COVID-19 Infections Among Students and Staff in New York City Public Schools

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abstract

BACKGROUND: The 2019 novel coronavirus disease (COVID-19) pandemic led many jurisdictions to close in-person school instruction.

METHODS: We collected data about COVID-19 cases associated with New York City (NYC) public schools from polymerase chain reaction testing performed in each school on a sample of asymptomatic students and staff and from routine reporting. We compared prevalence from testing done in schools to community prevalence estimates from statistical models. We compared cumulative incidence for school-associated cases to all cases reported to the city. School-based contacts were monitored to estimate the secondary attack rate and possible direction of transmission.

RESULTS: To assess prevalence, we analyzed data from 234 132 persons tested for severe acute respiratory syndrome coronavirus 2 infection in 1594 NYC public schools during October 9 to December 18, 2020; 986 (0.4%) tested positive. COVID-19 prevalence in schools was similar to or less than estimates of prevalence in the community for all weeks. To assess cumulative incidence, we analyzed data for 2231 COVID-19 cases that occurred in students and staff compared with the 86 576 persons in NYC diagnosed with COVID-19 during the same period; the overall incidence was lower for persons in public schools compared with the general community. Of 36 423 school-based close contacts, 191 (0.5%) subsequently tested positive for COVID-19; the likely index case was an adult for 78.0% of secondary cases.

CONCLUSIONS: We found that in-person learning in NYC public schools was not associated with increased prevalence or incidence overall of COVID-19 infection compared with the general community.

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Dr Varma conceptualized and designed the study, analyzed and interpreted the data, and drafted the initial manuscript; Mr Thamkittikasem, Ms Arslanian, Ms Bray, Dr Stephens, and Dr Long conceived the study, acquired data, and interpreted data; Ms Whittemore and Ms Alexander analyzed the data and interpreted the data; and all authors critically revised the manuscript for important intellectual content and approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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WHAT'S KNOWN ON THIS SUBJECT: In-person learning in schools may increase the risk of acquiring 2019 novel coronavirus disease infection for students and staff. No studies have been published from large urban school districts in the United States to measure incidence, prevalence, and secondary transmission of 2019 novel coronavirus disease infection.

WHAT THIS STUDY ADDS: When strict protocols were implemented for preventing, diagnosing, and managing school-associated cases, in-person learning in public schools was not associated with increased prevalence and incidence overall compared with the general community, and secondary transmission was infrequent.

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BACKGROUND

Schools provide large health, social, and economic benefits to children, families, and societies. The American Academy of Pediatrics recommends that jurisdictions strive to ensure that "students [be] physically present in school."[1] However, schools might also serve as a setting in which respiratory infections transmit readily, amplifying community incidence. The 2019 novel coronavirus disease (COVID-19) pandemic led many jurisdictions to close in-person school instruction for several months or the entire 2020 to 2021 academic year.[2] Closures might reduce community transmission; in part because they are often instituted along with other restrictions on businesses and gatherings, any added value has been difficult to measure.[3,4] Evidence has recently emerged that in-person schooling can be conducted in a way that minimizes COVID-19 transmission among students and staff and that the harms of school closure might outweigh a potential benefit in reducing community transmission.[5,6]

In response to rapidly accelerating transmission of COVID-19, New York City (NYC) closed public schools on March 16, 2020, and transitioned all students to remote (online) learning. NYC's first epidemic wave was among the most lethal in the world, resulting in >23 195 confirmed and probable COVID-19 deaths during February 29 to June 1, 2020.[7] During subsequent months, NYC reduced, but did not eliminate, COVID-19 transmission and opened its public schools to in-person instruction on September 21, 2020, with the implementation of substantial preventive measures.

To continuously assess the safety of its public schools, the city instituted a program to monitor the prevalence of COVID-19 infection by testing a sample of asymptomatic students and staff physically present in school each day. We analyzed data from this monitoring program and from cases occurring among students and staff diagnosed with COVID-19 through community-based testing during October 9 to December 18, 2020.

METHODS

Setting

The NYC Department of Education (DOE) directly oversees 1607 schools, located in 1400 buildings. These schools enroll ~1.1 million students annually. For the 2020 to 2021 academic year, all families were given the option of either fully remote or "hybrid" learning, which was defined as 1 to 3 days of in-person school per week combined with remote learning on the other days. No students received full-time, in-person learning. During October 12 to November 20, 288 199 students attended hybrid learning, and 80 876 adults were employed and physically present in schools as teachers, staff, or administrators. Schools were closed from November 19 to December 6, and only elementary and special education schools were reopened in December. More details are available in the Supplemental Information. During December 7 to 18, these numbers were 164 673 students and 44 634 adults (Supplemental Table 6).

For in-person learning, DOE made comprehensive changes to school policy, practices, and facilities. Details are in the Supplemental Information. Multiple city agencies involved in school health established a joint coordination center, hereafter referred to as the Situation Room, to receive, investigate, and act on reports of COVID-19 infection in students, teachers, or staff associated with the public school system.

Case Detection

Reports of COVID-19 cases associated with schools were received in the Situation Room through 3 sources. First, as mandated by law, clinical laboratories are required to report to the NYC Department of Health and Mental Hygiene (DOHMH) information about any city resident who has a severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) viral diagnostic test performed. For new laboratory-confirmed cases, students (or their parent or guardian) are interviewed and asked about any association with a school, and school-associated cases are notified to the Situation Room. Second, all school-affiliated persons were required and actively encouraged to notify their school if they are diagnosed with COVID-19, and schools notified the Situation Room about these cases; such reports are necessary if the person is not a NYC resident. Third, polymerase chain reaction (PCR) testing was performed in each school at least monthly, with results reported directly from clinical laboratories to the Situation Room.

Testing in Schools

Each public school was assigned a random day when testing would be performed among asymptomatic persons in a school. Testing was performed at least once per month in each school; the frequency changed to once per week for some schools in October to November, then for all schools in December. Further information about the change in testing frequency, consent, and sampling proportions is in the Supplemental Information. In each school, a single swab of the right and left anterior nares was collected and underwent PCR by using standard, US Food and Drug Administration (FDA)–authorized methods at 1 of 2 commercial laboratories (BioReference; Fulgent/Color Genomics).

Actions in Response to a Case

Each case prompted an investigation to determine if there were additional cases, and contact tracing was initiated by using established protocols in collaboration with school administrators. For public schools,

a close contact was defined as any person physically present in a classroom for any duration with the case or any person that spent at least 10 minutes cumulatively within 6 feet during the infectious period (from 2 days before through 10 days after symptom onset date or, if asymptomatic, specimen collection date).[8] Classrooms and buildings were closed and cleaned following DOE protocols.

Definitions

A COVID-19 case was defined as a person who tested positive for SARS-CoV-2 on an FDA-authorized PCR or antigen test who had not previously tested positive within the past 90 days. We excluded persons who were not positive on either a PCR or antigen test, including probable deaths and symptomatic persons with known COVID-19 exposure. Testing performed in schools only involved PCR. Testing in the community included PCR and antigen testing.

A COVID-19 event was defined as ≥2 cases occurring within the same school during a 7-day period regardless of whether the cases were known or presumed to be epidemiologically linked. We inferred index cases and possible direction of transmission using dates of diagnosis, symptom onset, interaction, and the absence of other explanations for infection, such as household contact.

The type of school was classified by using terminology of the NYC DOE to describe the range of grades included in a school, because schools can have a wide range of different grade levels: early childhood (preschool to grade 2); elementary (preschool to grade 5), junior high, intermediate, middle (grades 6–8); high school (grades 9–12), kindergarten through grade 8 (K–8); and kindergarten through grade 12 (K–12).

Statistical Analysis

School period prevalence was calculated by dividing the number of persons who tested positive for SARS-CoV-2 by the number of persons tested for a given school week (Monday–Friday) when testing was performed. For comparison, we calculated the period prevalence for the community by using estimates of the number of persons with COVID-19 infection in NYC, then dividing by the city's population to obtain an estimate of period prevalence.[9,10] The model by the Shaman group permitted analysis by age group for a given week.

We defined incidence as all cases reported during the evaluation period divided by the corresponding population. School incidence was calculated by using the results of any testing done on a student or staff person associated with in-person learning (ie, in-school testing, community testing, and verified self-report), then dividing all cases associated with the schools by the number of persons estimated by DOE to have been physically present in school during the evaluation period. We compared school incidence per week to community incidence using data for COVID-19 cases (PCR positive or antigen positive) from DOHMH. Incidence was stratified by age group and borough and calculated by school type. Because of the change in policy regarding schools and testing detailed in the Supplemental Information, we divided the incidence analysis into 2 periods (October 12–November 19 and December 7–18).

All statistical analysis was conducted in R (version 4.0.3).[11]

RESULTS

Prevalence of COVID-19 Infection From Testing in Schools

Of 234 132 asymptomatic persons tested for SARS-CoV-2 infection in 1594 NYC public schools during October 9 to December 18, 2020, 986 (0.4%) tested positive. Except for the first and last weeks of testing, test positivity increased each week, from 0.19% between October 12 and 16 to 0.67% between December 14 and 18, consistent with rising test positivity citywide during the same period (Table 1). The median age of all case patients was 31 years, with 25% to 75% interquartile range (IQR) of 10 to 47 years; for staff, it was 43 years (IQR: 34–53), and for students it was 9 years (IQR: 7–11).

Among staff who tested positive for COVID-19, test positivity was highest among K–8 schools, followed by elementary and early childhood schools (Table 2). Among students who tested positive, test positivity was highest among students at elementary schools, followed by early childhood schools and K–8 schools.

Period prevalence in the schools never exceeded both model estimates for community prevalence; school prevalence was lower than community prevalence in 4 of the 8 weeks for both models and between the 2 model estimates for the other 4 weeks (Table 3). Stratified by age, the school period prevalence was similar or lower for all groups compared with estimated community period prevalence except for persons aged 65 to 74 years old (Supplemental Table 7).

Incidence of COVID-19 Infection From Testing in Schools and Community

During October 9 to November 19, 2020, 44 091 persons in the city were diagnosed with COVID-19; for the same period, there were 1259 COVID-19 cases in persons associated with the schools (including 458 diagnosed from in-school testing) (Table 4). During this period, 3% to 6% of persons aged ≥18 years had a PCR performed each week across the community[12]; in contrast, 11% to 27% of staff in schools had a PCR performed in school each week.

TABLE 1 Results of Period Prevalence Testing for COVID-19 in Public Schools Over Time: NYC, October to December 2020

5-d Testing Wk	No. Persons Tested[a]	No. Persons Tested Positive for COVID-19 (%)	No. Students Tested	No. Students Tested Positive for COVID-19 (%)	No. Staff Tested	No. Staff Tested Positive for COVID-19 (%)
October 12–16	14 509	27 (0.19)	5300	8 (0.15)	9209	19 (0.21)
October 19–23	25 795	30 (0.12)	9308	16 (0.17)	16 487	14 (0.09)
October 26–30	32 934	51 (0.15)	11 536	21 (0.18)	21 398	30 (0.14)
November 2–6	29 796	65 (0.22)	11 001	26 (0.24)	18 795	39 (0.21)
November 9–13	32 436	138 (0.43)	12 755	56 (0.44)	19 681	82 (0.42)
November 16–20	23 920	146 (0.61)	8212	36 (0.39)	15 708	110 (0.70)
December 7–11	41 998	309 (0.74)	19 409	162 (0.83)	22 586	147 (0.65)
December 14–18	32 744	220 (0.67)	14 224	96 (0.68)	18 520	124 (0.67)

[a] For all persons, a single swab of the right and left anterior nares was collected and underwent nucleic acid amplification testing by using standard, FDA-authorized methods. For the period during November 20–December 7, all public schools were closed. For December 7 to 18, only elementary and special education schools were open.

Incidence among the school population was 341.1 cases per 100 000 population compared with incidence among the general community of 528.9 cases per 100 000 population. For persons 5 to 17 years old, incidence was 168.6 per 100 000 for the school population versus 383.7 per 100 000 for the community; for persons ≥18 years, it was 955.8 for the school population and 581.5 for the community. Stratified by age groups, incidence was lower in the school community for all persons except in those aged 65 to 74 years. Of all school cases identified during this period, 37.3% were missing age data.

During December 7 to 18, 2020, 42 485 persons in the city were diagnosed with COVID-19; for the same period, there were 972 COVID-19 cases in persons associated with the schools (including 529 diagnosed from in-school testing). During this period in December, 4% to 6% of persons aged ≥18 years had a PCR performed each week across the community[12]; in contrast, 41% to 51% of staff in schools had a PCR performed in school each week. Incidence among the school population was 464.4 cases per 100 000 population compared with incidence among the general community of 509.6 cases per 100 000 population. For persons 5 to 17 years old, incidence was 244.7 per 100 000 for the school population versus 367.3 for the community; for persons ≥18, incidence was 1274.8 for the school population and 560.1 for the community. Stratified by age groups, incidence was lower in the school community for persons <18 years old and higher for persons aged 18 to 44, 45 to 64, and 65 to 74 years. Of all school cases identified during this period, 38.4% were missing age data.

TABLE 2 Overall COVID-19 Positivity by School Type, Stratified by Staff and Students: NYC, October to December 2020

School Type[a]	No. Staff Tested Positive for COVID-19 (Percent Positive)[b]	No. Students Tested Positive for COVID-19 (Percent Positive)[a]
Secondary school (6–12)	13 (0.31)	5 (0.23)
High school (9–12)	52 (0.27)	11 (0.16)
Elementary (3K–5)	351 (0.44)	335 (0.54)
Early childhood (3K–2)	5 (0.36)	4 (0.45)
Junior high-intermediate-middle (6–8)	48 (0.32)	39 (0.34)
K–8	76 (0.46)	51 (0.43)
K–12	1 (0.15)	0 (0.00)

[a] School type refers to the classification used by the NYC public school system to describe the range of grades included in a school; as indicated, schools can have a wide range of different grade levels. 3K, preschool starting at age 3 y.
[b] For all persons, a single swab of the right and left anterior nares was collected and underwent nucleic acid amplification testing by using standard, FDA-authorized methods. The frequency of testing in schools varied during the period because of changes in State and City policy. During October–November, all schools had at least monthly testing, and some schools had weekly testing during October–November. During December, only elementary and special education schools were open, and all schools had weekly testing.

Outcomes of Close Contacts

A total of 36 423 persons were classified as school-based close contacts of a case with an exposure date during October 9 to December 18, 2020. Of those 36 423 close contacts, 191 (0.5%) tested positive for COVID-19 during the 14 days of quarantine (Table 5). For these 191 case patients, 132 (69%) had sufficient information about illness onset date, exposure period, and exposure locations for both cases and contacts to infer the likely direction of transmission. For these 132 case patients, 67 (51%) likely involved transmission from staff to staff, 36 (27%) from staff to student, 18 (14%) student to staff, and 11 (8%) from student to student.

DISCUSSION

During 8 weeks of in-person school, we found that persons associated with public schools had an overall burden of COVID-19 infections that was no higher than the burden in the general community and that transmission within schools was not common. Although our observation period was short, it involved a large, demographically diverse population that underwent extensive testing and case investigations.

TABLE 3 Comparison Between COVID-19 School Period Prevalence and Model Estimates of Overall NYC Community Period Prevalence: October to December 2020[a]

	No. Persons Estimated to Have Active COVID-19 Infection in NYC for Model 1	Estimated NYC Period Prevalence for Model 1 (95% CI)	No. Persons Estimated to Have Active COVID-19 Infection in NYC for Model 2	Estimated NYC Period Prevalence for Model 2 (95% CI)	No. Persons Tested Positive for COVID-19 in Schools	No. Persons Tested for COVID-19 in Schools	School Period Prevalence
October 12–18	9189	0.110 (0.108–0.113)	21 451	0.257 (0.254–0.261)	27	14 509	0.19 (0.13–0.27)
October 19–25	13 312	0.160 (0.157–0.162)	24 329	0.292 (0.288–0.296)	30	25 795	0.12 (0.08–0.17)
October 26–November 1	15 166	0.182 (0.179–0.185)	29 417	0.353 (0.349–0.357)	51	32 934	0.15 (0.12–0.21)
November 2–8	25 231	0.303 (0.299–0.306)	41 420	0.497 (0.492–0.502)	65	29 796	0.22 (0.17–0.28)
November 9–13	30 616	0.367 (0.363–0.371)	58 224	0.698 (0.693–0.704)	138	32 436	0.43 (0.36–0.50)
November 16–20	35 908	0.431 (0.426–0.435)	71 272	0.855 (0.849–0.861)	146	23 920	0.61 (0.52–0.72)
December 7–11	58 533	0.702 (0.696–0.708)	128 381	1.540 (1.532–1.548)	309	41 998	0.74 (0.66–0.82)
December 14–18	58 822	0.706 (0.700–0.711)	133 741	1.604 (1.596–1.613)	220	32 744	0.67 (0.59–0.77)

[a] Model 1 estimates of the number of persons with COVID-19 infection in NYC from the Shaman Group at Columbia University Mailman School of Public Health. The model used available case, mortality, and mobility data to estimate the number of persons with COVID-19 infection who are potentially infectious to others; as a result, it is likely to be an underestimate of all persons who test positive using a nucleic acid amplification test of a respiratory specimen. Model 2 estimates the number of persons with COVID-19 infection in NYC from covid19-projections.com, an open source project by Youyang Gu. The number of persons actively infectious includes those who were recently infected and no longer infectious; as a result, its estimates of prevalent infections are substantially higher than model 1 and, therefore, represent an upper-bound estimate of prevalent infections. To calculate period prevalence, we divided the number of persons estimated to have active COVID-19 infections by the population of NYC. See Supplemental Information for further details.

We assessed burden by analyzing both prevalence and incidence of COVID-19. In both analyses, using statistical models or official case notifications for comparison, we found that the overall population of persons participating in in-person learning at public schools had lower or similar measures of COVID-19 infection than the NYC community. We found that staff may have an elevated risk of COVID-19 infection relative to the community but that this risk is not clearly attributable to transmission in schools. Overall incidence was higher for staff than the general community and markedly higher for persons aged 45 to 64 years and 65 to 74 years during December. The fact that prevalence remained similar to or less than model estimates for persons 18 to 64 years old, however, suggests that increased incidence was attributable to increased ascertainment of infection (staff were tested at far higher rates, including 10 times the rate in December, than adults in the community) or acquisition of infection outside of school settings because of rising community incidence. Both prevalence and incidence were higher among persons aged 65 to 74 years, although the small number of cases makes it difficult to draw definitive conclusions.

Our evaluation cannot explain why we observed that in-person school was not associated with an overall increased COVID-19 burden, particularly among students. It is possible that the population that chose in-person learning adhered more rigorously to individual protective measures (such as mask wearing, physical distancing, and hand hygiene) or had other unmeasured characteristics, such as previous infection, that could explain lower levels of COVID-19 infection. It is also possible that the hours spent during school, however limited, help reduce the overall risk of infection by

TABLE 4 Overall COVID-19 Cases Associated With In-Person Public School and Comparison With Population Incidence: NYC, October to December 2020

	No. COVID-19 Cases Associated With in-Person School (%)	Incidence per 100 000 Population Among Persons Associated With in-Person School	No. COVID-19 Cases in NYC Population (%)	Incidence per 100 000 Population in NYC
Total during October 9–November 19	1259	341.1	44 091	528.9
Students	486 (38.6)	168.6	—	—
Staff	773 (61.4)	955.8	—	—
Age group, y				
0–4	20 (1.6)	122.4	1085 (2.5)	207.2
5–9	149 (11.8)	132.8	1440 (3.3)	297.3
10–14	137 (10.9)	128.3	1805 (4.1)	406.7
15–17	32 (2.5)	72.3	1277 (2.9)	506.1
18–44	281 (22.3)	484.1	23 233 (52.7)	698.7
45–64	162 (12.9)	534.2	10 943 (24.8)	539.9
65–74	8 (0.6)	759.0	2795 (6.3)	388.8
≥75	0 (0.0)	0.0	1497 (3.4)	266.6
Unknown[a]	470 (37.3)	—	0 (0.0)	—
Total during December 7–18	972	464.4	42 485	509.6
Students	403 (41.5)	244.7	—	—
Staff	569 (58.5)	1274.8	—	—
Age group, y				
0–4	18 (1.9)	132.1	1141 (2.7)	217.9
5–9	202 (20.8)	168.4	1536 (3.6)	317.2
10–14	54 (5.6)	189.0	1685 (4.0)	379.7
15–17	0 (0.0)	0.0	1104 (2.6)	437.6
18–44	179 (18.4)	633.0	20 296 (47.8)	610.4
45–64	134 (13.8)	790.3	11 623 (27.4)	573.4
65–74	12 (1.2)	1973.7	3200 (7.5)	445.2
≥75	0 (0.0)	0.0	1866 (4.4)	335.8
Unknown	373 (38.4)	—	0 (0.0)	—

We defined incidence as all cases reported during the evaluation period divided by the corresponding population. School incidence was calculated by using the results of any testing done on a student or staff person associated with in-person learning (ie, in-school testing, community testing, and verified self-report), then dividing all cases associated with the schools by the number of persons estimated by DOE to have been physically present in school during the evaluation period. We compared school incidence per week to community incidence using data for COVID-19 cases (PCR positive or antigen positive) from the NYC Health Department. Because of the change in policy regarding schools and testing, we divided the incidence analysis into 2 periods (October 12–November 19 and December 7–18). —, not applicable.

[a] Because more than one-third of the school-associated cases had missing data about age, incidence data by age group should be interpreted with caution.

reducing the opportunity for high-risk activities in the community. Longer-term analysis of school COVID-19 monitoring data and further evaluations, such as testing a representative population of students attending remote learning, could help elucidate factors that explain these findings.

TABLE 5 Outcomes of Close Contacts of School Cases: October 9 to December 18, 2020

	No. Persons (%)
Total number of close contacts identified with exposure date during October 9 to December 18, 2020	36 423
Close contacts who tested positive for COVID-19 within 14 d of exposure date	191 (0.5)
Close contacts for whom direction of infection was known	132 (69.1)
Staff to staff	67 (50.8)
Staff to student	36 (27.3)
Student to staff	18 (13.6)
Student to student	11 (8.3)

Studies have revealed that the strongest predictor of COVID-19 outbreaks in schools is the incidence of COVID-19 infection in the surrounding community.[13] In our evaluation, we observed that the prevalence of infection in the school community rose with increases in community incidence. Our policies to prevent COVID-19 transmission required us to close a classroom for 14 days in response to an individual case and, in situations with >1 case within a 7-day period, to close the entire building for 14 days if we could not link transmission to an exposure outside the school. Given that COVID-19 has a maximum 14-day incubation period and many persons could not recall a specific exposure that led to infection, the number of building closures grew as community transmission increased. However, the overall proportion of buildings closed for 14 days remained a small proportion of all buildings (9% for October–November; 13% for December).

We estimated the secondary attack rate associated with school exposures was 0.5% and, notably, that a staff person was the likely index case for 78% of these secondary cases. Our findings align with experiences from other jurisdictions that adults are more likely to transmit infection in school settings than children, even in situations, such as in NYC, in which the prevalence of undiagnosed infection was highest in younger children.[14] Schools should strengthen prevention and diagnosis of COVID-19 among staff, including strict adherence to masks and physical distancing in school and out of school and promotion of and priority access for routine periodic testing. Our estimate of the secondary attack rate is prone to error. It could be an overestimate because we do not have definitive proof that all cases arising during quarantine were acquired

from the school-based index case that triggered quarantine, rather than from other sources of exposure either inside or outside the school. The secondary attack rate could also be an underestimate because close contacts do not universally undergo testing, although the city's contact management program includes daily monitoring calls during quarantine that encourage contacts to get tested.

Our evaluation was subject to important limitations. First, investigations depend on interviews with patients (or their guardians) and their contacts, and such interviews rarely provide definitive information about the duration and source of infection. Second, in situations with >1 case within a school, we can only infer and cannot verify whether infections were linked and, if so, the direction of transmission. Third, during the October to November period, only 41% of parents provided consent to have their children tested. Our results could underestimate prevalence (but, importantly, not incidence for that period) if those students were systematically more likely to have undiagnosed COVID-19 infection. Fourth, more than one-third of school-associated cases had missing data about age, making it necessary to interpret analysis of school incidence by age strata with caution. Fifth, our analysis did not include seroprevalence data, which could provide additional information to assess prevalence and incidence in the school population. Sixth, although the 2 models of community prevalence provide plausible lower and upper-bound estimates to compare with school testing data, the models were not developed to estimate the proportion of persons who might test positive by PCR in a predominantly asymptomatic population. Finally, our analysis only covered a brief period of the school year and was not designed to assess the contribution of schools to community transmission. Multiple events that could increase community COVID-19 transmission occurred in NYC contemporaneous with the opening of public schools, including the opening of in-person learning at nonpublic schools and universities; the opening of higher-risk indoor activities, such as dining and fitness gyms (albeit with restricted capacity); the onset of cooler, lower humidity weather; and large increases in incidence in neighboring jurisdictions.

CONCLUSIONS

We found that in-person learning in NYC public schools was not associated with increased prevalence and incidence overall compared with the general community. Strict protocols for preventing, diagnosing, and managing school-associated cases might have contributed, but further studies are needed to understand which measures are most important to reducing transmission among students and staff. Longer follow-up and evaluation are also needed to understand how much increased incidence among staff is attributable to increased ascertainment through testing or increased exposures either in school or outside of school. Other jurisdictions seeking to open schools might wish to consider similar policies and practices for reducing transmission, periodic testing to monitor the effectiveness of COVID-19 safety measures, and use of multiagency operations centers, such as ours, to manage the complex process of receiving, investigating, and acting on COVID-19 cases continuously.

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ABBREVIATIONS

COVID-19: 2019 novel coronavirus disease
DOE: Department of Education
DOHMH: Department of Health and Mental Hygiene
FDA: US Food and Drug Administration
IQR: interquartile range
K–12: kindergarten through grade 12
K–8: kindergarten through grade 8
NYC: New York City
PCR: polymerase chain reaction
SARS-CoV-2: severe acute respiratory syndrome coronavirus 2

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REFERENCES

1. American Academy of Pediatrics. COVID-19 guidance for safe schools. Available at: 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/. Accessed March 18, 2021
2. Viner RM, Russell SJ, Croker H, et al. School closure and management practices during coronavirus outbreaks including COVID-19: a rapid systematic review. *Lancet Child Adolesc Health*. 2020;4(5):397–404
3. Auger KA, Shah SS, Richardson T, et al. Association between statewide school closure and COVID-19 incidence and mortality in the US. *JAMA*. 2020;324(9):859–870
4. Flaxman S, Mishra S, Gandy A, et al.; Imperial College COVID-19 Response Team. Estimating the effects of non-pharmaceutical interventions on COVID-19 in Europe. *Nature*. 2020;584(7820):257–261
5. World Health 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. 2020. Geneva, Switzerland: World Health Organization; 2020
6. 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
7. Thompson CN, Baumgartner J, Pichardo C, et al. COVID-19 Outbreak - New York City, February 29–June 1, 2020. *MMWR Morb Mortal Wkly Rep*. 2020;69(46):1725–1729
8. NYC Health Hospitals. Tracing: what to expect. Available at: https://www.nychealthandhospitals.org/test-and-trace/what-to-expect/. Accessed February 18, 2021
9. Yang W, Kandula S, Huynh M, et al. Estimating the infection-fatality risk of SARS-CoV-2 in New York City during the spring 2020 pandemic wave: a model-based analysis. *Lancet Infect Dis*. 2021;21(2):203–212
10. Gu Y. COVID-19 projections using machine learning. Available at: https://covid19-projections.com/infections/counties/ny/new-york-city. Accessed February 18, 2021
11. R Core Team. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing; 2020
12. New York City Health Department. Coronavirus data: testing by age. Available at: https://github.com/nychealth/coronavirus-data/blob/master/trends/testing-by-age.csv. Accessed February 1, 2021
13. Ismail SA, Saliba V, Lopez Bernal J, Ramsay ME, Ladhani SN. 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
14. European Centre for Disease Prevention and Control. COVID-19 in children and the role of school settings in transmission–first update. 2020. https://www.ecdc.europa.eu/en/publications-data/children-and-school-settings-covid-19-transmission. Accessed January 27, 2021

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