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Tuberculosis — United States, 2020

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Tuberculosis (TB) disease incidence has decreased steadily since 1993 (*1*), a result of decades of work by local TB programs to detect, treat, and prevent TB disease and transmission. During 2020, a total of 7,163 TB cases were provisionally reported to CDC's National Tuberculosis Surveillance System (NTSS) by the 50 U.S. states and the District of Columbia (DC), a relative reduction of 20%, compared with the number of cases reported during 2019.* TB incidence per 100,000 persons was 2.2 during 2020, compared with 2.7 during 2019. Since 2010, TB incidence has decreased by an average of 2%–3% annually (*1*). Pandemic mitigation efforts and reduced travel might have contributed to the reported decrease. The magnitude and breadth of the decrease suggest potentially missed or delayed TB diagnoses. Health care providers should consider TB disease when evaluating patients with signs and symptoms consistent with TB (e.g., cough of >2 weeks in duration, unintentional weight loss, and hemoptysis), especially when diagnostic tests are negative for SARS-CoV-2, the virus that causes COVID-19. In addition, members of the public should be encouraged to follow up with their health care providers for any respiratory illness that persists or returns after initial treatment. The steep, unexpected decline in TB cases raises concerns of missed cases, and further work is in progress to better understand factors associated with the decline.

Health departments in the 50 U.S. states and DC report cases of TB to CDC based on the Council for State and Territorial Epidemiologists' surveillance definition, which includes both laboratory and clinically verified cases.† For each case, health departments electronically submit a report of a verified case of TB to CDC. Although certain jurisdictions reported disruptions to routine TB prevention activities early in the pandemic (*2*), all reporting areas provided provisional reporting data to CDC. Among these reports, <5% of the data were missing, providing further confidence that they were reasonably complete. Provisional data were used to calculate national- and state-level TB case counts. Midyear U.S. Census Bureau population estimates§ were used for calculating national- and state-level TB

* This report is limited to National Tuberculosis Surveillance System data verified as of February 17, 2021. Updated data will be available in CDC's annual TB surveillance report later in 2021.

† https://www.cdc.gov/tb/programs/rvct/instructionmanual.pdf

§ https://www.census.gov/data/tables/time-series/demo/popest/2010s-national-total.html

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incidence per 100,000 persons. Case reports were grouped on the basis of self-reported race and ethnicity according to federal guidelines.[¶] Persons self-reporting Hispanic ethnicity are categorized as Hispanic regardless of self-reported race, persons not reporting Hispanic ethnicity are categorized by self-reported race, and non-Hispanic persons who self-reported more than one race are categorized as "multiple races." Midyear population estimates from the Current Population Survey[**] were used to calculate incidence by national origin and race/ethnicity.

A total of 7,163 TB cases were reported during 2020 (2.2 cases per 100,000 persons), 20% fewer than during 2019 (2.7 cases per 100,000 persons). Thirty-nine states and DC reported a decrease in cases, eight states reported an increase, and three reported no change. California reported the highest number of cases (1,703), and Alaska reported the highest incidence (7.9 cases per 100,000 persons) (Table 1). The East North Central region experienced the largest decrease in TB incidence (–25%).

During 2020, 71% of TB cases occurred among non–U.S.-born[††] persons, the same proportion as in 2019. Incidence decreased among both U.S.-born (0.9 to 0.7 cases per 100,000 persons) and non–U.S.-born persons (14.2 to 11.5 cases per 100,000 persons) (Figure). Among U.S.-born persons reported as having TB disease, 36% identified as Black, 28% as White, 24% as Hispanic, 5% as Asian, 4% as American Indian/Alaska Native (AI/AN), 2% as Native Hawaiian/other Pacific Islander (NH/PI), and 1% as multiple races.[§§] TB incidence decreased among all U.S.-born groups, except NH/PI[¶¶] (Table 2). Among non–U.S.-born persons with a diagnosis of TB, 48% identified as Asian, 32% as Hispanic, 13% as Black, 4% as White, 1% as NH/PI, 1% as multiple races, and <1% as AI/AN. During both 2019 and 2020, the most frequently reported countries of birth among non–U.S.-born persons were Mexico, the Philippines, India, Vietnam, and China.

During 2020, among all non–U.S.-born persons with TB cases, 10% had received a diagnosis ≤1 year after the person's arrival in the United States, compared with an average of 16% during 2015–2019. In addition, the proportion of cases identified among non–U.S.-born persons living in the United States for >20 years increased to 32% from an average of 28% during 2015–2019. The age distribution of persons with TB cases during 2020 was similar to the average distribution during 2015–2019. The largest proportion of cases occurred among persons aged 45–64 years (30%), followed by those aged 25–44 years (29%), ≥65 years (26%), 15–24 years (10%), 5–14 years (2%), and ≤4 years (2%).

¶ https://www.census.gov/topics/population/race/about.html

** https://www.census.gov/programs-surveys/cps.html

†† A person is considered U.S.-born if eligible for U.S. citizenship at birth, regardless of place of birth.

§§ Proportions were calculated excluding persons with missing race or ethnicity data.

¶¶ Small changes in case numbers or population size can lead to large relative changes because of the small size of this group.

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TABLE 1. Tuberculosis (TB) disease case counts, incidence, and annual percentage changes, by U.S. Census division and state — 50 states and the District of Columbia, 2019–2020

U.S. Census division	No. of cases* 2019	No. of cases* 2020	No. of cases* % Change	TB incidence† 2019	TB incidence† 2020	TB incidence† % Change§
Division 1: New England						
Connecticut	67	54	−19.4	1.9	1.5	−19.2
Maine	18	17	−5.6	1.3	1.3	−5.9
Massachusetts	178	142	−20.2	2.6	2.1	−20.2
New Hampshire	6	12	100.0	0.4	0.9	99.2
Rhode Island	14	9	−35.7	1.3	0.9	−35.7
Vermont	4	3	−25.0	0.6	0.5	−24.9
Subtotal	**287**	**237**	**−17.4**	**1.9**	**1.6**	**−17.4**
Division 2: Middle Atlantic						
New Jersey	310	237	−23.5	3.5	2.7	−23.5
New York	746	606	−18.8	3.8	3.1	−18.2
Pennsylvania	198	158	−20.2	1.5	1.2	−20.1
Subtotal	**1,254**	**1,001**	**−20.2**	**3.0**	**2.4**	**−19.9**
Division 3: East North Central						
Illinois	326	216	−33.7	2.6	1.7	−33.3
Indiana	108	92	−14.8	1.6	1.4	−15.1
Michigan	131	101	−22.9	1.3	1.0	−22.8
Ohio	150	130	−13.3	1.3	1.1	−13.3
Wisconsin	51	34	−33.3	0.9	0.6	−33.4
Subtotal	**766**	**573**	**−25.2**	**1.6**	**1.2**	**−25.1**
Division 4: West North Central						
Iowa	52	39	−25.0	1.6	1.2	−25.1
Kansas	38	38	—	1.3	1.3	—
Minnesota	148	117	−20.9	2.6	2.1	−21.2
Missouri	70	68	−2.9	1.1	1.1	−3.0
Nebraska	17	36	111.8	0.9	1.9	111.2
North Dakota	18	10	−44.4	2.4	1.3	−44.6
South Dakota	16	16	—	1.8	1.8	−0.6
Subtotal	**359**	**324**	**−9.7**	**1.7**	**1.5**	**−9.9**
Division 5: South Atlantic						
Delaware	19	16	−15.8	1.9	1.6	−16.7
District of Columbia	24	19	−20.8	3.4	2.7	−21.3
Florida	558	413	−26.0	2.6	1.9	−26.8
Georgia	298	221	−25.8	2.8	2.1	−26.4
Maryland	209	147	−29.7	3.5	2.4	−29.7
North Carolina	185	158	−14.6	1.8	1.5	−15.4
South Carolina	80	67	−16.3	1.6	1.3	−17.2
Virginia	191	168	−12.0	2.2	2.0	−12.4
West Virginia	10	13	30.0	0.6	0.7	30.8
Subtotal	**1,574**	**1,222**	**−22.4**	**2.4**	**1.8**	**−23.0**
Division 6: East South Central						
Alabama	87	75	−13.8	1.8	1.5	−14.0
Kentucky	66	67	1.5	1.5	1.5	1.4
Mississippi	58	41	−29.3	1.9	1.4	−29.0
Tennessee	129	113	−12.4	1.9	1.6	−13.1
Subtotal	**340**	**296**	**−12.9**	**1.8**	**1.5**	**−13.2**
Division 7: West South Central						
Arkansas	64	59	−7.8	2.1	1.9	−8.1
Louisiana	88	99	12.5	1.9	2.1	12.8
Oklahoma	73	67	−8.2	1.8	1.7	−8.7
Texas	1,162	888	−23.6	4.0	3.0	−24.6
Subtotal	**1,387**	**1,113**	**−19.8**	**3.4**	**2.7**	**−20.5**
Division 8: Mountain						
Arizona	183	136	−25.7	2.5	1.8	−27.0
Colorado	66	52	−21.2	1.1	0.9	−21.9
Idaho	7	8	14.3	0.4	0.4	11.9
Montana	2	4	100.0	0.2	0.4	98.1
Nevada	53	57	7.5	1.7	1.8	5.9
New Mexico	41	30	−26.8	2.0	1.4	−27.1
Utah	27	25	−7.4	0.8	0.8	−8.7
Wyoming	1	0	−100.0	0.2	—	−100.0
Subtotal	**380**	**312**	**−17.9**	**1.5**	**1.2**	**−19.0**

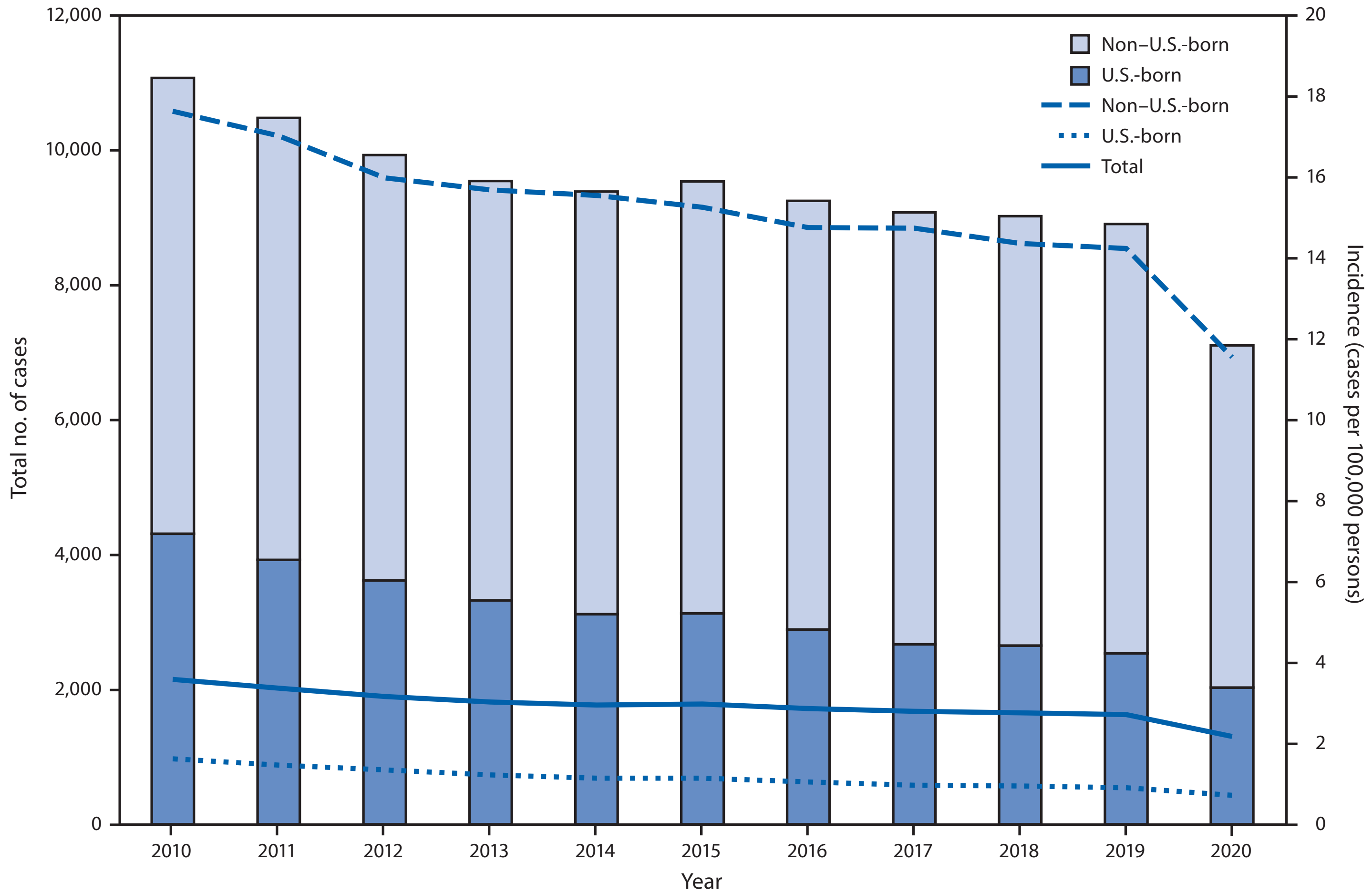
See table footnotes on the next page.

TABLE 1. (*Continued*) Tuberculosis (TB) disease case counts, incidence, and annual percentage changes, by U.S. Census division and state — 50 states and the District of Columbia, 2019–2020

	No. of cases*			TB incidence†		
U.S. Census division	**2019**	**2020**	**% Change**	**2019**	**2020**	**% Change§**
Division 9: Pacific						
Alaska	58	58	—	7.9	7.9	0.3
California	2,114	1,703	−19.4	5.4	4.3	−19.3
Hawaii	99	92	−7.1	7.0	6.5	−6.5
Oregon	70	67	−4.3	1.7	1.6	−4.9
Washington	221	165	−25.3	2.9	2.1	−26.1
Subtotal	**2,562**	**2,085**	**−18.6**	**4.8**	**3.9**	**−18.7**
Total	**8,909**	**7,163**	**−19.6**	**2.7**	**2.2**	**−19.9**

* Based on data reported to National Tuberculosis Surveillance System as of February 17, 2021.
† Cases per 100,000 persons. Rates calculated by using midyear population estimates from the U.S. Census Bureau.
§ Calculated by using unrounded figures.

FIGURE. Tuberculosis disease cases and incidence, by birth origin*,† — United States, 2010–2020



* Numbers of tuberculosis cases among persons with unknown origin are not shown (range = 2–61). Total rate includes cases among persons with unknown national origin.
† Rates for non–U.S.-born and U.S.-born persons were calculated by using midyear Current Population Survey estimates. Total rate was calculated by using midyear population estimates from the U.S. Census Bureau.

Discussion

TB cases and incidence have decreased gradually since the peak of resurgence in 1992 (*1*), highlighting the impact of nationwide TB control efforts. Although steep decreases have been reported previously, most notably after the 2008 economic recession (*3*), the annual decrease reported during 2020 is far larger than any reported during the last decade (*1*). Similar trends in TB have been reported globally (*4*) and for

TABLE 2. Tuberculosis disease case numbers and incidence per 100,000 persons, by race/ethnicity and birth origin — United States, 2017–2020

Birth origin and race/ethnicity	No. of cases* (incidence†) 2017	2018	2019	2020
U.S.-born§				
Hispanic	582 (1.5)	585 (1.5)	611 (1.5)	485 (1.2)
White, non-Hispanic	794 (0.4)	809 (0.4)	762 (0.4)	569 (0.3)
Black, non-Hispanic	1,004 (2.8)	950 (2.7)	908 (2.6)	719 (2.0)
Asian	126 (1.8)	134 (1.9)	117 (1.5)	106 (1.3)
American Indian/Alaska Native	91 (3.8)	102 (4.0)	79 (3.4)	71 (3.2)
Native Hawaiian/other Pacific Islander	44 (6.4)	41 (5.4)	25 (3.8)	42 (6.2)
Multiple or unknown race/ethnicity	29 (—¶)	30 (—¶)	32 (—¶)	35 (—¶)
Subtotal	**2,670 (1.0)**	**2,651(1.0)**	**2,534 (0.9)**	**2,027 (0.7)**
Non–U.S.-born				
Hispanic	1,975 (10.0)	2,045 (10.3)	2,079 (10.3)	1,619 (8.0)
White, non-Hispanic	264 (3.4)	258 (3.2)	252 (3.1)	220 (2.8)
Black, non-Hispanic	903 (22.3)	844 (20.3)	837 (19.8)	662 (15.3)
Asian	3,136 (27.4)	3,072 (26.1)	3,043 (26.1)	2,422 (21.7)
American Indian/Alaska Native	2 (2.9)	2 (3.5)	2 (3.5)	1 (2.5)
Native Hawaiian/Pacific Islander	67 (22.7)	73 (24.7)	80 (24.8)	69 (32.5)
Multiple or unknown race/ethnicity	56 (—¶)	71 (—¶)	76 (—¶)	82 (—¶)
Subtotal	**6,403 (14.7)**	**6,365 (14.4)**	**6,369 (14.2)**	**5,075 (11.5)**
Unknown national origin	6	3	6	61
Total	**9,079 (2.8)**	**9,019 (2.8)**	**8,909 (2.7)**	**7,163 (2.2)**

* Based on data reported to National Tuberculosis Surveillance System as of February 17, 2021.
† Cases per 100,000 persons. Rates for non–U.S.-born and U.S.-born persons were calculated by using Current Population Survey estimates. Total rate was calculated by using midyear population estimates from the U.S. Census Bureau.
§ A person is considered U.S.-born if eligible for U.S. citizenship at birth, regardless of place of birth.
¶ Rates could not be calculated for these categories because population estimates are not available.

other diseases domestically (*5*,*6*). Multiple factors have likely led to both a true decrease in TB incidence and underascertainment of cases.

The reduction in the number of persons with TB disease reported ≤1 year after arrival in the United States indicates that changes in immigration and travel patterns during 2020 might have contributed to a decrease in TB incidence. However, given the large proportion of cases that occur each year among persons who have been in the United States >1 year, particularly those who have been in the United States >10 years (*7*), and the broad decreases reported among both non–U.S.-born and U.S.-born populations, immigration and travel changes cannot fully explain the decrease in the number of reported TB cases during 2020. Another possible cause of this decrease is that mitigation strategies implemented for slowing the spread of COVID-19 (e.g., mask-wearing and social distancing) might have also reduced TB transmission.

The unexpectedly steep and widespread reduction in the number of reported TB cases causes concern regarding underdiagnosis. CDC has received anecdotal reports of persons who repeatedly sought medical attention for persistent TB signs and symptoms, received a negative test result for SARS-CoV-2 multiple times, and received a TB diagnosis much later (in certain cases on autopsy), demonstrating that other TB cases might have been missed during 2020. TB should be considered in the differential diagnosis of patients with prolonged (>2 weeks) cough or TB symptoms such as unintentional weight loss, particularly in the context of negative tests for SARS-CoV-2 and epidemiologic risk factors for TB (e.g., birth or former residence in a country with high TB incidence, a history of living in a congregate setting such as a homeless shelter or a correctional facility, or immune suppression). In such cases, health care providers should consider ordering rapid TB diagnostic tests (e.g., sputum microscopy or nucleic acid amplification tests) to quickly identify patients with TB disease. Clinical consultation for potential TB cases is also available through TB programs or the CDC-sponsored TB Centers of Excellence.***

Limited access to and reluctance to seek medical care during the COVID-19 pandemic have been reported (*8*) and might also contribute to underdiagnosis. Persons with persistent respiratory symptoms should be encouraged to seek medical attention and return to a health care provider if symptoms persist or return despite initial treatment (*8*,*9*). Timely TB diagnoses save lives and prevent further community transmission.

The findings in this report are subject to at least two limitations. First, this analysis is limited to provisional TB surveillance data reported for 2020. In previous years, final case counts have not differed substantially from provisional data. However, although anecdotal information from reporting areas

*** https://www.cdc.gov/tb/education/professionaltools.htm demonstrates that underreporting is not a major contributor to the reported decrease in TB incidence during 2020, underreporting from providers and underdiagnosis are possible. Second, denominators used to calculate incidence are based on estimated population numbers and might change slightly if population estimates are adjusted.

Further work is in progress to examine the causes of the steep decrease in reported TB cases. The extent of underdiagnosis will be explored by using external data sources of mortality, TB hospitalization, and anti-TB drug dispensation. Further analysis of laboratory data and conversations with clinical infection preventionists will help determine the extent of underreporting. In addition, changes in recent transmission will be examined by using isolate genotyping data. Identifying reversible causes of underdiagnosis or actual causes of an actual reduction in TB cases during 2020 will help identify effective public health responses. Supporting public health infrastructure for performing fundamental principles of TB control (e.g., case detection, contact tracing, and targeted testing and treatment for latent TB infection) is important. CDC remains committed to working with its public health partners to eliminate TB in the United States.

Summary

What is already known about this topic?

Tuberculosis (TB) incidence has decreased by an average of 2%–3% annually during the previous 10 years.

What is added by this report?

TB incidence during 2020 (2.2 cases per 100,000 persons) was 20% lower than that during 2019 (2.7 cases). The relative decrease in incidence was similar among U.S.-born and non–U.S.-born persons.

What are the implications for public health practice?

The steep decrease in TB incidence during the COVID-19 pandemic might be the result of reduced transmission and undetected cases. Health care providers should consider TB disease in patients with signs and symptoms consistent with TB, and the public should be encouraged to seek medical care when needed. Timely TB diagnoses save lives and prevent the spread of TB.

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Declines in Prevalence of Human Papillomavirus Vaccine-Type Infection Among Females after Introduction of Vaccine — United States, 2003–2018

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Human papillomavirus (HPV) is the most common sexually transmitted infection in the United States (*1*). Although most infections resolve without clinical sequalae, persistent HPV infection can cause cervical, other anogenital, and oropharyngeal cancers and anogenital warts. HPV vaccination has been recommended in the United States at age 11–12 years since 2006 for females and since 2011 for males. Catch-up vaccination is recommended through age 26 years.* A quadrivalent vaccine (4vHPV) targeting types 6, 11, 16, and 18 was mainly used until 2015, when a 9-valent vaccine (9vHPV), targeting the same four types as 4vHPV and five additional types (31, 33, 45, 52, and 58), was introduced; 9vHPV has been the only vaccine available in the United States since the end of 2016 (*2*). HPV vaccination coverage has increased but remains lower than that of other vaccinations recommended for adolescents (*3*). A decrease in prevalence of 4vHPV types detected in cervicovaginal swabs among young females from the prevaccine era (2003–2006) to 2007–2010 in the National Health and Nutrition Examination Survey (NHANES) was an early indicator of vaccine impact (*2*) and was also observed in later periods (*4*,*5*). NHANES data from 2017–2018 were included in this analysis to update HPV prevalence estimates among females aged 14–34 years. From the prevaccine era to 2015–2018, significant decreases in 4vHPV-type prevalence occurred among females aged 14–19 years (88%) and 20–24 years (81%). In sexually experienced females, 4vHPV-type prevalence decreased in those who reported receiving ≥1 HPV vaccine dose (97% among those aged 14–19 years, 86% among those aged 20–24 years) and in those who reported no vaccination (87% among those aged 14–19 years, 65% among those aged 20–24 years). Significant declines among unvaccinated females suggest herd effects. These data show increasing impact of HPV vaccination in the United States. HPV vaccination is a critical prevention tool against HPV infection, anogenital warts, and HPV-attributable precancers and cancers. HPV vaccination is highly effective and is recommended routinely at age 11–12 years and through 26 years for persons not already vaccinated.

NHANES is an ongoing cross-sectional survey conducted by CDC's National Center for Health Statistics designed to monitor the health and nutrition of the U.S. non-institutionalized civilian population. Data collection for NHANES was approved by the National Center for Health Statistics Research Ethics Review Board. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.† Demographic and HPV vaccination information are obtained during in-home interviews. Sexual behavior information is obtained via audio computer-assisted self-interview, and self-collected cervicovaginal specimens are obtained in mobile examination centers.§ CDC determines HPV DNA genotypes from these specimens using L1 consensus polymerase chain reaction testing followed by type-specific hybridization to detect 37 HPV types¶ and β-globin (*6*). Samples negative for both HPV and β-globin are considered inadequate and were excluded from analysis. Data from 2003 through 2018 were analyzed in 4-year periods: 2003–2006, 2007–2010, 2011–2014, and 2015–2018. Age groups were categorized as 14–19, 20–24, 25–29, and 30–34 years. Self-reported race/ethnicity was categorized as non-Hispanic White, non-Hispanic Black, Mexican American,** or other races. Self- or parent-reported vaccination history was analyzed as ever vaccinated (receipt of ≥1 dose). Sexual behaviors analyzed included ever having had sex†† (sexually experienced) and number of lifetime sex partners (fewer than three or three or more partners§§). HPV prevalences¶¶ and 95% confidence intervals (CIs) were estimated for each 4-year period for the following type categories: 4vHPV types,*** five additional 9vHPV

* https://www.cdc.gov/vaccines/hcp/acip-recs/vacc-specific/hpv.html#recs

† 45 C.F.R. part 46.102(l)(2), 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.

§ https://wwwn.cdc.gov/nchs/data/nhanes/2017-2018/manuals/2017_MEC_Interviewers_Procedures.pdf

¶ Research Use Only Linear Array HPV Genotyping Test which tests for HPV 6, 11, 16, 18, 26, 31, 33, 35, 39, 40, 42, 45, 51, 52[XR], 53, 54, 55, 56, 58, 59, 61, 62, 64, 66, 67, 68, 69, 70, 71, 72, 73, 81, 82, 83, 84, 89, and IS39.

** NHANES oversamples subpopulations to increase reliability and precision of estimates for specific racial/ethnic groups. Because of changes in oversampling methodology of persons who are Hispanic across the study period, the National Center for Health Statistics recommends that researchers do not report estimates for other Hispanic persons (i.e., Hispanic persons who are not Mexican American persons) using data before 2007 or for Hispanic subgroups other than Mexican American, in any survey cycle through 2018. Therefore, only estimates for persons who are Mexican American could be presented for this entire study period.

†† Anal, oral, or vaginal sex.

§§ Includes same sex and opposite sex partners.

¶¶ Prevalence estimates with a relative standard error of >30% were noted and considered unstable.

*** HPV 6, 11, 16, and 18.

types,††† non-4vHPV types,§§§ and non-9vHPV types.¶¶¶ Prevalence ratios (PRs) and adjusted prevalence ratios (aPRs), comparing 2015–2018 with 2003–2006, were estimated using logistic regression. For females aged 14–19 years, estimates were adjusted a priori for race/ethnicity and ever having had sex. For females aged 20–24, 25–29, and 30–34 years, estimates were adjusted a priori for race/ethnicity and number of lifetime sex partners. Distributions of participant characteristics and behaviors were estimated for each 4-year period; 2015–2018 was compared with 2003–2006 using Wald F tests. Among sexually experienced females, 4vHPV-type prevalence in each 4-year period was estimated overall, by age group and vaccination history. Complex survey analytic methods were used to account for the survey design; analyses used examination weights.**** Statistical significance was defined as $p<0.05$, or 95% CIs that did not include one for PRs. Prevalence estimates with relative standard error >30% were noted for stability concerns. Data management and analysis were performed using SAS (version 9.4; SAS Institute) and SUDAAN (version 11.0; RTI International). Because the analyses required restricted-use data, the data were accessed through CDC's Research Data Center.††††

Prevalence of 4vHPV-type infection decreased 88% among females aged 14–19 years, from 11.5% during 2003–2006 (prevaccine era) to 1.1% during 2015–2018 (aPR = 0.12; 95% CI = 0.06–0.26) (Table 1). Prevalence of five additional 9vHPV types in this age group decreased 65%, from 8.4% during 2003–2006 to 2.3% during 2015–2018 (aPR = 0.35; 95% CI = 0.18–0.65). Among females aged 20–24 years, 4vHPV-type prevalence decreased 81%, from 18.5% during 2003–2006 to 3.3% during 2015–2018 (aPR = 0.19; 95% CI = 0.09–0.40); the prevalence of the five additional 9vHPV types did not decline significantly. Among females in older age groups, no statistically significant differences in the prevalence of 4vHPV or the five additional 9vHPV types were noted from 2003–2006 to 2015–2018. Regarding HPV types not targeted by vaccine, among females aged 14–19 years, the prevalence of non-4vHPV types decreased from 31.2% during the prevaccine era to 20.9% during 2015–2018 (aPR = 0.72; 95% CI = 0.57–0.92); the prevalence of non-9vHPV types decreased from 29.0% to 20.6% (aPR = 0.77; 95% CI = 0.61–0.98). The prevalences of non-4vHPV and non-9vHPV types in the other age groups were not statistically significantly different during 2015–2018 compared with 2003–2006.

Reported receipt of ≥1 HPV vaccine dose increased from 2007–2010 to 2015–2018 in all age groups (Table 2). The percentages of females aged 14–19 years reporting ever having had sex and three or more lifetime partners were significantly lower during 2015–2018 than during 2003–2006. Among females in older age groups, during 2003–2006 and 2015–2018, >90% reported ever having had sex; the percentage with three or more lifetime partners did not change significantly. The distribution of race/ethnicity was different in most age groups during 2015–2018 than during the prevaccine era.

Among sexually experienced females, the prevalence of 4vHPV-type infections among those aged 14–19 years decreased from 19.3% during 2003–2006 to the following during 2015–2018: overall, 1.5% (PR = 0.08; 95% CI = 0.03–0.22); those vaccinated, 0.6% (PR = 0.03; 95% CI = 0.00–0.25); those unvaccinated, 2.4% (PR = 0.13; 95% CI = 0.03–0.48) (i.e., a 97% decrease among those vaccinated and an 87% decrease among those unvaccinated). In sexually experienced females aged 20–24 years, 4vHPV-type prevalence decreased from 17.9% during 2003–2006 to 2.5% (PR = 0.14; 95% CI = 0.05–0.41) among those vaccinated and to 6.3% (PR = 0.35; 95% CI = 0.14–0.85) among those unvaccinated during 2015–2018 (i.e. an 86% decrease among those vaccinated and a 65% decrease among those unvaccinated). Smaller, nonsignificant decreases in 4vHPV-type prevalences were observed among vaccinated females in older age groups: from 12.4% to 4.6% among those aged 25–29 years and from 9.0% to 4.4% among those aged 30–34 years (Figure) (Supplementary Table, https://stacks.cdc.gov/view/cdc/104147).

Discussion

During 2015–2018, the prevalence of 4vHPV types was 88% lower than that during the prevaccine era among females aged 14–19 years and 81% lower among those aged 20–24 years after adjustment for sexual behavior and race/ethnicity. The decline among females aged 14–19 years was first observed within 4 years of vaccine introduction (*2*), and prevalence has continued to decline in subsequent years (*4*). The decline among females aged 20–24 years was first observed within 6 years of vaccine introduction (*6*); 10 years after introduction, through 2016, 4vHPV-type prevalence among women aged 20–24 years had decreased 71% (*5*). This report, through 12 years after vaccine introduction, shows sustained low 4vHPV-type prevalence among females aged 14–19 years and larger declines among those aged 20–24 years.

Very few participants surveyed during 2017–2018 would have received 9vHPV; therefore, it is likely too early for

††† HPV 31, 33, 45, 52, and 58.

§§§ Thirty-three HPV types detected using linear array that are not HPV 6, 11, 16, or 18.

¶¶¶ Twenty-eight types detected using linear array that are not HPV 6, 11, 16, 18, 31, 33, 45, 52, or 58.

**** https://wwwn.cdc.gov/nchs/data/nhanes/analyticguidelines/11-16-analytic-guidelines.pdf

†††† https://www.cdc.gov/rdc/index.htm

TABLE 1. Prevalence of human papillomavirus (HPV) infection among females aged 14–34 years, by age group and survey years — National Health and Nutrition Examination Survey, United States, 2003–2018*

Age group (yrs) and HPV types	Prevaccine era 2003–2006	2007–2010	2011–2014	2015–2018	Comparison of 2015–2018 with 2003–2006 PR (95% CI)	aPR (95% CI)†
	% (95% CI)					
14–19	n = 1,363	n = 740	n = 797	n = 666	0.10 (0.05–0.21)	0.12 (0.06–0.26)
4vHPV§	11.5 (9.1–14.4)	5.0 (3.8–6.6)	3.3 (1.9–5.8)	1.1 (0.5–2.4)¶		
Additional five types in 9vHPV**	8.4 (6.6–10.6)	6.1 (4.4–8.5)	5.3 (3.4–8.4)	2.3 (1.3–4.1)	0.28 (0.15–0.51)	0.35 (0.18–0.65)
Non-4vHPV††	31.2 (27.9–34.8)	25.3 (21.4–29.5)	25.5 (21.3–30.2)	20.9 (16.9–25.6)	0.67 (0.53–0.84)	0.72 (0.57–0.92)
Non-9vHPV§§	29.0 (26.0–32.2)	24.4 (20.8–28.4)	24.7 (20.6–29.4)	20.6 (16.6–25.3)	0.71 (0.57–0.90)	0.77 (0.61–0.98)
20–24	n = 432	n = 445	n = 442	n = 368	0.18 (0.09–0.35)	0.19 (0.09–0.40)
4vHPV§	18.5 (14.9–22.8)	19.9 (15.4–25.3)	7.2 (4.7–11.1)	3.3 (1.7–6.3)¶		
Additional five types in 9vHPV**	16.5 (11.3–23.4)	13.8 (10.2–18.2)	13.2 (8.8–19.4)	10.2 (7.2–14.4)	0.62 (0.38–1.02)	0.62 (0.38–1.01)
Non-4vHPV††	50.7 (43.4–58.0)	57.4 (51.3–63.3)	55.8 (49.9–61.6)	49.9 (42.3–57.5)	0.98 (0.80–1.21)	0.97 (0.80–1.18)
Non-9vHPV§§	47.6 (40.7–54.6)	54.9 (48.9–60.8)	53.4 (47.8–58.8)	47.1 (39.7–54.7)	0.99 (0.80–1.22)	0.97 (0.79–1.18)
25–29	n = 403	n = 414	n = 395	n = 430	0.77 (0.46–1.29)	0.85 (0.50–1.46)
4vHPV§	11.8 (8.8–15.6)	13.1 (10.0–17.2)	8.8 (6.3–12.1)	9.1 (5.8–14.0)		
Additional five types in 9vHPV**	10.8 (7.3–15.7)	13.1 (9.7–17.3)	13.9 (10.5–18.1)	11.6 (8.1–16.3)	1.07 (0.64–1.79)	0.99 (0.58–1.67)
Non-4vHPV††	43.8 (38.9–48.9)	48.6 (43.7–53.6)	43.7 (37.7–49.9)	45.2 (39.2–51.4)	1.03 (0.87–1.23)	1.05 (0.86–1.27)
Non-9vHPV§§	39.8 (34.8–45.0)	44.7 (40.0–49.4)	42.0 (36.2–48.0)	42.1 (36.6–47.9)	1.06 (0.88–1.27)	1.07 (0.88–1.31)
30–34	n = 389	n = 433	n = 433	n = 413	0.65 (0.38–1.11)	0.67 (0.37–1.21)
4vHPV§	9.5 (6.7–13.2)	8.9 (6.5–11.9)	7.1 (5.1–9.9)	6.2 (4.0–9.5)		
Additional five types in 9vHPV**	9.8 (7.1–13.5)	6.8 (4.7–9.9)	6.9 (4.6–10.0)	6.9 (4.4–10.8)	0.70 (0.41–1.21)	0.68 (0.37–1.27)
Non-4vHPV††	44.5 (39.1–50.1)	37.8 (31.6–44.5)	39.2 (33.6–45.0)	34.7 (29.1–40.8)	0.78 (0.63–0.96)	0.82 (0.67–1.00)
Non-9vHPV§§	40.4 (35.0–46.0)	36.1 (30.3–42.3)	38.2 (32.7–44.0)	31.9 (26.6–37.6)	0.79 (0.64–0.98)	0.83 (0.67–1.03)

Abbreviations: aPR = adjusted prevalence ratio; CI = confidence interval; 4vHPV = quadrivalent HPV vaccine; 9vHPV = 9-valent HPV vaccine; PR = prevalence ratio.
* All analyses were weighted using the National Health and Nutrition Examination Survey examination sample weights.
† Adjustments for aPR: females aged 14–19 years, race/ethnicity and ever had sex; females aged 20–24, 25–29, and 30–34 years, race/ethnicity and number of lifetime sex partners (fewer than three or three or more).
§ HPV 6, 11, 16, or 18.
¶ Relative standard error >30% and ≤50%, considered unstable.
** HPV 31, 33, 45, 52, or 58.
†† Thirty-three HPV types detected using linear array that are not HPV 6, 11, 16, or 18.
§§ Twenty-eight HPV types detected using linear array that are not HPV 6, 11, 16, 18, 31, 33, 45, 52, or 58.

9vHPV vaccination to explain all of the decline in prevalence of the additional 9vHPV-type infections among females aged 14–19 years. The significant declines also in prevalences of non–4vHPV-type and non–9vHPV-type infections in this age group from the prevaccine era to 2015–2018 suggest lower exposure to HPV; this is consistent with the decrease in reported sexual behaviors from 2003–2006 to 2015–2018 in the current report. Lower exposure might have contributed to some of the observed decrease in 4vHPV-type prevalence among females aged 14–19 years. Among females aged 20–24 years, an age group with no significant changes in reported sexual behavior, a dramatic decline in 4vHPV-type prevalence from the prevaccine era to 2015–2018 occurred without significant change in non–4vHPV-type or non–9vHPV-type prevalence, demonstrating vaccine impact in the absence of potential changes in HPV exposure.

In addition to significantly lower 4vHPV-type prevalence among sexually experienced vaccinated females compared with those in the prevaccine era, 4vHPV-type prevalence was also lower among unvaccinated females: 87% in females aged 14–19 years and 65% in those aged 20–24 years. These findings suggest strong herd effects, or indirect protection of unvaccinated females, as reported in previous NHANES analyses and in data from other countries (*4*,*7*). The herd effects are likely attributable to less circulation of vaccine-type HPV because of both female and male vaccination in the United States (*2*,*3*).

The findings in this report are subject to at least three limitations. First, differences in sexual behavior were noted among females aged 14–19 years in 2015–2018 compared with 2003–2006. To account for this, prevalence ratios were adjusted for sexual behaviors, and a subanalysis was restricted to sexually experienced females; however, residual confounding might be present. Second, self- and parent-reported vaccination history could have resulted in misclassification, which might bias findings, including those related to herd effects (*8*). Finally, small sample size resulted in limited precision for certain subgroup analyses.

TABLE 2. Characteristics of females aged 14–34 years, by age group and survey years — National Health and Nutrition Examination Survey, United States, 2003–2018*

Age group (yrs) and characteristic	% (95% CI) Prevaccine era 2003–2006	2007–2010	2011–2014	2015–2018
14–19				
HPV vaccine history: ≥1 dose†	N/A	34.1 (28.4–40.3)	54.7 (49.6–59.7)	54.3 (49.2–59.4)
Ever had sex§	54.0 (50.9–57.0)	50.3 (45.0–55.6)	48.2 (43.0–53.3)	45.4 (41.0–49.8)
Three or more lifetime partners§	25.6 (22.5–29.0)	22.6 (19.9–25.5)	23.4 (19.4–27.9)	17.5 (14.3–21.2)
Race/Ethnicity§				
White, non-Hispanic	65.5 (58.9–71.6)	60.1 (54.4–65.6)	57.7 (50.2–64.9)	51.6 (43.3–59.8)
Black, non-Hispanic	14.8 (11.0–19.7)	15.3 (12.1–19.0)	14.5 (10.2–20.3)	14.6 (10.7–19.4)
Mexican American	10.1 (7.6–13.5)	12.4 (8.8–17.2)	13.6 (10.6–17.5)	15.1 (11.1–20.2)
Other races	9.5 (6.8–13.1)	12.2 (9.3–15.9)	14.1 (11.3–17.5)	18.7 (15.0–23.1)
20–24				
HPV vaccine history: ≥1 dose†	N/A	17.8 (12.4–24.9)	43.0 (36.0–50.4)	59.9 (53.0–66.5)
Ever had sex	91.4 (86.1–94.8)	91.9 (88.3–94.5)	91.4 (86.9–94.5)	94.9 (90.4–97.3)
Three or more lifetime partners	60.7 (53.7–67.2)	71.8 (66.1–77.0)	68.4 (63.9–72.5)	67.5 (62.3–72.4)
Race/Ethnicity				
White, non-Hispanic	61.6 (54.6–68.2)	56.7 (49.0–64.2)	55.7 (46.9–64.1)	55.3 (47.5–62.7)
Black, non-Hispanic	15.7 (11.1–21.9)	15.9 (12.3–20.5)	16.6 (11.4–23.6)	13.1 (9.1–18.6)
Mexican American	11.5 (8.2–15.9)	12.9 (9.0–18.0)	9.6 (6.6–13.8)	13.0 (8.2–20.1)
Other races	11.2 (7.7–15.9)	14.5 (10.3–19.9)	18.1 (13.8–23.4)	18.6 (14.2–23.9)
25–29				
HPV vaccine history: ≥1 dose†	N/A	7.8 (5.5–11.1)	24.8 (19.7–30.7)	40.7 (34.6–47.1)
Ever had sex	95.0 (91.7–97.1)	95.6 (92.0–97.7)	95.4 (92.5–97.2)	94.1 (89.8–96.7)
Three or more lifetime partners	73.2 (66.4–79.0)	71.9 (66.7–76.6)	71.8 (64.9–77.8)	72.1 (65.7–77.6)
Race/Ethnicity§				
White, non-Hispanic	65.0 (57.9–71.6)	63.6 (56.0–70.5)	56.4 (47.8–64.7)	53.8 (48.0–59.5)
Black, non-Hispanic	12.5 (8.9–17.4)	12.3 (8.7–17.2)	11.9 (8.6–16.2)	15.7 (11.5–21.1)
Mexican American	12.1 (8.6–16.7)	10.0 (7.2–13.6)	11.5 (7.6–16.9)	10.9 (6.9–16.7)
Other races	10.4 (7.1–14.9)	14.2 (10.4–19.0)	20.2 (15.9–25.4)	19.7 (15.3–25.0)
30–34				
HPV vaccine history: ≥1 dose†	N/A	3.7 (2.0–6.7)	7.0 (4.6–10.4)	18.9 (13.9–25.2)
Ever had sex	98.4 (95.4–99.4)	97.4 (93.0–99.1)	99.1 (97.8–99.7)	95.5 (91.7–97.7)
Three or more lifetime partners	73.6 (68.2–78.4)	69.3 (63.5–74.6)	75.9 (70.0–81.0)	72.3 (66.2–77.6)
Race/Ethnicity§				
White, non-Hispanic	61.8 (55.6–67.7)	58.1 (48.5–67.0)	59.7 (53.1–66.0)	53.4 (44.8–61.8)
Black, non-Hispanic	15.8 (11.6–21.2)	14.4 (9.9–20.5)	13.6 (10.2–18.0)	12.7 (9.2–17.1)
Mexican American	11.9 (9.4–15.1)	14.0 (9.8–19.7)	11.4 (7.4–17.4)	9.7 (6.5–14.4)
Other races	10.4 (6.8–15.7)	13.5 (9.3–19.2)	15.2 (12.6–18.2)	24.3 (18.5–31.2)

Abbreviations: CI = confidence interval; N/A = not applicable.
* All analyses were weighted using the National Health and Nutrition Examination Survey examination sample weights.
† Significant difference from 2015–2018 to 2007–2010 (p<0.05).
§ Significant difference from 2015–2018 to 2003–2006 (p<0.05).

This report adds to the robust data on the impact of the national HPV vaccination program, including herd effects. In addition to decreases in the prevalence of vaccine types, decreasing rates of cervical precancers and anogenital warts also have been demonstrated in the United States and other countries after introduction of HPV vaccination (*7*,*9*). The COVID-19 pandemic has the potential to reverse gains made in HPV vaccination coverage in the United States, as indicated by lower adolescent vaccine orders in 2020 (*3*,*10*). Efforts are needed to increase HPV vaccination to maintain the substantial progress of the vaccination program. Continued monitoring in NHANES will provide information to evaluate changes in U.S. vaccination recommendations and 9vHPV vaccine introduction on HPV prevalence as well as any setbacks attributable to the COVID-19 pandemic. HPV vaccination is a critical prevention tool against HPV infection, anogenital warts, and HPV-attributable precancers and cancers. HPV vaccination is highly effective and is recommended routinely at age 11–12 years and through age 26 years for persons not already vaccinated.

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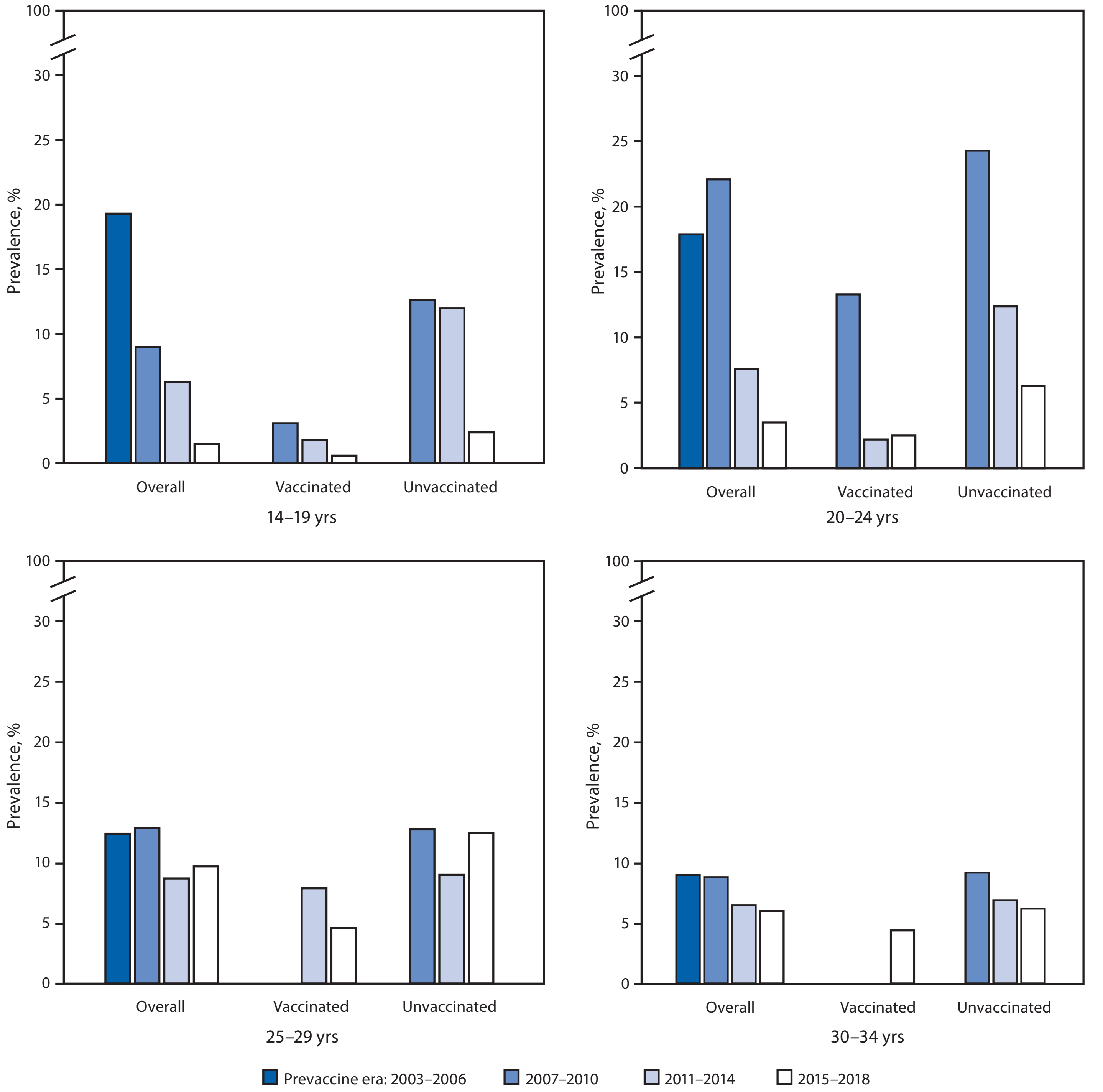
FIGURE. Quadrivalent vaccine-type (4vHPV-type) prevalence among sexually experienced females aged 14–34 years, by age group, vaccination history,* and survey years — National Health and Nutrition Examination Survey, United States, 2003–2018†,§



* Reported receipt of ≥1 HPV vaccine dose.
† All analyses were weighted using the examination sample weights.
§ Estimates are not shown for vaccinated females aged 25–29 years in 2007–2010 and for vaccinated females aged 30–34 years in 2007–2010 and 2011–2014 because of the low proportion of females in those age groups who were vaccinated.

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Summary

What is already known about this topic?

Through 2016, human papillomavirus (HPV) vaccine-type prevalence decreased among young females after introduction of HPV vaccination in 2006.

What is added by this report?

Nationally representative data through 2018 indicate that HPV vaccine-type prevalence continues to decline among females aged 14–19 (88%) and 20–24 (81%) years compared with before vaccination. The findings also show evidence of indirect protection of unvaccinated females through herd effects in these age groups.

What are the implications for public health practice?

HPV vaccination is a critical prevention tool against HPV infection, anogenital warts, and HPV-attributable precancers and cancers. HPV vaccination is highly effective and is recommended routinely at age 11–12 years and through age 26 years for persons not already vaccinated.

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Rapid Scale-up of an Antiretroviral Therapy Program Before and During the COVID-19 Pandemic — Nine States, Nigeria, March 31, 2019–September 30, 2020

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In 2018, an estimated 1.8 million persons living in Nigeria had HIV infection (1.3% of the total population), including 1.1 million (64%) who were receiving antiretroviral therapy (ART) (*1*). Effective ART reduces morbidity and mortality rates among persons with HIV infection and prevents HIV transmission once viral load is suppressed to undetectable levels (*2*,*3*). In April 2019, through the U.S. President's Emergency Plan for AIDS Relief (PEPFAR),* CDC launched an 18-month ART Surge program in nine Nigerian states to rapidly increase the number of persons with HIV infection receiving ART. CDC analyzed programmatic data gathered during March 31, 2019–September 30, 2020, to describe the ART Surge program's progress on case finding, ART initiation, patient retention, and ART Surge program growth. Overall, the weekly number of newly identified persons with HIV infection who initiated ART increased approximately eightfold, from 587 (week ending May 4, 2019) to 5,329 (week ending September 26, 2020). The ART Surge program resulted in 208,202 more HIV-infected persons receiving PEPFAR-supported ART despite the COVID-19 pandemic (97,387 more persons during March 31, 2019–March 31, 2020 and an additional 110,815 persons during April 2020–September 2020). Comprehensive, data-guided, locally adapted interventions and the use of incident command structures can help increase the number of persons with HIV infection who receive ART, reducing HIV-related morbidity and mortality as well as decreasing HIV transmission.

In April 2019, CDC launched an 18-month ART Surge program to rapidly increase the number of persons with HIV infection receiving ART.† CDC and its four implementing partners§ established incident command structures to manage operations in nine Nigerian states (*4*) with a combined estimated ART coverage gap of 320,921 persons with HIV infection not on ART, according to the 2018 Nigeria HIV/AIDS Indicator and Impact Survey (NAIIS) (*1*) (Benue, 35,623 of 320,921 [11%]; Delta, 34,325 of 320,921 [11%]; Enugu, 29,623 of 320,921 [9%]; Federal Capital Territory, 1,169 of 320,921 [0.4%]; Gombe, 684 of 320,921 [0.2%]; Imo, 33,401 of 320,921 [10%]; Lagos, 37,217 of 320,921 [12%]; Nasarawa, 10,207 of 320,921 [3%]; and Rivers, 138,672 of 320,921 [43%]). State-based consortiums with government and nongovernmental organizations were established to improve local engagement, along with high-level engagement by U.S. Mission Nigeria (U.S. Embassy and Consulate in Nigeria) leadership.¶ Implementing partners reported weekly site-level data, beginning April 28, 2019. Data were distributed broadly to critical stakeholders (e.g., CDC Nigeria country office, U.S. CDC headquarters, and implementing partners) through an Excel-based dashboard, which was used to analyze data and adapt operations. Interstate learning was facilitated through weekly videoconferences among stakeholders and site visits.

Weekly ART Surge programmatic data and quarterly PEPFAR Monitoring and Evaluation Reporting data,** was analyzed to assess ART Surge progress across four areas: 1) case findings†† measured by the weekly number of positive test results

* https://www.state.gov/pepfar/

† Among the NAIIS-derived estimated 1.8 million persons with HIV infection in Nigeria, 1.1 million were receiving ART; according to PEPFAR program data, 709,654 persons with HIV infection were receiving PEPFAR-supported ART as of December 31, 2018.

§ The Institute of Human Virology, Nigeria; the Centre for Integrated Health Program, Abuja, Nigeria; the Catholic Caritas Foundation Nigeria, and the AIDS Prevention Initiative in Nigeria.

¶ Since August 2019, senior leaders from the U.S. Mission Nigeria (including the ambassador, deputy chief of mission, and consul general), and country directors for the U.S. CDC and the U.S. Agency for International Development, engaged state governors, religious and traditional leaders, and civil society groups. Engagement activities included outreach to destigmatize HIV, advocacy to eliminate user fees for persons seeking HIV treatment, and requests for assistance with the provision of rapid test kits. Diplomatic engagement enlisted state governors in Benue, Imo, Lagos, Nasarawa, and Rivers to support ART Surge activities, resulting in increased health resources for and knowledge of the CDC ART Surge program.

** Weekly programmatic data reporting began the week ending on May 4, 2019. Reporting weeks end on Saturdays. All PEPFAR-supported countries are required to report Monitoring and Evaluation Reporting data quarterly.

†† Case finding interventions included prioritization of substate geographic units with the largest estimated ART coverage gap; enhanced use of a nationally validated risk stratification tool to screen persons with higher risk for HIV infection; engagement of core community-based organizations; targeted community testing; and programming based on weekly reported data.

and positivity rate (i.e., proportion of tests that were positive); 2) ART initiation, measured by the weekly number of newly identified persons with HIV infection who initiated ART and the rates of linkage to ART, using a proxy indicator calculated as the number of newly identified persons with HIV infection who initiated ART, divided by the number of positive test results; 3) annualized patient retention, measured using a proxy indicator calculated as the number of persons with HIV infection receiving ART as of March 31, 2020, divided by the sum of those receiving ART as of March 31, 2019, and the number of newly identified persons with HIV infection who initiated ART during April 1, 2019–March 31 2020; and 4) ART program growth, defined as the increase in total number of persons with HIV infection receiving ART between two time points. Persons with HIV infection receiving ART were defined as clients at a PEPFAR-supported site in one of the nine states with a maximum of 27 days since their last appointment; clients whose last appointment was ≥28 days earlier were considered to not be receiving ART. Medians were assessed overall and by state for each of the four programmatic areas, and positivity rates were assessed compared with NAIIS-estimated state prevalence. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[§§]

During May 4, 2019–March 21, 2020, the weekly number of HIV tests conducted in the nine states that participated in the ART Surge program increased 500%, from 14,244 to 85,326 tests conducted, and the weekly number of positive test results increased 370%, from 622 to 2,929 persons with HIV infection identified (Figure 1). The overall median weekly positivity rate was 4.3% (range = 3.4% [March 21, 2020] to 5.4% [July 27, 2019]). The state median weekly positivity rate was above the estimated state prevalence (median positivity rate range = 2.5% in Nasarawa [estimated state prevalence = 1.6%] to 9.2% in Benue [estimated state prevalence = 4.3%]). The weekly number of newly identified persons with HIV infection who initiated ART increased 410% from 587 to 2,996 (Figure 2). The overall median weekly proxy for ART initiation was 101% (range = 93% [May 11, 2019] to 107% [September 28, 2019]). State median weekly proxies for ART initiation ranged from 96% in Lagos to 117% in Benue.[¶¶] In the first 12 months of the ART Surge program, the number of persons with HIV infection receiving ART in the nine ART Surge states increased by 97,387 (30%), from 322,247 on March 31, 2019, to 419,634 on March 31, 2020 (Table). The annualized (March 2019–March 2020) proxy retention indicator was 99% overall, and the state proxy retention indicator ranged from 88% in Lagos to 117% in Gombe.[***]

ART Surge activities were affected by the COVID-19 pandemic during March–May 2020,[†††] with fewer tests conducted, fewer positive test results, and fewer newly identified persons with HIV infection who initiated ART. Following Nigeria Centre for Disease Control guidelines, the ART Surge program implemented COVID-19 mitigation measures, including provision of face masks for staff members, enhanced hand hygiene by staff members and clients during clinical visits, and physical distancing measures (e.g., staggered clinical appointments, 2-meter spacing between seating). Given limitations in facility-based services, community-based activities were increased through mobile teams, toward strengthened case finding, ART initiation, and patient retention. By May 16, 2020, ART Surge activities returned to prepandemic levels (i.e., those before March 21, 2020) and continued to increase (Figure 1) (Figure 2). During April 2020–September 2020, 109,398 persons with newly identified HIV infection initiated ART and the number of persons with HIV infection receiving ART increased by 110,815 (26%) (from 419,634 [March 31, 2020] to 530,449 [September 30, 2020]) (Table).

Discussion

During May 2019–September 2020, ART Surge activities in nine Nigerian states resulted in an approximate eightfold increase in the weekly number of newly identified persons with HIV infection who initiated ART and a 65% increase in the total number of persons (208,202) with HIV infection receiving PEPFAR-supported ART. During April–September 2020 alone, ART Surge activities resulted in an increase of 26% in the total number of persons (110,815) with HIV infection receiving ART across nine Nigerian states, demonstrating rapid program adaptation during the COVID-19 pandemic. These increases accelerated progress toward achieving the Joint United Nations Programme on HIV/AIDS (UNAIDS) targets (*5*). Estimates from the NAIIS were crucial in identifying states and substate geographic units with a large estimated number of persons with HIV infection who were not receiving ART

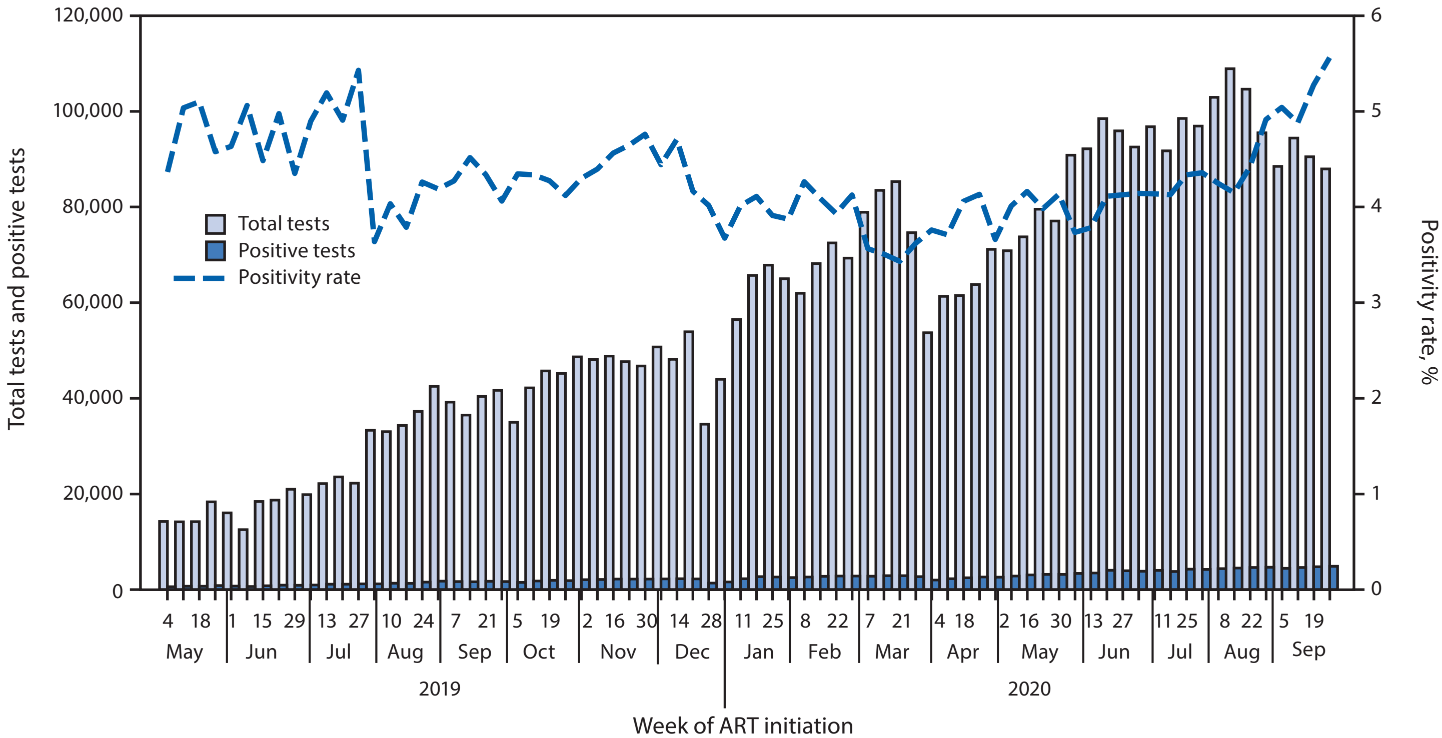
§§ 45 C.F.R. part 46.102(l)(2), 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.

¶¶ A proxy indicator for ART initiation was calculated as the number of newly identified persons with HIV infection who initiated ART divided by the number of positive test results. As such, ART initiation rates using the proxy indicator could exceed 100% if persons with HIV infection identified in 1 week did not initiate ART until the following week.

*** The proxy indicator did not directly measure the number of persons with HIV infection retained on ART, and the total number of persons with HIV infection receiving PEPFAR-supported ART included persons with HIV who entered into the ART program for reasons other than ART initiation (e.g., reengaged persons with HIV infection). Thus, >100% retention was possible.

††† On February 27, 2020, the Nigeria Centre for Disease Control confirmed the first confirmed COVID-19 case and activated an Emergency Operations Center on February 28. Thereafter, the Government of Nigeria implemented COVID-19 mitigation efforts, including school closures (beginning March 19), international travel bans (beginning March 23), and statewide stay-at-home orders (beginning March 30).

FIGURE 1. Total number of HIV tests conducted, positive test results, and positivity rate (%),* by week — nine Nigerian states†,§ participating in the Antiretroviral Therapy (ART) Surge program, May 4, 2019–September 26, 2020



* Positivity rate was calculated as the number of positive tests divided by the total number of tests conducted using weekly reported programmatic data. Reporting began the week ending with May 4, 2019. Reporting weeks end on Saturdays.

† Benue, Delta, Enugu, Federal Capital Territory, Gombe, Imo, Lagos, Nasarawa, and Rivers.

§ On February 27, 2020, the Nigeria Centre for Disease Control confirmed the first confirmed COVID-19 case and activated an Emergency Operations Center on February 28. Thereafter, the government of Nigeria implemented COVID-19 mitigation efforts, including school closures (beginning March 19), international travel bans (beginning March 23), and statewide stay-at-home orders (beginning March 30).

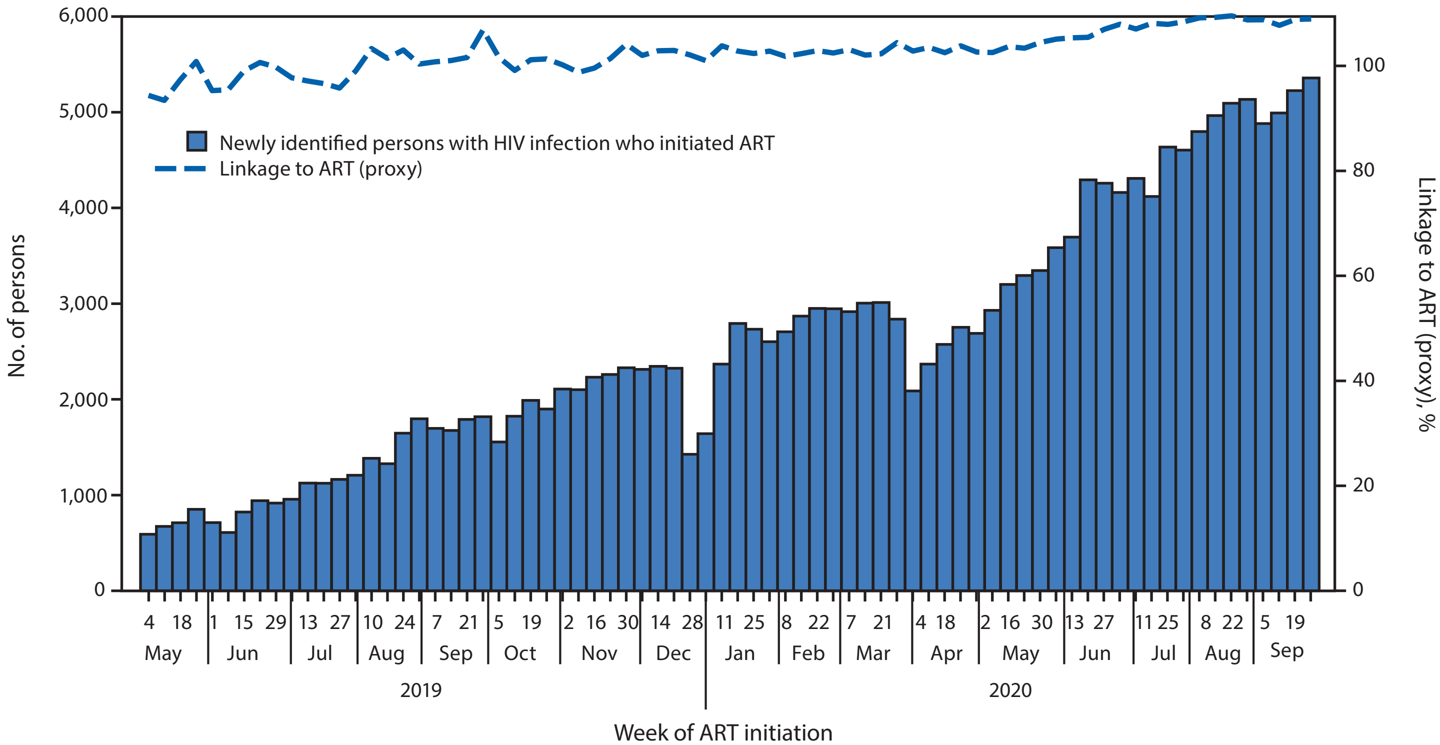
(*1*). In addition, the ART Surge program's incident command structures provided flexible management of operations, and weekly data disseminated through a user-friendly dashboard allowed for data-guided, locally adapted interventions and improved accountability. Collaboration among ART Surge states facilitated interstate learning and helped disseminate successful interventions to achieve broader implementation. Finally, diplomatic engagement with governors and local leaders helped combat HIV stigma, supported the elimination of user fees (e.g., registration fees and folder fees), and assisted with the provision of rapid test kits from local stakeholders.

Despite this progress, many persons with HIV infection in Nigeria remain unaware of their status and are not receiving ART (*1*). Additional interventions could help improve case finding, ART initiation, and patient retention. For example, in October 2020, through PEPFAR, CDC expanded the ART Surge program strategies to nine additional states.[§§§] Data analysis that supports programmatic activities, such as case finding and rapid linkage to treatment, might help identify more persons with HIV infection who are not receiving ART, including female sex workers and men who have sex with men, who are among the populations at higher risk for infection. As more persons with HIV infection receive ART, adherence, patient retention, and viral load suppression remain critical. In addition, preventive measures to minimize losses and reengage persons with HIV infection who miss appointments, or have dropped out of care, are important to reach and maintain ART coverage targets. Site-level improvements adapted to local needs and preferences are also important.

The findings in this report are subject to at least four limitations. First, despite continual PEPFAR data quality assurance activities, data quality might be affected by reporting challenges (e.g., site-level electricity or Internet outages preventing data transmission). Second, newly identified patients with HIV infection were categorized by client self-reporting; therefore, the actual proportion of newly identified persons with HIV infection who initiated ART is unknown. Third, proxy indicators derived from aggregate program data were used to evaluate

§§§ In addition to the nine ART Surge states (Benue, Delta, Enugu, Federal Capital Territory, Gombe, Imo, Lagos, Nasarawa, and Rivers), in October 2020, through PEPFAR, CDC expanded the ART Surge program strategy to the following nine states: Ekiti, Kaduna, Katsina, Kogi, Ogun, Ondo, Osun, Oyo, and Plateau.

FIGURE 2 . Number of newly identified persons with HIV infection who initiated antiretroviral therapy (ART) and proxy indicator for linkage to ART (%),* by week — nine Nigerian states[†,§] participating in the ART Surge program, May 4, 2019–September 26, 2020



* Using weekly reported program data, a proxy indicator for ART initiation was calculated as the number of newly identified persons with HIV infection who initiated ART divided by the number of positive test results. ART initiation rates using the proxy indicator could exceed 100%, including if persons with HIV infection identified in one week did not initiate ART until the following week. Weekly programmatic data reporting began the week ending May 4, 2019. Reporting weeks end on Saturdays.

† Benue, Delta, Enugu, Federal Capital Territory, Gombe, Imo, Lagos, Nasarawa, and Rivers.

§ On February 27, 2020, the Nigeria Centre for Disease Control confirmed the first confirmed COVID-19 case, and activated an Emergency Operations Center on February 28. Thereafter, the government of Nigeria implemented COVID-19 mitigation efforts, including school closures (beginning March 19), international travel bans (beginning March 23), and statewide stay-at-home orders (beginning March 30).

ART initiation and patient retention, which might vary from patient-level analysis. Finally, persons with HIV infection can access health services at any site, regardless of state of residence; therefore, some persons might have been counted more than once, which limited direct assessment of ART coverage.

Despite the challenges of the COVID-19 pandemic, CDC's ART Surge program has accelerated progress toward HIV epidemic control in Nigeria, which is aligned with UNAIDS targets (*5*). Comprehensive, data-guided, locally adapted interventions and incident command structures can help increase and retain the number of persons with HIV infection who receive ART, reducing HIV-related morbidity and mortality as well as decreasing HIV transmission.

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Nigerian federal and state governments; state-based consortium; site staff members; implementing partners.

Summary

What is already known about this topic?

In 2018, an estimated 1.8 million persons living in Nigeria had HIV infection. Through the U.S. President's Emergency Plan for AIDS Relief (PEPFAR), CDC launched an 18-month antiretroviral therapy (ART) Surge program in nine Nigerian states in April 2019, including implementation of incident command structures to manage operations.

What is added by this report?

The weekly number of persons with newly identified HIV infection who initiated ART increased approximately eightfold, from May 4, 2019, to September 26, 2020. Compared with March 2019, a total of 208,202 more persons were receiving PEPFAR-supported ART in September 2020.

What are the implications for public health practice?

Comprehensive, data-guided, locally adapted interventions and use of incident command structures can increase the number of persons with HIV infection who receive ART, reducing mortality and decreasing HIV transmission.

TABLE. Number of persons with HIV infection receiving antiretroviral therapy (ART), total number of newly identified persons with HIV infection who initiated ART, and annualized proxy retention indicator, before and during COVID-19 — nine Nigerian states participating in the ART Surge program,* March 31, 2019–September 30, 2020

ART Surge program states	Before COVID-19 (April 2019–March 2020): No. of persons with HIV receiving ART, As of Mar 31, 2019	No. of persons with HIV receiving ART, As of Mar 31, 2020	Newly identified persons with HIV infection who initiated ART† (total no.)	Program growth§ (% increase)	Proxy indicator for retention (%)¶	During COVID-19 (April 2020–September 2020): No. of persons with HIV infection receiving ART, As of Jun 30, 2020	No. of persons with HIV infection receiving ART, As of Sep 30, 2020	Newly identified persons with HIV infection who initiated ART** (total no.)	Program growth†† (% increase)	ART Surge total (April 2019–September 2020): Newly identified persons with HIV infection who initiated ART§§ (total no.)	Program growth¶¶ (% increase)
Total	**322,247**	**419,634**	**102,497**	**97,387 (30)**	**99**	**461,574**	**530,449**	**109,398**	**110,815 (26)**	**211,895**	**208,202 (65)**
Benue	136,606	156,579	21,280	19,973 (15)	99	160,626	171,434	15,945	14,855 (9)	37,225	34,828 (25)
Delta	15,208	20,673	6,080	5,465 (36)	97	26,234	32,779	12,790	12,106 (59)	18,870	17,571 (116)
Enugu	18,110	22,893	5,640	4,783 (26)	96	25,035	28,783	6,307	5,890 (26)	11,947	10,673 (59)
Federal Capital Territory	38,185	44,901	8,161	6,716 (18)	97	48,777	57,007	11,520	12,106 (27)	19,681	18,822 (49)
Gombe	14,377	21,284	3,805	6,907 (48)	117	22,263	24,675	3,218	3,391 (16)	7,023	10,298 (72)
Imo	12,057	16,945	5,174	4,888 (41)	98	19,104	21,162	4,650	4,217 (25)	9,824	9,105 (76)
Lagos	25,291	31,538	10,535	6,247 (25)	88	38,404	44,819	12,448	13,281 (42)	22,983	19,528 (77)
Nasarawa	36,372	42,780	7,419	6,408 (18)	98	44,865	50,057	6,439	7,277 (17)	13,858	13,685 (38)
Rivers	26,041	62,041	34,403	36,000 (138)	103	76,266	99,733	36,081	37,692 (61)	70,484	73,692 (283)

* The ART Surge program is supported by CDC through the U.S. President's Emergency Plan for AIDS Relief (PEPFAR).
† Includes all newly identified persons with HIV infection who initiated ART during April 2019–March 2020.
§ Difference between the number of persons with HIV infection receiving ART on March 31, 2019 and March 31, 2020.
¶ PEPFAR Monitoring and Evaluation Reporting quarterly data; the annualized proxy retention indicator is calculated as the number of persons with HIV infection receiving PEPFAR-supported ART as of March 31, 2020, divided by the sum of the number of persons with HIV infection receiving PEPFAR-supported ART as of March 31, 2019, and the number of newly identified persons with HIV infection who initiated ART during April 1, 2019–March 31, 2020. The proxy indicator does not directly measure the number of persons with HIV infection retained on ART, and persons with HIV infection entered into the ART program for reasons other than ART initiation (e.g., re-engaged persons with HIV infection). Thus, >100% retention is possible.
** Includes all newly identified persons with HIV infection who initiated ART during April 2020–September 2020.
†† Difference between the number of persons with HIV infection receiving ART on March 31, 2020, and September 30, 2020.
§§ Includes all newly identified persons with HIV infection who initiated ART during April 2019–September 2020.
¶¶ Difference between the number of persons with HIV infection receiving ART on March 31, 2019, and September 30, 2020.

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Epidemiology of Tuberculosis and Progress Toward Meeting Global Targets — Worldwide, 2019

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Although tuberculosis (TB) is curable and preventable, in 2019, TB remained the leading cause of death from a single infectious agent worldwide and the leading cause of death among persons living with HIV infection (*1*). The World Health Organization's (WHO's) End TB Strategy set ambitious targets for 2020, including a 20% reduction in TB incidence and a 35% reduction in the number of TB deaths compared with 2015, as well as zero TB-affected households facing catastrophic costs (defined as costs exceeding 20% of annual household income) (*2*). In addition, during the 2018 United Nations High-Level Meeting on TB (UNHLM-TB), all member states committed to setting 2018–2022 targets that included provision of TB treatment to 40 million persons and TB preventive treatment (TPT) to 30 million persons, including 6 million persons living with HIV infection and 24 million household contacts of patients with confirmed TB (4 million aged <5 years and 20 million aged ≥5 years) (*3*,*4*). Annual data reported to WHO by 215 countries and territories, supplemented by surveys assessing TB prevalence and patient costs in some countries, were used to estimate TB incidence, the number of persons accessing TB curative and preventive treatment, and the percentage of TB-affected households facing catastrophic costs (*1*). Globally, TB illness developed in an estimated 10 million persons in 2019, representing a decline in incidence of 2.3% from 2018 and 9% since 2015. An estimated 1.4 million TB-related deaths occurred, a decline of 7% from 2018 and 14% since 2015. Although progress has been made, the world is not on track to achieve the 2020 End TB Strategy incidence and mortality targets (*1*). Efforts to expand access to TB curative and preventive treatment need to be substantially amplified for UNHLM-TB 2022 targets to be met.

TB data are reported annually to WHO by 215 countries and territories and are reviewed and validated in collaboration with reporting entities (*1*). Four methods are used to estimate TB incidence: 1) TB prevalence surveys; 2) notifications from country surveillance systems, adjusted by a standard factor to account for underreporting, overdiagnosis, and underdiagnosis; 3) TB inventory studies that measure the level of underreporting of persons with diagnosed TB combined with capture-recapture modeling; and 4) national notification data supplemented by expert opinion regarding case detection gaps. For HIV-negative persons, estimates of TB mortality were based on all-cause mortality data from civil registration and vital statistics, mortality surveys, or the product of TB incidence and the case-fatality rate (CFR) (i.e., the proportion of persons with TB who die from the disease) (*1*). Among persons living with HIV infection, TB mortality estimates were calculated as the product of incidence and the CFR. The number of persons receiving TB curative and preventive treatment is reported by individual countries directly to WHO. National TB patient cost surveys were used to assess the proportion of TB-affected households facing catastrophic costs.

Globally, TB illness developed in an estimated 10 million persons in 2019 (130 per 100,000 population), 815,000 (8.2%) of whom were HIV-infected (Table). Overall, TB incidence declined 2.3% from 2018 and 9% from 2015. An estimated 1.4 million persons died from TB in 2019, including 208,000 persons who were living with HIV infection. The

TABLE. Estimated number of incident tuberculosis (TB) cases, TB incidence rate, number of TB-associated deaths among all persons and among HIV-positive persons, and number of TB patients with rifampicin-resistant TB (RR-TB), by World Health Organization region — worldwide, 2019

WHO region	No. of TB cases, x1,000	Incidence*	No. of deaths, x1,000 (CFR, %)	No. of TB cases among HIV-positive persons, x1,000	No. of TB deaths among HIV-positive persons, x1,000	No. of RR-TB cases,† x1,000	Incidence of RR-TB*,†	% of RR-TB cases†
Global (all regions)	**9,960**	**130**	**1,418 (14.2)**	**815.0**	**208.0**	**465**	**6.1**	**4.7**
African	2,470	226	547 (22.1)	595.0	169.0	77	7.0	3.1
Americas	290	29	22.9 (7.9)	29.0	5.9	11	1.0	3.8
Eastern Mediterranean	819	114	78.7 (9.6)	7.9	2.7	36	5.0	4.4
Europe	246	26	24.2 (9.8)	30.0	4.2	70	7.5	28.5
South-East Asia	4,340	217	652 (15.0)	117.0	20.0	171	8.6	3.9
Western Pacific	1,800	93	90.3 (5.0)	36.0	6.3	101	5.2	5.6

Source: Adapted from World Health Organization. Global tuberculosis report 2020. Geneva, Switzerland: World Health Organization; 2020. https://www.who.int/teams/global-tuberculosis-programme/tb-reports
Abbreviation: CFR = case-fatality rate.
* Number of cases per 100,000 population.
† Includes multidrug-resistant TB.

total number of TB deaths declined by 7% from 2018 to 2019 and by 14% since 2015 (*1*).

During 2019, multidrug-resistant (MDR) TB illness (TB that is resistant to at least isoniazid and rifampicin, the two most potent anti-TB drugs) (*5*) or rifampicin-resistant TB illness (RR-TB) developed in an estimated 465,000 persons. These patients accounted for 4.7% of all persons with TB, 3.3% of persons with a new TB diagnosis, and 18% of persons previously treated for TB.

Most persons who became ill with TB in 2019 lived in the WHO regions of South-East Asia (44%), Africa (25%), and the Western Pacific (18%), with smaller percentages in the Eastern Mediterranean (8.2%), the Americas (2.9%), and Europe (2.5%) (Table). Eight countries accounted for two thirds of the total global TB cases: India (26%), Indonesia (8.5%), China (8.4%), the Philippines (6.0%), Pakistan (5.7%), Nigeria (4.4%), Bangladesh (3.6%), and South Africa (3.6%). The WHO European and African regions have experienced the largest declines in incidence (19% and 16%, respectively) and mortality (31% and 19%, respectively) since 2015.

If persons who received a TB diagnosis that was reported to national authorities are assumed to be treated for TB (*1*), then in 2019, a total of 7.1 million persons were treated for TB, a slight increase from 7.0 million in 2018. With an estimated 10 million incident cases, this leaves a gap of 2.9 million persons with incident TB who either did not receive a diagnosis or did receive a diagnosis but were not reported to national authorities. Among the estimated 815,000 HIV-infected persons with cases of incident TB, 456,426 (56%) persons were reported as having received a diagnosis and been treated. Among the estimated 465,000 persons with incident MDR or RR-TB, only 177,099 (38%) were enrolled in MDR or RR-TB treatment.

A total of 4.1 million persons received TPT in 2019 (Figure), an 86% increase from 2.2 million in 2018 and a 300% increase from 1.0 million in 2015. Most persons who received TPT were persons living with HIV infection (3.5 million in 2019 and 1.8 million in 2018). Among the estimated 1.3 million children aged <5 years who were household contacts of TB patients, 433,156 (33%) received TPT in 2019, compared with 349,796 (27%) in 2018 (an 18% increase in the number of children treated). Among older household contacts, the number of persons who received TPT was 105,240 persons in 2019 and 73,811 in 2018 (a 43% increase). The total number of older household contacts is unknown.

Among 17 countries that have completed national TB patient cost surveys since 2015, an average of 49% of TB-affected households faced catastrophic costs (country-level estimates = 19%–83%). This figure increased to 80% in households affected by drug-resistant TB (country-level estimates = 67%–100%) (*1*).

Discussion

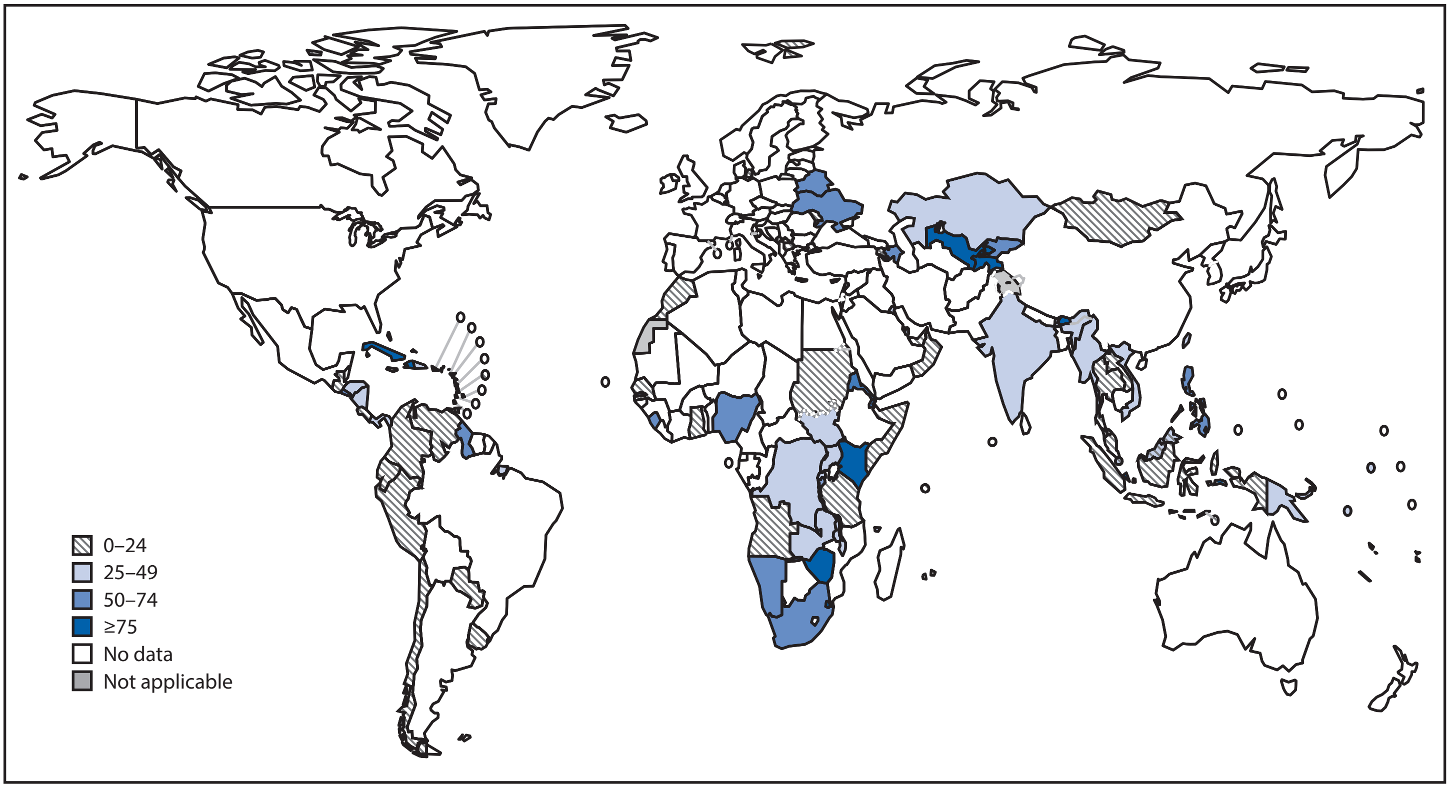
Globally, although TB incidence and mortality have been steadily decreasing, these declines are likely not occurring quickly enough for WHO End TB Strategy targets to be reached, with only a 9% decrease in incidence (2020 target = 20% decrease) and a 14% decrease in the number of deaths (2020 target = 35% decrease) from 2015 to 2019. The WHO European region is on track to reach both the incidence and mortality targets, and the African region has made progress toward meeting the targets. However, with one half of TB-affected households facing catastrophic costs, the world is far from reaching the WHO target of zero TB-affected households facing catastrophic costs.

Although challenges remain, assessment of the UNHLM-TB targets after the second year of the 2018–2022 timeline is more encouraging. During 2018 and 2019, a total of 14.1 million persons (35% of the UNHLM target) received TB treatment globally. For the target of 40 million patients treated to be achieved, an additional 26 million persons need to be treated during 2020–2022, which would represent substantial progress toward closing the gap between the number of persons who become ill with TB and the number who receive a diagnosis and are treated each year.

Although substantial progress has been made in TPT implementation, only 6.3 million persons, less than one fourth (23%) of the UNHLM-TB target, received TPT in 2018 and 2019. For the target of 30 million persons receiving TPT during 2018–2022 to be achieved, approximately 24 million additional persons must be reached with TPT during 2020–2022. Most persons who have received TPT to date are living with HIV infection, and the world is on track to reach the UNHLM target for this group. Despite strong growth in TPT provision to these persons, providing TPT to household contacts of TB patients, especially persons aged ≥5 years, continues to face substantial challenges.

Acceleration of TB service provision in 2020 was not possible in most countries because of the COVID-19 pandemic. Stay-at-home orders, movement restrictions, and the prioritization of COVID-19 mitigation activities have affected TB services through restricted service provision, diverted human resources, and disrupted supply chains (*6*). This has likely led to reductions in timely diagnosis and treatment of new tuberculosis cases (*7*). India, Indonesia, the Philippines, and South Africa reported monthly decreases in TB case notifications to approximately 50% of the January 2020 total during the first 6 months of 2020, with reductions of smaller magnitudes (25%–30%) reported by other high-incidence countries (*1*). The COVID-19 pandemic is continuing in 2021 and will have a long-term impact on national TB programs as well as global TB incidence and prevalence (*7*).

FIGURE. Percentage of persons living with HIV infection and on antiretroviral treatment who received tuberculosis preventive treatment — worldwide, 2019



Source: Adapted from World Health Organization. Global tuberculosis report 2020. Geneva, Switzerland: World Health Organization; 2020. https://www.who.int/teams/global-tuberculosis-programme/tb-reports

The findings in this report are subject to at least three limitations. First, underlying data quality, particularly for surveillance, might affect the accuracy of country estimates. Second, the differing methodologies used to generate country-level estimates might affect the comparability of estimates between regions and countries. Finally, a limited number of countries completed a national survey of costs faced by TB patients and their households, which might affect the generalizability of this indicator.

Programmatic efforts will need to be substantially enhanced for UNHLM targets for TB curative and preventive treatment to be reached by 2022, and more broadly, for future WHO End TB strategy targets to be met. For global TB targets to be achieved, innovations and adaptations in TB diagnosis, care, and treatment are needed to accelerate global TB progress and to meet the additional challenges presented by the COVID-19 pandemic (*8*), which threatens not only to slow future progress but also to reverse the gains made in recent years. However, the pandemic also provides new and unique opportunities to implement and evaluate innovations such as dual TB and COVID-19 screening of patients with respiratory symptoms, as well as multi-month dispensing of TPT and TB treatment combined with the use of digital health technologies to monitor patients in the context of fewer face-to-face encounters. Services for TB are an essential component of resilient health systems and can be strengthened by promoting synergies in the responses to both TB and COVID-19.

Summary

What is already known about this topic?

The 2018 United Nations High Level Meeting on Tuberculosis (TB) and the World Health Organization's End TB Strategy set ambitious goals for reducing TB incidence, deaths, and patient costs and increasing the provision of TB curative and preventive treatment.

What is added by this report?

With an estimated 10 million incident TB cases and 1.4 million TB deaths in 2019, the world is not on track to achieve global targets. Further, the COVID-19 pandemic has hampered TB-related service delivery in many countries.

What are the implications for public health practice?

Innovations and adaptations in TB diagnosis, care, and treatment are needed to accelerate global TB progress and overcome the COVID-19 pandemic–associated challenges to TB diagnosis and treatment.

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County-Level COVID-19 Vaccination Coverage and Social Vulnerability — United States, December 14, 2020–March 1, 2021

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The U.S. COVID-19 vaccination program began in December 2020, and ensuring equitable COVID-19 vaccine access remains a national priority.* COVID-19 has disproportionately affected racial/ethnic minority groups and those who are economically and socially disadvantaged (*1*,*2*). Thus, achieving not just vaccine equality (i.e., similar allocation of vaccine supply proportional to its population across jurisdictions) but equity (i.e., preferential access and administration to those who have been most affected by COVID-19 disease) is an important goal. The CDC social vulnerability index (SVI) uses 15 indicators grouped into four themes that comprise an overall SVI measure, resulting in 20 metrics, each of which has national and state-specific county rankings. The 20 metric-specific rankings were each divided into lowest to highest tertiles to categorize counties as low, moderate, or high social vulnerability counties. These tertiles were combined with vaccine administration data for 49,264,338 U.S. residents in 49 states and the District of Columbia (DC) who received at least one COVID-19 vaccine dose during December 14, 2020–March 1, 2021. Nationally, for the overall SVI measure, vaccination coverage was higher (15.8%) in low social vulnerability counties than in high social vulnerability counties (13.9%), with the largest coverage disparity in the socioeconomic status theme (2.5 percentage points higher coverage in low than in high vulnerability counties). Wide state variations in equity across SVI metrics were found. Whereas in the majority of states, vaccination coverage was higher in low vulnerability counties, some states had equitable coverage at the county level. CDC, state, and local jurisdictions should continue to monitor vaccination coverage by SVI metrics to focus public health interventions to achieve equitable coverage with COVID-19 vaccine.

COVID-19 vaccine administration data are reported to CDC by multiple entities via immunization information systems (IIS), the Vaccine Administration Management System, or direct data submission.† Vaccination coverage was defined as the number of residents who received at least one dose of COVID-19 vaccine during December 14, 2020–March 1, 2021, and whose data were reported to CDC by March 6, 2021.§ Total county population denominators used to create vaccination coverage estimates were obtained from the U.S. Census Bureau 2019 Population Estimates Program.¶ Social vulnerability data were obtained from the CDC SVI 2018 database,** which includes metrics to identify communities that might need additional support during emergencies, including the COVID-19 pandemic (Supplementary Figure 1, https://stacks.cdc.gov/view/cdc/104111). County-level social vulnerability rankings for 15 SVI indicators, four SVI themes, and the overall SVI (20 total SVI metrics) were used.†† Each of the SVI metrics was categorized into national§§ and state-specific¶¶ tertiles*** (low, moderate, and high social vulnerability) based

* https://www.whitehouse.gov/wp-content/uploads/2021/01/National-Strategy-for-the-COVID-19-Response-and-Pandemic-Preparedness.pdf

† https://www.cdc.gov/vaccines/covid-19/vaccination-provider-support.html

§ Providers are required to report administration records to the state IIS within 72 hours; 5 additional days of observation were included to account for delays in reporting and transmission of records to CDC.

¶ https://www.census.gov/data/datasets/time-series/demo/popest/2010s-counties-total.html

** https://www.atsdr.cdc.gov/placeandhealth/svi/documentation/SVI_documentation_2018.html; SVI metrics were created using 2014–2018 (5-year) data from the American Community Survey.

†† SVI ranks counties according to 15 social factors (indicators): 1) percentage of persons with incomes below poverty threshold, 2) percentage of civilian population (aged ≥16 years) that is unemployed, 3) per capita income, 4) percentage of persons aged ≥25 years with no high school diploma, 5) percentage of persons aged ≥65 years, 6) percentage of persons aged ≤17 years, 7) percentage of civilian noninstitutionalized population with a disability, 8) percentage of single-parent households with children aged <18 years, 9) percentage of persons who are racial/ethnic minorities (i.e., all persons except those who are non-Hispanic White), 10) percentage of persons aged ≥5 years who speak English "less than well," 11) percentage of housing in structures with ≥10 units (multiunit housing), 12) percentage of housing structures that are mobile homes, 13) percentage households with more persons than rooms (crowding), 14) percentage of households with no vehicle available, and 15) percentage of persons in group quarters. Estimates were created using 2014–2018 (5-year) data from the American Community Survey. The 15 indicators are categorized into four themes: 1) socioeconomic status (indicators 1–4), 2) household composition and disability (indicators 5–8), 3) racial/ethnic minority status and language (indicators 9 and 10), and 4) housing type and transportation (indicators 11–15). Overall SVI includes all 15 indicators as a composite measure.

§§ Based on data for all counties within the 49 states (excluding Hawaii, which did not systematically report county of residence) included in the national analyses, national SVI metric ranks were created so that each county was ranked against other counties in this sample.

¶¶ State-level SVI ranks excluded jurisdictions with three or fewer counties (Delaware with three counties and DC with one county) and that did not systematically report county of residence (Hawaii). State-level SVI ranks were created for each of the 48 remaining states so that each state's counties were ranked only among counties in that state; state-level analyses were restricted to overall SVI and the four SVI themes.

*** Each of the 20 SVI metrics (ranks) were divided into tertiles from lowest to highest rank. Counties were classified as follows: 0–0.33: low social vulnerability counties; >0.33–0.66: moderate social vulnerability counties; and >0.66–1: high social vulnerability counties.

on their national (among all U.S. counties) or state (among each state's counties) rank.

Vaccination coverage (percentage of residents who received at least one COVID-19 vaccine dose) and 95% confidence intervals (CIs) within SVI tertiles were calculated for each of the 20 SVI metrics for the national analyses, with jurisdictional exclusions based on missing data for state of residence, missing data for county of residence (Hawaii, which did not systematically report these data), or no available SVI metrics (eight territories and freely associated states).[†††] A vaccination rate ratio (RR) and 95% CI for each SVI metric was calculated using Wald's unconditional maximum likelihood estimation to assess the relative differences in vaccination coverage, comparing low and moderate vulnerability counties with high vulnerability counties. The rate difference was also calculated to assess the difference between SVI tertiles. Because of the large sample sizes, rather than using statistical significance to determine meaningful differences between tertiles, a difference of ≥0.5 percentage points was used. State-level analyses for the overall SVI and four SVI themes were conducted among states with more than three counties. In addition, vaccination coverage for SVI metrics (national analyses) and SVI metrics within states (state-level analyses) were normalized so that the sum across tertiles was one.[§§§] (When vaccination coverage is equally distributed among tertiles within an SVI metric, the proportion of persons vaccinated in each SVI tertile is 0.33.) This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[¶¶¶]

During December 14, 2020–March 1, 2021, a total of 51,873,700 residents of 49 U.S. states and DC received at least one dose of COVID-19 vaccine. County of residence was available for 95.0% (49,264,338) of these records for analysis. National first-dose vaccination coverage was 15.1%. For overall SVI, vaccination coverage was 1.9 percentage points higher in low vulnerability counties than in high vulnerability counties (15.8% versus 13.9%, respectively) (Table). The same pattern was found for the SVI themes of socioeconomic status, household composition and disability status, and racial/ethnic minority status and language, with the largest vaccination coverage disparity in the socioeconomic status theme (difference of 2.5 percentage points). Vaccination coverage was ≥0.5 percentage points lower in low vulnerability counties than in high vulnerability counties for the following indicators: 1) population aged ≥65 years (2.3 percentage points lower), 2) multiunit housing (1.3 percentage points lower), and 3) households with no vehicle (0.7 percentage points lower) (Figure 1). Indicators associated with similar coverage in low and high vulnerability counties were 1) percentage of persons with a disability and 2) percentage of persons who speak English "less than well." Vaccination coverage was higher in low vulnerability counties than in high vulnerability counties for the remaining 10 indicators. Among socioeconomic status indicators, the largest disparity was the percentage of adults without a high school diploma (difference of 2.8 percentage points between high and low vulnerability counties). The majority of vaccination coverage differences between tertiles were <2 percentage points.

In the state-level analyses, across overall SVI and all four themes, higher vaccination coverage in high vulnerability counties compared with low vulnerability counties (i.e., equity) was found in two states (Arizona and Montana) (Figure 2) (Supplementary Table, Supplementary Figure 2, https://stacks.cdc.gov/view/cdc/104111). Three other states had higher vaccination coverage in high vulnerability counties than in low vulnerability counties for the overall SVI and three of four themes (Alaska, all except the socioeconomic status theme, and Minnesota and West Virginia, all except the racial/ethnic minority status and language theme). Vaccination disparities were observed in 31 states (overall SVI measure); in 11 of these states, the disparity was found in all four SVI themes.

Discussion

Ensuring equitable COVID-19 vaccine access is a priority for the U.S. COVID-19 vaccination program.[****] In the first 2.5 months of the program, vaccination coverage was lower in high vulnerability counties nationwide, demonstrating that additional efforts are needed to achieve equity in vaccination coverage for those who have been most affected by COVID-19 (*3*). Improving COVID-19 vaccination coverage in communities with high proportions of racial/ethnic minority groups and persons who are economically and socially marginalized is critical because these populations have been disproportionately affected by COVID-19–related morbidity and mortality (*4–6*). Monitoring community-level metrics is essential to informing tailored, local vaccine delivery efforts, which might reduce inequities. Public health officials can investigate whether disparities are occurring because of access problems (e.g., vaccine supply, vaccination clinic availability, and lack of prioritization of vulnerable groups) or other challenges, such as vaccine hesitancy. Vaccination promotion, outreach, and administration might focus on high vulnerability populations within counties (e.g., providing

[†††] Among the 52,833,001 persons who received at least one dose of COVID-19 vaccine in the United States, 1.8% (959,301) were excluded, including 1) recipients for whom state of residence was unknown (n = 225,633), 2) residents of eight U.S. territories and freely associated states (n = 475,978) for which SVI data were not available, and 3) residents of Hawaii (257,690).

[§§§] Vaccination coverage metrics were normalized so that each tertile's vaccination coverage was its proportion of total vaccination coverage for that state or national metric.

[¶¶¶] 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.

[****] https://www.cdc.gov/vaccines/imz-managers/downloads/Covid-19-Vaccination-Program-Interim_Playbook.pdf

TABLE. Association between county-level COVID-19 vaccination coverage and social vulnerability index (SVI) metrics among persons who received at least one vaccine dose (N = 49,264,338) — United States, December 14, 2020–March 1, 2021*

SVI metric†	Vaccination coverage estimate§ (95% CI)			Rate ratio for relative differences in vaccination coverage (95% CI)**		Rate differences in vaccination coverage††	
	Low social vulnerability¶	Moderate social vulnerability¶	High social vulnerability¶	Low versus high estimate	Moderate versus high estimate	Low–high	Moderate–high
Overall SVI	**15.8 (15.83–15.84)**	**15.6 (15.57–15.59)**	**13.9 (13.89–13.90)**	**1.1 (1.14–1.14)**	**1.1 (1.12–1.12)**	**1.94**	**1.69**
Socioeconomic status							
Total	**15.9 (15.91–15.92)**	**15.0 (14.97–14.98)**	**13.5 (13.45–13.46)**	**1.2 (1.18–1.18)**	**1.1 (1.11–1.11)**	**2.46**	**1.52**
Poverty	15.9 (15.85–15.86)	14.8 (14.79–14.80)	14.2 (14.21–14.23)	1.1 (1.11–1.12)	1.0 (1.04–1.04)	1.64	0.58
Unemployment	15.4 (15.38–15.40)	15.3 (15.30–15.31)	14.5 (14.54–14.55)	1.1 (1.06–1.06)	1.1 (1.05–1.05)	0.85	0.76
Per capita income	15.6 (15.57–15.58)	14.4 (14.35–14.37)	13.5 (13.45–13.48)	1.2 (1.16–1.16)	1.1 (1.07–1.07)	2.11	0.90
No high school diploma	16.0 (16.01–16.02)	15.3 (15.26–15.27)	13.2 (13.22–13.23)	1.2 (1.21–1.21)	1.2 (1.15–1.16)	2.79	2.04
Household composition and disability status							
Total	**15.6 (15.62–15.63)**	**14.4 (14.41–14.42)**	**14.2 (14.20–14.22)**	**1.1 (1.10–1.10)**	**1.0 (1.01–1.02)**	**1.42**	**0.21**
Age ≥65 yrs	14.6 (14.58–14.59)	15.9 (15.89–15.91)	16.9 (16.90–16.92)	0.9 (0.86–0.86)	0.9 (0.94–0.94)	−2.32	−1.01
Age ≤17 yrs	16.6 (16.57–16.58)	15.5 (15.51–15.53)	13.6 (13.56–13.57)	1.2 (1.22–1.22)	1.1 (1.14–1.14)	3.01	1.95
Disability	15.1 (15.13–15.14)	15.0 (14.95–14.97)	14.9 (14.88–14.90)	1.0 (1.02–1.02)	1.0 (1.00–1.01)	0.24	0.07
Single parent	16.7 (16.68–16.70)	15.6 (15.55–15.56)	14.0 (13.99–14.00)	1.2 (1.19–1.19)	1.1 (1.11–1.11)	2.70	1.56
Racial/Ethnic minority status and language							
Total	**15.5 (15.45–15.48)**	**15.6 (15.56–15.58)**	**14.9 (14.90–14.91)**	**1.0 (1.04–1.04)**	**1.0 (1.04–1.05)**	**0.57**	**0.67**
Racial/Ethnic minority	15.5 (15.51–15.54)	15.7 (15.66–15.67)	14.8 (14.75–14.76)	1.1 (1.05–1.05)	1.1 (1.06–1.06)	0.77	0.91
Limited English	15.3 (15.30–15.33)	15.5 (15.47–15.49)	14.9 (14.93–14.93)	1.0 (1.02–1.03)	1.0 (1.04–1.04)	0.38	0.55
Housing type and transportation							
Total	**14.8 (14.81–14.82)**	**15.3 (15.25–15.26)**	**15.0 (15.03–15.05)**	**1.0 (0.98–0.99)**	**1.0 (1.01–1.01)**	**−0.23**	**0.21**
Multiunit housing	14.0 (13.96–13.99)	14.5 (14.49–14.51)	15.2 (15.24–15.24)	0.9 (0.92–0.92)	1.0 (0.95–0.95)	−1.26	−0.74
Mobile homes	15.2 (15.22–15.23)	15.1 (15.05–15.07)	14.0 (13.98–14.00)	1.1 (1.09–1.09)	1.1 (1.08–1.08)	1.24	1.07
Crowding	16.1 (16.08–16.10)	15.1 (15.09–15.11)	14.7 (14.65–14.66)	1.1 (1.10–1.10)	1.0 (1.03–1.03)	1.43	0.45
No vehicle	14.5 (14.49–14.51)	15.4 (15.35–15.36)	15.2 (15.15–15.16)	1.0 (0.96–0.96)	1.0 (1.01–1.01)	−0.66	0.20
Group quarters	15.9 (15.85–15.86)	14.8 (14.79–14.80)	14.2 (14.21–14.23)	1.1 (1.11–1.12)	1.0 (1.04–1.04)	1.64	0.58

Abbreviation: CI = confidence interval.

* Vaccines administered to residents of 49 U.S. states (excluding Hawaii) and the District of Columbia during December 14, 2020–March 1, 2021, and reported to CDC by March 6, 2021.

† SVI ranks counties according to 15 social factors (indicators): 1) percentage of persons with incomes below poverty threshold, 2) percentage of civilian population (aged ≥16 years) that is unemployed, 3) per capita income, 4) percentage of persons aged ≥25 years with no high school diploma, 5) percentage of persons aged ≥65 years, 6) percentage of persons aged ≤17 years, 7) percentage of civilian noninstitutionalized population with a disability, 8) percentage of single-parent households with children aged <18 years, 9) percentage of persons who are racial/ethnic minorities (all persons except non-Hispanic White), 10) percentage of persons aged ≥5 years who speak English "less than well," 11) percentage of housing in structures with ≥10 units (multiunit housing), 12) percentage of housing structures that are mobile homes, 13) percentage households with more persons than rooms (crowding), 14) percentage of households with no vehicle available, and 15) percentage of persons in group quarters. Estimates are created using 2014–2018 (5-year) data from the American Community Survey. The 15 indicators are categorized into four themes: 1) socioeconomic status (indicators 1–4), 2) household composition and disability (indicators 5–8), 3) racial/ethnic minority status and language (indicators 9 and 10), and 4) housing type and transportation (indicators 11–15). Overall SVI includes all 15 indicators as a composite measure. Additional details are available (https://www.atsdr.cdc.gov/placeandhealth/svi/documentation/SVI_documentation_2018.html).

§ Total county population denominators used to create vaccination coverage estimates were obtained from the U.S. Census Bureau 2019 Population Estimates Program (https://www.census.gov/data/datasets/time-series/demo/popest/2010s-counties-total.html). Vaccination coverage was calculated as the total number of vaccine doses administered divided by the total population size for included counties in each SVI tertile.

¶ Counties were assigned to tertiles (low, moderate, and high social vulnerability) for each of the 20 SVI ranking metrics.

** Rate ratios compare the relative difference in vaccination coverage between SVI tertiles; high social vulnerability is the reference category.

†† Rate differences compare the difference in vaccination coverage between SVI tertiles; high social vulnerability is the reference category. Vaccination coverage differences of ≥0.5 percentage points were considered meaningful differences between SVI tertiles.

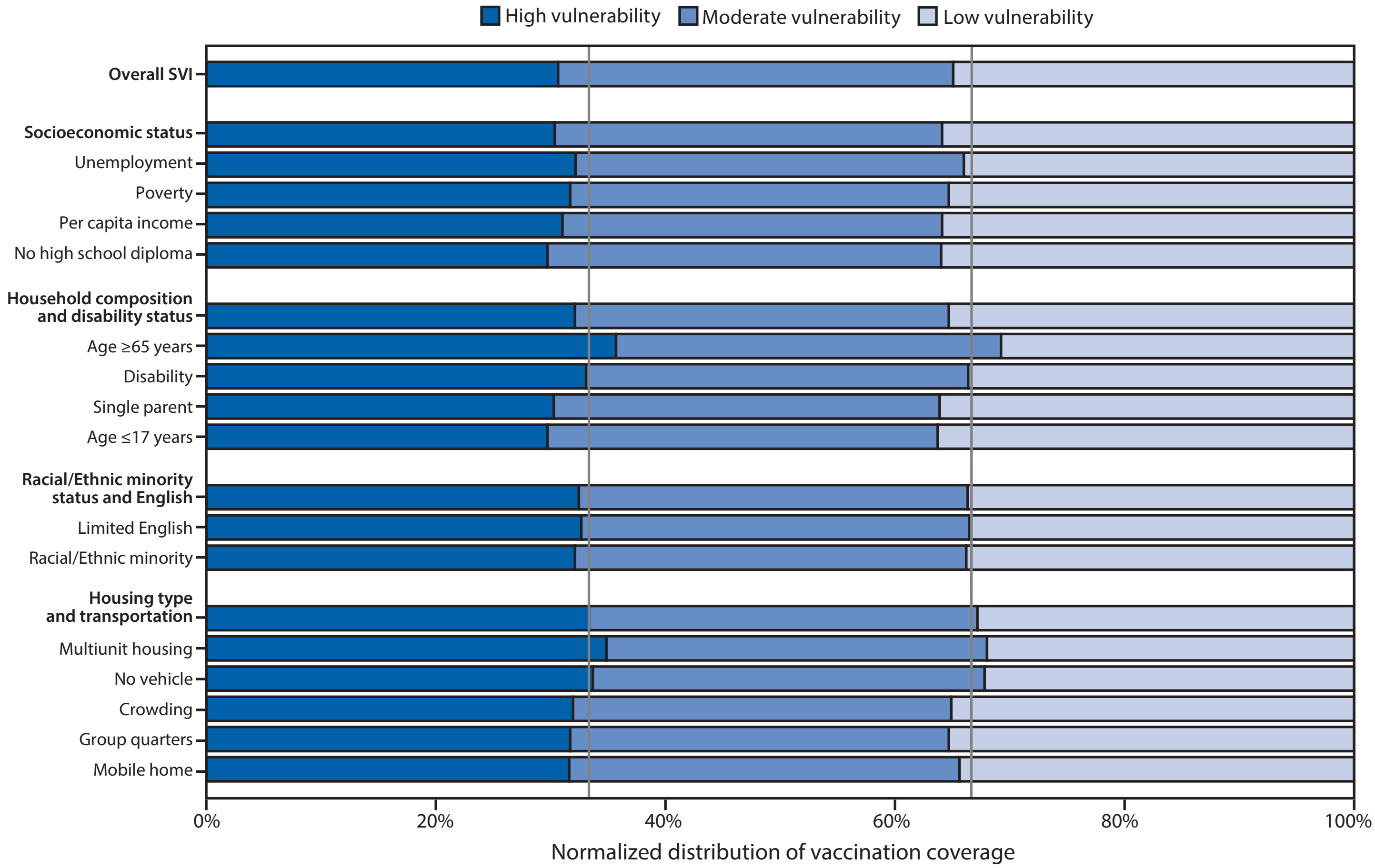
resources to federally qualified health centers when socioeconomic disparities are identified).††††

Vaccination coverage was consistently lower in high vulnerability counties than in low vulnerability counties for the socioeconomic status indicators (i.e., poverty, unemployment, low income, and no high school diploma); the coverage disparity was largest for the education indicator. However, equal vaccination coverage in counties with low and high social vulnerability was observed for the indicators relating to the percentages of persons who speak English less than well and with persons with a disability, which is encouraging in light of the disproportionate incidence of COVID-19 in these populations.§§§§ Higher coverage in

†††† https://www.cdc.gov/vaccines/covid-19/planning/health-center-program.html

§§§§ https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-with-disabilities.html

FIGURE 1. Distribution of county-level* COVID-19 vaccination coverage among persons who received at least one vaccine dose (N = 49,264,338),† by social vulnerability index (SVI) metric§ and tertile — United States, December 14, 2020–March 1, 2021



* Counties were assigned to tertiles (low, moderate, and high) for overall SVI. Data are presented as a 100% stacked bar chart (normalized across states), with the length of each bar segment representing the proportion of total vaccination coverage for each SVI tertile. When proportions of vaccination coverage are equal among SVI tertiles, each proportion represents 0.33, represented by the vertical lines. When proportions of vaccination coverage estimates are not equally distributed among SVI tertiles, then proportions do not align with threshold lines representing 0.33.

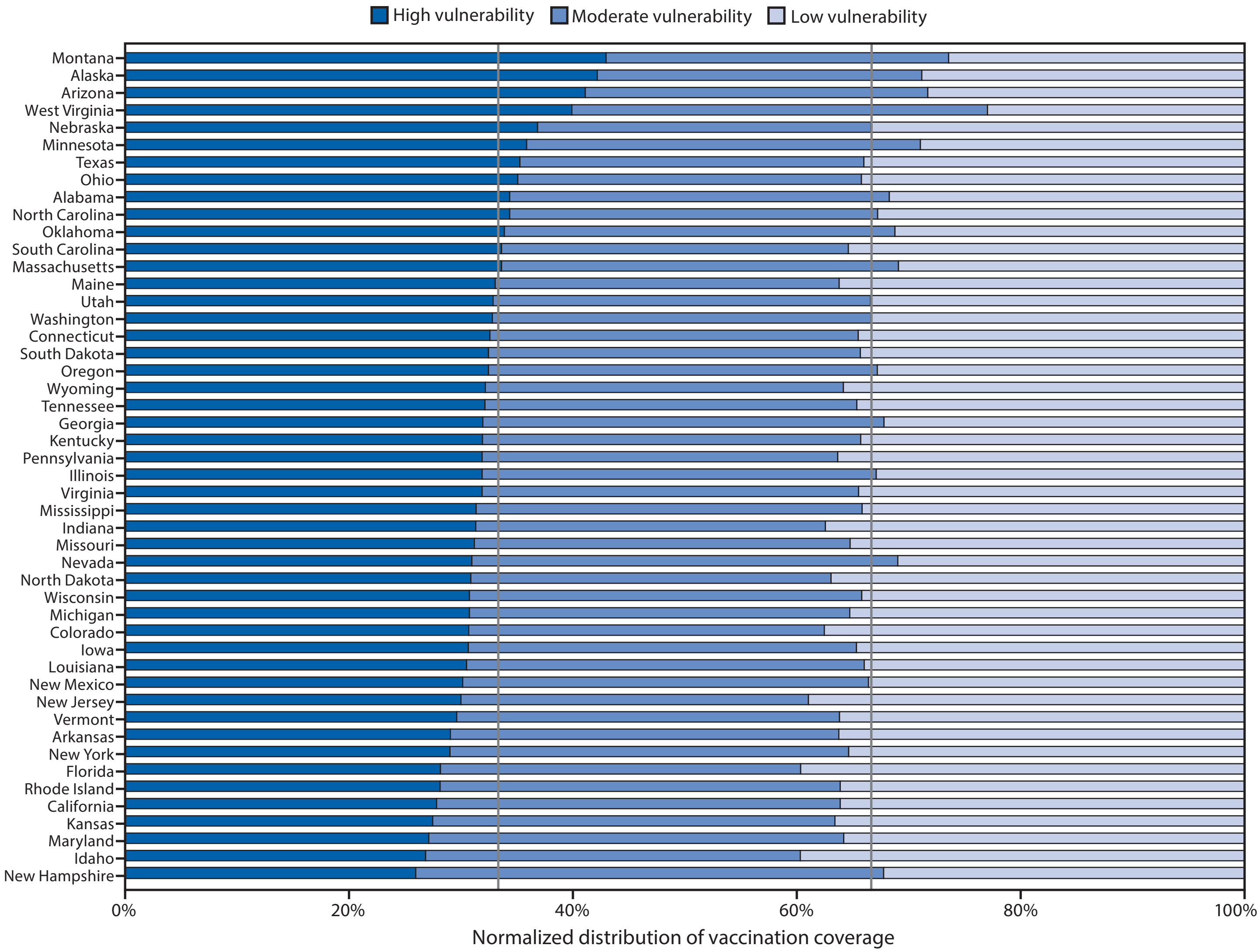
† Vaccines administered to residents of 49 U.S. states (excluding Hawaii) and the District of Columbia during December 14, 2020–March 1, 2021, and reported to CDC by March 6, 2021.

§ SVI ranks counties according to 15 social factors (indicators): 1) percentage of persons with incomes below poverty threshold, 2) percentage of civilian population (aged ≥16 years) that is unemployed, 3) per capita income, 4) percentage of persons aged ≥25 years with no high school diploma, 5) percentage of persons aged ≥65 years, 6) percentage of persons aged ≤17 years, 7) percentage of civilian noninstitutionalized population with a disability, 8) percentage of single-parent households with children aged <18 years, 9) percentage of persons who are racial/ethnic minorities (i.e., all persons except those who are non-Hispanic White), 10) percentage of persons aged ≥5 years who speak English "less than well," 11) percentage of housing in structures with ≥10 units (multiunit housing), 12) percentage of housing structures that are mobile homes, 13) percentage households with more persons than rooms (crowding), 14) percentage of households with no vehicle available, and 15) percentage of persons in group quarters. Estimates are created using 2014–2018 (5-year) data from the American Community Survey. The 15 indicators are categorized into four themes: 1) socioeconomic status (indicators 1–4), 2) household composition and disability (indicators 5–8), 3) racial/ethnic minority status and language (indicators 9 and 10), and 4) housing type and transportation (indicators 11–15). Overall SVI includes all 15 indicators as a composite measure.

counties with large proportions of older adults was consistent with the prioritization of this age group early in the vaccination program; however, the higher coverage in counties with lower percentages of households with a vehicle available was unexpected and warrants further investigation. Despite these positive findings, equity in access to COVID-19 vaccination has not been achieved nationwide.

COVID-19 vaccination equity varied among states. In most states, coverage was higher in low vulnerability counties than in high vulnerability counties. Despite this, states such as Arizona and Montana achieved higher vaccination coverage in high vulnerability counties across SVI metrics. Practices in states with high equity included 1) prioritizing persons in racial/ethnic minority groups during the early stages of the vaccine program implementation, 2) actively monitoring and addressing barriers to vaccination in vulnerable communities, 3) directing vaccines to vulnerable communities, 4) offering free transportation to vaccination sites, and 5) collaborating

FIGURE 2. Distribution of county-level* COVID-19 vaccination coverage among persons who received at least one vaccine dose (N = 49,019,117),† by state and overall social vulnerability index (SVI) tertile — United States, December 14, 2020–March 1, 2021



* Counties were assigned to tertiles (low, moderate, and high) for overall SVI. Data are presented as a 100% stacked bar chart (normalized across states), with the length of each bar segment representing the proportion of total vaccination coverage for each SVI tertile. When proportions of vaccination coverage are equal among SVI tertiles, each proportion represents 0.33, represented by the vertical lines. When proportions of vaccination coverage estimates are not equally distributed among SVI tertiles, then proportions do not align with threshold lines representing 0.33.

† Vaccines administered to residents of 48 U.S. states (excluding Delaware, the District of Columbia, and Hawaii) during December 14, 2020–March 1, 2021, and reported to CDC by March 6, 2021.

with community partners, tribal health organizations, and the Indian Health Service.¶¶¶¶ More investigation is needed to understand these differences to identify best practices to achieve COVID-19 vaccination equity.

These findings demonstrate that estimates for overall SVI obscured variations among SVI themes and that SVI themes masked variations among indicators within a theme group. In addition, the national coverage estimates by SVI metrics did not capture the wide variation among states. These results highlight the importance of examining individual SVI indicators in addition to the composite SVI measure and themes to monitor equitable vaccine administration. State and local jurisdictions should also consider analyzing SVI metrics at the level of the census tract (when these data are available).

¶¶¶¶ https://dphhs.mt.gov/covid19vaccine; https://www.azdhs.gov/documents/preparedness/epidemiology-disease-control/infectious-disease-epidemiology/novel-coronavirus/vapac-cara-christ-presentation.pdf; https://states.aarp.org/arizona/covid-19-vaccine-distribution; https://www.cnn.com/2021/03/09/us/alaska-covid-19-vaccine-success-trnd/index.html; https://www.usnews.com/news/best-states/articles/2021-03-09/q-a-how-alaska-is-leading-in-covid-19-vaccination-efforts

Summary

What is already known about this topic?

COVID-19 has disproportionally affected racial/ethnic minority groups and persons who are economically and socially disadvantaged. Ensuring equitable COVID-19 vaccine coverage is a national priority.

What is added by this report?

In the first 2.5 months of the U.S. vaccination program, high social vulnerability counties had lower COVID-19 vaccination coverage than did low social vulnerability counties. Although vaccination coverage estimates by county-level social vulnerability varied widely among states, disparities in vaccination coverage were observed in the majority of states.

What are the implications for public health practice?

Continued monitoring of vaccination coverage by social vulnerability metrics is critical for developing tailored, local vaccine administration and outreach efforts to reduce COVID-19 vaccination inequities.

The findings in this report are subject to at least five limitations. First, because specific populations were prioritized for vaccination in each state, the differences observed might be due, in part, to prioritization based on age, occupational exposures, and underlying health conditions. Second, these associations are ecological and reported for population-based metrics rather than individual-level vulnerability data. With only age, sex, and limited race/ethnicity data available at the national level, use of these population-based metrics is an important method to evaluate socioeconomic and demographic disparities. Third, although the geographic unit of analysis was the county, the vulnerabilities and vaccination coverage rates might vary within counties; state and local jurisdictions might prioritize vaccination efforts for high vulnerability communities in smaller geographic units (e.g., census tracts). Fourth, SVI metrics do not include all population characteristics that could be used to identify disparities and focus vaccination efforts, such as lack of Internet access (*7*). Finally, coverage was calculated based on total population, and vaccines authorized for use during the study period were only recommended for persons aged ≥16 or ≥18 years.*****

The results of this study indicate that COVID-19 vaccination coverage was lower in high vulnerability counties than in low vulnerability counties, a finding largely driven by socioeconomic disparities. As vaccine supply increases and administration expands to additional priority groups, CDC, state, and local jurisdictions should continue to monitor vaccination levels by SVI metrics to aid in the development of community efforts to improve vaccination access, outreach, and administration among populations most affected by COVID-19.

***** https://www.cdc.gov/vaccines/covid-19/eua/index.html

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COVID-19 in Primary and Secondary School Settings During the First Semester of School Reopening — Florida, August–December 2020

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After detection of cases of COVID-19 in Florida in March 2020, the governor declared a state of emergency on March 9,* and all school districts in the state suspended in-person instruction by March 20. Most kindergarten through grade 12 (K–12) public and private schools in Florida reopened for in-person learning during August 2020, with varying options for remote learning offered by school districts. During August 10–December 21, 2020, a total of 63,654 COVID-19 cases were reported in school-aged children; an estimated 60% of these cases were not school-related. Fewer than 1% of registered students were identified as having school-related COVID-19 and <11% of K-12 schools reported outbreaks. District incidences among students correlated with the background disease incidence in the county; resumption of in-person education was not associated with a proportionate increase in COVID-19 among school-aged children. Higher rates among students were observed in smaller districts, districts without mandatory mask-use policies, and districts with a lower proportion of students participating in remote learning. These findings highlight the importance of implementing both community-level and school-based strategies to reduce the spread of COVID-19 and suggest that school reopening can be achieved without resulting in widespread illness among students in K–12 school settings.

Florida has one independent school district in each of its 67 counties. For the 2020–21 school year, 2,809,553 registered students were enrolled in approximately 6,800 public, charter, and private K–12 schools, ranging from 707 to 334,756 students per school district. In response to the COVID-19 pandemic, some school districts delayed the start of the 2020–21 academic year after suspension of in-person learning in March. Most schools resumed in-person instruction sometime during August 10–31, 2020, except those in the two largest school districts, Broward and Miami-Dade, which began remote learning in August but did not resume in-person instruction until October 9 and November 10, respectively. Statewide, as of September 24, 45% of registered students received full-time in-person instruction.

To assess the occurrence of COVID-19 in Florida schools after resumption of in-person instruction, CDC and the Florida Department of Health (FDOH) reviewed school-related cases and outbreaks during August–December 2020.† County health department staff members conducted case investigations and contact tracing for all COVID-19 cases and reported data via the FDOH reportable disease surveillance system. A COVID-19 case was defined as nucleic acid amplification or antigen detection of acute infection with SARS-CoV-2 (the virus that causes COVID-19) in a symptomatic or asymptomatic person. A school-related case was defined as a COVID-19 case in a student or staff member who had been on campus for class, work, athletics, or other reasons during the 14 days preceding symptom onset or testing, and could reflect cases acquired in the school, home, or community setting. A school-based outbreak was defined as two or more epidemiologically linked school-related cases. Data regarding school start dates by district, student enrollment, and proportion of registered students receiving full-time in-person instruction were obtained from the Florida Department of Education. Information regarding temporary COVID-19–related school closures was obtained from FDOH staff members in the various counties. Data on school district mask use policies were obtained from reopening plans in each district (*1*). Descriptive statistics were computed; one-way analysis of variance and simple linear regression analyses were conducted to identify factors associated with student incidence by district. Statistical analyses were performed using JMP software (version 15.1; SAS Institute). This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.§

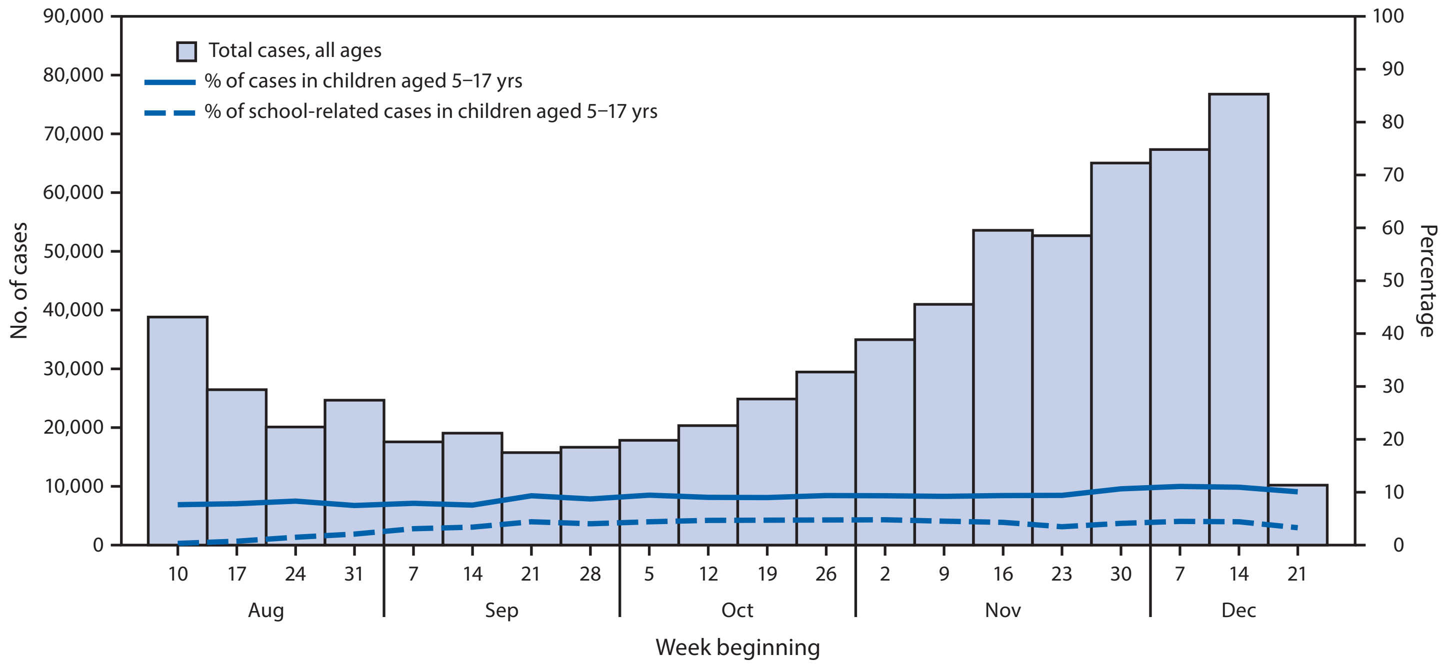
During August 10–December 21, 2020, a total of 63,654 cases of COVID-19 among persons aged 5–17 years were reported to FDOH; during the same period, 34,959 school-related COVID-19 cases were reported, including 25,094 (72%) among students and 9,630 (28%) among staff members. Therefore, among all cases reported among school-aged children, 39.4% were classified as school-related (Figure). School-related cases in children occurred in <1% (25,094 of 2,809,553) of all registered students. Among all cases in children aged 5–17 years, the median age was 13 years (interquartile range = 9–15 years) and did not differ between cases

* https://www.flgov.com/wp-content/uploads/orders/2020/EO_20-52.pdf

† The last school day before Christmas break was December 18 in most districts; however, cases reported through December 21 were included to allow for testing and reporting time lag.

§ 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.

FIGURE. Weekly school-related COVID-19 cases reported among students, as a proportion of overall cases in children aged 5–17 years and in the general population — Florida, August–December 2020*



* Week beginning December 21 is a partial week, only including December 21, 2020.

that were and were not school-related. Among school-related cases, 101 hospitalizations and no deaths were reported among students, and 219 hospitalizations and 13 deaths were identified among school staff members. Among the 13 staff members who died, nine had risk factors for severe outcomes, including obesity (seven), age >60 years (four), and other chronic conditions (four); some reported probable exposures outside the school setting, including within the household.

Contact tracing investigations identified 86,832 persons who had close school setting contact[¶] with persons with cases of school-related COVID-19; among these, 37,548 (43%) received testing. Overall, 10,092 (27% of contacts who were tested) received a positive SARS-CoV-2 test result while in quarantine. Testing of symptomatic persons was encouraged; however, 11% of school contacts who had COVID-19–symptoms[**] were not tested.

A total of 695 school-based outbreaks were identified in 62 (93%) of 67 school districts, involving 4,370 total cases, for a statewide average of 6.3 COVID-19 cases per outbreak. Therefore, <11% (695 of 6800) of schools reported an outbreak. A subset of 562 (81%) outbreaks with additional information was further analyzed; 110 (20%) of these outbreaks were associated with activities outside the classroom setting, including sports (91), nonschool–sponsored social gatherings (12), or transportation to school (four). The most frequent extracurricular sports-related outbreaks involved football (27), basketball (14), volleyball (nine), wrestling (eight), dance (eight), cheerleading (seven), and soccer (six). Sports-related outbreaks were larger on average than were nonsports–related outbreaks (mean = 6.0 cases versus 4.1 cases; $p<0.01$). The four largest sports-related outbreaks involved two wrestling events (58 and 27 cases) and two football events (18 and 17 cases). Most sports-related outbreaks involved high school grade levels.

Through December 18, 2020, a total of 28 schools in 12 counties closed temporarily because of COVID-19, with a median closure duration of 4 days (range = 1–14 days); 16 (57%) closures occurred in public schools, nine (32%) in private schools, and three (11%) in charter schools. Partial closures of one or more classrooms, but not the entire school, occurred in 226 schools in 38 counties; 88% of these partial closures occurred in public schools, 8% in private, and 4% in charter schools. Elementary school grades accounted for 75% of partial closures.

Descriptive statistics for the 67 county-based school districts indicated that a median of 70% of students were attending school and receiving full-time in-person instruction as of September 24 (range = <1% [Miami-Dade and Broward] to 94% [Baker]) (Table 1). The median incidence among registered students was 1,280 per 100,000 students, ranging from 394 to 3,200 among counties.

Factors identified in bivariate analysis associated with student case rate by district were county population size,

¶ Close contact is defined as contact within 6 feet of a person with a case of COVID-19 for ≥15 minutes, within a 24-hour period.

** https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html

TABLE 1. COVID-19 school-related cases in 67 county-based school districts — Florida, August 10–December 21, 2020

County characteristic	Median (range)
County population, all ages	130,642 (8,613–2,830,500)
Students enrolled in K–12 schools	15,306 (707–334,756)*
Students attending in-person full-time,[†] median % (range)	70 (<1–94)
COVID-19 incidence by county	
County incidence[§] in general population	3,163 (1,915–14,606)
Incidence of school-related student cases among all registered students[¶]	1,280 (394–3,200)
School-related cases among students	170 (18–2,780)
School-related cases among staff members	68 (9–863)
Ratio of student to staff member cases	2.5 (1.1–7.4)
No. of school-based outbreaks**	5 (1–69)
No. of cases associated with school-based outbreaks	31 (2–541)

Abbreviation: K–12 = kindergarten through grade 12.
* A total of 2,809,553 registered students were enrolled in approximately 6,800 public, charter, and private K–12 schools.
† As reported by Florida Department of Education on September 24, 2020.
§ Total number of cases in the county during August 10–December 21, divided by county population, expressed per 100,000 persons.
¶ School-related cases in students by school district, during school start date and December 21, per 100,000 registered students (adjusted for school start date, i.e., adjusted rate = crude rate [131/x] where x = days from school start to December 18 and maximum number of days = 131).
** Two or more epidemiologically linked school-related cases.

TABLE 2. Factors associated with COVID-19 incidence — Florida, August 10–December 21, 2020

Factor	Student rate*	P-value
County population size by quartile[†]		
Q1: 8,613–28,089	2,212	<0.0001
Q2: 28,090–130,642	1,430	
Q3: 130,643–368,678	1,226	
Q4: 368,679–2,830,500	970	
Opening date		
August 10–14	1,882	0.01
After August 16	1,367	
Masks mandated in district reopening plan[§]		
Yes	1,171	<0.01
No	1,667	
Full-time in-person students[¶]	R** = 0.5069 R-squared = 0.2570	<0.0001
County case rate[††]	R** = 0.4442 R-squared = 0.1973	<0.001

Abbreviations: Q = quartile; R = correlation coefficient.
* School-related cases in students by school district, during school start date and December 21, per 100,000 registered students (adjusted for school start date: adjusted rate = crude rate[131/x] where x = days from school start to December 18 and maximum number of days = 131).
† Sixty-seven Florida counties divided into four groups (quartiles) with quartile 1 containing the 17 counties with the lowest population per county, and quartile 4 containing the 16 counties with the highest population per county. Each of the other quartiles contains 17 counties. County population range of each quartile is specified next to each quartile designation.
§ Twenty-seven (40%) school districts had reopening plans requiring masks in schools. Inclusion in plan might not be an accurate reflection of mask use in school setting.
¶ Proportion of students attending full-time in-person instruction (continuous 0%–100%).
** R is a measure of correlation between the continuous independent variable indicated in the Factor column and the continuous dependent variable of student case rate per 100,000. R-squared indicates the percent of variation in student case rate that is explained by the independent variable included in the regression model.
†† Per 100,000 population; excludes one outlier county (county with very small population and large outbreak in correctional facility, resulting in large county population rate with limited community spread).

school opening during the first week, district reopening plans that included mandatory mask use, proportion of students attending in-person instruction, and the background case rate per county during August 10–December 21 (Table 2). Higher mean student case rates were reported from counties with the lowest population, districts opening school during August 10–14, and districts that did not mandate mask use in their reopening plans, compared with rates in larger counties, districts opening after August 16, and those with mask mandates. The background cumulative disease incidence during August 10–December 21 in each county was positively correlated with the incidence among students. The proportion of students, by district, attending full-time in-person instruction also positively correlated with the student case rate. In general, smaller counties resumed classes earlier, had a higher proportion of students attending in-person instruction, were less likely to mandate universal mask use in schools, and had higher student incidences (2,212 per 100,000 in the lowest county population quartile versus 970 in the highest).

Discussion

Although COVID-19 can and does occur in school settings, the results of these analyses indicate that in Florida, 60% of COVID-19 cases in school-aged children were not school-related, <1% of registered students were identified as having school-related COVID-19, and <11% of K–12 schools reported outbreaks. These findings add to a growing body of evidence suggesting that COVID-19 transmission does not appear to be demonstrably more frequent in schools than in noneducational settings (*2*). Temporal trends in the United States also indicate that among school-aged children, school-based transmission might be no higher than transmission outside the school setting (*3*,*4*); the limited in-school transmission observed in Florida has also been observed in other states (*5*) and countries (*6*).

Success in preventing the introduction of SARS-CoV-2 into schools depends upon controlling community transmission and adhering to mitigation measures in schools, particularly masking, physical distancing, testing, and increasing room air ventilation (*2*,*4*,*7*). Where feasible, supporting family choice for remote versus in-person learning likely reduces in-school crowding and facilitates better physical distancing in schools. In Florida, a large proportion of school-related outbreaks was observed among social gatherings and extracurricular sporting activities. Household transmission and social gatherings might pose a higher risk for infection among school-aged children than does school attendance (*8*). School sports and other extracurricular activities in which masking and physical distancing are difficult or impossible to achieve should be postponed, particularly during periods of high community transmission (*2*,*9*).

The findings in this report are subject to at least six limitations. First, because data on the number of teachers and staff members statewide or by county were not available, rates of total school-related cases could not be calculated; instead, the number of student cases per 100,000 registered students was used. Second, screening testing was generally not done in most schools, therefore, asymptomatic infections might have been underascertained. Third, classification of school-related cases, contacts, and outbreaks was dependent on thorough case interviews and might have been incomplete, relative to the overall number of cases in school-aged children. Fourth, although the operational definition used for school-related cases was likely sensitive, it does not ensure that all persons with school-related cases acquired infection in the school setting because infections might have been acquired elsewhere. Fifth, limited data were available at the school district level on some mitigation measures, such as mask use in schools, so these mitigation measures could not be fully assessed. Finally, results should be interpreted with caution because most students in the largest school districts did not resume in-person education for the first part of the analysis period.

These findings provide further evidence that resumption of school can likely be achieved without the rapid disease spread observed in congregate living facilities or high-density worksites. Both community-level and school-based measures to prevent spread of disease are essential to reduce SARS-CoV-2 transmission in school settings (*10*).

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Summary

What is already known about this topic?

Limited U.S. data have been reported regarding COVID-19 in students and school staff members as kindergarten through grade 12 (K–12) schools have reopened.

What is added by this report?

COVID-19 school-related disease incidence among Florida students was correlated with community incidence in the counties observed and was highest in smaller counties, districts without mask requirements, and those that reopened earliest after closure in March 2020. Incidence increased with the proportion of students receiving in-person instruction. Fewer than 1% of registered students were identified as having school-related COVID-19.

What are the implications for public health practice?

Both community-level and school-based mitigation measures are important in limiting transmission of COVID-19; school reopening can likely be achieved without widespread student illness in K–12 settings.

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Low SARS-CoV-2 Transmission in Elementary Schools — Salt Lake County, Utah, December 3, 2020–January 31, 2021

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School closures affected more than 55 million students across the United States when implemented as a strategy to prevent the transmission of SARS-CoV-2, the virus that causes COVID-19 (*1*). Reopening schools requires balancing the risks for SARS-CoV-2 infection to students and staff members against the benefits of in-person learning (*2*). During December 3, 2020–January 31, 2021, CDC investigated SARS-CoV-2 transmission in 20 elementary schools (kindergarten through grade 6) that had reopened in Salt Lake County, Utah. The 7-day cumulative number of new COVID-19 cases in Salt Lake County during this time ranged from 290 to 670 cases per 100,000 persons.[†] Susceptible[§] school contacts[¶] (students and staff members exposed to SARS-CoV-2 in school) of 51 index patients[**] (40 students and 11 staff members) were offered SARS-CoV-2 reverse transcription–polymerase chain reaction (RT-PCR) testing. Among 1,041 susceptible school contacts, 735 (70.6%) were tested, and five of 12 cases identified were classified as school-associated; the secondary attack rate among tested susceptible school contacts was 0.7%. Mask use among students was high (86%), and the median distance between students' seats in classrooms was 3 ft. Despite high community incidence and an inability to maintain ≥6 ft of distance between students at all times, SARS-CoV-2 transmission was low in these elementary schools. The results from this investigation add to the increasing evidence that in-person learning can be achieved with minimal SARS-CoV-2 transmission risk when multiple measures to prevent transmission are implemented (*3*,*4*).

On August 24, 2020, a school district in Salt Lake County, Utah, reopened schools for in-person learning.[††] Elementary schools restricted school-related extracurricular activities and large group gatherings, placed students in cohorts by classroom, and implemented other COVID-19 strategies to limit spread.[§§] During December 3, 2020–January 31, 2021, CDC was invited by the Utah Department of Health to investigate SARS-CoV-2 transmission in a convenience sample of 20 elementary schools in partnership with the school district, the University of Utah's Health and Economic Recovery Outreach (HERO) Project,[¶¶] Utah Department of Health, and Salt Lake County Health Department.

School contacts of identified index patients completed a questionnaire about symptoms and exposures and received SARS-CoV-2 testing. Written consent was provided by participants (or by a parent or guardian for minors). Persons not susceptible to SARS-CoV-2 infection were excluded. Saliva samples (or nasal swabs if saliva was unobtainable) were collected for SARS-CoV-2 RT-PCR testing 5–10 days postexposure; turnaround time for results was typically 1–2 days. Household members of school contacts with a positive SARS-CoV-2 test result were interviewed and offered SARS-CoV-2 RT-PCR testing. The Utah Public Health Laboratory performed whole

* These authors contributed equally to this report.

† The 7-day cumulative number of new COVID-19 cases in Salt Lake County was obtained from the Utah Department of Health and the Salt Lake County Health Department.

§ Susceptible persons were defined as those with no record of previous positive test results for SARS-CoV-2 or whose date of laboratory-confirmed infection onset was at least 90 days earlier (https://www.cdc.gov/coronavirus/2019-ncov/hcp/duration-isolation.html).

¶ A school contact was defined as a student or staff member who was in contact with the index patient for a cumulative total of 15 minutes or more during a 24-hour period in a classroom, cafeteria, school bus, or recess space during an index patient's infectious period.

** An index patient was defined as a student or staff member with laboratory-confirmed SARS-CoV-2 infection who had attended in-person school while infectious for at least 1 day. Infectious period was estimated as 2 days before to 10 days after date of symptom onset (if symptomatic) or date of first positive specimen collection (if asymptomatic) (https://www.cdc.gov/coronavirus/2019-ncov/ php/contact-tracing/contact-tracing-plan/investigating-covid-19-case.html).

†† This school district consists of approximately 67,000 K–12 students and 7,500 employees at 63 elementary schools, 15 junior high schools, eight high schools, and other special schools. Once schools reopened, students were given the option to participate in a hybrid model (four days of in-person school and one day of online learning) or all online learning. Winter break occurred during December 21, 2020–January 1, 2021; in total, the investigation period encompassed 21 days of in-person learning.

§§ Students were placed in cohorts by classroom whenever possible to reduce interactions between classes. Most schools staggered lunch, gym classes, and special activities, such as library use or art classes. At some schools, classes would mix by grade level at recess. Schools limited nonessential extracurricular in-person events, and other events (e.g., sports, assemblies, performances, and field trips) were held virtually when feasible.

¶¶ The University of Utah's HERO Project is sponsored by the Governor's Office of Management and Budget and aims to provide data to aid in decision-making that allows a safe return to normal for Utah's citizens and economy (https://eccles.utah.edu/utah-hero/).

genome sequencing (WGS) for available positive specimens. A school contact who received a positive test result was considered not to have a school-associated case of COVID-19 when one of the following occurred: 1) illness onset preceded the first date of school exposure, 2) a household member had illness onset during the 14 days preceding the school contact's illness onset (for symptomatic school contacts) or before the last date of school exposure (for asymptomatic school contacts), or 3) WGS demonstrated that the lineage of the index patient's isolate differed from that of the school contact.[***] To understand school mitigation measures and classroom characteristics, principals and teachers of each index patient were surveyed. Classroom seat distances between students and between the teacher and nearest student were measured. SAS (version 9.4; SAS Institute) was used for descriptive statistics. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[†††]

The 20 elementary schools included 1,214 staff members and 10,171 students, 81% of whom attended school in person and 56% of whom were eligible for free or reduced-price meal programs. Among the student population, 53% were non-Hispanic White persons, 31% were Hispanic or Latino persons, 5% were Asian persons, 5% were Native Hawaiian or Other Pacific Islander persons, and 4% were Black or African American persons. Fifty-one index patients (40 students, median age = 9.5 years [range = 5–12 years] and 11 staff members, median age = 50 years [range = 26–62 years]) were identified from 48 classrooms (Table 1). These index patients were infectious at school for a median of 2 days (range = 1–4 days), and 16 (31%) were asymptomatic. A total of 1,083 school contacts (943 students and 140 staff members) were identified; 42 (4%) were not susceptible to SARS-CoV-2 infection.[§§§] Among the 1,041 susceptible school contacts (student median age = 9 years [range = 5–18 years]; staff member median age = 39.5 years [range = 19–83 years]), 144 (14%) were quarantined (Table 2). Among the 735 (71%) tested school contacts (participation range = 44%–100% across schools), testing was completed a median of 8 days after the school exposure (range = 6–15 days). Overall, 103 of 133 (77%) staff member contacts and 632 of 908 (70%) student contacts were tested; among 303 Hispanic or Latino contacts and 566 non-Hispanic White contacts, 237 (78%) and 382 (67%) respectively, were tested.

*** SARS-CoV-2 genome sequences were assigned to global lineages with pangolin (v.2.1.10, pangoLEARN v.2021–02–01; https://github.com/cov-lineages/pangolin).

††† 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.

§§§ An additional 52 school contacts had at least one household member with laboratory-confirmed SARS-CoV-2 during the preceding 90 days; these school contacts were still considered susceptible and eligible for inclusion, although they might have been previously infected and already immune.

Among all 735 tested contacts, 12 (1.6%) (11 students, one teacher) had a positive SARS-CoV-2 test result, seven of whom were determined not to have school-associated cases because of epidemiologic evidence (four) or because WGS suggested community acquisition based on lineage differences (three) (Supplementary Figure, https://stacks.cdc.gov/view/cdc/104112). WGS was only available for three pairs of index patients and their associated contacts (Table 3). After exclusion, five cases from five separate classrooms were classified as school-associated, for a secondary attack rate of 0.7% (five of 728). No outbreaks were detected.[¶¶¶] Three of five persons with school-associated cases had been quarantined (the secondary attack rate among quarantined persons who were tested was 3.0% [three of 101]); the remaining two persons with school-associated cases had not been quarantined and were isolated only after a positive test result (secondary attack rate among nonquarantined contacts who were tested = 0.3% [two of 627]).[****] Among the five persons with school-associated cases, three persons were asymptomatic, and three persons were exposed to asymptomatic index patients; four cases were attributed to student-to-student transmission, and one was attributed to student-to-teacher transmission. Four of the five school-associated transmission events occurred because the contact sat <6 ft from the index patient during class (two) or during lunch (two), or the index patient or contact had poor mask use (two) or physical distancing behavior (two) (Table 3). All five households of persons with school-associated cases were tested. Tertiary transmission was detected in three households; within those households, six of eight household members received positive SARS-CoV-2 test results.

On December 17, 2020, Utah modified its quarantine recommendations for school contacts (students or staff members) who were identified as close contacts (persons within 6 ft of the index patient for a cumulative total of ≥15 minutes during a 24-hour period). Previously, school contacts who were close contacts were quarantined[††††] regardless of mask use; afterwards, they were only quarantined when the index patient or the contact did not wear a mask during the interaction. The school district implemented this recommendation on January 4, 2021, after a holiday break, and 158 students who were close contacts continued attending in-person school. Among these 158 students, 111 (70%) were tested; no school-associated cases were detected.

¶¶¶ An outbreak was defined as two or more cases epidemiologically linked to the same index patient classroom.

**** The secondary attack rate excludes seven nonschool-associated cases from the numerator and the denominator. Among 105 quarantined school contacts who were tested, the secondary attack rate excludes four nonschool-associated cases. Among 630 non-quarantined school contacts who were tested, the secondary attack rate excludes three nonschool-associated cases.

†††† Persons could return to school without SARS-CoV-2 testing after a 10-day quarantine. Those who received a negative SARS-CoV-2 test result on quarantine days 7–9 could return to school early.

TABLE 1. Characteristics of index and school-associated patients with laboratory-confirmed COVID-19 in 20 elementary schools — Salt Lake County, Utah, December 3, 2020–January 31, 2021

Characteristic	No. (%) of persons with COVID-19	
	Index (n = 51)*	School-associated (n = 5)†
Cases per school, median (range)	2 (1–9)	0 (0–2)
School contacts, median (range)	20 (5–53)	—§
Close contacts, median (range)	6 (0–23)	—
Other school contacts, median (range)	13 (0–52)	—
Median age, yrs (range)		
Students (index: n = 40; school-associated: n = 4)	9.5 (5–12)	10.5 (10–12)
Staff members (index: n = 11; school-associated: n = 1)	50 (26–62)	43 (43–43)
Sex		
Male	24 (47.1)	2 (40.0)
Female	27 (52.9)	3 (60.0)
Race/Ethnicity		
White, non-Hispanic	30 (58.8)	1 (20.0)
Hispanic/Latino	15 (29.4)	2 (40.0)
Black/African American	1 (2.0)	0 (0.0)
Asian	1 (2.0)	1 (20.0)
Native Hawaiian/Other Pacific Islander	2 (3.9)	0 (0.0)
American Indian or Alaska Native	0 (0.0)	0 (0.0)
Multiracial	2 (3.9)	1 (20.0)
Grade in school¶		
Kindergarten	5 (12.5)	0 (0.0)
1	3 (7.5)	0 (0.0)
2	2 (5.0)	0 (0.0)
3	6 (15.0)	0 (0.0)
4	6 (15.0)	2 (50.0)
5	8 (20.0)	0 (0.0)
6	10 (25.0)	2 (50.0)
Role in school		
Students	40 (78.4)	4 (80.0)
Head teachers	6 (11.8)	1 (20.0)
Paraeducators**	0 (0.0)	0 (0.0)
Other teachers††	4 (7.8)	0 (0.0)
Other staff members§§	1 (2.0)	0 (0.0)
Days in school while infectious, median (range)	2 (1–4)	0 (0–2)
Symptom status		
Ever symptomatic	35 (68.6)	2 (40.0)
Asymptomatic	16 (31.4)	3 (60.0)
One or more underlying medical condition¶¶	9 (20.9)	0 (0.0)
Quarantine status after exposure to index patient* **		
Under quarantine	—	3 (60.0)
Notified, close contact	—	0 (0.0)
Notified, not close contact	—	2 (40.0)

Abbreviation: IQR = interquartile range.

* An index patient was defined as a student or staff member with laboratory-confirmed SARS-CoV-2 infection who had attended in-person school while infectious for at least 1 day. Infectious period was estimated as 2 days before to 10 days after symptom onset (if symptomatic) or first positive specimen collection date (if asymptomatic).

† School-associated transmission was excluded if 1) the school contact had an illness onset (if symptomatic, symptom onset, if asymptomatic, first positive test date) before the last date of school exposure, 2) a household member had an illness onset (if symptomatic, symptom onset, if asymptomatic, first positive test date) within 14 days of the positive school contact's illness onset (if school contact was symptomatic) or before the last date of school exposure (if the school contact was asymptomatic) or 3) whole genome sequencing supported nonschool-associated transmission.

§ Dashes indicate that data are not applicable.

¶ Restricted to students. For index patients, n = 40, for secondary cases, n = 4.

** Includes teacher aides and interns.

†† Includes ethics teachers, instructional coaches, learning support teachers, special education teachers, and substitute teachers.

§§ Includes administrators, bus drivers, and health specialists.

¶¶ Missing data: Underlying medical conditions: eight index patients, one school-associated patient.

*** Starting January 4, 2021, the school district changed its quarantine policy based on changes to state recommendations and only students and staff members identified as close contacts (i.e., within 6 ft of the index patient for a cumulative total of ≥15 minutes over a 24-hour period) of the index patient were quarantined when both were maskless; previously, all close contacts would have been quarantined regardless of mask use. Any close contacts identified in January who met the criteria to not quarantine were categorized as "Notified, close contact." Those who shared a classroom space with the index patient but were not identified as close contacts were categorized as "Notified, not close contact."

TABLE 2. Characteristics of COVID-19–susceptible school contacts* in 20 elementary schools — Salt Lake County, Utah, December 3, 2020–January 31, 2021

Characteristic	No. (%) of school contacts	
	Total (N = 1,041)	Tested (n = 735)
Overall participation	—[†]	735 (70.6)
Median percent participation across 20 schools (range)	—	69.7 (44.4–100.0)
Median age, yrs (range)[§]		
Students (n = 908)	9.0 (5.0–18.0)	9.0 (5.0–18.0)
Staff members (n = 112)	39.5 (19.0–83.0)	39.0 (19.0–83.0)
Sex		
Male	487 (47.7)	352 (47.9)
Female	535 (52.3)	383 (52.1)
Race/Ethnicity		
White, non-Hispanic	566 (55.9)	382 (52.0)
Hispanic/Latino	303 (29.9)	237 (32.2)
Black/African American	28 (2.8)	25 (3.4)
Asian	33 (3.3)	29 (3.9)
Native Hawaiian/Other Pacific Islander	28 (2.8)	15 (2.0)
American Indian or Alaska Native	8 (0.8)	7 (1.0)
Multiracial	47 (4.6)	40 (5.4)
Grade[¶]		
Kindergarten	110 (12.1)	61 (9.7)
1	107 (11.8)	79 (12.5)
2	139 (15.3)	108 (17.1)
3	113 (12.4)	78 (12.3)
4	134 (14.8)	95 (15.0)
5	118 (13.0)	86 (13.6)
6	182 (20.0)	121 (19.1)
≥7	5 (0.6)	4 (0.6)
Role in school		
Students	908 (87.2)	632 (86.0)
Head teachers	77 (7.4)	61 (8.3)
Paraeducators**	24 (2.3)	13 (1.8)
Other teachers[††]	14 (1.3)	12 (1.6)
Other staff members[§§]	18 (1.7)	17 (2.3)
Days between school exposure and test date, median (range)[¶¶]	8 (6–15)	8 (6–15)
Quarantine status after exposure to index patient* **		
Quarantined	144 (13.8)	105 (14.3)
Notified, close contact	183 (17.6)	131 (17.8)
Notified, not close contact	714 (68.6)	499 (67.9)

* School contact was defined as a student or staff member who was in contact with the index patient for a total of ≥15 minutes in a classroom, cafeteria, school bus, or recess space during an index patient's infectious period. This includes any contacts who received positive SARS-CoV-2 test results but were not determined to have school-associated cases.
† Dashes indicate that data are not applicable.
§ Missing data (also applies to Sex and Race/Ethnicity categories): Age: 21 nonparticipating staff members; Sex: 19 nonparticipating staff members; Race/Ethnicity: 28 nonparticipants.
¶ Restricted to students (n = 908). Students in grade 7 or higher were contacts of an elementary school student on the school bus. All five students in grade 7 or higher were contacts of the same index patient. Bus contacts were not routinely included on the list of school contacts for all 51 index patients.
** Includes teacher aides and interns.
†† Includes ethics teachers, instructional coaches, learning support teachers, special education teachers, and substitute teachers.
§§ Includes administrators, bus drivers, and health specialists.
¶¶ All classroom testing occurred 6–10 days after exposure. One contact was tested on day 8 and offered a follow-up repeat testing on day 15.
*** Starting January 4, 2021, the school district changed its quarantine policy based on changes to state recommendations, and only students and staff members identified as close contacts (i.e., within 6 ft of the index patient for a cumulative total of ≥15 minutes over a 24-hour period) of the index patient were quarantined when both were maskless; previously, all close contacts would have been quarantined regardless of mask use. Any close contacts identified in January who met the criteria to not quarantine were categorized as "Notified, close contact." Those who shared a classroom space with the index patient but were not identified as close contacts were categorized as "Notified, not close contact."

TABLE 3. Characteristics of 12 contacts who received positive SARS-CoV-2 test results and summary of evidence for school-associated transmission in five contacts across 20 elementary schools — Salt Lake County, Utah, December 3, 2020–January 31, 2021*

	Index patient		School contact†		School-associated transmission			Factors associated with transmission			
					Basis for exclusion of school-associated transmission					Poor adherence to distancing, mask use, or neither at school	
Positive contact ID	School role	Symptoms reported	School role	Symptoms reported	Epidemiologic data	WGS data	School-associated transmission hypothesized	Close contact between patient and contact†	Contact sat <6 ft from index patient	Index patient	Contact
I1	Student	N	Student	N	N	NA	Y	Y	Class	Distancing	Mask use, distancing
J2	Student	N	Student	Y	N	NA	Y	Y	Class	Neither	Mask use
X3	Student	Y	Student	N	N	NA	Y	N	Lunch	Neither	Distancing
AA4	Student	Y	Student	N	N	NA	Y	Y	Lunch	Neither	Neither
EE5	Student	N	Teacher	Y	N	NA	Y	N	Neither	Neither	Neither
A6	Student	Y	Student	Y	N	Y	N	Y	—§	—	—
A7	Student	Y	Student	N	N	Y	N	Y	—	—	—
L8	Student	N	Student	Y	N	Y	N	Y	—	—	—
O9	Teacher	N	Student	Y	Y	NA	N	Y	—	—	—
T10	Student	Y	Student	Y	Y	NA	N	Y	—	—	—
RR11	Teacher	Y	Student	Y	Y	NA	N	Y	—	—	—
VV12	Student	Y	Student	Y	Y	NA	N	Y	—	—	—

Abbreviations: ID = identifier; Y = yes; N = no; NA = not available; WGS = whole genome sequencing.
* School-associated transmission was excluded by epidemiologic data if 1) the school contact had an illness onset (if symptomatic, symptom onset; if asymptomatic, first positive test date) before the last date of school exposure, or 2) a household member had an illness onset (if symptomatic, symptom onset; if asymptomatic, first positive test date) within 14 days of the positive school contact's illness onset (if school contact was symptomatic) or before the last date of school exposure (if the school contact was asymptomatic). School-associated transmission was excluded by WGS data if the index patient isolate was found to be a different lineage from the positive school contact isolate.
† Persons were determined to be close contacts if they were <6 ft from the index patient for a cumulative total of ≥15 minutes during a 24-hour period at school. All other school contacts were students or staff members who were in contact with the index patient for a cumulative total of ≥15 minutes in a classroom, cafeteria, school bus, or recess space during an index patient's infectious period.
§ Dashes indicate that data are not applicable.

Students in 42 classrooms[§§§§] (median class size = 22 students [range = 3–33 students]) sat a median of 3 ft (range = 1–5 ft) apart within the classroom, with a median of eight students (range = 1–16 students) sitting within a radius of 6 ft (Supplementary Table 1, https://stacks.cdc.gov/view/cdc/104112). Among 37 teachers with available data, 23 (62%) were seated ≥6 ft from the closest student (median = 6 ft, range = 2–10 ft), but all teachers reported daily one-on-one or small group instruction in close proximity to students, almost always without using plexiglass or physical barriers. Among 42 teachers, 36 (86%) reported that students always wore masks indoors except when eating or drinking. Nineteen of 20 (95%) principals reported using staggered mealtimes to increase spacing between students during lunch in the cafeteria (although still <6 ft apart). All schools reported implementing multiple measures to decrease in-school SARS-CoV-2 transmission (Supplementary Table 2, https://stacks.cdc.gov/view/cdc/104112).

§§§§ Among the 51 index patients, 42 classroom teachers were surveyed. Six index patients did not have traditional classroom exposures and were excluded; five were teachers or staff members who circulated among multiple classrooms a day and interacted with students one-on-one or in small groups, and one was a student in a class for children with special health care needs. Three classrooms had two index patients; only one teacher's survey was used to avoid double counting the classrooms.

Discussion

Despite high community incidence and an inability to space students' classroom seats ≥6 ft apart, this investigation found low SARS-CoV-2 transmission and no school-related outbreaks in 20 Salt Lake County elementary schools with high student mask use and implementation of multiple strategies to limit transmission. Other U.S. studies have also detected minimal school-associated transmission when implementing strict mitigation measures, although testing was limited to symptomatic close contacts (*3*,*4*). Because children with COVID-19 are frequently asymptomatic (*5*), the expanded testing to all school contacts regardless of symptom status in this investigation strengthens the evidence for low elementary school transmission.

In addition to implementation of multiple strategies to reduce in-school transmission, school-related activities that increase the risk for SARS-CoV-2 transmission, such as school-based team sports (*6*), were suspended. Although most teachers were seated ≥6 ft from students, CDC's recommendation at the time of the study of ≥6 ft student distancing within the classroom (*7*) was not possible because of limited space. A recent study in Massachusetts found no difference in student and staff member case rates from school districts

Summary

What is already known about this topic?

Data suggest that school-associated SARS-CoV-2 transmission is low.

What is added by this report?

SARS-CoV-2 testing was offered to 1,041 school contacts of 51 index patients across 20 elementary schools in Salt Lake County, Utah. In a high community transmission setting, low school-associated transmission was observed with a 0.7% secondary attack rate. Mask adherence was high, but students' classroom seats were <6 ft apart and a median of 3 ft apart.

What are the implications for public health practice?

These findings add to evidence that in-person elementary schools can be opened safely with minimal in-school transmission when critical prevention strategies including mask use are implemented, even though maintaining ≥6 ft between students' seats might not be possible.

with ≥3 feet physical distancing requirements compared with school districts with ≥6 feet physical distancing requirements (*8*). The study detected no teacher-driven transmission; other school investigations have identified teachers and staff members as being central to in-school transmission¶¶¶¶ (*9*,*10*). Although school-associated transmission was rare in this investigation, most cases did lead to household transmission, highlighting the importance of reducing school transmission to prevent infected children from transmitting SARS-CoV-2 to household members.

The modified quarantine policy, allowing contacts to continue attending in-person school if both the index patient and the contact were wearing a mask, did not lead to additional school-associated transmission and resulted in over 1,200 student in-person learning days saved.***** Among the five school-associated cases, the contact or index patient often had poor mask compliance, or they sat near one another during lunch. Findings suggest that quarantine determinations based on mask use of the index patient and close contacts might be adequate for preventing additional school-associated transmission in schools implementing multiple critical prevention strategies.

The findings in this report are subject to at least four limitations. First, WGS to differentiate school-associated from community transmission in a high incidence setting was not always available. Second, some infected contacts might have been missed because not all contacts received testing and the winter break mid-investigation might have interrupted additional school-associated transmission. Third, misclassification of susceptibility might have occurred as immunity status was unknown. Finally, these findings are specific to the current circulating SARS-CoV-2 variant distribution; as variant distribution shifts to new variants, more transmission might occur.

In an urban county with high SARS-CoV-2 community incidence, comprehensive testing of contacts detected low school-associated transmission in elementary schools, with a secondary attack rate of 0.7%. These results suggest that when ≥6 ft distancing is not feasible, schools in high-incidence communities can still limit in-school transmission by consistently using masks and implementing other important mitigation strategies.

¶¶¶¶ https://www.medrxiv.org/content/10.1101/2021.02.04.21250670v2.full

***** This calculation assumes that each student would have missed 8 in-person school days because the students attended in-person learning four out of five school days a week. In addition, it also assumes that all 158 students who would have been quarantined in December but were not quarantined in January were not school-associated cases, although only 111 of 158 were tested for SARS-CoV-2.

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Pilot Investigation of SARS-CoV-2 Secondary Transmission in Kindergarten Through Grade 12 Schools Implementing Mitigation Strategies — St. Louis County and City of Springfield, Missouri, December 2020

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Many kindergarten through grade 12 (K–12) schools offering in-person learning have adopted strategies to limit the spread of SARS-CoV-2, the virus that causes COVID-19 (*1*). These measures include mandating use of face masks, physical distancing in classrooms, increasing ventilation with outdoor air, identification of close contacts,* and following CDC isolation and quarantine guidance[†] (*2*). A 2-week pilot investigation was conducted to investigate occurrences of SARS-CoV-2 secondary transmission in K–12 schools in the city of Springfield, Missouri, and in St. Louis County, Missouri, during December 7–18, 2020. Schools in both locations implemented COVID-19 mitigation strategies; however, Springfield implemented a modified quarantine policy permitting student close contacts aged ≤18 years who had school-associated contact with a person with COVID-19 and met masking requirements during their exposure to continue in-person learning.[§] Participating students, teachers, and staff members with COVID-19 (37) from 22 schools and their school-based close contacts (contacts) (156) were interviewed, and contacts were offered SARS-CoV-2 testing. Among 102 school-based contacts who received testing, two (2%) had positive test results indicating probable school-based SARS-CoV-2 secondary transmission. Both contacts were in Springfield and did not meet criteria to participate in the modified quarantine. In Springfield, 42 student contacts were permitted to continue in-person learning under the modified quarantine; among the 30 who were interviewed, 21 were tested, and none received a positive test result. Despite high community transmission, SARS-CoV-2 transmission in schools implementing COVID-19 mitigation strategies was lower than that in the community. Until additional data are available, K–12 schools should continue implementing CDC-recommended mitigation measures (*2*) and follow CDC isolation and quarantine guidance to minimize secondary transmission in schools offering in-person learning.

A student, teacher, or staff member who received a positive SARS-CoV-2 nucleic acid amplification test or antigen test result and who had been physically present at the school or a school-associated event while potentially infectious was most often reported to school officials within 1–2 days of receipt of laboratory results. School officials initiated contact tracing to identify contacts in the school environment[¶] within 12–24 hours of notification. In Springfield, school officials assessed whether student contacts met criteria for a modified quarantine based on information from the contact tracing investigation. During December 7–18, 2020, an investigation team from Washington University in St. Louis, Saint Louis University, and CDC invited eligible** persons with

* A close contact was defined as any person who spent a cumulative total of ≥15 minutes in one 24-hour period within 6 ft of a person with COVID-19 while that person was potentially infectious, regardless of mask use. A person with COVID-19 was considered potentially infectious to others starting from 2 days before symptom onset (or if asymptomatic, 2 days before the collection of the first positive SARS-CoV-2 test specimen) until the person was isolated. https://www.cdc.gov/coronavirus/2019-ncov/php/contact-tracing/contact-tracing-plan/appendix.html#contact (accessed February 4, 2021).

† https://www.cdc.gov/coronavirus/2019-ncov/if-you-are-sick/quarantine.html (accessed January 31, 2021).

§ In November 2020, Springfield–Greene County Health Department and Springfield Public Schools adopted a modified quarantine policy for K–12 schools. Under this policy, student close contacts of a person with COVID-19 were permitted to attend school in person during their quarantine period if 1) the school had a mask mandate, the school's classrooms were arranged to maximize physical distancing, the school had increased hand hygiene practices, and the school screened students and staff members for COVID-19 symptoms and immediately isolated symptomatic persons and 2) the close contacts were K–12 students aged ≤18 years, their only exposure to the person with COVID-19 was in the educational environment (e.g., a classroom), they did not have prolonged (≥15 minutes) direct physical contact with the person with COVID-19, and the close contacts and person with COVID-19 had all been wearing masks appropriately during the time of exposure. https://www.springfieldmo.gov/5369/Modified-Quarantine (accessed January 2, 2021).

¶ The school environment includes exposures inside or outside of the classroom and school-based extracurricular and athletic activities.

** Persons with COVID-19 who were present in the school environment while potentially infectious ≤5 days before recruitment and contacts whose most recent exposure was ≤5 days before recruitment were eligible for inclusion. Participants aged ≥18 years provided oral agreement to participate; parent/guardian oral agreement was required for children aged <18 years, and oral agreement was required from children aged 12–17 years. Contacts could participate in the investigation regardless of whether the person with COVID-19 to whom they were exposed participated; however, contacts were excluded if they lived with the person who had COVID-19.

COVID-19 and their contacts to participate in the pilot investigation within 12–24 hours of identification by school officials. Overall numbers of identified contacts in the school environment were available for analysis regardless of participation and were used to characterize the number of school contacts identified per case.

To collect more detailed contact tracing information and epidemiologic data, a trained interviewer conducted a standardized telephone interview with 1) participants aged ≥18 years, 2) participants aged 12–17 years and/or their parents or guardians, and 3) parents or guardians of participants aged <12 years. Data were entered into and managed in a REDCap database (version 9.5.5; Washington University in St. Louis) and analyzed using SAS (version 9.4; SAS Institute). Contacts were monitored prospectively until 14 days after their last exposure. Saliva samples were collected from persons with COVID-19 soon after they agreed to participate and from contacts 5–8 days after their last exposure; samples were tested for SARS-CoV-2 by reverse transcription–polymerase chain reaction (RT-PCR).[††] Whole genome sequencing (97%–99% coverage) was conducted on RT-PCR–positive saliva samples using Oxford Nanopore Technologies MinION sequencing at CDC (*3*). For each contact who received a positive SARS-CoV-2 RT-PCR test result, the investigation team followed a case determination protocol to ascertain whether school-based secondary transmission was probable, possible, or unlikely[§§] (*4*,*5*). To gather data on mitigation measures implemented in schools, standardized interviews were conducted with school officials representing 57 K–12 schools (12 St. Louis County schools and 45 Springfield schools). This project was reviewed and approved by the Washington University in St. Louis Institutional Review Board and by CDC and was conducted consistent with applicable federal law and CDC policy.[¶¶]

All schools offered in-person learning, and all but one offered full- or part-time virtual learning. Among all schools, 9,216 of 30,558 (30%) students were participating in virtual learning only, and 21,342 (70%) attended in-person school at least part-time. Data on implemented mitigation strategies were reported for 55 schools, and 100% implemented a mask mandate. In addition, in at least some classrooms, 100% of schools spaced desks ≥3 ft apart, 27% spaced desks ≥6 ft apart, and 98% placed physical barriers between teachers and students. Ninety-eight percent had handwashing or hand sanitizing stations available at school entrances, and 100% had stations available in cafeterias or other dining areas, restrooms, and classrooms. Modifications to increase ventilation to prevent COVID-19 were reported by 98% of schools: 91% opened windows or doors, 87% used fans, 93% decreased occupancy in spaces where ventilation with outdoor air could not be increased, and 5% replaced or updated heating, ventilation, and air conditioning systems.

School officials identified 56 persons with COVID-19 who had a total of 270 contacts with school-based exposure and monitored them until the end of their isolation or quarantine period (Figure). All 326 persons were eligible for participation in the pilot investigation (interview, saliva testing, or both); among these, 193 (59%) agreed to participate. Participants included 37 (66%) persons with COVID-19 and 156 (58%) contacts from 22 of the 57 participating schools. Among participating persons with COVID-19 and their contacts, 65% and 88%, respectively, were students. Distributions by gender, age, and race/ethnicity among participating persons with COVID-19 and contacts were similar (Table). The number of identified contacts per participating person with COVID-19 ranged from 1 to 35 (median = 5).

Fifty-four of the 156 participating contacts declined testing; among the 102 who were tested, two (2%) received positive

[††] Saliva samples were tested at Washington University in St. Louis using the Washington University SARS-CoV-2 Ultrasensitive-High-Throughput-Saliva Version 1.0 assay. This RT-PCR assay is designed to detect two regions of the N gene (N1 and N2) in SARS-CoV-2 using primers and probes that were developed and validated under the Emergency Use Authorization for the CDC assay, as well as endogenous human control RNA (RNase P). Rarely, a health care provider collected a sample via nasal swab instead of a saliva sample from a contact to test for SARS-CoV-2 by RT-PCR outside of the pilot investigation, and results were reported to the investigation team.

[§§] Case determinations were made as follows: 1) probable school-based transmission: the person who received a positive SARS-CoV-2 test result was a close contact of someone with laboratory-confirmed COVID-19 in the school environment only, had no other known exposure to another person with confirmed or suspected COVID-19 in the 14 days before symptom onset or date of collection of the first specimen with positive test results, the person's exposure history and symptom and testing timeline was consistent with the known epidemiology of COVID-19 (e.g., did not experience symptoms on the same day as the first contact with the person with COVID-19), and (if sequencing data were available) the sequences generated from the specimens from the contact and school index case were identical or nearly identical; 2) possible school-based transmission: the person who received a positive SARS-CoV-2 test result was a close contact of a person with laboratory-confirmed COVID-19 in the school environment but had nonhousehold community exposure to that person or another person with confirmed or suspected COVID-19 in the 14 days before symptom onset or date of collection of their first specimen with positive test results, the person's exposure history and symptom and testing timeline was consistent with the known epidemiology of COVID-19, and sequencing data were unavailable or indeterminate; 3) unlikely school-based transmission: the person who received a positive SARS-CoV-2 test result was a close contact of a person with laboratory-confirmed COVID-19 in the school environment but lived in the same household as another person with confirmed or suspected COVID-19 in the 14 days before symptom onset or date of collection of the first specimen with positive test results or the person's exposure history and symptom and testing timeline was not consistent with the known epidemiology of COVID-19 and (if sequencing data were available) the sequences generated from the contact's specimen and the school index case's specimen were not identical or nearly identical.

[¶¶] 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.

SARS-CoV-2 test results (Figure). These two contacts were from separate schools in Springfield and were contacts of two different persons with COVID-19 (persons A and B) (5% of participating persons with COVID-19). School-based secondary transmission was probable for both contacts based on their exposure histories and symptom and testing timelines. One student contact of person A (a student in the same grade) received a positive test result 6 days after exposure. Although no sequencing data were available, the student contact had no other known sources of exposure. One student contact of person B (an elementary school teacher) received a positive SARS-CoV-2 test result 7 days after exposure in the classroom (<3 ft for >15 minutes) and had no other known exposure sources. The consensus sequence generated from whole genome sequencing of the student's saliva sample was nearly identical to that of person B, differing by only one nucleotide. Because neither contact of person A or B who received a positive test result met the criteria for Springfield's modified quarantine, they completed their quarantine at home.[***] Of the 168 contacts who did not receive testing from the investigation team, none was identified by school officials as having received positive test results during the 14 days after their last school-based exposure.

In the Springfield school district that implemented a modified quarantine, 131 (85%) of 155 contacts were students, 82 (63%) of whom agreed to participate in the pilot investigation; 42 (51%) participants met criteria for a modified quarantine and continued in-person learning during their quarantine period, 30 (71%) of whom were interviewed. Among 52 student contacts who did not meet modified quarantine criteria and were interviewed, the most common reasons student contacts did not meet modified quarantine criteria were unmasked exposure (31; 60%), athletic activity contact (11; 21%), and lunch or recess contact (seven; 13%). Testing results were available for 21 (70%) of 30 students who participated in the modified quarantine and were interviewed, and none received a positive SARS-CoV-2 test result.

Discussion

Schools across the United States have adopted various strategies to limit the risk for SARS-CoV-2 transmission and reduce disruptions to in-person learning (*1*). In-person school has psychosocial and health benefits beyond educational enrichment for many children, particularly those who depend on school-based services for physical, nutritional, and mental health support (*6*). Various mitigation strategies were implemented by the 55 surveyed schools with available data, including face mask mandates, increased physical distancing in classrooms, use of physical barriers to separate teachers from students, increased ventilation with outdoor air, and virtual learning options.

In this 2-week pilot investigation in K–12 schools that had implemented multiple strategies to limit SARS-CoV-2 transmission, school-based secondary transmission involving 37 participating students, teachers, and staff members with COVID-19 was identified among only two (2%) of 102 tested school close contacts. In both instances of probable school-based secondary transmission, each person with COVID-19 infected only one other person in the school environment. No outbreaks were identified in participating schools, despite the 2-week cumulative community incidence of 711 COVID-19 cases per 100,000 persons in St. Louis County[†††] and 996 in Springfield–Greene County.[§§§] Considering that only two probable school-based secondary transmission cases were identified, the 2-week school incidence would have been approximately eight cases per 100,000 persons, <1% of the average community incidence in the two sites over the same time period.[¶¶¶] These findings are consistent with other studies that have reported that despite high community SARS-CoV-2 transmission, schools that implemented multicomponent measures to reduce spread reported lower in-school transmission (*7*,*8*) unless lapses in these measures occurred (*9*).

The Springfield school district, which implemented a modified quarantine for certain students, permitted 42 student contacts to continue in-person learning during their quarantine period; 30 of these contacts were interviewed, and none of the 21 students who received testing had a positive test result. Assuming that an average 10-day quarantine period[****] results in 8 missed school days, an estimated 240 person-days of in-person learning were saved by implementing the modified quarantine for these student contacts. However, the testing data for participating student contacts in modified quarantine are insufficient to recommend that other schools nationwide adopt a modified quarantine policy; additional data are needed.

*** Neither contact met the criteria for modified quarantine: one had contact at lunch and recess in addition to in the classroom with person A and the other had prolonged direct physical contact with person B during one-on-one instruction. Because both close contacts did not meet the criteria for modified quarantine, both were completing their respective quarantine periods at home.

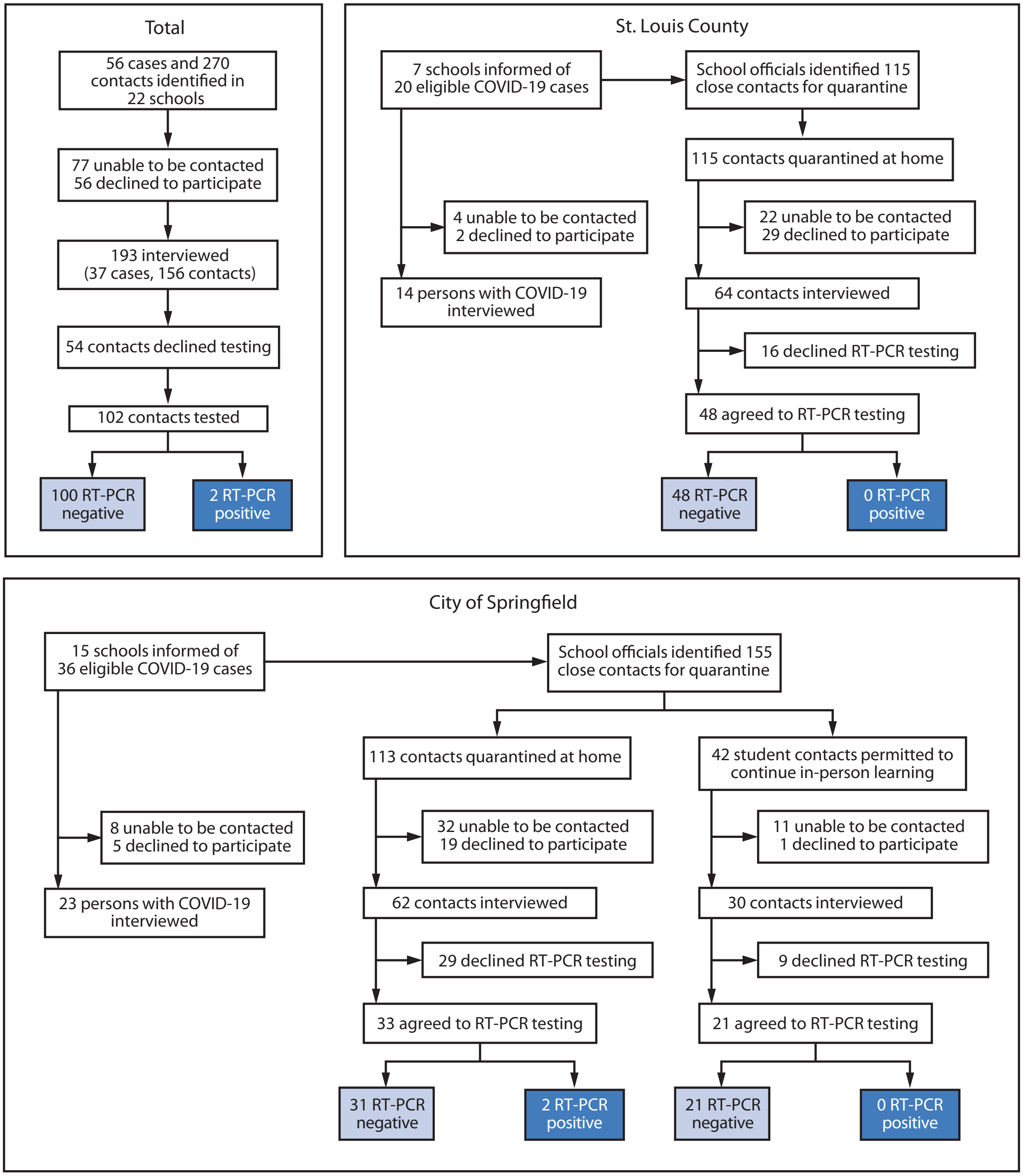
††† Data from https://stlcorona.com/resources/covid-19-statistics/archived-covid-19-reports/archived-trend-reports/covid-19-trends-12-28-2020/ (accessed January 1, 2021).

§§§ Data from https://www.springfieldmo.gov/5147/Recovery-Dashboard (accessed January 1, 2021).

¶¶¶ Crude incidence calculation based an estimated 26,000 in-person students, teachers, and staff members in participating schools over a 2-week period, compared with 711 (St. Louis County) and 996 (Springfield–Greene County) cases per 100,000 persons (combined average of 854 cases per 100,000 persons).

**** https://www.cdc.gov/coronavirus/2019-ncov/more/scientific-brief-options-to-reduce-quarantine.html (accessed February 12, 2021).

FIGURE. Identification of students, teachers, and staff members with school-associated COVID-19,* school-based close contacts,† and SARS-CoV-2 RT-PCR test results§ among close contacts — St. Louis County and city of Springfield, Missouri,¶, December 2020**



See figure footnotes on the next page.

Abbreviations: K–12 = kindergarten through grade 12; NAAT = nucleic acid amplification test; RT-PCR = reverse transcription–polymerase chain reaction.

* Receipt of a positive NAAT or antigen test result in a student, teacher, or staff member who was physically present at the school or a school-associated event while potentially infectious; cases were most often reported to school officials within 1–2 days of laboratory results.

† Any person who spent a cumulative total of ≥15 minutes in one 24-hour period within 6 ft of a person with COVID-19 while that person was potentially infectious, regardless of mask use. A person with COVID-19 was considered potentially infectious to others starting from 2 days before symptom onset (or if asymptomatic, 2 days before the collection of their first positive SARS-CoV-2 test specimen) until the person was isolated. https://www.cdc.gov/coronavirus/2019-ncov/php/contact-tracing/contact-tracing-plan/appendix.html#contact

§ Among 168 contacts who did not receive testing from the investigation team, during the 14 days after their last exposure, no other school-associated cases with a positive SARS-CoV-2 NAAT or antigen test result were reported to school officials.

¶ In November 2020, Springfield–Greene County Health Department and Springfield Public Schools adopted a modified quarantine policy for K–12 schools. Under this policy, student close contacts of a person with COVID-19 were permitted to attend school in person during their quarantine period if 1) the school had a mask mandate, the school's classrooms were arranged to maximize physical distancing, the school had increased hand hygiene practices, and the school screened students and staff members for COVID-19 symptoms and immediately isolated symptomatic persons and 2) the close contacts were K–12 students aged ≤18 years, their only exposure to the person with COVID-19 was in the educational environment (e.g., a classroom), they did not have prolonged (≥15 minutes) direct physical contact with the person with COVID-19, and the close contacts and person with COVID-19 had all been wearing masks appropriately during the time of exposure. https://www.springfieldmo.gov/5369/Modified-Quarantine

** The two close contacts who received positive SARS-CoV-2 RT-PCR test results were from separate Springfield schools, were quarantining at home, and were contacts of two different persons with COVID-19 (persons A and B). School-based secondary transmission was probable for both contacts based on their exposure histories and symptom and testing timelines. One student contact of person A (a student in the same grade) received a positive test result 6 days after exposure. Although no genetic sequencing data were available, the student had no other known sources of exposure. One student contact of person B (a teacher) received a positive SARS-CoV-2 test result 7 days after exposure. The student was exposed in the classroom (<3 ft from the teacher for >15 minutes) and had no other known exposure sources. The consensus sequence generated from whole genome sequencing of the student's saliva sample was nearly identical to that of person B, differing by only one nucleotide.

The findings in this report are subject to at least five limitations. First, school contact tracing might not have identified all close contacts. Second, participation in the investigation project was 59%, possibly because of COVID-19 testing fatigue or other factors cited by persons who declined to participate. Third, not all possible mitigation strategies or school characteristics that might have affected school-based secondary transmission were assessed, and whether masks were worn appropriately was not assessed. Fourth, symptom status, mitigation practices, exposure histories, and underlying medical conditions of persons who participated might have differed from those who did not. Therefore, these findings might not be representative of all persons in the participating schools and might not be generalizable to other schools. Finally, persons who were infected with SARS-CoV-2 but who did not receive testing in this investigation might have been missed, particularly if they were asymptomatic and did not receive testing elsewhere.

The findings from this pilot investigation suggest that implementation of CDC-recommended SARS-CoV-2 mitigation measures in schools might help reduce school-based transmission. The absence of positive test results among student contacts who participated in a modified quarantine raises important epidemiologic questions that require additional study, including the effect of modified quarantine on school-based SARS-CoV-2 secondary transmission and specific criteria for a modified quarantine. The pilot investigation did not include sufficient data to answer these questions; however, data from a more extensive ongoing investigation in six urban, suburban, and rural Missouri public school districts representing approximately 70,000 students, teachers, and staff members will help address these important public health concerns. Until additional data are available, K–12 schools should continue implementing SARS-CoV-2 mitigation strategies that include mask use policies, physical distancing, increased ventilation, and attention to hand hygiene (*2*) and follow CDC isolation and quarantine guidance to minimize secondary transmission of SARS-CoV-2 in schools offering in-person learning.

Summary

What is already known about this topic?

Many kindergarten through grade 12 (K–12) schools have implemented strategies to limit school-associated SARS-CoV-2 transmission.

What is added by this report?

In 22 participating K–12 schools implementing multiple COVID-19 mitigation strategies, school-based SARS-CoV-2 secondary transmission was detected in two of 102 tested close contacts of 37 persons with COVID-19. Among 21 tested student contacts participating in a modified quarantine, all SARS-CoV-2 test results were negative.

What are the implications for public health practice?

Schools implementing strategies including mask mandates, physical distancing, and increased ventilation had much lower SARS-CoV-2 transmission than in the community. K–12 schools should continue implementing these measures and following CDC isolation and quarantine guidance to minimize secondary transmission in schools.

TABLE. Characteristics of persons with school-associated COVID-19 cases* and their school-based close contacts† from 22 kindergarten through grade 12 schools — St. Louis County and city of Springfield, Missouri, December 2020

Characteristic	No. (%)		
	Cases (n = 37)	Contacts (n = 156)	Total (n = 193)
School location			
St. Louis County§	14 (38)	64 (41)	78 (40)
City of Springfield¶	23 (62)	92 (59)	115 (60)
Age of students, yrs, median (range)	14 (6–18)	11 (5–18)	12 (5–18)
Age of teachers/staff members, yrs, median (range)	50 (29–61)	44 (28–63)	47 (28–63)
School status			
Elementary school student (grades K–5)	7 (19)	65 (42)	72 (37)
Middle school student (grades 6–8)	4 (11)	21 (13)	25 (13)
High school student (grades 9–12)	13 (35)	51 (33)	64 (33)
Teacher	7 (19)	12 (8)	19 (10)
Staff member	6 (16)	7 (4)	13 (7)
Gender identity**			
Female	22 (59)	88 (56)	110 (57)
Male	15 (41)	65 (42)	80 (41)
Other/Nonbinary	0 (—)	2 (1)	2 (1)
Unknown	0 (—)	1 (1)	1 (1)
Race			
American Indian or Alaska Native	1 (3)	1 (1)	2 (1)
Asian	0 (—)	1 (1)	1 (1)
Black	3 (8)	29 (19)	32 (17)
Native Hawaiian or Other Pacific Islander	0 (—)	0 (—)	0 (—)
White	26 (70)	115 (74)	141 (73)
Multiracial	4 (11)	6 (4)	10 (5)
Prefer not to say or unknown	3 (8)	4 (3)	7 (4)
Ethnicity			
Hispanic/Latino	3 (8)	11 (7)	14 (7)
Non-Hispanic/Latino	34 (92)	142 (91)	176 (91)
Prefer not to say or unknown	0 (—)	3 (2)	3 (2)
Preexisting medical condition††			
Yes	17 (46)	49 (31)	66 (34)
No	20 (54)	105 (67)	125 (65)
Unknown	0 (—)	2 (1)	2 (1)

* Receipt of a positive nucleic acid amplification test or antigen test result in a student, teacher, or staff member who was physically present at the school or a school-associated event while potentially infectious; cases were most often reported to school officials within 1–2 days of laboratory results.

† Any person who spent a cumulative total of ≥15 minutes in one 24-hour period within 6 ft of a person with COVID-19 while that person was potentially infectious, regardless of mask use. A person with COVID-19 was considered potentially infectious to others starting from 2 days before symptom onset (or if asymptomatic, 2 days before the collection of the first positive SARS-CoV-2 test specimen) until the person was isolated. https://www.cdc.gov/coronavirus/2019-ncov/php/contact-tracing/contact-tracing-plan/appendix.html#contact

§ Includes participants from seven schools.

¶ Includes participants from 15 schools.

** In response to the question "I am going to read a list of genders. Please let me know which one you identify yourself as (your child identifies themselves as)."

†† Including but not limited to type 1 or type 2 diabetes, hypertension, cardiovascular disease, chronic renal disease, chronic lung disease, immunosuppressive conditions, autoimmune conditions, and premature birth.

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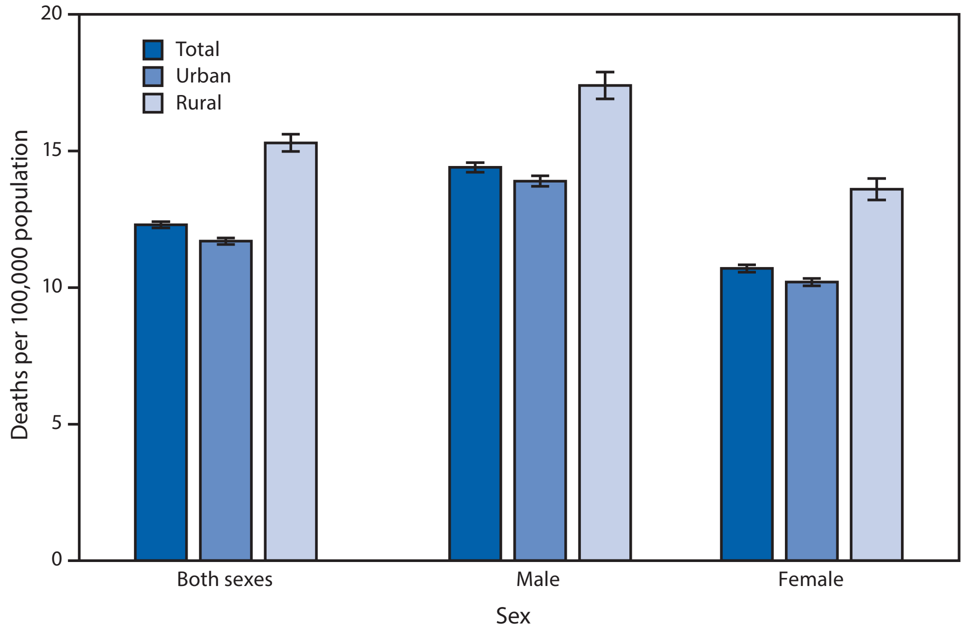
QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Age-Adjusted Death Rates* for Influenza and Pneumonia,† by Urbanization Level§ and Sex — National Vital Statistics System, United States, 2019



* Deaths per 100,000 population are age-adjusted to the 2000 U.S. standard population with 95% confidence intervals indicated by errors bars.

† Deaths attributed to influenza and pneumonia were identified using *International Classification of Diseases, Tenth Revision* underlying cause-of-death codes J09–J18.

§ Counties were classified using the 2013 National Center for Health Statistics urban-rural classification scheme for counties. https://www.cdc.gov/nchs/data/series/sr_02/sr02_166.pdf

In 2019, age-adjusted death rates for influenza and pneumonia were higher among males (14.4 per 100,000) than females (10.7) and among those who lived in rural counties (15.3) compared with those who lived in urban counties (11.7). Among males, the age-adjusted death rate for influenza and pneumonia was 17.4 in rural counties and 13.9 in urban counties. Among females, the age-adjusted death rate for influenza and pneumonia was 13.6 in rural counties and 10.2 in urban counties.

Source: National Center for Health Statistics, National Vital Statistics System, Mortality file. https://www.cdc.gov/nchs/nvss/deaths.htm

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