Utilization and Impact of Symptomatic and Exposure SARS-CoV-2 Testing in K-12 Schools

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abstract

OBJECTIVES: The Centers for Disease Control and Prevention recommend that schools can offer severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) diagnostic (on-demand) testing for students and staff with coronavirus disease 2019 symptoms or exposures. Data related to the uptake, implementation, and effect of school-associated on-demand diagnostic testing have not been described.

METHODS: The Rapid Acceleration of Diagnostics Underserved Populations Return to School program provided resources to researchers to implement on-demand SARS-CoV-2 testing in schools. This study describes the strategies used and uptake among the different testing programs. Risk of positivity was compared for symptomatic and exposure testing during the δ and o variant periods. We estimated the number of school absence days saved with school-based diagnostic testing.

RESULTS: Of the 16 eligible programs, 7 provided school-based on-demand testing. The number of persons that participated in these testing programs is 8281, with 4134 (49.9%) receiving >1 test during the school year. Risk of positivity was higher for symptomatic testing compared with exposure testing and higher during the o variant predominant period compared with the δ variant predominant period. Overall, access to testing saved an estimated 13 806 absent school days.

CONCLUSIONS: School-based on-demand SARS-CoV-2 testing was used throughout the school year, and nearly half the participants accessed testing on more than 1 occasion. Future studies should work to understand participant preferences around school-based testing and how these strategies can be used both during and outside of pandemics.

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DOI: https://doi.org/10.1542/peds.2022-060352I

Accepted for publication Apr 4, 2023

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PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) testing is a crucial part of controlling the spread of coronavirus disease 2019 (COVID-19). During the 2021 to 2022 school year, testing was recommended for all persons with symptoms that may be consistent with COVID-19 and for those exposed to SARS-CoV-2.[1] Empirical isolation or quarantine (between 5–10 days) was recommended during the 2021 to 2022 school year for symptomatic individuals, as well as for those who were exposed and not fully vaccinated for SARS-CoV-2.[2] In the school setting, SARS-CoV-2 testing access for symptomatic students can minimize absenteeism for those who are not infected. For exposed students, test-to-stay (TTS) programs facilitate safe, in-person attendance.[3] The ability to exclude the diagnosis of SARS-CoV-2 in symptomatic or exposed students and staff members reduces absenteeism and decreases time spent in remote learning.

Racial, ethnic, and socioeconomic disparities in accessing SARS-CoV-2 testing have been well documented.[4,5] Furthermore, learning loss secondary to remote education during the pandemic has been projected to be higher in Black, Hispanic, and low-income students.[6,7] Options to safely increase in-person learning time are needed to decrease these disparities. Providing on-demand or readily accessible SARS-CoV-2 testing in schools can minimize the barriers associated with accessing testing, including finding transportation to a testing site.[8]

Although screening testing and TTS programs were recommended by the Centers for Disease Control and Prevention (CDC) for the 2021 to 2022 school year, the utilization and impact of providing symptomatic and exposure testing are not well documented. As part of the Rapid Acceleration of Diagnostics-Underserved Populations (RADx-UP) Return to School (RTS) Program, researchers partnered with school districts to provide exposed and/or symptomatic persons with SARS-CoV-2 testing.[9] In this manuscript, we describe the different testing programs and estimate the impact of on-demand school-based testing on absenteeism in a subset of RADx-UP RTS programs.

METHODS

RADX-UP Safe Return to School Diagnostic Testing Programs

Sixteen programs participated in the RADx-UP RTS Program.[10] For this study, sites were eligible if they provided on-demand diagnostic testing, which included testing for persons with COVID-19 symptoms or those exposed to SARS-CoV-2, including TTS programs. Sites performing only screening testing were excluded from this study. All eligible sites were invited to participate.

Data Collection

Sites that agreed to participate submitted deidentified data that were collected and managed using REDCap electronic data capture tools hosted at Children's Mercy Kansas City (Kansas City, MO USA).[11,12] Sites were asked to describe their diagnostic testing program in the data collection tool. Participant race and ethnicity were self-reported, with the option to select multiple responses. District-level race and ethnicity data were obtained from publicly available sources. Test type was categorized into symptomatic (person tested had symptoms concerning for COVID-19), exposure (person tested had been exposed to SARS-CoV-2, but was not participating in a TTS program), or TTS (person tested had been exposed to SARS-CoV-2 and was participating in a TTS program). TTS protocols varied across programs, but all required a cadence of repeated testing in an exposed person while attending school. Data collected included demographics of persons accessing symptomatic or exposure testing, number of symptomatic and exposure tests performed, risk of positivity during the δ and o variant predominant periods, and number of tests performed per student. The δ variant predominance period was defined as July 1, 2021 through December 18, 2021, and the o variant predominance period was defined as December 19, 2021 through May 1, 2022.[13] Only deidentified data were provided. Institutional Review Board approval was obtained from each site as part of their individual studies.

Statistical Analysis

To describe testing programs by site, we first examined the type of testing program, which was categorized as diagnostic or symptomatic testing, exposure testing, and TTS. In this study, TTS was categorized as exposure testing in the analysis. Sites could participate in both programs and be included in both analyses. Data from July 1, 2021 to May 1, 2022 were included. Number of tests administered were categorized as 1, 2 to 4, and 5 or more tests per participant. We also reported on student demographics by site. We reported the total number of students tested by race and ethnicity.

We compared symptomatic test positivity results by sites stratified by δ and o variant time periods for total number of tests provided and test positivity risks. We included the total number of tests and the positivity risk across all sites. We repeated the analysis for the exposure testing. We estimated the number of school days saved through implementation of symptomatic testing programs by site. The number of absent days saved with access to school-based diagnostic testing was estimated using the following assumptions: since school-based testing was available, we assumed that SARS-CoV-2 testing was accessed on day 0 of illness. For most of the 2021 to 2022 school year, the CDC recommended a 10-day isolation period (ie, return to school on day 11) for persons with COVID-19.[14] Persons with COVID-19 symptoms were required to isolate until a SARS-CoV-2 test generated a negative result. Empirical 10-day isolation was recommended by the CDC in symptomatic cases where a SARS-CoV-2 test was unable to be accessed. Based on turnaround time of results from the programs and previous rates of absenteeism associated with illness, we assumed that students with a negative SARS-CoV-2 test would be able to return on day 3 of illness, thereby saving 6 missed school days, accounting for an average of 2 nonschool isolation days (ie, weekends) by accessing on-demand SARS-CoV-2 testing.

We present all results using site-level data. Sites were able to submit multiple entries into the survey. Data from multiple sites under the same program were aggregated as overall site-level data. All analysis was performed using SAS version 9.4 (SAS Institute, Inc., Cary, NC USA).

RESULTS

Overview of Testing Program Types

Of the 16 RADx-UP RTS programs, 15 responded to the invitation to participate, and 12 confirmed that they performed either symptomatic, exposure, or TTS COVID-19 testing. Five sites were excluded because they did not have data to submit ($n = 3$), could not distinguish surveillance testing from symptomatic and exposure testing ($n = 1$), and were only performing testing in non-K through 12th grade students. Therefore, 7 sites responded with complete information for inclusion (Table 1). One program tested exclusively students, whereas the remainder offered testing to both students and staff. Five programs performed both symptomatic and exposure testing; 1 program performed symptomatic testing, exposure testing, and TTS; and 1 program only performed TTS. In total, 8281 persons participated in the testing programs and 15 742 diagnostic tests were performed. The average number of tests per participant across all programs was 2 with individual sites having an average of 1 to 2 tests per participant. Approximately half of the participants (4134; 49.9%) underwent >1 test during the school year. Most of the participants (5987; 72.3%) were students. A racially and ethnically diverse student population accessed diagnostic testing (Table 2).

SARS-CoV-2 Risk of Positivity

Risk of positivity from symptomatic testing (Table 3) were generally higher than from exposure testing (Table 4) at each site. Symptomatic testing was assessed during both δ

TABLE 1 Testing Program Characteristics by Site

Site	Type of Testing Program	Total Number of Participants Tested	Total Number of Tests Performed	1 Test per Participant[a], *n* (%)	2–4 Tests per Participant[a], *n* (%)	5+ Tests per Participant[a], *n* (%)	Average Number of Tests per Participant[b]
Children's Mercy and ICF	Diagnostic or symptomatic, exposure; school-based PCR	359	399	313 (87.2)	46 (12.8)	0 (0)	1.1
Duke University	TTS; school-based antigen	4576	10568	1319 (28.8)	3068 (67)	189 (4.1)	2.3
San Diego State University	Diagnostic or symptomatic, exposure; school and home-based; antigen	635	1392	328 (51.7)	264 (41.6)	43 (6.8)	2.2
University of Miami	Diagnostic or symptomatic, exposure; school-based PCR	542	680	384 (70.8)	158 (29.2)	0 (0)	1.3
University of Rochester	Diagnostic or symptomatic, TTS, exposure; school and home-based; PCR	176	294	79 (44.9)	96 (54.5)	1 (0.6)	1.7
Washington University School of Medicine	Diagnostic or symptomatic, exposure; school, home, and community-based PCR	1927	2311	1673 (86.8)	230 (11.9)	24 (1.2)	1.2
Washington University School of Medicine in St. Louis and Special School District of St Louis county	Diagnostic or symptomatic, exposure; school and home-based; PCR	66	98	51 (77.3)	12 (18.2)	3 (4.5)	1.5
All sites		8281	15742	4147 (50.1)	3874 (46.8)	260 (3.1)	1.9

ICF, The Inner City Fund; PCR, polymerase chain reaction; TTS, test-to-stay.
[a] Percentages are calculated based on the total number of participants tested.
[b] Calculated as number total number of tests performed divided by total number of participants tested.

TABLE 2 Self-Reported Race and Ethnicity Demographics for Students per Testing Site						
Site	Total Number of Participants Tested	Total Number of Students Tested[a], *n* (%)	White[b], *n* (%)	Black[b], *n* (%)	Hispanic[b], *n* (%)	Asian[b], *n* (%)
Children's Mercy and ICF	359	262 (73)	41 (15.6)	68 (26)	79 (30.2)	10 (3.8)
Duke University	4576	4100 (89.6)	3215 (78.4)	548 (13.4)	495 (12.1)	79 (1.9)
San Diego State University	635	517 (81.4)	19 (3.7)	6 (1.2)	424 (82)	43 (8.3)
University of Miami	542	542 (100)	150 (27.7)	367 (67.7)	186 (34.3)	7 (1.3)
University of Rochester	176	56 (31.8)	31 (55.4)	7 (12.5)	3 (5.4)	1 (1.8)
Washington University School of Medicine	1927	497 (25.8)	155 (31.2)	259 (52.1)	36 (7.2)	4 (0.8)
Washington University School of Medicine in St. Louis and Special School District of St Louis county	66	13 (19.7)	4 (30.8)	7 (53.8)	0 (0)	1 (7.7)
All sites	8281	5987 (72.3)	3615 (60.4)	1262 (21.1)	1223 (20.4)	145 (2.4)

ICF, The Inner City Fund.
[a] Percentages are calculated based on the total number of participants tested.
[b] Percentages are calculated based on the total number of students tested.

and *o* predominance periods. Overall, risk of positivity was higher among symptomatic participants during the *o* period (ranging from 13.3% to 40.8%) compared with the δ period (ranging from 0% to 10.5%) across sites (Table 3). Similarly, risk of positivity from exposure testing was higher in the *o* period compared with δ (Table 4). Duke University performed exclusively TTS and observed low risk of positivity: 2.4% during the δ period and 4.5% during *o* (Table 4).

Estimated Days Saved With Diagnostic Testing

Of the 6 sites that performed symptomatic testing, 15% of symptomatic participants were positive for SARS-CoV-2 during the 2021 to 2022 school year (Table 5). The estimated number of absent days saved with access to rapid, on-demand diagnostic testing in schools for symptomatic persons was 13 806 days among the 6 sites.

DISCUSSION

School-based SARS-CoV-2 diagnostic testing can decrease absenteeism and increase in-person learning time. As demonstrated by the RADx-UP RTS sites, school-academic partners can work toward providing highly sensitive and specific diagnostic testing with rapid turnaround times to promote safe in-person learning and decrease learning loss associated with the COVID-19 pandemic.

CDC guidance continues to evolve throughout the pandemic, particularly related to COVID-19 mitigation in schools. For the 2022 to 2023 school year, routine screening testing and TTS are no longer recommended.[15] Importantly, the

TABLE 3 Symptomatic Testing and Positivity Risk Stratified by Time of Collection						
	All(7/1/2021–5/1/2022)		Δ(7/1/2021–12/18/2021)		0(12/19/2021–5/1/2022)	
Site	Total Tests	Total Positive[a], *n* (%)	Total Tests	Total Positive[b], *n* (%)	Total Tests	Total Positive[c], *n* (%)
Children's Mercy and ICF	326	70 (21.5)	130	8 (6.2)	196	62 (31.6)
San Diego State University	1012	118 (11.7)	168	4 (2.4)	844	114 (13.5)
University of Miami	511	55 (10.8)	225	17 (7.6)	286	38 (13.3)
University of Rochester	216	24 (11.1)	136	8 (5.9)	80	16 (20)
Washington University School of Medicine	635	153 (24.1)	351	37 (10.5)	284	116 (40.8)
Washington University School of Medicine in St. Louis and Special School District of St Louis county	25	4 (16)	9	0 (0)	16	4 (25)
All sites	2725	424 (15.6)	1019	74 (7.3)	1706	350 (20.5)

ICF, The Inner City Fund.
[a] Percentages are calculated based on the total number of participants tested during the survey time period.
[b] Percentages are calculated based on the total number of participants tested during the δ variant time period.
[c] Percentages are calculated based on the total number of participants tested during the *o* variant time period.

TABLE 4 Exposure Testing and Positivity Risk Stratified by Time of Collection						
	All (7/1/2021–5/1/2022)		Δ (7/1/2021–12/18/2021)		*o* (12/19/2021–5/1/2022)	
Site	Total Tests	Total Positive[a], *n* (%)	Total Tests	Total Positive[b], *n* (%)	Total Tests	Total Positive[c], *n* (%)
Children's Mercy and ICF	73	3 (4.1)	48	1 (2.1)	25	2 (8)
Duke University	10 568	394 (3.7)	3853	93 (2.4)	6715	301 (4.5)
San Diego State University	380	14 (3.7)	79	0 (0)	301	14 (4.7)
University of Miami	169	7 (4.1)	138	1 (0.7)	31	6 (19.4)
University of Rochester	78	3 (3.8)	38	1 (2.6)	40	2 (5)
Washington University School of Medicine	1676	102 (6.1)	1355	59 (4.4)	321	43 (13.4)
Washington University School of Medicine in St. Louis and Special School District of St Louis county	73	2 (2.7)	11	0 (0)	62	2 (3.2)
All sites	13 017	525 (4)	5522	155 (2.8)	7495	370 (4.9)

ICF, The Inner City Fund.
[a] Percentages are calculated based on the total number of participants tested during the survey time period.
[b] Percentages are calculated based on the total number of participants tested during the δ variant time period.
[c] Percentages are calculated based on the total number of participants tested during the *o* variant time period.

CDC continues to emphasize the importance of schools offering symptomatic and exposure diagnostic testing, highlighting that these types of on-demand testing remain important as the United States enters the next phase of the COVID-19 pandemic. Access to testing through schools can occur through multiple different methods, including school-based polymerase chain reaction or rapid antigen tests, as well as distribution of and instructions for use of at-home test kits.

The goal of the RADx-UP RTS programs is to address the needs of children with unequal access to SARS-CoV-2 testing.[16] Throughout the pandemic, access to SARS-CoV-2 testing has been limited. The programs in this review successfully enrolled a racially and ethnically diverse population for diagnostic testing in distinct geographic regions. A STAT-Harris poll in 2021 noted that one-quarter of people were unable to access a SARS-CoV-2 test when they desired one.[8] Reasons for limited testing access included proximity to testing site, long wait times for testing, unavailable transportation to the testing site, and lack of knowledge about testing locations. Even with increased availability of at-home SARS-CoV-2 tests, not all of which are approved for children of all ages, test costs may be prohibitive to some families. Caregivers may also feel uncomfortable independently administering SARS-CoV-2 tests to their child. Lastly, the cost of at-home tests may be prohibitive for some families. Diagnostic testing in schools minimizes some of these barriers. However, despite the reported successes, participation in diagnostic testing at all study sites was variable, consistent with national reports.[17–20]

During both the δ and *o* dominant periods, less than half of the symptomatic participants tested were diagnosed with COVID-19, and other respiratory viruses continued to circulate throughout the 2021 to 2022

TABLE 5 Estimated Number of Missed Days and Days Saved With Symptomatic Testing Program Implementation				
Site	Total Tests	Total Positive[a], *n* (%)	Estimated Number of Days Missed[b]	Predicted Days Saved[c]
Children's Mercy and ICF	326	70 (21.5)	3260	1536
San Diego State University	1012	118 (11.7)	10 120	5364
University of Miami	511	55 (10.8)	5110	2736
University of Rochester	216	24 (11.1)	2160	1152
Washington University School of Medicine	635	153 (24.1)	6350	2892
Washington University School of Medicine in St. Louis and Special School District of St Louis county	25	4 (16)	250	126

ICF, The Inner City Fund.
[a] Percentages are calculated based on the total number of tests.
[b] Calculated based on the assumption that without a testing program, 1 test equates to 10 days missed.
[c] Calculated based on the assumption that 1 negative test equates to 2 days missed. Therefore, 6 days saved per negative test.

school year.[21,22] Acute respiratory infection symptoms, including fever, cough, sore throat, and rhinorrhea or congestion are common in COVID-19, as well as in other respiratory viruses and noninfectious conditions (eg, seasonal allergies). Therefore, early and consistent diagnostic testing is the only reliable way to identify COVID-19. Accurately diagnosing COVID-19 is crucial as isolation and return to school recommendations differ from other respiratory illnesses. Students with the common cold or influenza can return to school when they are fever-free for 24 hours and have improved symptoms.[23] Previous data suggest that children miss an average of 2 days of school with each respiratory illness.[24] In contrast, COVID-19 isolation periods during the 2021 to 2022 school year ranged from 5 to 10 days. School guidance recommends SARS-CoV-2 testing for anyone with COVID-19 symptoms. When testing cannot be performed, an empirical isolation period is recommended. For students and staff with limited access to SARS-CoV-2 testing, school-based testing can potentially decrease student absenteeism, increase in-person learning time, and mitigate staffing shortages.

Our study had some limitations. First, although the programs included are diverse in location, population, and program design, they are not representative of all schools; therefore, our findings may not be generalizable to all school systems. Second, in many of these programs, research staff assisted with and/or performed SARS-CoV-2 testing, which may not be feasible in schools with limited test and personnel resources. Third, programs varied in their testing methods, including performing on-site polymerase chain reaction testing, on-site antigen testing, or home distribution of antigen tests through the school. Fourth, we estimated the number of absentee days saved with access to school-based testing; in some cases, students may have had a more severe illness, requiring more than 2 absentee days. Fifth, we recognize that SARS-CoV-2 testing could have been accessed at other locations, and same-day return of a negative test may have resulted in a more rapid return to school (eg, the next day) in some cases; however, all programs provided results within 1 to 48 hours, consistent with most testing sites. Sixth, we did not collect absentee days and assumed general infection prevention strategies were standard, including policies requiring students to be fever-free and with symptomatic improvement before return to school in the case of non–SARS-CoV-2 illnesses.[25] In some cases, absent days could have coincided with school holidays, inclement weather days, or school breaks. We did account for 1 weekend in each isolation period, but we were not able to account for each individual participant, given the nature of the study and inclusion of multiple districts with different schedules. Finally, we recognize that in some cases, persistent symptoms may require multiple successive tests, particularly if antigen tests are used.

CONCLUSIONS

Accessing on-demand testing for SARS-CoV-2 in the school setting has broad implications for minimizing staffing shortages and maximizing in-person learning, particularly in populations who may have limited access to testing. The implementation of diagnostic testing has implications for other infectious diseases (eg, influenza); readily available access to symptomatic and exposure testing beyond SARS-CoV-2 could help schools augment infection prevention strategies when outbreaks occur and assist with timely access to treatment strategies. SARS-CoV-2 testing has been crucial to understanding the COVID-19 pandemic, and children must be tested to discern the burden of disease in the pediatrics population, particularly in school settings. Implementing testing programs in schools, specifically for symptomatic and exposed children, is integral to understanding how children are affected by the current and future pandemics. Further studies are needed to measure student and staff preferences around in-school diagnostic testing and to comprehend the impact of testing on health and education.

ACKNOWLEDGMENTS

We thank Erin Campbell, MS, who provided editorial review and submission of this manuscript; and Ms Campbell did not receive compensation for her contributions, apart from her employment at the institution where this study was conducted.

ABBREVIATIONS

CDC: Centers for Disease Control and Prevention
COVID-19: coronavirus disease 2019
SARS-CoV-2: severe acute respiratory syndrome coronavirus 2
RADx®-UP: Rapid Acceleration of Diagnostic Underserved Populations
RTS: return to school
TTS: test to stay

FUNDING: Research reported in this publication was supported by the Office of the Director of the National Institutes of Health (NIH) under award number U24MD016258. National Institutes of Health Agreement No.'s OT2HD107559, OT2 HD107557, OT2 HD107553, OT2 HD107555, OT2HD108111, OT2HD108112, and 3P0HD103525-03S1; the National Center for

Advancing Translational Sciences of the National Institutes of Health under award number U24TR001608; and the National Institute of Child Health and Human Development of the National Institutes of Health under contract HHSN275201000003I. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the official policies, either expressed or implied, of the NIH.

CONFLICT OF INTEREST DISCLOSURES: Dr Kalu reports funding from Center for Disease Control and Prevention (CDC) Epicenter, National Institutes of Health (NIH) and receives consultancy fees from IPEC Experts and Wayfair. Dr Zimmerman reports funding from the National Institutes of Health (NIH) and US Food and Drug Administration (FDA). Dr Goldman reports funding from the NIH. Dr Schuster reports funding from the National Institutes of Health, CDC, and Merck. Dr Selvarangan reports funding from NIH, CDC, Merck, Biofire, Abbott, GSK, Biorad, Becton and Dickinson, Hologic, Luminex and Diasorin. Dr Newland reports funding from NIH, Pfizer, and Merck. Dr McDaniels-Davidson reports funding from the Health Resources and Services Administration and NIH; she has received compensation as a consultant for Gilead Scientific; her spouse is employed by QuidelOrtho Corporation and participates in the employee stock purchase program. Dr Oren reports funding from the National Institutes of Health.

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