States, December 2020–January 2021

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Summary: We assessed SARS-CoV-2 transmission in a Georgia school district using in-depth epidemiologic investigations and whole-genome sequencing. In-school transmission occurred primarily when the index case was from an indoor sports setting, was a staff member, or had symptoms.

Abstract

Background: To inform prevention strategies, we assessed the extent of SARS-CoV-2 transmission and settings in which transmission occurred in a Georgia public school district.

Methods: During December 1, 2020–January 22, 2021, SARS-CoV-2–infected index cases and their close contacts in schools were identified by school and public health officials. For in-school contacts, we assessed symptoms and offered SARS-CoV-2 RT-PCR testing; performed epidemiologic investigations and whole-genome sequencing to identify in-school transmission; and calculated secondary attack rate (SAR) by school setting (e.g., sports, elementary school classroom), index case role (i.e., staff, student), and index case symptomatic status.

Results: We identified 86 index cases and 1,119 contacts, 688 (63.1%) of whom received testing. Fifty-nine (8.7%) of 679 contacts tested positive; 15 (17.4%) of 86 index cases resulted in ≥2 positive contacts. Among 55 persons testing positive with available symptom data, 31 (56.4%) were asymptomatic. Highest SAR were in indoor, high-contact sports settings (23.8%, 95% confidence interval [CI] 12.7, 33.3), staff meetings/lunches (18.2%, CI 4.5–31.8), and elementary school classrooms (9.5%, CI 6.5–12.5). SAR was higher for staff (13.1%, CI 9.0–17.2) versus student index cases (5.8%, CI 3.6–8.0) and for symptomatic (10.9%, CI 8.1–13.9) versus asymptomatic index cases (3.0%, CI 1.0–5.5).

Conclusions: Indoor sports may pose a risk to the safe operation of in-person learning. Preventing infection in staff members, through measures that include COVID-19 vaccination, is critical to reducing in-school transmission. Because many positive contacts were asymptomatic, contact tracing should be paired with testing, regardless of symptoms.

Key words: SARS-CoV-2, COVID-19, schools, infection control, physical distancing

Introduction

The coronavirus disease 2019 (COVID-19) pandemic, caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has triggered worldwide school closures. As U.S. schools now expand in-person learning options, detailed assessments of in-school SARS-CoV-2 transmission in multiple contexts are needed to inform mitigation measures and improve safety. Because many people, particularly children [1], experience mild or no symptoms following SARS-CoV-2 infection, investigations of in-school transmission require detailed contact tracing paired with comprehensive SARS-CoV-2 testing [2, 3]. During December 1, 2020–January 22, 2021, we investigated in-school SARS-CoV-2 transmission in a Georgia public-school district. We quantified in-school transmission among students and staff in several school settings (e.g., classroom, buses, and sports) and performed network analyses of transmission clusters using data from detailed epidemiologic assessments and whole-genome sequencing (WGS).

Methods

Setting

The public-school district is located in the Atlanta metropolitan area and includes eight elementary schools (kindergarten–5th grade), two middle schools (6th–8th grade), and one high school (9th–12th grade). The district serves approximately 8,500 students and employs approximately 1,400 staff members. The student body is racially, ethnically, and socioeconomically diverse; 38% of students are Hispanic, 36% are non-Hispanic Black, 20% are non-Hispanic White, and 60% qualify for the free or reduced meal program.

During the investigation period (December 1, 2020–January 22, 2021), in-person instruction was provided Monday–Thursday (only virtual learning/tutoring was available on Fridays), and students of any grade level could attend school fully in person or fully virtually

those 4 days, based on parent/guardian preference. Approximately 5,300 students attended school in person during the investigation period; attendance rates varied among schools and by school level: 63–89% in elementary schools (average class size = 17), 39–66% in middle schools (average class size = 14), and 32% in the high school (average class size = 7).

Prevention measures implemented to reduce the spread of SARS-CoV-2 in the school district included mandatory mask use on campus (except during indoor or outdoor sports participation). Physical distancing was implemented where possible; in general, distance between student desks was 3–6 feet in the middle and high schools but was <3 feet in the elementary school classrooms due to higher attendance rates. Prevention measures also included three-sided plastic shields on all desks, hand hygiene promotion, increased frequency of facility cleaning and disinfection, advising community members to perform self-screening for symptoms and remain home if symptomatic, and contact tracing for staff or students who tested positive for SARS-CoV-2 infection. Measures to improve ventilation, including opening windows in classrooms and buses, were implemented where possible; for heating, ventilation, and air conditioning (HVAC) systems in all school buildings, outside air intake was increased from 15% to 30%, HVAC filters were increased from a minimum efficiency reporting value (MERV) of 5 to MERV 10, and ionization devices were installed in air handlers.

The investigation period included a 16-day holiday (December 19, 2020–January 3, 2021). Local county COVID-19 incidence (7-day cumulative number of new cases per 100,000 persons) increased from 192 (December 1, 2020) to a peak of 705 (January 13, 2021) cases.

School case and contact definitions

A case was defined as a K–12 student or staff member (e.g., teacher, paraprofessional, bus driver, administrator) who attended school in person within ≤2 days before testing positive for SARS-CoV-2 infection by reverse-transcriptase polymerase chain reaction (RT-PCR) or antigen, or from symptom onset; an index case was the first identified case within a given group of exposed students or staff in one or more settings (e.g. classroom, bus, sports team). Close contacts (contacts) were defined as persons exposed to an index case at school (within six feet for longer than 15 minutes cumulatively over a 24-hour period) during the index case's infectious period (48 hours before to 10 days after symptom onset or specimen collection, if asymptomatic).

Investigation Procedures

Index cases were either self-reported to the school or identified by local public health officials through laboratory results received by Georgia Department of Public Health (GDPH). Local public health officials performed investigations of cases to obtain information regarding demographics, symptoms, and contacts. School officials identified contacts based on classroom and bus seating charts and interviews with index cases and staff members. School officials attempted to reach all contacts on the same day the school was notified of the index case's test results and advised contacts to quarantine (if asymptomatic) or isolate (if symptomatic or tested positive) based on local public health guidance [4].

During the investigation period, project staff contacted school contacts to obtain verbal consent (from parents/guardians of persons aged <18 years) to participate in the investigation, offer SARS-CoV-2 RT-PCR testing, and collect symptom information at the time of testing. Project staff also monitored symptoms for 14 days through daily text-message based symptom monitoring [5] after the last date of their in-school exposure. SARS-CoV-2

RT-PCR testing was performed on anterior nasal swabs collected by investigators within 5–10 days after the last in-school exposure, or sooner if a contact reported symptoms, based on modified state quarantine recommendations [4]. For contacts who tested positive, we offered testing to their household members.

Investigation inclusion and exclusion criteria

To be considered a school-associated positive contact, the positive contact could not have known community or household exposure to anyone with confirmed SARS-CoV-2 infection in the two weeks before testing positive, including with the index case outside of school. WGS results, if available, were used to determine similarities between isolates from index cases and their contacts and assess likelihood of in-school transmission. We excluded from analyses contacts who were not tested within 10 days after their in-school exposure and contacts with positive tests results whose infections were likely acquired outside of school (based on epidemiologic or WGS data). If a contact was tested before the recommended 5th day after exposure [4] and the test result was negative, the test result was excluded for the purposes of calculating the secondary attack rate (SAR).

Laboratory Methods:

SARS-CoV-2 RT-PCR testing was performed at Georgia Public Health Laboratory using the PerkinElmer® New Coronavirus Nucleic Acid Detection Kit (Extraction using PerkinElmer®Chemagic^{TM} 360, RT-PCR using Applied Biosystems^{TM}PCR-7500 Fast Dx) under an FDA emergency use authorization. Sixty-nine available specimens with <32 cycle threshold (Ct) vales by RT-PCR from index cases (n = 11), positive contacts (n = 38), and family members (n = 20) were sent to CDC for WGS. Extracted nucleic acid was subjected to Illumina MiSeq sequencing following previously published protocols [6]. Consensus sequences were generated with Minimap2 2.17 [7] and Samtools 1.9 [8]. Phylogenetic

relations were inferred through approximate maximum likelihood analyses implemented in TreeTime [9] using the NextStrain pipeline [10]. All full genome sequences from the state of Georgia and representative sequences for the US were downloaded from GISAID on February 25, 2021. PANGO lineage for study sequences was assigned on March 2, 2021 [11].

Data Analysis

We described the demographic characteristics of index cases, negative contacts, and positive contacts. We examined the proportion of positive contacts with any symptoms by age, and whether their symptoms met the Council of State and Territorial Epidemiologists (CSTE) case definition for COVID-19 [12].

Using the number of contacts tested in each scenario as the denominator, we calculated SAR by setting (i.e., classroom, bus, indoor sports [basketball, wrestling, cheerleader], staff interactions), index case role (i.e., student, staff), symptom status of index case (i.e., presence versus absence of any symptoms), and month of exposure. Contacts exposed concurrently to >1 index case in the same setting (e.g., a particular classroom) were counted only once. Otherwise, contacts exposed concurrently to >1 index case in multiple settings are counted for each exposure (e.g., included in the SAR for both bus and classroom). SAR estimates and bias-corrected and accelerated bootstrap 95% confidence intervals [13] (CI) were constructed by taking 9,999 samples with replacement using the R package *confintr* (*v0.1.1*; Mayer, 2020).

We displayed clusters, defined as an episode in which an index case was epidemiologically linked with ≥2 positive contacts in school, using MicrobeTrace (version 0.6.1) [14] to visualize transmission patterns among index cases, positive contacts, and household members who tested positive on or after the positive contact's test date. We used

case investigation details to determine epidemiologic links and possible direction of transmission and used WGS to assess relatedness of isolates.

We performed analyses using R statistical software (version 3.6.3; The R Foundation) and SAS (version 9.4; SAS Institute, Cary, North Carolina). This activity was reviewed by CDC, CDPH, and GDPH, and was conducted consistent with applicable Georgia law, federal law, and CDC policy.* A description of in-school transmission clusters in this school district's elementary schools was previously published [15].

Results

Index case and contact characteristics

Of 98 index cases identified during the investigation period, 86 were included in the analysis, including 33 (38.4%) staff and 53 (61.6%) students; 12 index cases were excluded because their associated contacts were not reached for interviews or testing within the 10-day window (**Figure 1**). The remaining 86 index cases generated 1,119 contacts, including 112 staff and 1,007 student contacts. The median number of contacts identified per index case was 14 (interquartile range 5.0–19.0).

In total, 688 (63.1%) contacts received testing for SARS-CoV-2; reasons for not testing and counts for unique persons are included in **Figure 1**. Among contacts tested, 620 (91.3%) tested negative (70 staff contacts [89.7%], 550 student contacts [90.4%]) and 68 tested positive (8 staff contacts [10.3%], 60 student contacts [9.8%]). Nine positive contacts (all students) who had known exposures to persons with SARS-CoV-2 infection outside of school were excluded. In total, 59 positive contacts (87.3%) [8 staff, 51 students] met criteria for inclusion. Among the 114 household members of 40 positive contacts who agreed to be

tested, 32 (28.1%) tested positive. Demographic features of index cases, positive contacts, and negative contacts are displayed at the level of unique persons in **Table 1**.

Symptoms of positive students and staff

Symptom data was available for 55 persons [6 staff, 49 students] that tested positive; 24 (43.6%) (five staff cases [83.3%], 19 student cases [38.8%]) reported symptoms, and 20 (36.4%) (three staff [50.0%], 17 students [34.7%]) reported symptoms meeting the CSTE COVID-19 case definition.

Transmission events and attack rate by setting, index case role, symptom status, and month of exposure.

Overall, 24 (27.9%) index cases were associated with ≥1 positive contact and 15 (17.4%) were associated with ≥2 positive contacts (**Table 2/Supplementary Figure 1**). The overall SAR was 8.7% (95% CI: 6.8–10.9). When stratified by exposure setting, SAR was highest in indoor sports settings (including basketball, wrestling, and cheerleading) (23.8%, 12.7–33.3), interactions among staff (e.g., group lunches, staff meetings) (18.2%, 4.5–31.8), and in elementary school classrooms (9.5%, 6.5–12.5). SAR was higher for staff index cases (13.1%, 9.0–17.2) compared with student index cases (5.8%, 3.6–8.0), driven by the elementary school setting where staff index cases had an SAR of 15.0% (10.2–19.8) compared with student index cases (2.7%, 0.7–5.3). SAR was higher when the index case was symptomatic (10.9%, 8.1–13.9) versus asymptomatic (3.0%, 1.0–5.5). When stratified by index case role and symptom status, asymptomatic student index cases had the lowest SAR (2.3%, 0.6–4.6). In December 2020, the SAR was 13.6% (9.8–17.5) compared with 5.1% (3.1–7.4) in January 2021.

Within the high school setting, 15 (93.7%) positive contacts among students were associated with sports. In the non-sports settings for all grade levels (K–12), most positive staff contacts (87.5%) and positive student contacts (72.2%) were attributed to a staff index case.

Cluster descriptions

Based on epidemiologic evidence and WGS, we identified 14 clusters, including eight clusters involving elementary school classrooms, three involving middle school classrooms, and three involving high school close-contact indoor sports (**Figure 2**). Clusters ranged in size from 3–17 persons (including the 26 household members of positive contacts in 9 clusters). Inadequate mask use in specific instances and distancing <3 feet among students and teachers in elementary schools may have facilitated transmission events.

WGS supported epidemiologic evidence of common source of infection in seven clusters (all strains within clusters differed by <3 single nucleotide polymorphisms) (**Supplementary Figure 2a–c**); the remaining clusters were not confirmed with WGS because samples were not available or were not sequenced.

SARS-CoV-2 Variants

Of 69 samples sequenced, the majority were in Nextstrain clade 20G (74%) and PANGO lineage B.1.2 (72%) (**Supplementary Figure 3**). The highly transmissible variant of SARS-CoV-2, B.1.1.7, and other variants of concern, were not detected; the distribution of lineages was similar to the distribution found in the state of Georgia.

Discussion

In this comprehensive prospective investigation of SARS-CoV-2 transmission in a Georgia school district, which was conducted during a period of peak community COVID-19 incidence, 9% of contacts exposed to a COVID-19 index case were found to be positive, with the highest SAR identified in the setting of indoor sports (24%) and staff interactions (18%). In-school transmission seen in this investigation was higher than reported in recent studies from those in the United States and abroad where mitigation measures were strictly followed [16-22]. In particular, a higher SAR was observed in elementary school classrooms (9%) compared with high school classrooms (2%), with staff index cases having a higher SAR than student index cases.

The relatively high SAR identified in this school district might be related to the prominent role of staff in transmission events. Staff were overrepresented among index cases; while they made up approximately 20% of persons attending school in person, they accounted for nearly 40% of cases. SAR was more than twice as high when a staff index case was involved compared with a student index case; and most positive student and staff contacts in non-sports settings likely acquired SARS-CoV-2 from exposure to a staff member. Our findings add to a growing body of research [20, 23, 24] suggesting that staff play a central role in transmission in schools. This may, in part, be because adults are more likely to be symptomatic, and having symptoms is associated with a higher risk of transmission both in this investigation and others [25, 26].

Preventing SARS-CoV-2 infections in staff is a critical component to reducing in-school transmission and minimizing interruptions to in-person learning. Actions needed to prevent SARS-CoV-2 infections in staff include use of personal protection (e.g., a well-fitting mask) in the workplace and in the community, administrative measures (e.g., minimizing

nonessential in-person meetings and informal gatherings, ensuring adequate sick leave policies to prevent coming to school with symptoms), environmental changes (e.g., minimizing the use of shared office space and shared tables in break rooms), and increasing awareness among staff about the risk of acquiring COVID-19 from other staff members and the community outside of school [3]. COVID-19 vaccinations for staff are an important additional measure; vaccines, which are highly effective at preventing severe illness, may also reduce risk in school transmission through reduction in asymptomatic infection [15, 27]. During the investigation, the school district implemented many of these measures to prevent infection among staff. Written communication and virtual in-services during mid-December and early January were used to educate staff on the risk of transmission among adults. In January, staff were no longer required to be in school buildings on Fridays for lesson planning. In mid-January, desk spacing was optimized to allow ≥3 feet of space among students in elementary schools, and changes were made to increase distancing during small group and rug time in elementary schools. These factors, along with one particularly large cluster in December, which contributed to the higher SAR in December, might partially explain the observed decrease in in-school transmission rates from December 2020 (13%) to January 2021 (5%).

Our finding that the in-school SAR was lower in high school classrooms than for elementary school classrooms contrasts with other published studies [28, 29] but could be related to the relatively low in-person attendance in the school district's high school compared with elementary schools and differences in the student-educator dynamics needed to meet the educational needs of young children [15]. There were more students per class in the elementary school than in the high school, and elementary school students may require closer and more frequent small group interactions with educators and support staff than do older students [15]. Additionally, young children with behavioral or emotional challenges

may struggle with mask compliance [17]. Schools should maximize available space, especially during mealtimes, and layering other prevention strategies, such as reinforcing universal and correct use of masks, cohorting students when possible, frequent handwashing, respiratory etiquette, and staying home when ill [30].

We might have identified higher rates of transmission in this school district compared with certain other studies [16, 17] because of our comprehensive testing protocol, as well as differences in local community disease dynamics and school prevention strategy implementation. As more than half of positive cases were asymptomatic, many positive contacts might have been missed if testing had been triggered only by the presence of symptoms, particularly in students. This finding emphasizes the importance of testing contacts, regardless of symptoms, to identify SARS-CoV-2 infections and stop transmission through early isolation of positive contacts.

Consistent with previous reports, indoor high-contact sports occurring outside of in-person learning were the major setting of SARS-CoV-2 transmission for high school students [31-33]. Most positive high school student contacts and all high school clusters were associated with indoor, high-contact sports rather than high school classrooms, where in-person attendance was low. Although high school athletics programs are highly valued in communities throughout the nation, officials should carefully weigh the benefits of these programs against the potential risk they pose to the safe operation of in-person learning [31].

This report has several limitations. Because adults with SARS-CoV-2 infection are more likely to exhibit symptoms [1] and therefore be tested, they might be more likely to be identified as an index case. This may bias our investigation towards under-detection of student-to-student and student-to-staff transmission events. To assess this bias, we conducted a sensitivity analysis for SAR calculations by re-assigning the index case from a staff

member to a student in four situations where the index case might have been a person in either role, or when there might have been two simultaneous introductions of infection. Even with this recategorization, our analyses still suggested a predominant role of staff in school transmission events (data not shown). Despite the use of in-depth epidemiologic investigation and WGS, it is challenging to definitively determine whether a person became infected in school versus the community and to know from which index case a positive contact might have become infected in settings with >1 index case. These challenges are compounded when local community is high. Over 35% of contacts identified did not get tested, so our investigation might over- or underestimate in-school transmission rates if the contacts who refused testing differed systematically from those who participated. Our findings of low transmission rates in high school classrooms might not be generalizable to settings with high in-person high school attendance rates. Finally, we were not able to assess the impact of ventilation on transmission because ventilation changes were universally applied across all school district buildings.

Nonetheless, our investigation's strength lies with the pairing of contact investigations with systematic testing and detailed epidemiologic and laboratory assessments of transmission. We identified key areas of focus for prevention of SARS-CoV-2 transmission in schools. Maintaining a safer in-person learning environment will require community, state, and nationwide efforts and policies to keep schools operational.

Footnote:

***** 45 C.F.R. part 46, 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.

NOTES

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Table 1: Demographic features of K–12 staff and students[a] participating in an investigation of SARS-CoV-2 transmission in a Georgia school district — United States, December 1, 2020–January 22, 2021[b]

	Staff			Students		
	Index Cases[c]	Negative Contacts	Positive Contacts	Index Cases[c]	Negative Contacts	Positive Contacts
	N=33	N=71	N=8	N=53	N=515	N=51
School level	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Elementary	20 (60.6)	41 (57.7)	6 (75.0)	27 (50.9)	325 (63.1)	30 (58.8)
Middle	3 (9.1)	14 (19.7)	1 (12.5)	14 (26.4)	105 (20.4)	5 (9.8)
High	4 (12.1)	11 (15.5)	1 (12.5)	12 (22.6)	85 (16.5)	16 (31.4)
District-level staff	6 (18.2)	5 (7.0)	0 (0.0)	n/a	n/a	n/a
Age (years)						
Median (IQR)	40.5 (29.5, 50.5)	38.5 (29.2 49.7)	38.5 (35, 48)	10.0 (9.0, 14.0)	11.5 (7.7, 15.2)	11.0 (7.0, 14.5)
Range	23–76	20–69	34–61	5–18	5–18+	5–18
Unknown	1 (3.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Gender						
Male	5 (15.2)	11 (15.5)	1 (12.5)	36 (67.9)	280 (54.4)	32 (62.7)
Female	28 (84.9)	60 (84.5)	7 (87.5)	16 (30.2)	233 (45.2)	19 (37.3)
Gender non-conforming/Unknown	0 (0)	0 (0.0)	0 (0)	1 (1.9)	2 (0.4)	0 (0)
Race/ethnicity						
NH White	20 (60.6)	41 (57.7)	3 (37.5)	9 (17.0)	109 (21.2)	9 (18.5)
NH Black	8 (24.2)	24 (33.8)	0 (0.0)	15 (28.3)	139 (27.0)	19 (37.0)
Hispanic or Latin[d]	4 (12.1)	5 (7.0)	3 (37.5)	27 (50.9)	248 (48.2)	18 (35.2)
NH multiracial	1 (3.0)	0 (0.0)	0 (0.0)	0 (0.0)	7 (1.4)	1 (1.9)
NH Asian	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	5 (0.4)	0 (0.0)
Other/Unknown[e]	0 (0.0)	1 (1.4)	2 (25.0)	2 (3.8)	7 (1.4)	4 (7.4)

Abbreviations: IQR = interquartile range, NH = non-Hispanic

[a] Data in this table represent unique persons. If a person was identified as a contact more than once during the investigation (i.e., they were exposed to >1 index case), they are represented only once within the negative or positive contact columns.

[b] Data are n (%), unless otherwise specified

[c] Includes 10 persons who were identified as contacts who tested positive and subsequently exposed other persons in school.

[d] Persons of Hispanic or Latin ethnicity might be of any race. Persons are classified in only 1 race/ethnicity category

[e] 14 (2.2%) persons who were contacts were missing race/ethnicity data.

Table 2: Secondary attack rate[a] for contacts[b] exposed to COVID-19 index cases (N = 86) in school by exposure setting, index case role, index case symptom status, month of study at 12 schools in a school district — Georgia, United States, December 1, 2020–January 22, 2021

	Index Cases	Contacts	Median contacts (IQR)	Contacts Tested	Positive Contacts	Secondary Attack Rate (95% CI)	Exposures with ≥1 positive contact	Exposures with ≥2 positive contacts
Exposure Setting								
Elementary School Classroom	42	563	15.0 (10.0, 18.0)	337	32	9.5 (6.5, 12.5)	13	9
Middle School Classroom	15	126	8.0 (4.5, 10.5)	84	5	6.0 (1.2, 10.7)	3	1
High School Classroom	10	98	9.5 (4.2, 10.8)	64	1	1.6 (0.0, 4.7)	1	0
Sports[c]	7	94	15.0 (10.5, 17.0)	63	15	23.8 (12.7, 33.3)	4	3
Extracurricular[d]	4	5	1.0 (1.0, 1.2)	5	0	n/a	0	0
School Bus	21	189	7.0 (5.0, 12.0)	97	2	2.1 (0.0, 5.2)	2	0
Staff Interactions	9	24	3.0 (1.0, 4.0)	22	4	18.2 (4.5, 31.8)	4	0
Index Case Role								
Staff	33	421	16.0 (3.0, 19.0)	268	35	13.1 (9.0, 17.2)	15	9
Staff in elementary classrooms	17	296	18.0 (16.0, 19.0)	187	28	15.0 (10.2, 19.8)	10	8
Student	53	689	13.5 (8.0, 17.0)	411	24	5.8 (3.6, 8.0)	9	6
Students in elementary classrooms	25	267	12.0 (7.0, 15.0)	150	4	2.7 (0.7, 5.3)	3	1
Index Case Symptom Status[e]								
Any symptoms Total	58	734	13.5 (7.0, 18.0)	467	51	10.9 (8.1, 13.9)	19	12
Asymptomatic Total	24	346	16.0 (8.5, 20.0)	200	6	3.0 (1.0, 5.5)	4	2
Any symptoms Staff	27	379	17.0 (4.0, 20.0)	241	33	13.7 (9.1, 17.8)	13	9
Asymptomatic Staff	4	39	10.0 (2.7, 17.0)	25	2	8.0 (0.0, 20.0)	2	0
Any symptoms Student	31	355	10.0 (7.0, 15.5)	226	18	8.0 (4.4, 11.5)	6	3
Asymptomatic Student	20	307	16.0 (10.0, 21.5)	175	4	2.3 (0.6, 4.6)	2	2
Month of exposure								
December	39	539	15.0 (8.5, 18.5)	286	39	13.6 (9.8, 17.5)	12	9
January	47	571	13.0 (4.0, 18.5)	393	20	5.1 (3.1, 7.4)	12	6
Overall	**86**	**1,110**	**14.0 (5.0, 19.0)**	**679**	**59**	**8.7 (6.8, 10.9)**	**24**	**15**

Abbreviation: CI = confidence interval; IQR = interquartile range

[a] Secondary attack rate (SAR) was calculated as the number of contacts testing positive divided by the number who received testing. Index cases can appear more than once in this table and in SAR calculations if they exposed contacts in more than one setting. Contacts exposed concurrently to >1 index case in the same setting (e.g., a particular classroom) were counted only once. Otherwise, contacts exposed concurrently to >1 index case in multiple settings are counted for each exposure (e.g. included in the SAR for both bus and classroom).

[b] Among 1,110 contacts, 1,099 (99.0%) had data available regarding exposure setting, 100% for index case role, 1,104 (99.5%) for symptom status of the index case, and 100% for month of study. Nine contacts were excluded because household transmission was likely.

[c] Sports included basketball, wrestling, and cheerleading within the middle and high schools.

[d] Extracurricular activities included a play, driver's education, and sports-related meetings (not practice or game)

[e] 24 contacts exposed concurrently to >1 index case with discordant index case symptom status excluded.

FIGURE LEGENDS

Figure 1: K–12 staff and student participation in an investigation of SARS-CoV-2 transmission in a Georgia school district — United States, December 1, 2020–January 22, 2021

[a] Index cases were excluded because contacts could not be reached until greater than ten days after exposure.

[b] Contacts were excluded because they could not be reached (30%), refused testing (67%), or were tested greater than 10 days after their exposure date (3%).

[c] These contacts were students who were excluded from analyses because they likely acquired SARS-CoV-2 from household members.

Figure 2: SARS-CoV-2 Transmission Clusters (n=15) in a K–12 School District—Georgia, United States, December 1, 2020–January 22, 2021.

A cluster was defined as an episode in which an index case was epidemiologically linked with ≥2 positive contacts in school. The presence of two red shapes within a cluster indicates that two persons might have introduced SARS-CoV-2 infection into the setting at the same time; the index case identified by school officials are indicated by an asterisk. Links in cluster B and I without arrows indicate genetic links between these two cases but does not suggest that transmission occurred between these two cases.

Figure 1

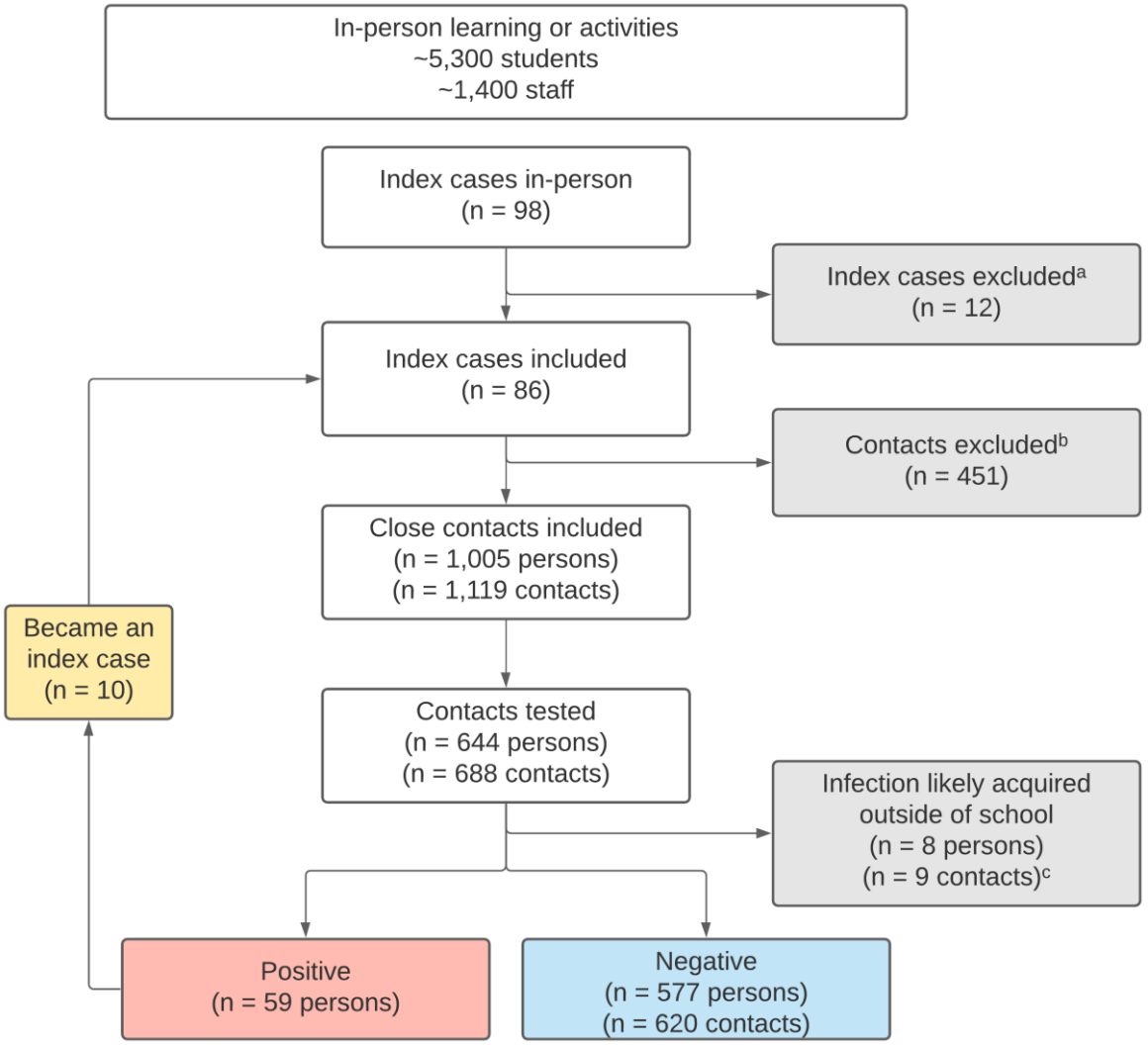
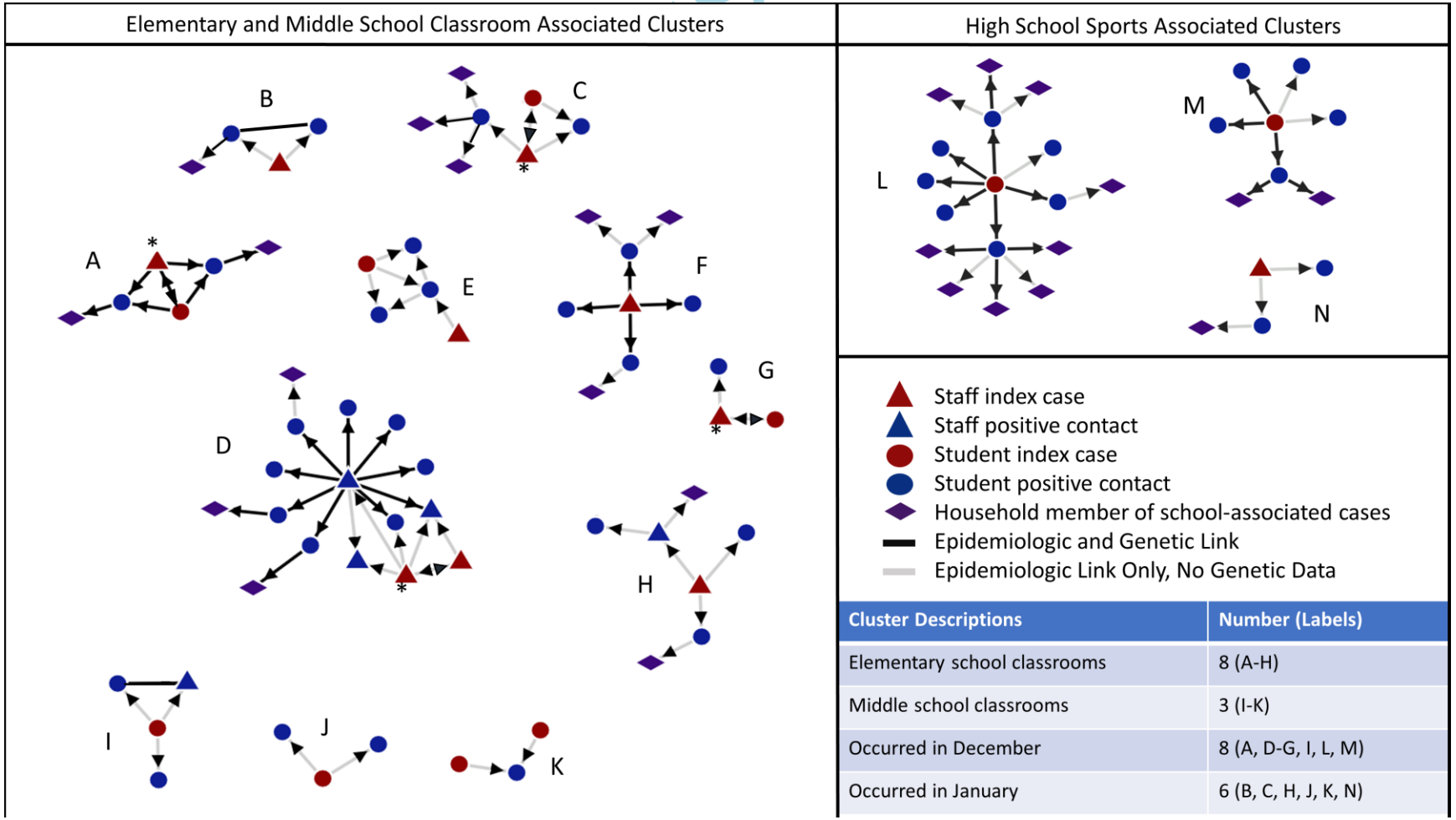

In-person learning or activities
~5,300 students
~1,400 staff
Index cases in-person
(n = 98)
Index cases excluded[a]
(n = 12)
Index cases included
(n = 86)
Contacts excluded[b]
(n = 451)
Close contacts included
(n = 1,005 persons)
(n = 1,119 contacts)
Became an index case
(n = 10)
Contacts tested
(n = 644 persons)
(n = 688 contacts)
Infection likely acquired outside of school
(n = 8 persons)
(n = 9 contacts)[c]
Positive
(n = 59 persons)
Negative
(n = 577 persons)
(n = 620 contacts)

Figure 2



Cluster Descriptions	Number (Labels)
Elementary school classrooms	8 (A-H)
Middle school classrooms	3 (I-K)
Occurred in December	8 (A, D-G, I, L, M)
Occurred in January	6 (B, C, H, J, K, N)