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Tuberculosis — United States, 2021

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During 1993–2019, the incidence of tuberculosis (TB) in the United States decreased steadily; however, during the later years of that period the annual rate of decline slowed (*1*) until 2020 when a substantial decline (19.9%) was observed. This sharp decrease in TB incidence might have been related to multiple factors coinciding with the COVID-19 pandemic, including delayed or missed TB diagnoses or a true reduction in TB incidence related to pandemic mitigation efforts and changes in immigration and travel (*2*). During 2021, a total of 7,860 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). National incidence of reported TB (cases per 100,000 persons) rose 9.4% during 2021 (2.37) compared with that in 2020 (2.16) but remained 12.6% lower than the rate during 2019 (2.71).* During 2021, TB incidence increased among both U.S.-born and non–U.S.-born persons. The increased TB incidence observed during 2021 compared with 2020 might be partially explained by delayed diagnosis of cases in persons with symptom onset during 2020; however, the continued, substantial reduction from prepandemic levels raises concern for ongoing underdiagnosis. TB control and prevention services, including early diagnosis and complete treatment of TB and latent TB infection, should be maintained and TB awareness promoted to achieve elimination in the United States.

Health departments in the 50 U.S. states and DC report TB cases to CDC based on the Council of State and Territorial Epidemiologists' surveillance case definition, which includes both laboratory and clinically verified cases.† For each case, health departments electronically submit a report of a verified TB case to CDC. Midyear U.S. Census Bureau population estimates§ were used to calculate national- and state-level TB incidence per 100,000 persons along with incidence stratified by age groups. Persons with TB were grouped by self-reported race and ethnicity according to federal guidelines.¶ Persons who self-identified as Hispanic were categorized as Hispanic irrespective of self-reported race, persons not identifying as Hispanic were categorized by self-reported race, and non-Hispanic persons who reported more than one race were

* This report is limited to National Tuberculosis Surveillance System data verified as of February 9, 2022. Updated data will be available in CDC's annual TB surveillance report later in 2022.

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

§ 2021 vintage population estimates were used for 2021 and 2020. 2020 vintage population estimates were used for 2011–2019. https://www.census.gov/programs-surveys/popest/data/tables.html

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

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categorized as "multiple races." Midyear population estimates from the Current Population Survey** were used to calculate incidence by birth origin†† and race/ethnicity. Percent changes in incidence were calculated using unrounded figures.

A total of 7,860 TB cases were reported during 2021, 687 more than during 2020 (7,173) and 1,040 fewer than during 2019 (8,900) (Table 1). From 2020 to 2021, TB incidence (cases per 100,000 population) rose 9.4%, from 2.16 to 2.37, but remained 12.6% lower than during 2019 (2.71). California reported the highest number of cases (1,750), and Alaska reported the highest incidence (7.92). Eighteen states and DC reported the same number or fewer TB cases during 2021 than during 2020; the remaining 32 states reported more cases during 2021 than 2020.

During 2021, 71% of TB cases occurred among non–U.S.-born persons, the same proportion as in 2020 and 2019. Incidence (cases per 100,000 population) among U.S.-born persons increased from 0.71 in 2020 to 0.79 in 2021 and among non-U.S.-born persons from 11.71 in 2020 to 12.16 in 2021 (Figure). Among U.S.-born persons reported as having TB disease, 4% identified as American Indian or Alaska Native (AI/AN), 6% as Asian, 33% as Black, 25% as Hispanic, 2% as Native Hawaiian or other Pacific Islander (NH/OPI), 29% as White, and 1% as multiple races.§§ From 2020 to 2021, TB incidence decreased 0.4% among U.S.-born Black persons and 5.7% among U.S.-born NH/OPI persons and increased among all other U.S.-born groups (including AI/AN [5.0%], Asian [32.6%], Hispanic [16.3%], and White [13.8%] persons) (Table 2). Among non–U.S.-born persons reported as having TB disease, <1% identified as AI/AN, 48% as Asian, 12% as Black, 34% as Hispanic, 1% as NH/OPI, 4% as White, and 1% as multiple races. From 2020 to 2021, TB incidence decreased 8.7% among non–U.S.-born Black persons and 40.3% among non–U.S.-born NH/OPI persons and increased among all other non–U.S.-born groups (including Asian [3.7%], Hispanic [7.9%], and White [4.5%] persons).¶¶ Compared with TB incidence in 2020, incidence during 2021 declined 2.2% among children aged ≤4 years, 0.3% among children and adolescents aged 5–14 years, and 2.9% among persons aged 15–24 years. Incidence increased among adults aged 25–44 years (5.3%), 45–64 years (10.6%), and ≥65 years (13.2%).

During 2021, among non–U.S.-born persons reported as having TB, 9.3% (507 of 5,456) received a diagnosis <1 year

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

†† Persons born in the United States or a U.S. territory or elsewhere to at least one U.S. citizen parent are categorized as U.S.-born. All other persons are categorized as non–U.S.-born.

§§ Persons with missing race or ethnicity data are excluded from calculations of proportions.

¶¶ Percent change is not reported for non–U.S.-born AI/AN persons because there were no reported cases during 2020.

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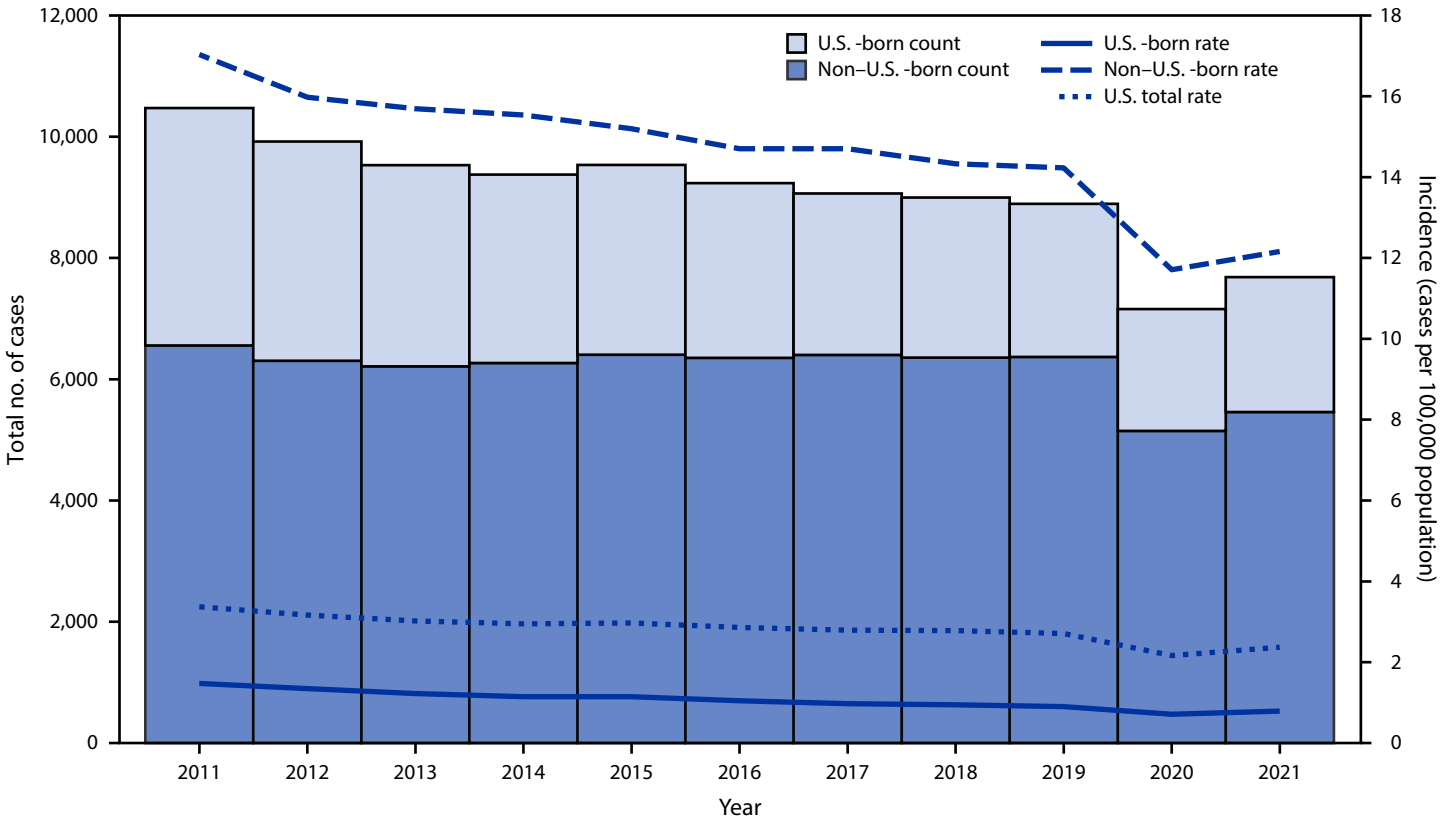
TABLE 1. Tuberculosis disease case counts and incidence, by U.S. state — 50 states and the District of Columbia, 2019–2021

U.S. jurisdiction	No. of TB cases*			TB incidence†		
	2019	2020	2021	2019	2020	2021
Total	**8,900**	**7,173**	**7,860**	**2.71**	**2.16**	**2.37**
Alabama	87	72	92	1.77	1.43	1.83
Alaska	58	58	58	7.91	7.92	7.92
Arizona	183	136	129	2.51	1.89	1.77
Arkansas	64	59	69	2.12	1.96	2.28
California	2,111	1,706	1,750	5.35	4.32	4.46
Colorado	66	52	58	1.15	0.90	1.00
Connecticut	67	54	54	1.88	1.50	1.50
Delaware	18	17	43	1.84	1.71	4.29
District of Columbia	24	19	19	3.39	2.75	2.84
Florida	558	412	499	2.60	1.91	2.29
Georgia	302	221	228	2.84	2.06	2.11
Hawaii	99	92	106	6.99	6.34	7.35
Idaho	7	8	4	0.39	0.43	0.21
Illinois	326	216	255	2.57	1.69	2.01
Indiana	108	92	127	1.60	1.36	1.87
Iowa	52	39	49	1.65	1.22	1.53
Kansas	37	37	43	1.27	1.26	1.47
Kentucky	66	67	57	1.48	1.49	1.26
Louisiana	88	99	86	1.89	2.13	1.86
Maine	18	17	14	1.34	1.25	1.02
Maryland	209	148	192	3.45	2.40	3.11
Massachusetts	178	142	151	2.58	2.02	2.16
Michigan	131	101	136	1.31	1.00	1.35
Minnesota	148	117	134	2.62	2.05	2.35
Mississippi	58	41	45	1.95	1.39	1.53
Missouri	70	79	77	1.14	1.28	1.25
Montana	2	4	3	0.19	0.37	0.27
Nebraska	17	33	22	0.88	1.68	1.12
Nevada	53	57	61	1.71	1.83	1.94
New Hampshire	6	12	12	0.44	0.87	0.86
New Jersey	310	245	279	3.49	2.64	3.01
New Mexico	41	29	24	1.95	1.37	1.13
New York	746	605	681	3.83	3.00	3.43
North Carolina	185	159	178	1.76	1.52	1.69
North Dakota	18	10	15	2.36	1.28	1.94
Ohio	150	130	149	1.28	1.10	1.26
Oklahoma	73	67	69	1.84	1.69	1.73
Oregon	70	67	78	1.66	1.58	1.84
Pennsylvania	199	156	166	1.55	1.20	1.28
Rhode Island	14	7	17	1.32	0.64	1.55
South Carolina	80	67	88	1.55	1.31	1.70
South Dakota	16	16	12	1.80	1.80	1.34
Tennessee	129	113	85	1.89	1.63	1.22
Texas	1,154	883	991	3.98	3.02	3.36
Utah	27	29	17	0.84	0.88	0.51
Vermont	4	3	2	0.64	0.47	0.31
Virginia	191	169	161	2.23	1.96	1.86
Washington	221	163	199	2.90	2.11	2.57
West Virginia	9	13	7	0.50	0.73	0.39
Wisconsin	51	35	66	0.88	0.59	1.12
Wyoming	1	0	3	0.17	0.00	0.52

Abbreviation: TB = tuberculosis.
* Case counts are based on data reported to the National Tuberculosis Surveillance System as of February 9, 2022.
† Cases per 100,000 persons using midyear population estimates from the U.S. Census Bureau. 2019 population estimates are based on the 2010 U.S. Census. 2020 and 2021 population estimates are based on the 2020 U.S. Census. https://www.census.gov/programs-surveys/popest/data/tables.html

after arrival in the United States, compared with 9.7% (499 of 5,149) during 2020 and an average of 15.6% (996 of 6,377) during 2015–2019. Among non–U.S.-born persons with reported TB during 2021, approximately one third (1,811; 33.2%) had lived in the United States for at least 20 years before receiving a diagnosis, similar to the percentage during 2020 (1,662; 32%), and slightly more than the average of 28% (1,766) during 2015–2019. The proportion of persons

FIGURE. Tuberculosis disease case counts* and incidence,† by patient birth origin§ — United States, 2011–2021



* Case counts are based on data from the National Tuberculosis Surveillance System as of February 9, 2022.
† Cases per 100,000 persons. The Current Population Survey provides the population denominators used to calculate tuberculosis incidence according to national origin and racial/ethnic group. https://www.census.gov/programs-surveys/cps.html (Accessed February 9, 2022).
§ Cases with unknown origin at birth excluded.

who received a diagnosis of TB who had visible acid-fast bacilli on sputum smear microscopy, a marker of infectiousness and more advanced disease, during 2020 (46.4%) and 2021 (48.1%) were higher than the average proportion during 2015–2019 (44.3%).*** When stratified by birth origin, the prevalence of smear positivity among non–U.S.-born persons during 2020 (45.5%) and 2021 (47.8%) were higher than the average during 2015–2019 (42.6%). This increase in smear-positivity was not observed among U.S.-born persons who had received a diagnosis of TB (2021 = 48.2%; 2020 = 48.9%; average 2015–2019 = 48.7%).

Discussion

U.S. TB incidence during 2021 increased by 9.4% following a large decrease during 2020 (*2*). Although TB cases and incidences have gradually declined in the United States since 1993, with a slowing pace of decline in recent years (*1*), larger changes in reported TB have occurred during the COVID-19 pandemic. Similar changes in TB incidence have been reported globally (*3*,*4*). In the United States, the causes for the changes in TB incidence are likely multifactorial. Probable explanations include a true reduction in TB disease resulting from reduced TB transmission because of pandemic mitigation efforts and fewer new arrivals from countries with higher TB incidence than the United States. In addition, delayed or missed TB diagnoses because of disruptions in health care access or assumptions that patients with respiratory symptoms had COVID-19 might contribute to the observed changes (*5*).

The reduction in the number of persons with TB disease reported <1 year after arrival in the United States coincides with changes in immigration and travel associated with the pandemic. Immigration to the United States declined by 31% during 2020,††† and similar patterns are suggested during

*** Percentage of positive sputum smears is calculated among persons with a positive or negative sputum smear result; those with unknown results or for whom testing was reported as not performed were excluded.

††† https://www.dhs.gov/immigration-statistics/yearbook/2020

TABLE 2. Tuberculosis disease case counts and incidence, by birth origin and race/ethnicity — United States, 2018–2021

Birth origin and race/ethnicity	No. of TB cases* (incidence†)			
	2018	2019	2020	2021
U.S.-born§				
AI/AN	100 (3.91)	79 (3.35)	78 (3.54)	84 (3.72)
Asian	135 (1.88)	115 (1.50)	95 (1.15)	125 (1.53)
Black, non-Hispanic	950 (2.67)	909 (2.56)	731 (2.04)	739 (2.03)
Hispanic	584 (1.47)	609 (1.52)	475 (1.17)	553 (1.36)
White, non-Hispanic	806 (0.43)	756 (0.41)	565 (0.30)	640 (0.35)
NH/OPI	39 (5.17)	26 (3.92)	42 (6.20)	45 (5.85)
Unknown race/ethnicity or multiple races¶	28 (—)	31 (—)	21 (—)	38 (—)
Subtotal	**2,642 (0.95)**	**2,525 (0.90)**	**2,007 (0.71)**	**2,224 (0.79)**
Non–U.S.-born				
AI/AN	2 (3.49)	2 (3.51)	0 (—)	1 (1.33)
Asian	3,074 (26.08)	3,049 (26.17)	2,478 (22.18)	2,613 (22.99)
Black, non-Hispanic	848 (20.36)	838 (19.83)	679 (15.67)	623 (14.30)
Hispanic	2,040 (10.28)	2,076 (10.24)	1,650 (8.17)	1,821 (8.81)
NH/OPI	73 (24.70)	80 (24.78)	75 (35.36)	68 (21.10)
White, non-Hispanic	260 (3.23)	254 (3.16)	212 (2.73)	225 (2.85)
Unknown race/ethnicity or multiple races¶	58 (—)	70 (—)	55 (—)	105 (—)
Subtotal	**6,355 (14.33)**	**6,368 (14.23)**	**5,149 (11.71)**	**5,456 (12.16)**
Unknown national origin¶	3 (—)	7 (—)	17 (—)	180 (—)
Total	**9,000 (2.75)**	**8,900 (2.71)**	**7,173 (2.16)**	**7,860 (2.37)**

Abbreviations: AI/AN = American Indian or Alaska Native; NH/OPI = Native Hawaiian or other Pacific Islander; TB = tuberculosis.
* Case counts are based on data from the National Tuberculosis Surveillance System as of February 9, 2022.
† Incidence is calculated per 100,000 persons. The Current Population Survey (https://www.census.gov/programs-surveys/cps.html) provides the population denominators used to calculate TB incidence according to national origin and racial/ethnic group. (Accessed February 9, 2022). Total rate was calculated by using midyear population estimates from the U.S. Census Bureau.
§ Persons born in the United States or a U.S. territory or elsewhere to at least one U.S. citizen parent are categorized as U.S.-born. All other persons are categorized as non–U.S.-born.
¶ Incidence rates were not calculated for these categories because population estimates were not available.

2021.§§§ However, immigration and travel reductions during 2020–2021 cannot fully account for the reduction in TB, because most TB cases among non–U.S.-born persons occur among those who have lived in the United States for many years and are likely the result of reactivation of latent TB infection (LTBI) (*1*). Despite overall case count declines, the number of TB cases among non–U.S.-born persons living in the United States for 20 years or longer before diagnosis increased during 2021 compared with average case counts during 2015–2019, highlighting the importance of evaluation and treatment of LTBI to prevent progression to TB disease. CDC is working to raise awareness of TB and LTBI among communities at risk and their health care providers through the new "Think. Test. Treat TB" campaign.¶¶¶

The increased TB incidence observed during 2021 compared with 2020 might be partially explained by delayed detection of cases with symptom onset during 2020 that were not diagnosed until 2021 because of delayed health care–seeking behavior, interruptions in health care access, or disrupted TB services related to the COVID-19 pandemic (*6*,*7*). The small increase in the prevalence of smear positivity at diagnosis, predominantly among non–U.S.-born persons, suggests more advanced pulmonary disease, which might result from delayed diagnosis. Avoiding missed or delayed diagnosis of TB is crucial to preventing transmission. TB should be considered in the differential diagnosis of patients with prolonged cough (>2 weeks) or TB symptoms such as unintentional weight loss or hemoptysis, particularly among persons with epidemiologic risk factors for TB (e.g., birth or former residence in a country with higher TB incidence than that in the United States, history of living in a congregate setting such as a homeless shelter or a correctional facility, or immune suppression).****

The findings in this report are subject to at least two limitations. First, this analysis is limited to provisional 2021 TB surveillance data and case counts might change. Second, calculated rates are based on population estimates that are subject to change.

§§§ https://www.census.gov/library/stories/2021/12/net-international-migration-at-lowest-levels-in-decades.html
¶¶¶ https://www.cdc.gov/thinktesttreattb/

**** Clinical consultation for potential TB cases is also available through state or local TB programs or the CDC-sponsored TB Centers of Excellence. https://www.cdc.gov/tb/education/professionaltools.htm

Summary

What is already known about this topic?

The number of reported U.S. tuberculosis (TB) cases decreased sharply in 2020, possibly related to multiple factors associated with the COVID-19 pandemic.

What is added by this report?

Reported TB incidence (cases per 100,000 persons) increased 9.4%, from 2.2 during 2020 to 2.4 during 2021 but was lower than incidence during 2019 (2.7). Increases occurred among both U.S.-born and non–U.S.-born persons.

What are the implications for public health practice?

Factors contributing to changes in reported TB during 2020–2021 likely include an actual reduction in TB incidence as well as delayed or missed TB diagnoses. Timely evaluation and treatment of TB and latent tuberculosis infection remain critical to achieving U.S. TB elimination.

Ongoing analyses of NTSS data and external data sources, including anti-TB drug dispensing and hospitalization data, will provide more information about the effects of the COVID-19 pandemic on U.S. TB epidemiology, including the extent to which delayed diagnosis has been a factor. Focusing on essential TB activities, including early diagnosis and complete treatment of TB and LTBI, remains critical to achieving TB elimination in the United States.

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Lessons Learned from Programmatic Gains in HIV Service Delivery During the COVID-19 Pandemic — 41 PEPFAR-Supported Countries, 2020

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The U.S. President's Emergency Plan for AIDS Relief (PEPFAR) supports country programs in identifying persons living with HIV infection (PLHIV), providing life-saving treatment, and reducing the spread of HIV in countries around the world (*1*,*2*). CDC used Monitoring, Evaluation, and Reporting (MER) data* to assess the extent to which COVID-19 mitigation strategies affected HIV service delivery across the HIV care continuum† globally during the first year of the COVID-19 pandemic. Indicators included the number of reported HIV-positive test results, the number of PLHIV who were receiving antiretroviral therapy (ART), and the rates of HIV viral load suppression. Percent change in performance was assessed between countries during the first 3 months of 2020, before COVID-19 mitigation efforts began (January–March 2020), and the last 3 months of the calendar year (October–December 2020). Data were reviewed for all 41 countries to assess total and country-level percent change for each indicator. Then, qualitative data were reviewed among countries in the upper quartile to assess specific strategies that contributed to programmatic gains. Overall, positive percent change was observed in PEPFAR-supported countries in HIV treatment (5%) and viral load suppression (2%) during 2020. Countries reporting the highest gains across the HIV care continuum during 2020 attributed successes to reducing or streamlining facility attendance through strategies such as enhancing index testing (offering of testing to the biologic children and partners of PLHIV)§ and community- and home-based testing; treatment delivery approaches; and improvements in data use through monitoring activities, systems, and data quality checks. Countries that reported program improvements during the first year of the COVID-19 pandemic offer important information about how lifesaving HIV treatment might be provided during a global public health crisis.

During 2020, 41 countries received PEPFAR support for direct HIV service delivery.¶ To determine gains in HIV service delivery, MER indicators were analyzed to identify programmatic changes in 1) the number of reported positive HIV test results, 2) the number of PLHIV receiving ART, and 3) the percentage of PLHIV receiving ART with suppressed HIV viral load** during 2020 to assess change before and during the first year of the COVID-19 pandemic. The number of sites ranged from three to 1,520 per country. The analysis was limited to sites within each country that reported indicator data during both periods. The number of treatment sites in each country that reported during both periods was proportional to the size of the PEPFAR ART program. Overall percent change for all 41 countries from January–March to October–December 2020†† was calculated for each of the three indicators. The percent change for each indicator was further analyzed for countries in the highest quartile for each indicator. A thematic analysis was conducted using qualitative MER narratives for each indicator among countries in the upper quartile to identify specific adaptive strategies that were reported to contribute to gains for each indicator. This

* https://www.state.gov/wp-content/uploads/2019/10/PEPFAR-MER-Indicator-Reference-Guide-Version-2.4-FY20.pdf

† https://www.cdc.gov/hiv/pdf/library/factsheets/cdc-hiv-care-continuum.pdf

§ https://apps.who.int/iris/bitstream/handle/10665/251655/9789241549868-eng.pdf

¶ Direct service delivery for HIV treatment support from PEPFAR is defined as both provision of critical personnel or commodities and support to improve the quality of services through site visits as often as deemed necessary by the partner and country team. Eight countries were excluded from the analysis because PEPFAR exclusively provides nondirect service delivery support (i.e., technical assistance only) for treatment services.

** MER indicators: number of persons receiving a positive HIV test result, number of persons currently receiving antiretroviral therapy, and rate of viral load suppression. The viral load indicator collects information among persons who have been receiving ART for ≥3 months and assesses suppression among those who have had a test in the past 12 months. HIV viral load suppression is defined as having a documented viral load result of <1,000 HIV RNA copies/ml within the past 12 months. Because of reporting requirements, data on viral load might include data from previous reporting quarters and fiscal years. MER narrative reports are collected during each reporting period and include qualitative information to supplement the values reported for the indicator.

†† Data analysis was conducted using data reported from facilities during January–March and October–December 2020 to provide appropriate comparison of results before and during the first year of the COVID-19 pandemic. Community sites were included for the HIV testing indicator. This period was chosen to avoid any possible impact of COVID-19 vaccination rollout and avoid substantive programmatic changes that could take place outside a single calendar year.

activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[§§]

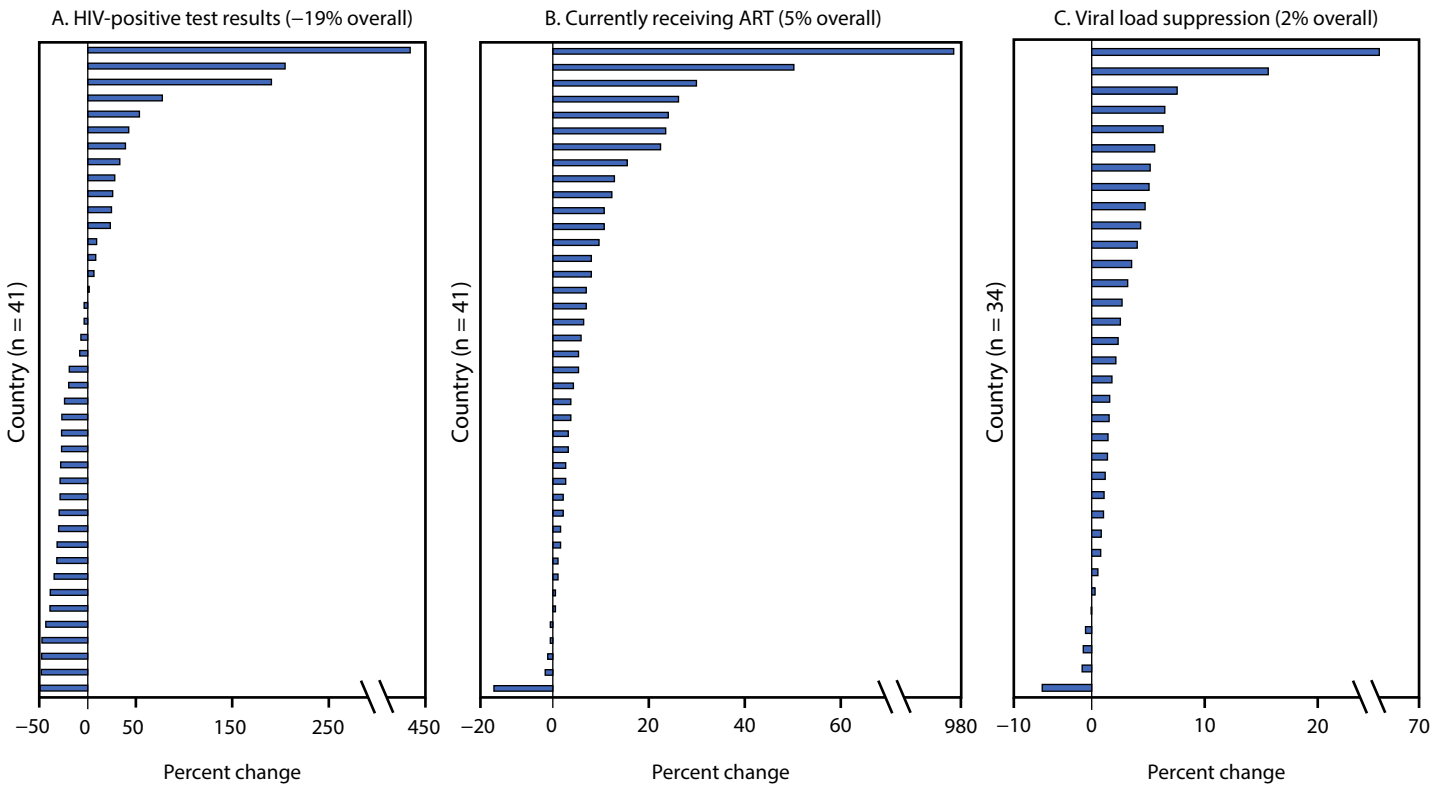
Among all 41 countries, programmatic gains (i.e., positive percent changes) were observed in the number of PLHIV reported to be currently receiving treatment and the percentage who had achieved viral load suppression before and during the COVID-19 pandemic. Positive percent change among all sites reported across the 41 countries was reported for the number of PLHIV currently receiving treatment (5%) and for HIV viral load suppression (2%). However, an overall negative percent change (−19%) was reported in HIV-positive test results (Figure). Percent change at the country level varied by indicator. Positive percent change was observed in the number of HIV-positive test results reported in 16 (39%) countries, the number of persons receiving ART in 36 (88%) countries, and HIV viral load suppression rates in and 29 of 34 countries with reported data[¶¶] (85%).

Twenty-three (56%) countries were in the upper quartile for at least one indicator, and six (15%) reported the highest overall percent change for two of the three indicators. One country (Nicaragua) showed gains across all three indicators. Countries reporting increases for any of the three indicators spanned all regions where PEPFAR supports HIV programs, including eight countries in West Africa, three in East Africa, two in Southern Africa, five in Central America, four in Asia, and one in the Caribbean. Among countries in the highest quartile, a median increase of 43% was reported in the number of HIV-positive test results identified (range = 25%–430%), 23% in the number of PLHIV receiving ART (range = 11%–965%), and 6% in HIV viral load suppression rates (range = 5%–62%)

[§§] 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.

[¶¶] Thirty-four of 41 countries were included; seven countries did not report data for the viral load indicator.

FIGURE. Percent change in HIV-positive test results* (A), number of persons with HIV receiving antiretroviral therapy† (B), and rates of viral load suppression§ (C) — U.S. President's Emergency Plan for AIDS Relief, 41 countries, January–March to October–December 2020



Abbreviations: ART = antiretroviral therapy; UNAIDS = Joint United Nations Programme on HIV/AIDS; WHO = World Health Organization.

* Number of persons who received a positive HIV test result. https://datim.zendesk.com/hc/en-us/articles/360000084446-MER-Indicator-Reference-Guides

† Number of adults and children who are currently receiving ART in accordance with the nationally approved treatment protocol (or WHO/UNAIDS standards) at the end of the reporting period. https://datim.zendesk.com/hc/en-us/articles/360000084446-MER-Indicator-Reference-Guides

§ Percentage of viral load suppression. Only sites that are in the highest quartile in both prepandemic (January–March 2020) and pandemic (October–December 2020) periods are included. Thirty-four of the 41 countries were included; seven countries did not report data for the viral load indicator.

from January–March to October–December 2020 (during the COVID-19 pandemic) (Table).

Review of quarterly aggregate MER narrative reports among countries in the upper quartile of positive HIV tests reported and case finding approaches attributed success to enhancing index testing and community- and home-based testing approaches tailored to geographic locations and populations at increased risk for HIV. Country programs in the upper quartile for increases in HIV treatment during the analytic time frame were associated with policy shifts toward multimonth dispensing of HIV treatment; streamlining facility visits (e.g., appointment spacing); facilitating community, peer, and home ART delivery options; improvements in data systems and management processes (e.g., patient tracking and tracing and site-level monitoring); and the use of telecommunication methods for improving client services. Gains in HIV viral load suppression among upper quartile programs were attributed to addressing a backlog of sample testing associated with the shifting priorities early in COVID-19 responses and reagent stockouts as well as improved patient monitoring and data quality. Tracking and tracing efforts among PLHIV with elevated viremia and aligning viral load testing with medication pick-up were reported as strategies to improve rates of viral load suppression.

Discussion

During 2020, many countries experienced disruptions to routine health care service delivery and challenges with infrastructure, human resources, and medical supplies as a result of the COVID-19 pandemic. Early estimates projected negative

TABLE. Countries with upper quartile gains in HIV service delivery* — U.S. President's Emergency Plan for AIDS Relief, 23 countries, January–March and October–December 2020

Country	No. of sites	Jan–Mar 2020, no. or %	Oct–Dec 2020, no. or %	% Change
No. of HIV-positive test results†				
Indonesia	37	132	700	430.3
Laos	3	63	192	204.8
Liberia	11	180	523	190.6
El Salvador	10	102	181	77.5
Panama	7	65	100	53.8
Nicaragua	5	47	67	42.6
Vietnam	69	1,987	2,767	39.3
Nigeria	1,288	77,099	102,742	33.3
Dominican Republic	17	1,702	2,181	28.1
Rwanda	146	1,450	1,825	25.9
Burkina Faso	17	1,022	1,276	24.9
No. of PLHIV currently receiving ART§				
Liberia	12	1,023	10,895	965.0
Nicaragua	6	886	1,328	49.9
Nigeria	1,435	907,653	1,177,770	29.8
Ghana	44	12,181	15,353	26.0
Democratic Republic of the Congo	516	134,107	166,081	23.8
Thailand	36	45,159	55,770	23.5
Togo	24	28,433	34,777	22.3
South Sudan	65	27,926	32,267	15.5
Mozambique	1,520	1,224,808	1,378,579	12.6
Laos	7	6,699	7,517	12.2
Senegal	4	3,347	3,708	10.8
% Viral load suppression¶				
Nicaragua	5	51	83	62.1
Cameroon	142	78	90	15.6
Mozambique	563	82	88	7.6
Panama	8	73	77	6.5
Guatemala	8	83	88	6.3
Côte d'Ivoire	490	84	88	5.6
Democratic Republic of the Congo	510	88	93	5.2
Honduras	6	85	90	5.1
Malawi	641	89	93	4.7

Abbreviations: ART = antiretroviral therapy; PLHIV = persons living with HIV; UNAIDS = Joint United Nations Programme on HIV/AIDS; WHO = World Health Organization.
* Percent change in number of HIV-positive test results, persons with HIV on antiretroviral treatment, and percentage with viral load suppression.
† Number of persons who received a positive HIV test result. https://datim.zendesk.com/hc/en-us/articles/360000084446-MER-Indicator-Reference-Guides
§ Number of adults and children who are currently receiving ART in accordance with the nationally approved treatment protocol (or WHO/UNAIDS standards) at the end of the reporting period. https://datim.zendesk.com/hc/en-us/articles/360000084446-MER-Indicator-Reference-Guides
¶ Percentage of viral load suppression. Only sites in the highest quartile in both prepandemic (January–March 2020) and pandemic (October–December 2020) periods are included. Thirty-four of the 41 countries were included; seven countries did not report data for the viral load indicator.

pandemic-related impacts on HIV service delivery (*3*). This report highlights the capacity of PEPFAR-supported countries to adapt HIV programs to the COVID-19 pandemic, particularly related to gains in HIV treatment and viral load suppression. Strategies reported among countries with gains in HIV programming included finding effective ways to reduce the frequency and duration of facility visits; streamlining service provision through community approaches, telecommunications, or messaging services; and enhancing quality and use of MER data and improving data systems for program improvement. PLHIV who are receiving ART experience less severe outcomes related to COVID-19 infection than do those who are not receiving ART (*4*,*5*), making access to HIV testing and treatment services critically important as the COVID-19 pandemic continues.

Countries reporting increases in identifying new HIV infections attributed accomplishments to increasing community- and home-based testing and index testing approaches. Case finding efforts based on community-based and index testing have historically provided opportunities for early identification of PLHIV and reaching persons outside of facility settings (*6*,*7*). Scaling up community-based testing during the COVID-19 pandemic might have helped relieve some of the strain on health care infrastructure by reducing the overall number of persons visiting facilities for HIV testing services. Gains in identification of new HIV-positive persons was reported by the lowest percentage (39%) of countries, compared with gains in HIV treatment (88%) and viral load suppression (85%), in line with PEPFAR recommendations*** to focus efforts on retaining known PLHIV on treatment.

HIV treatment gains were reported from a variety of programmatic strategies, including facility-, community-, peer-, and telecommunications-based approaches; improved data use related to patient tracking and tracing activities; and site-level monitoring. Facilities reported activities that reduced onsite attendance such as community home delivery models. Multimonth dispensing of ART, a strategy known to be successful in providing ART to PLHIV among countries affected by COVID-19 (*8*), was also used by PEPFAR programs. Reports of viral load testing coverage being negatively affected across PEPFAR-supported countries early in the COVID-19 pandemic have been described (*9*). Countries were able to align laboratory services with current SARS-CoV-2 testing needs to provide increases in HIV viral load testing activities over time (*9*); several countries were able to regain losses in viral load testing coverage, as well as show gains in viral load suppression, by focusing on tracking and tracing efforts among PLHIV with high levels of viremia, addressing stockout and testing backlog challenges, and aligning viral load testing with medication pickup.

The findings in this report are subject to at least five limitations. First, data are cross-sectional and reported quarterly in aggregate, precluding the ability to monitor and track persons across time. Second, data quality varies across country programs, and narrative reports were not systematically collected. Third, timing of the effect of COVID-19 on SARS-CoV-2 testing capacity and implemented mitigation measures has varied at the country level. The time frame selected for this analysis covers all reporting quarters within the calendar year to account for COVID-19 pandemic fluctuations and precedes any possible effects related to national COVID-19 vaccination rollout. Fourth, country context can affect overall results based on the capacity to adapt local infrastructures and to make programmatic shifts, including program approaches and strategies, or changes in implementing partners. To reduce the potential effects of programmatic shifts, only PEPFAR-supported facilities that reported data during both periods were included in the analysis. Finally, some countries are reaching HIV epidemic control and therefore might not have had extensive programmatic improvements, and the maintenance of those gains would not have been reflected in positive percent change in indicators. Given that lower percent change did not inherently represent reductions in program performance, the narrative analysis was restricted to countries in the upper quartile of percent change during the specified time frame. The number of sites ranged widely among countries; however, the numbers are proportional to the country size and PEPFAR ART program. Although this variation might have affected the magnitude of overall percent change across indicators, particularly in the smallest programs, the direction of change provided valuable information in assessing programmatic gains across the HIV care continuum.

Qualitative data were reviewed from countries that reported the highest percentage of programmatic gains to help identify specific strategies that might have improved HIV service delivery, considering the stress placed on HIV programs as countries worked toward mitigating SARS-CoV-2 transmission. Programs can learn from these strategies and assess their implementation feasibility to help develop sustainable activities as well as adapt programs during a global health crisis. These findings demonstrate how community- and home-based approaches, in conjunction with improving data use for program improvement, can effectively reduce facility visits in PEPFAR-supported countries and therefore help mitigate SARS-CoV-2 transmission while preserving life-saving services for PLHIV.

*** During the COVID-19 pandemic, PEPFAR technical guidance focused efforts on continuity of treatment for PLHIV. Specific testing guidance was provided to maintain protection against COVID-19 for all persons supporting programmatic efforts related to HIV testing based on local and government policies, with the acknowledgment that testing services might be affected because of COVID-19 mitigation measures.

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Summary

What is already known about the topic?

The COVID-19 pandemic has affected health care infrastructure worldwide.

What is added by this report?

In 41 U.S. President's Emergency Plan for AIDS Relief (PEPFAR)–supported countries, overall gains were observed in HIV treatment (5%) and viral load suppression (2%) during the first year of the COVID-19 pandemic. Among countries with the largest overall programmatic gains, strategies that facilitated HIV program improvements included enhanced index testing and community- and home-based testing; multimonth dispensing of medications; streamlining clinic visits; aligning medication pick-up with viral load testing; and improvements in data use.

What are the implications for public health practice?

Lessons learned from PEPFAR-supported countries reporting the most programmatic progress in HIV programs provide important insights into strategies that can be used to realize programmatic gains during a global health crisis.

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Health Needs and Use of Services Among Children with Developmental Disabilities — United States, 2014–2018

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Developmental delays, disorders, or disabilities (DDs) manifest in infancy and childhood and can limit a person's function throughout life* (*1*–*3*). To guide strategies to optimize health for U.S. children with DDs, CDC analyzed data from 44,299 participants in the 2014–2018 National Health Interview Survey (NHIS). Parents reported on 10 DDs,† functional abilities, health needs, and use of services. Among the approximately one in six (17.3%) U.S. children and adolescents aged 3–17 years (hereafter children) with one or more DDs, 5.7% had limited ability to move or play, 4.7% needed help with personal care, 4.6% needed special equipment, and 2.4% received home health care, compared with ≤1% for each of these measures among children without DDs. Children with DDs were two to seven times as likely as those without DDs to have taken prescription medication for ≥3 months (41.6% versus 8.4%), seen a mental health professional (30.6% versus 4.5%), a medical specialist (26.0% versus 12.4%), or a special therapist, such as a physical, occupational, or speech therapist, (25.0% versus 4.5%) during the past year, and 18 times as likely to have received special education or early intervention services (EIS) (41.9% versus 2.4%). These percentages varied by type of disability and by sociodemographic subgroup. DDs are common, and children with DDs often need substantial health care and services. Policies and programs that promote early identification of children with developmental delays and facilitate increased access to intervention services can improve health and reduce the need for services later in life.§ Sociodemographic inequities merit further investigation to guide public health action and ensure early and equitable access to needed care and services.

The study included data from the 2014–2018 NHIS, an annual, multistage probability sample survey of the noninstitutionalized U.S. civilian population.¶ In-person interviews were conducted to obtain information on household members. Among families with children, a child questionnaire was administered to a knowledgeable adult (usually, and hereafter parent) about a randomly selected child (aged 0–17 years). During 2014–2018, the response rate for the child questionnaire was 59.2%–66.6%.

Parents of children aged ≥3 years were asked about their child's functional abilities, health needs, and use of services (Supplementary Box 1, https://stacks.cdc.gov/view/cdc/115478) (*2*–*5*), as well as whether their child had any of 10 specific types of DDs (Supplementary Box 2, https://stacks.cdc.gov/view/cdc/115479). Children could be included in multiple diagnostic types of DDs; however, children with co-occurring learning disabilities and intellectual disabilities were excluded from the learning disability category. Weighted prevalence estimates of DDs and 95% CIs were calculated. The weighted percentages of children with each measure of reported functional ability, health needs, and use of specialty health care providers or education services were estimated overall, by selected sociodemographic characteristics, number of DDs, and each type of DD. Differences in percentages were evaluated using Rao-Scott chi-square tests with $p<0.05$ considered statistically significant. To reflect the complex sampling design and generate nationally representative estimates, all analyses accounted for clustering, stratification, and weights, using SAS software (version 9.4; SAS Institute) and were verified using SUDAAN (version 11.0.1; RTI International).

Of the 44,866 children aged 3–17 years included in the 2014–2018 NHIS, 567 were excluded because of missing information on any question related to DDs or abilities, health needs, or use of services, resulting in a total of 44,299. The estimated prevalence of DDs among U.S. children aged 3–17 years was 17.3%, ranging from 0.2% (blindness) to 9.4% (attention-deficit/hyperactivity disorder) (Table 1); 6.7% of U.S. children had two or more DDs. Among children with DDs, 5.7% had limited movement or play abilities, 4.7% needed help with personal care, 4.6% needed special equipment, and 2.4% received home health care, compared with ≤1% of children without DDs. Children with DDs were two to seven times as likely as those without DDs to have taken prescription medication for ≥3 months (41.6% versus 8.4%), have seen a mental health professional (30.6% versus 4.5%), a medical specialist (26.0% versus 12.4%), or a therapist (25.0% versus 4.5%) during the past year (Table 1). Children with DDs were more likely to participate in special education or EIS

* https://acl.gov/sites/default/files/about-acl/2016-12/dd_act_2000.pdf
† Attention-deficit/hyperactivity disorder, autism spectrum disorder, blindness, cerebral palsy, moderate-to-profound hearing loss, learning disability, intellectual disability, seizures in the past 12 months, stutter or stammering in the past 12 months, or any other developmental delay.
§ https://sites.ed.gov/idea/statute-chapter-33/subchapter-iii/1431
¶ https://www.cdc.gov/nchs/nhis/index.htm

TABLE 1. Prevalence of developmental delays, disorders, or disabilities among children and adolescents aged 3–17 years and percentage with selected functional abilities, health needs, and related service use, by type and number of developmental delays, disorders, or disabilities — National Health Interview Survey, United States 2014–2018

		% (95% CI)*									
			Abilities	Special health needs				Specialty services used			
DD	No.†	Prevalence	Limited ability to crawl, walk, run, or play	Needs help with personal care	Needs special equipment	Received home health care	Took prescription medications for ≥3 months	Saw a mental health professional	Saw a medical specialist	Saw a therapist§	Receives special education or EIS
No DDs	36,582	82.7 (82.2– 83.2)	1.0 (0.8–1.1)	0.1 (0.1–0.1)	0.7 (0.6–0.8)	0.3 (0.3–0.4)	8.4 (8.0–8.7)	4.5 (4.2–4.8)	12.4 (11.9–12.9)	4.5 (4.2–4.8)	2.4 (2.2–2.6)
Any DDs¶	7,717	17.3 (16.8–17.8)	5.7 (5.0–6.4)	4.7 (4.1–5.4)	4.6 (4.0–5.3)	2.4 (1.9–2.9)	41.6 (40.1–43.1)	30.6 (29.2–32.0)	26.0 (24.7–27.3)	25.0 (23.7–26.3)	41.9 (40.5–43.4)
One DD	4,674	10.5** (10.2–10.9)	3.0 (2.4–3.8)	1.3 (0.9–1.9)	2.9 (2.3–3.6)	0.9 (0.6–1.3)	34.8 (33.0–36.7)	22.9 (21.2–24.6)	21.4 (19.8–23.0)	17.6 (16.1–19.2)	27.4 (25.6–29.2)
Two or more DDs	3,043	6.7** (6.4–7.0)	9.8 (8.4–11.3)	10.0 (8.6–11.6)	7.2 (6.0–8.6)	4.7 (3.7–5.9)	52.3 (49.9–54.7)	42.6 (40.3–45.0)	33.3 (30.9–35.7)	36.5 34.2–38.8)	64.8 (62.5–67.0)
ADHD	4,280	9.4 (9.0–9.8)	3.2 (2.5–3.9)	2.8 (2.1–3.7)	1.7 (1.3–2.3)	2.0 (1.4–2.7)	58.4 (56.3–60.5)	41.0 (39.0–43.0)	25.7 (23.9–27.5)	16.1 (14.7–17.6)	37.1 (35.2–39.1)
Autism spectrum disorder	1,064	2.4 (2.2–2.6)	9.7 (7.4–12.5)	17.3 (14.3–20.8)	4.8 (3.2–6.8)	6.7 (4.6–9.4)	44.2 (40.2–48.2)	49.9 (46.1–53.8)	34.5 (30.4–38.8)	45.4 (41.4–49.4)	73.1 (69.6–76.5)
Blindness	65	0.2 (0.1–0.2)	42.9 (28.0–58.8)	37.4 (22.9–53.7)	39.2 (25.1–54.8)	15.9†† (5.8–32.3)	38.9 (23.9–55.6)	10.4†† (3.7–21.9)	48.9 (33.1–64.9)	29.8 (18.2–43.8)	50.1 (35.0–65.3)
Cerebral palsy	114	0.3 (0.2–0.4)	71.7 (58.9–82.3)	40.1 (28.2–52.9)	55.7 (42.9–67.9)	15.4 (8.1–25.7)	50.5 (37.9–63.1)	29.5 (18.0–43.4)	72.1 (60.9–81.6)	69.5 (57.2–80.1)	68.5 (56.0–79.2)
Moderate-to-profound hearing loss	268	0.6 (0.5–0.7)	16.1 (10.1–23.8)	11.1 (6.7–17.0)	39.3 (31.6–47.4)	3.6†† (1.3–7.7)	33.1 (25.4–41.5)	25.2 (18.4–32.9)	39.5 (31.5–47.9)	48.0 (39.9–56.3)	40.2 (32.6–48.1)
Learning disability§§	2,941	6.5 (6.2–6.9)	5.2 (4.1–6.5)	4.6 (3.6–5.7)	3.5 (2.6–4.7)	2.6 (1.9–3.5)	39.8 (37.5–42.2)	34.3 (31.8–36.8)	25.4 (23.3–27.6)	29.7 (27.4–32.0)	60.6 (58.1–63.0)
Intellectual disability	529	1.1 (1.0–1.3)	24.8 (20.1–30.0)	30.8 (25.2–36.9)	18.7 (14.5–23.4)	9.9 (6.3–14.6)	53.7 (47.9–59.4)	43.7 (37.9–49.6)	47.7 (41.8–53.7)	49.3 (43.6–55.0)	81.7 (77.1–85.7)
Seizures	332	0.7 (0.6–0.9)	22.5 (16.4–29.6)	18.3 (12.5–25.3)	16.0 (10.6–22.8)	8.2 (4.8–12.9)	62.3 (53.6–70.4)	24.5 (18.2–31.7)	53.1 (45.6–60.5)	30.4 (24.1–37.4)	39.3 (32.0–47.0)
Stuttering	842	2.0 (1.8–2.2)	8.6 (6.4–11.3)	8.3 (5.9–11.2)	4.5 (3.0–6.4)	2.3 (1.2–3.9)	31.0 (27.1–35.0)	25.1 (21.4–29.1)	23.7 (20.2–27.4)	40.5 (36.1–45.0)	41.0 (36.6–45.4)
Other developmental delay	1,732	3.9 (3.6–4.1)	12.7 (10.5–15.2)	10.6 (8.7–12.6)	9.8 (7.8–12.0)	3.6 (2.6–4.9)	35.4 (32.4–38.4)	29.4 (26.6–32.3)	33.3 (30.3–36.4)	47.5 (44.4–50.6)	59.4 (56.3–62.5)

Abbreviations: ADHD = attention-deficit/hyperactivity disorder; DDs = developmental delays, disorders, or disabilities; EIS = early intervention services.
* Weighted estimates and 95% CIs account for the complex survey design.
† Unweighted number of children; children might have more than one DD, except as indicated.
§ A physical therapist, speech therapist, respiratory therapist, audiologist, or occupational therapist.
¶ Children whose parents answered affirmatively to questions for one or more of the 10 conditions listed in the table, regardless of the number of conditions reported.
** Does not sum to percentage of children with any DD because of rounding.
†† Potentially unreliable estimates based on a relative standard error ≥30% and <50%.
§§ Children with both intellectual disability and learning disability were not included in the estimate of children with learning disability.

(41.9% versus 2.4%). The percentage of children with limited abilities, special health needs, or who used specialty services was higher among children with two or more DDs than among those with one DD or none. Children with each type of DD were more likely than were those without DDs to have limited abilities or special health needs, or to use specialty services.

Among children with DDs, the percentage with limited abilities and special health needs, and who used specialty services varied across sociodemographic subgroups (Table 2). Compared with non-Hispanic White children with DDs, a lower percentage of non-Hispanic Black, non-Hispanic other, and Hispanic children with DDs took prescription medication. Compared with non-Hispanic White children with DDs, Hispanic children with DDs were less likely to have seen a mental health professional, and non-Hispanic Black and Hispanic children with DDs were less likely to have seen a medical specialist. Compared with children aged 3–8 years who had DDs, a lower percentage of children aged 9–17 years with DDs needed special equipment or help with personal care, received home health care, or saw a therapist, whereas a higher percentage took prescription medications or saw a mental health professional.

Among children with DDs, those whose mother had less than a high school education were less likely to take prescription medication or to see specialty health care professionals, but more likely to receive special education or EIS. Compared with children living above the federal poverty level, those living at or below the federal poverty level were less likely to see a medical specialist and more likely to receive special education or EIS. The percentage of children with DDs who needed help with personal care or received home health care and used services was higher in the Northeast and West than in the South; a higher

TABLE 2. Prevalence of selected functional disabilities, health needs, and related service use among U.S. children and adolescents aged 3–17 years with one or more developmental delays, disorders, or disabilities,* by socioeconomic and demographic group — National Health Interview Survey, United States, 2014–2018

		% (95% CI)†								
		Abilities	Special health needs				Specialty services used			
Demographic group	No.§	Limited ability to crawl, walk, run, or play	Needs help with personal care	Needs special equipment	Received home health care	Took prescription medications for ≥3 months	Saw a mental health professional	Saw a medical specialist	Saw a therapist¶	Receives special education or EIS
Sex										
Male	5,071	4.9 (4.1–5.8)	4.5 (3.7–5.4)	3.8 (3.1–4.6)	2.1 (1.6–2.7)	42.5 (40.6–44.3)	31.5 (29.8–33.3)	25.5 (23.8–27.2)	25.8 (24.1–27.5)	43.2 (41.4–45.0)
Female	2,646	7.1 (5.8–8.6)	5.1 (4.1–6.4)	6.0 (4.9–7.3)	2.8 (2.0–3.9)	40.0 (37.7–42.5)	28.8 (26.5–31.1)	27.0 (24.8–29.3)	23.5 (21.3–25.9)	39.6 (37.1–42.1)
p-value**	NA	0.004	0.357	0.001	0.154	0.109	0.052	0.282	0.130	0.020
Race or ethnicity										
Black, non-Hispanic	1,083	5.4 (3.4–8.1)	5.1 (3.1–7.7)	4.6 (3.0–6.8)	2.4†† (1.1–4.5)	40.0§§ (36.2–43.9)	29.4 (26.0–33.0)	22.0§§ (18.7–25.5)	23.3 (19.9–27.1)	43.4 (39.5–47.4)
White, non-Hispanic	4,398	5.4 (4.5–6.3)	4.1 (3.4–5.0)	4.7 (3.9–5.6)	2.1 (1.6–2.8)	46.3 (44.4–48.3)	32.0 (30.2–33.9)	28.4 (26.6–30.2)	24.3 (22.6–26.1)	40.9 (38.9–42.9)
Other, non-Hispanic	653	5.4 (3.4–8.2)	4.7 (2.7–7.5)	5.1 (3.1–7.7)	2.3 (1.2–3.9)	38.1§§ (33.1–43.2)	34.9 (29.7–40.3)	24.5 (20.5–28.8)	24.4 (20.2–29.0)	40.9 (35.8–46.1)
Hispanic	1,570	6.7 (5.1–8.6)	6.0 (4.5–7.8)	4.1 (2.9–5.5)	2.9 (1.9–4.4)	31.0§§ (28.1–34.0)	26.1§§ (23.1–29.1)	23.2§§ (20.7–25.9)	27.8 (24.6–31.3)	44.0 (40.6–47.3)
p-value**	NA	0.549	0.213	0.842	0.662††	<0.001	0.002	<0.001	0.171	0.344
Age group, yrs										
3–8	2,127	6.8 (5.4–8.4)	7.3 (5.9–8.9)	5.9 (4.6–7.4)	3.0 (2.2–4.1)	32.9 (30.3–35.6)	26.8 (24.3–29.4)	27.7 (25.3–30.2)	42.6 (39.9–45.3)	44.4 (41.7–47.1)
9–11	1,673	4.8 (3.4–6.6)	5.4 (3.9–7.4)	3.9¶¶ (2.8–5.2)	3.5 (2.2–5.3)	46.8¶¶ (43.6–50.1)	33.3¶¶ (30.3–36.4)	23.5 (20.8–26.3)	23.3¶¶ (20.6–26.2)	42.1 (39.0–45.3)
12–17	3,917	5.4 (4.5–6.4)	2.8¶¶ (2.2–3.5)	4.1¶¶ (3.3–5.1)	1.4¶¶ (1.0–1.9)	44.5¶¶ (42.3–46.7)	31.6¶¶ (29.7–33.6)	26.1 (24.3–28.0)	14.9¶¶ (13.4–16.6)	40.3 (38.2–42.5)
p-value**	NA	0.133	<0.001	0.029	0.001	<0.001	0.001	0.061	<0.001	0.063
Mother's education										
Less than HS or GED	2,375	6.0 (4.8–7.5)	5.1 (4.0–6.5)	4.5 (3.4–5.7)	2.2 (1.4–3.1)	35.9 (33.5–38.3)	25.9 (23.7–28.3)	22.3 (20.0–24.8)	24.9 (22.6–27.4)	45.4 (42.7–48.0)
HS or greater	4,461	5.6 (4.7–6.7)	4.7 (3.9–5.7)	4.9 (4.0–5.8)	2.6 (2.0–3.4)	43.8 (41.7–45.8)	32.4 (30.5–34.3)	28.9 (27.1–30.7)	25.8 (24.1–27.7)	40.5 (38.6–42.4)
p-value**	NA	0.613	0.575	0.577	0.422	<0.001	<0.001	<0.001	0.552	0.003
Poverty status ***										
<100% FPL	1,605	6.3 (4.8–8.2)	4.9 (3.5–6.7)	5.1 (3.6–6.9)	2.4 (1.5–3.6)	40.5 (37.3–43.7)	32.2 (29.1–35.3)	23.0 (20.4–25.8)	24.4 (21.6–27.4)	45.1 (41.8–48.5)
≥100% FPL	5,885	5.3 (4.6–6.2)	4.6 (3.9–5.4)	4.4 (3.7–5.2)	2.4 (1.8–3.0)	42.4 (40.7–44.1)	30.2 (28.6–31.9)	27.4 (25.8–29.0)	25.1 (23.5–26.6)	41.0 (39.3–42.8)
p-value**	NA	0.250	0.697	0.427	0.916	0.294	0.256	0.006	0.695	0.035
U.S. Census Bureau region of residence†††										
Northeast	1,314	6.7 (4.7–9.1)	6.0§§§ (4.2–8.3)	5.6 (3.9–7.8)	4.3§§§ (2.7–6.4)	40.5 (36.6–44.6)	36.3§§§ (33.1–39.5)	30.3§§§ (26.9–34.0)	29.6§§§ (26.0–33.4)	54.3§§§ (50.5–58.0)
South	2,946	5.1 (4.1–6.3)	3.6 (2.7–4.6)	3.8 (2.9–4.9)	1.4 (1.0–2.0)	45.1 (42.8–47.4)	26.6 (24.3–29.0)	24.7 (22.7–26.9)	21.5 (19.5–23.5)	37.2 (34.9–39.6)
Midwest	1,688	5.0 (3.8–6.4)	4.3 (3.2–5.6)	5.2 (4.0–6.7)	2.4 (1.5–3.5)	43.5 (40.3–46.7)	31.1§§§ (28.2–34.1)	26.2 (23.5–29.2)	26.1§§§ (23.3–29.1)	39.5 (36.5–42.6)
West	1,769	6.8 (5.1–8.8)	6.3§§§ (4.8–8.2)	4.6 (3.3–6.0)	2.6§§§ (1.7–3.8)	33.3§§§ (30.3–36.3)	33.0§§§ (29.9–36.3)	24.5 (21.8–27.3)	26.7§§§ (23.9–29.6)	43.7§§§ (40.7–46.7)
p-value**	NA	0.196	0.007	0.168	0.001	<0.001	<0.001	0.023	<0.001	<0.001
Health insurance¶¶¶										
None	342	3.1†† (1.3–6.0)	2.6†† (0.9–5.8)	3.1†† (1.3–6.1)	—****	21.4 (16.2–27.2)	19.5 (14.0–26.2)	11.3 (7.7–15.8)	14.9 (9.9–21.3)	31.4 (24.5–39.0)
Any	7,351	5.8 (5.1–6.6)	4.8 (4.2–5.5)	4.7 (4.0–5.4)	2.4 (2.0–3.0)	42.6 (41.1–44.2)	31.0 (29.6–32.5)	26.7 (25.3–28.1)	25.4 (24.1–26.8)	42.4 (40.9–43.9)
p-value**	NA	0.066	0.145	0.249	—****	<0.001	0.001	<0.001	0.002	0.004

See table footnotes on the next page.

TABLE 2. (*Continued*) Prevalence of selected functional disabilities, health needs, and related service use among U.S. children and adolescents aged 3–17 years with one or more developmental delays, disorders, or disabilities,* by socioeconomic and demographic group — National Health Interview Survey, United States, 2014–2018

Abbreviations: DDs = developmental delays, disorders, or disabilities; EIS = early intervention services; FPL = federal poverty level; GED = general educational development certificate; HS = high school; NA = not applicable.

* Children whose parents answered affirmatively to questions for one or more of 10 selected conditions (attention-deficit/hyperactivity disorder, autism spectrum disorder, blindness, cerebral palsy, moderate to profound hearing loss, learning disability, intellectual disability, seizures, stuttering, or other DD), irrespective of the number of conditions reported (7,717).

† Weighted estimates and 95% CIs account for the complex survey design.

§ The unweighted number of children with any DD in the specified demographic group.

¶ A physical therapist, speech therapist, respiratory therapist, audiologist, or occupational therapist.

** p-value for Rao-Scott chi-square test for difference in percentages among subgroups.

†† Potentially unreliable estimates based on a relative standard error ≥30% and <50%, or comparison based on a group with an unreliable estimate.

§§ Significantly different from non-Hispanic White children (p<0.05; Rao-Scott chi-square test).

¶¶ Significantly different from children aged 3–8 years (p<0.05; Rao-Scott chi-square test).

*** Ratio of family income to FPL.

††† *Midwest:* Kansas, Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin; *Northeast:* Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont; *South:* Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia; and *West:* Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

§§§ Significantly different from children living in the South (p<0.05; Rao-Scott chi-square test).

¶¶¶ Any health insurance coverage at the time of the interview under private health insurance. Medicare, Medicaid, State Children's Health Insurance Program, a state-sponsored health plan, other government programs, or military health plan (includes TRICARE, Veterans Affairs, and Civilian Health and Medical Program of the Department of Veterans Affairs).

**** Unreliable estimate based on a relative standard error ≥50% or comparison based on a group with an unreliable estimate are not shown.

percentage in the Midwest saw a mental health professional or therapist, and a lower percentage in the West took prescription medications for ≥3 months. The percentage of children with DDs who took prescription medication for ≥3 months, saw medical specialists, or received special education or EIS services was lower among those without health insurance.

Discussion

During 2014–2018, approximately one in six (17.3%) children had a DD, and one in 15 (6.7%) had two or more DDs. Children with DDs have a higher prevalence of limited ability to move or play, health needs, and specialized service use compared to those without DDs. The prevalences of DDs during 2014–2018, overall and by type, are consistent with 2015–2017 (*1*). Although differing DD definitions and study methods used in previous years present challenges to comparing the findings in this report with data from 1997–2005 and 2006–2010, the percentage of U.S. children with any DD who had limitations in movement or play appeared to be slightly lower during 2014–2018 overall, but not for children with blindness, cerebral palsy, or hearing loss (*2*,*3*). In contrast, the percentage of U.S. children with special health needs or who took prescription medications, saw specialty health care providers, or received education services appeared to be similar or higher during 2014–2018 than 1997–2005, with the exception of children with autism spectrum disorder (*2*,*3*). One explanation for potential decreases in health needs and service use over time is the inclusion of children with less significant support needs associated with autism spectrum disorder.**

This study provides new data on sociodemographic differences in the health needs and use of special services among children with DDs. The observed differences could be associated with differential access to care resulting from a variety of factors, including health insurance coverage, specialist proximity, language or cultural barriers, and variability in practices and policies (*4*,*6*–*8*). A 2018 study examining health care coverage and access among children, adolescents, and young adults during 2010–2016 suggests that significant improvements in health care coverage occurred with the implementation of the Affordable Care Act in 2010, yet gaps remain, particularly among adolescents as they transition to adult care (*7*). Eligibility criteria, service availability, long waiting times, cost, and lack of information are reported barriers to receipt of services for children with DDs (*8*). Referral practices and coordination across early childhood service providers and systems also affect access to early intervention for young children (*4*,*6*). Lower service use associated with poverty is of concern given the impact of poverty on child development (*4*,*7*–*9*). Although implementation of programs in low-income settings might help increase early identification of DDs among children living in poverty, one study of treatment for children with autism spectrum disorder suggests that differential service by geographic region might not be explained by child and family characteristics (*10*). In addition, lower service use associated with race or ethnic identification is of concern given the pervasive impact of racism on child development (*4*,*7*–*9*). More work is needed to ensure that children with identified delays receive a diagnosis and services through enhanced access, coordination of care across systems (e.g., school, health care, and community), and increased workforce capacity (*7*–*9*). Strategies and programs that support families, health care, education, and social service providers with evidence-based interventions and tools to promote early identification and

** https://pubmed.ncbi.nlm.nih.gov/26632847/

Summary

What is already known about this topic?

Developmental delays, disorders, and disabilities (DDs) are common among U.S. children and adolescents.

What is added by this report?

Approximately one in six (17.3%) U.S. children and adolescents aged 3–17 years had DDs during 2014–2018. Compared with children and adolescents without DDs, those with DDs were two to seven times as likely to take prescription medication and receive mental health or specialized health care provider services and 18 times as likely to receive special education or early intervention services.

What are the implications for public health practice?

Policies and programs that promote early identification of children and adolescents with DDs and increase access to intervention services could improve health and reduce the need for services later in life.

coordinated care across systems for children with DDs could potentially improve access to needed health care and services.[††]

The findings in this report are subject to at least four limitations. First, information is reported by the parent and has not been independently verified; therefore, it might be subject to recall bias or variation in interpretation. Second, the reported DDs in this analysis are a heterogeneous grouping that vary materially in severity, prevalence, and persistence over time. Third, children's symptoms and abilities relevant to diagnosis or their eligibility for services might change with intervention or age. Finally, estimates are unadjusted for demographic or other characteristics; thus, observed differences across groups might be attributable to other factors, such as other medical conditions or contextual factors.

These data confirm that DDs are common and often co-occur, and that children with DDs have more health-related needs and service use than do children without DDs. Strategies that promote early identification and coordination of services for children with DDs could improve health and reduce the need for services later in life. Inequities in use and receipt of medications and services by sociodemographic subgroups deserve further investigation to guide development and implementation of strategies to promote health equity and ensure that all children with DDs have access to needed care and services to enable them to thrive.

[††] CDC's Learn the Signs. Act Early. (https://www.cdc.gov/ActEarly); CDC-funded Association of University Centers on Disabilities Children's Mental Health Champions (https://nationalcenterdph.org/our-focus-areas/wellness-and-mental-health/mental-health-champions/); CDC-funded programs through the National Resource Center on ADHD resources (https://www.cdc.gov/ADHD) and the Tourette Association of America (https://www.cdc.gov/ActEarly https://www.cdc.gov/Tourette); CDC's epilepsy program (https://www.cdc.gov/epilepsy/groups/parents.htm); Department of Education, Office of Special Education Program's Parent Centers (https://www.parentcenterhub.org) and the Health Resources Services Administration, Maternal and Child Health Bureau's Early Childhood Comprehensive Systems (https://mchb.hrsa.gov/earlychildhoodcomprehensivesystems); Healthy Start (https://mchb.hrsa.gov/maternal-child-health-initiatives/healthy-start); Home Visiting (https://mchb.hrsa.gov/maternal-child-health-initiatives/home-visiting-overview); Leadership Education in Neurodevelopmental and Other Related Disabilities (LEND) program); (https://mchb.hrsa.gov/training/projects.asp?program);and Got Transition (https://www.hrsa.gov/library/got-transition).

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Effectiveness of mRNA Vaccination in Preventing COVID-19–Associated Invasive Mechanical Ventilation and Death — United States, March 2021–January 2022

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COVID-19 mRNA vaccines (BNT162b2 [Pfizer-BioNTech] and mRNA-1273 [Moderna]) are effective at preventing COVID-19–associated hospitalization (*1*–*3*). However, how well mRNA vaccines protect against the most severe outcomes of these hospitalizations, including invasive mechanical ventilation (IMV) or death is uncertain. Using a case-control design, mRNA vaccine effectiveness (VE) against COVID-19–associated IMV and in-hospital death was evaluated among adults aged ≥18 years hospitalized at 21 U.S. medical centers during March 11, 2021–January 24, 2022. During this period, the most commonly circulating variants of SARS-CoV-2, the virus that causes COVID-19, were B.1.1.7 (Alpha), B.1.617.2 (Delta), and B.1.1.529 (Omicron). Previous vaccination (2 or 3 versus 0 vaccine doses before illness onset) in prospectively enrolled COVID-19 case-patients who received IMV or died within 28 days of hospitalization was compared with that among hospitalized control patients without COVID-19. Among 1,440 COVID-19 case-patients who received IMV or died, 307 (21%) had received 2 or 3 vaccine doses before illness onset. Among 6,104 control-patients, 4,020 (66%) had received 2 or 3 vaccine doses. Among the 1,440 case-patients who received IMV or died, those who were vaccinated were older (median age = 69 years), more likely to be immunocompromised* (40%), and had more chronic medical conditions compared with unvaccinated case-patients (median age = 55 years; immunocompromised = 10%; p<0.001 for both). VE against IMV or in-hospital death was 90% (95% CI = 88%–91%) overall, including 88% (95% CI = 86%–90%) for 2 doses and 94% (95% CI = 91%–96%) for 3 doses, and 94% (95% CI = 88%–97%) for 3 doses during the Omicron-predominant period. COVID-19 mRNA vaccines are highly effective in preventing COVID-19–associated death and respiratory failure treated with IMV. CDC recommends that all persons eligible for vaccination get vaccinated and stay up to date with COVID-19 vaccination (*4*).

Using surveillance data from the Influenza and Other Viruses in the Acutely Ill (IVY) Network, a case-control analysis was conducted to evaluate effectiveness of mRNA COVID-19 vaccines against COVID-19–associated IMV or death. During March 11, 2021–January 24, 2022, adults aged ≥18 years hospitalized at 21 medical centers in 18 states† who received testing for SARS-CoV-2 were enrolled. Case-patients were adults who were hospitalized with COVID-19–like illness§ and who received positive SARS-CoV-2 nucleic acid amplification test (NAAT) or antigen test results within 10 days of

* Immunocompromising conditions included having one or more of the following conditions: active solid organ cancer (active cancer defined as treatment for the cancer or newly diagnosed cancer in the past 6 months); active hematologic cancer (e.g., leukemia, lymphoma, or myeloma); HIV infection without AIDS; AIDS; congenital immunodeficiency syndrome; previous splenectomy; previous solid organ, stem cell, or bone marrow transplant; immunosuppressive medication; systemic lupus erythematosus; rheumatoid arthritis; psoriasis; scleroderma; or inflammatory bowel disease, including Crohn's disease or ulcerative colitis.

† Hospitals (cities, states) included Baystate Medical Center (Springfield, Massachusetts), Beth Israel Deaconess Medical Center (Boston, Massachusetts), Montefiore Medical Center (Bronx, New York), Vanderbilt University Medical Center (Nashville, Tennessee), University of Miami Medical Center (Miami, Florida), Emory University Medical Center (Atlanta, Georgia), Johns Hopkins Hospital (Baltimore, Maryland), Wake Forest University Baptist Medical Center (Winston-Salem, North Carolina), Baylor Scott & White Health (Temple, Texas), University of Iowa Hospitals (Iowa City, Iowa), University of Michigan Hospital (Ann Arbor, Michigan), Hennepin County Medical Center (Minneapolis, Minnesota), Barnes-Jewish Hospital (St. Louis, Missouri), Cleveland Clinic (Cleveland, Ohio), Ohio State University Wexner Medical Center (Columbus, Ohio), Stanford University Medical Center (Stanford, California), UCLA Medical Center (Los Angeles, California), UCHealth University of Colorado Hospital (Aurora, Colorado), Oregon Health & Science University Hospital (Portland, Oregon), Intermountain Medical Center (Murray, Utah), and University of Washington (Seattle, Washington).

§ COVID-19–like illness was defined as having one or more of the following signs or symptoms: fever, cough, shortness of breath, loss of taste, loss of smell, use of respiratory support for the acute illness, or new pulmonary findings on chest imaging consistent with pneumonia.

illness onset. Case-patients in this analysis were limited to those who received IMV or died in the hospital within 28 days of admission. Control-patients were hospitalized adults with or without COVID-19–like illness who received a negative NAAT test result for SARS-CoV-2 within 10 days of illness onset. Individual matching was not performed, but sites attempted 1:1 enrollment of case-patients and controls, with controls enrolled within 2 weeks of case-patients. Patients or their proxies were interviewed about demographic and clinical characteristics and COVID-19 vaccination history. COVID-19 mRNA vaccination status (i.e., receipt of Pfizer-BioNTech or Moderna vaccine products) was ascertained from state registry data, hospital electronic medical records, vaccination record cards, and self-report. For this analysis, patients were included if they 1) received 2 doses of an mRNA vaccine, with the second dose administered ≥14 days before illness onset, 2) received 3 doses of an mRNA vaccine following authorization[¶] with the third dose administered ≥7 days before illness onset, or 3) received no COVID-19 mRNA vaccine doses before illness onset. Information about chronic medical conditions and in-hospital outcomes, including IMV or death within 28 days of admission, were collected through structured chart reviews.

Differences in demographic and clinical characteristics between COVID-19 case-patients who were vaccinated with 2 or 3 vaccine doses versus unvaccinated were compared using Pearson's chi-square for categorical variables or Wilcoxon rank-sum tests for continuous variables. VE was calculated using unconditional logistic regression by comparing the odds for previous mRNA vaccination (2 or 3 doses) among COVID-19 case-patients who received IMV or experienced in-hospital death versus control-patients. VE was calculated as (1 − odds ratio) × 100, and estimates were adjusted for U.S. Health and Human Services region, calendar time in biweekly intervals, age, sex, and self-reported race and Hispanic ethnicity as prespecified covariates. Results were stratified by age, immunocompromising conditions, number of categories of chronic medical conditions,[**] number of COVID-19 mRNA vaccine doses received, and variant-predominant period when admitted to hospital. Variant-predominant periods were defined as pre-Delta (March 11–July 3, 2021), Delta (July 4–December 25, 2021), or Omicron (December 26, 2021–January 24, 2022), based on when a variant accounted for >50% of sequenced SARS-CoV2 viruses using on whole-genome sequencing of specimens collected in the IVY network. An additional sensitivity analysis was conducted by restricting COVID-19–negative controls to those known to have received IMV or to have died in the hospital within 28 days of admission. Analyses were conducted using STATA software (version 16.0; StataCorp); p-values <0.05 were considered statistically significant. This activity was determined to be public health surveillance by each participating site and CDC and was conducted in a manner consistent with applicable federal law and CDC policy.[††]

Among 9,211 COVID-19 case-patients with IMV or in-hospital death and COVID-19–negative controls enrolled during March 11, 2021–January 24, 2022, 1,667 (18%) were excluded from the analysis. The most common reasons for exclusion included receiving a licensed mRNA COVID-19 vaccine but not being in a vaccination group considered in this analysis (638), receiving a non-mRNA COVID-19 vaccine product (445), inability to determine vaccination status (279), COVID-19–like illness onset after hospital admission (119), and receiving a third vaccine dose before authorization (96); 90 patients were excluded for other reasons. Among 7,544 included patients, 1,440 (19%) were COVID-19 case-patients with IMV, death, or both, and 6,104 (81%) were COVID-19–negative controls. Compared with unvaccinated case-patients with IMV or in-hospital death, those who were vaccinated (2 or 3 doses) were older (median age 69 versus 55 years; p<0.001), more likely to live in a long-term care facility (11% versus 2%; p<0.001), more likely to have been hospitalized previously in the past year (44% versus 22%; p<0.001), more likely to have immunocompromising conditions (40% versus 10%; p<0.001), and had more chronic medical conditions (Table 1).

Overall VE against COVID-19–associated IMV or death across the surveillance period was 90% (95% CI = 88%–91%) (Table 2), similar to that for IMV only (91%; 95% CI = 89%–92%) and in-hospital death only (88%; 95% CI = 85%–90%), and similar in a sensitivity analysis restricting COVID-19 test-negative control-patients to those who also received IMV or died in the hospital (86%; 95% CI = 82%–89%). Among recipients of 2 vaccine doses, VE over the entire study period was 92% (95% CI = 90%–94%) at 14–150 days after receipt of the second dose versus 84% (95% CI = 80%–87%) at >150 days postvaccination. VE was 94% (95% CI = 91%–96%) among recipients of 3 vaccine doses. Among immunocompetent adults with no chronic medical conditions, VE for 2 or 3 vaccine

[¶] Recipients of 3 doses of mRNA vaccine were included if they received a third dose after Emergency Use Authorization (after August 12, 2021, for adults with immunocompromising conditions and after September 22, 2021, for adults without immunocompromising conditions) and they received the third dose ≥28 days after dose 2 to complete a primary vaccine series for adults with immunocompromising conditions and ≥150 days after dose 2 as a booster dose for adults without immunocompromising conditions.

[**] Categories of nonimmunocompromising chronic medical conditions included cardiovascular disease, neurologic disease, pulmonary disease, gastrointestinal disease, endocrine disease, renal disease, hematologic disease, and other conditions (e.g., unintentional weight loss of ≥10 pounds in the past 90 days, sarcoidosis, or amyloidosis).

[††] 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.

doses was 98% (95% CI = 97%–99%). VE was lowest among adults with immunocompromising conditions (74%; 95% CI = 64%–81%). However, among 123 vaccinated COVID-19 case-patients with immunocompromising conditions, only 17 (14%) had received 3 vaccine doses and were considered fully vaccinated.[§§] During the Omicron period, VE against IMV or in-hospital death was 79% (95% CI = 66%–87%) for recipients of 2 doses and 94% (95% CI = 88%–97%) for recipients of 3 doses.

[§§] For adults with moderately to severely immunocompromising conditions who have received 2 doses of an mRNA vaccine, a third vaccine dose is recommended ≥28 days after the second dose as part of a primary vaccine series, with a fourth vaccine dose recommended ≥3 months later as a booster dose.

Discussion

Analysis of data on severe COVID-19 outcomes from a multistate hospital network found that receipt of 2 or 3 doses of a COVID-19 mRNA vaccine conferred 90% protection against COVID-19–associated IMV or in-hospital death among adults. Most vaccinated patients who experienced COVID-19–associated IMV or who died in hospital were older or had complex underlying conditions, commonly immunosuppression. Protection against IMV or death was consistent throughout the Delta and Omicron periods and was higher in adults who received a third vaccine dose, including 94% during the Omicron period. These findings reinforce the highly protective effects of up-to-date COVID-19 vaccination against severe illness and death among adults, including against current SARS-CoV-2 variants.

TABLE 1. Characteristics of case-patients with laboratory-confirmed COVID-19 who received invasive mechanical ventilation or died in the hospital (n = 1,440) and COVID-19 test-negative controls, by mRNA vaccination group — 21 hospitals,* 18 states, March 2021–January 2022

Characteristic	COVID-19 test-negative controls, no. (%) (n = 6,104)	Case patients with IMV or death, no. (%)		P-value[†]
		Vaccinated (n = 307)	Unvaccinated (n = 1,133)	
Age, median, yrs (IQR)	63 (50–72)	69 (60–77)	55 (42–66)	<0.001
Female sex	3,043 (49.9)	135 (44.0)	463 (40.9)	0.327
Race and ethnicity[§]				
White, non-Hispanic	3,690 (60.5)	191 (62.2)	638 (56.3)	0.317
Black, non-Hispanic	1,276 (20.9)	49 (16.0)	200 (17.7)	
Hispanic	792 (13.0)	47 (15.3)	200 (17.7)	
All other races, non-Hispanic	262 (4.3)	15 (4.9)	59 (5.2)	
Unknown	84 (1.4)	5 (1.6)	36 (3.2)	
LTCF resident,[¶] no./total no. (%)	330/5,920 (5.6)	32/284 (11.3)	20/1,023 (2.0)	<0.001
One or more previous hospitalizations in the last year, no./total no. (%)	3,097/5,674 (54.6)	125/284 (44.0)	217/975 (22.3)	<0.001
Current tobacco use, no./total no. (%)	1,035/5,426 (19.1)	25/241 (10.4)	97/835 (11.6)	0.592
Immunocompromising condition, no./total no.	1,504 (24.6)	123 (40.1)	109 (9.6)	<0.001
Among immunocompetent, no. of chronic medical condition types, median (IQR)	2 (1–3)	2 (1.5–3)	1 (0–2)	<0.001
Specific categories of conditions				
Chronic cardiovascular disease	4,246 (69.6)	252 (82.1)	571 (50.4)	<0.001
Chronic pulmonary disease	2,016 (33.0)	91 (29.6)	213 (18.8)	<0.001
Diabetes mellitus	1,991 (32.6)	140 (45.6)	323 (28.5)	<0.001
Received 2 or 3 mRNA vaccine doses	4,020 (65.9)	307 (100)	0 (—)	—
Vaccinated, no. of doses received				
2	3,488 (86.8)	277 (90.2)	—	—
3	532 (13.2)	30 (9.8)	—	—

Abbreviations: IMV = invasive mechanical ventilation; LTCF = long-term care facility.

* Hospitals (cities, states) included Baystate Medical Center (Springfield, Massachusetts), Beth Israel Deaconess Medical Center (Boston, Massachusetts), Montefiore Medical Center (Bronx, New York), Vanderbilt University Medical Center (Nashville, Tennessee), University of Miami Medical Center (Miami, Florida), Emory University Medical Center (Atlanta, Georgia), Johns Hopkins Hospital (Baltimore, Maryland), Wake Forest University Baptist Medical Center (Winston-Salem, North Carolina), Baylor Scott & White Health (Temple, Texas), University of Iowa Hospitals (Iowa City, Iowa), University of Michigan Hospital (Ann Arbor, Michigan), Hennepin County Medical Center (Minneapolis, Minnesota), Barnes-Jewish Hospital (St. Louis, Missouri), Cleveland Clinic (Cleveland, Ohio), Ohio State University Wexner Medical Center (Columbus, Ohio), Stanford University Medical Center (Stanford, California), UCLA Medical Center (Los Angeles, California), UCHealth University of Colorado Hospital (Aurora, Colorado), Oregon Health & Science University Hospital (Portland, Oregon), Intermountain Medical Center (Murray, Utah), and University of Washington (Seattle, Washington).

† Comparisons between vaccinated and unvaccinated COVID-19 case-patients made by Pearson's chi-square test for categorical variables or Wilcoxon rank-sum test for continuous variables.

§ Race and ethnic groups were self-reported as a single category by patient or proxy listed in table; "All other races, non-Hispanic" included Asian (151), Native American or Alaska Native (52), Native Hawaiian or other Pacific Islander (33), and Other (100).

¶ LTCF included residence in a nursing home, assisted living home, or rehab hospital/other subacute or chronic facility before hospital admission.

SARS-CoV-2 infection, like that from other respiratory viruses, is manifested by a gradient in illness severity, ranging from asymptomatic or mild infection to critical or fatal complications (*2*,*5*). Protection against asymptomatic or milder infection might be reduced by waning of neutralizing antibody levels after vaccination or by immune evasion by emerging variants (*6*,*7*). However, vaccination stimulates long-lasting memory B and T-cell responses that might limit severity of illness in infected adults (*8*). Some studies have found that COVID-19 vaccines provided reduced protection against milder infection (*6*,*7*). The findings of this study indicate that COVID-19 vaccines provide strong protection against severe COVID-19 resulting in respiratory failure or in-hospital death.

The findings in this report are subject to at least five limitations. First, although receipt of 3 mRNA vaccine doses was associated with better protection against critical COVID-19 outcomes than was receipt of 2 doses, understanding the durability of protection over time or against emerging SARS-CoV-2 variants will require ongoing surveillance. Second, although adjustments were made for calendar time, age, and race/ethnicity, among other potential confounders, unmeasured or residual confounding is possible. Third, control-patients hospitalized without COVID-19 might not have been fully representative of

TABLE 2. Effectiveness of COVID-19 mRNA vaccines against COVID-19–associated invasive mechanical ventilation or in-hospital death — 21 hospitals, 18 states,*,† March 2021–January 2022

Group/Characteristic	No. of vaccinated case-patients with IMV or death/ total no. of case-patients (%)	No. of vaccinated control-patients/ total no. of control-patients (%)	Vaccine effectiveness, % (95% CI)
All variant periods§	307/1,440 (21.3)	4,020/6,104 (65.9)	90 (88–91)
No. of mRNA vaccine doses received			
2	277/1,410 (19.6)	3,488/5,572 (62.6)	88 (86–90)
14–150 days after dose 2	92/1,225 (7.5)	2,039/4,123 (49.5)	92 (90–94)
>150 days after dose 2	185/1,318 (14.0)	1,449/3,533 (41.0)	84 (80–87)
3	30/1,163 (2.6)	532/2,616 (20.3)	94 (91–96)
Age group, yrs			
18–64	115/931 (12.4)	1,807/3,326 (54.3)	91 (89–93)
≥65	192/509 (37.7)	2,213/2,778 (79.7)	88 (84–90)
Health status			
Immunocompromised	123/232 (53.0)	1,090/1,504 (72.5)	74 (64–81)
Immunocompetent	184/1,208 (15.2)	2,930/4,600 (63.7)	92 (91–94)
No. of chronic conditions among immunocompetent			
None	12/368 (3.3)	322/642 (50.2)	98 (97–99)
1	34/337 (10.1)	647/1,094 (59.1)	95 (92–96)
2	60/264 (22.7)	886/1,320 (67.1)	89 (85–93)
≥3	78/239 (32.6)	1,075/1,544 (69.6)	84 (78–89)
Variant period,¶ no. of doses			
Pre-Delta, 2 doses	13/259 (5.0)	893/1,738 (51.4)	95 (90–97)
Delta, 2 or 3 doses	235/1,027 (22.9)	2,741/3,865 (70.9)	89 (87–91)
2 doses, median = 159 days after dose 2	218/1,010 (21.6)	2,402/3,526 (68.1)	88 (86–90)
3 doses, median = 35 days after dose 3	17/809 (2.1)	339/1,463 (23.2)	95 (91–97)
Omicron, 2 or 3 doses	59/154 (38.3)	386/501 (77.0)	86 (79–91)
2 doses, median = 256 days after dose 2	46/141 (32.6)	193/308 (62.7)	79 (66–87)
3 doses, median = 60 days after dose 3	13/108 (12.0)	193/308 (62.7)	94 (88–97)

Abbreviations: IMV = invasive mechanical ventilation; VE = vaccine effectiveness.

* Reported VE results are for 2 or 3 vaccine doses except where otherwise noted. VE was estimated using logistic regression comparing the odds of being vaccinated with 2 or 3 doses of an mRNA vaccine versus being unvaccinated for laboratory-confirmed cases with IMV or death and test-negative controls and calculated as VE = 100 × (1 − odds ratio). Logistic regression models were adjusted for date of hospital admission (biweekly intervals), U.S. Department of Health and Human Services region of hospital (10 regions), age group (18–49, 50–64, and ≥65 years), sex, and race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic of any race, non-Hispanic other, or unknown). Age-specific models were adjusted for age as a continuous variable.

† Hospitals (cities, states) included Baystate Medical Center (Springfield, Massachusetts), Beth Israel Deaconess Medical Center (Boston, Massachusetts), Montefiore Medical Center (Bronx, New York), Vanderbilt University Medical Center (Nashville, Tennessee), University of Miami Medical Center (Miami, Florida), Emory University Medical Center (Atlanta, Georgia), Johns Hopkins Hospital (Baltimore, Maryland), Wake Forest University Baptist Medical Center (Winston-Salem, North Carolina), Baylor Scott & White Health (Temple, Texas), University of Iowa Hospitals (Iowa City, Iowa), University of Michigan Hospital (Ann Arbor, Michigan), Hennepin County Medical Center (Minneapolis, Minnesota), Barnes-Jewish Hospital (St. Louis, Missouri), Cleveland Clinic (Cleveland, Ohio), Ohio State University Wexner Medical Center (Columbus, Ohio), Stanford University Medical Center (Stanford, California), UCLA Medical Center (Los Angeles, California), UCHealth University of Colorado Hospital (Aurora, Colorado), Oregon Health & Science University Hospital (Portland, Oregon), Intermountain Medical Center (Murray, Utah), and University of Washington (Seattle, Washington).

§ With vaccination defined as receipt of either 2 or 3 mRNA vaccine doses.

¶ Variant periods were defined by hospital admission dates as the following: pre-Delta (when the Alpha variant dominated but other variants co-circulated), March 11–July 3, 2021; Delta, July 4–December 25, 2021, and Omicron, December 26, 2021–January 24, 2022. Start dates for variant periods were selected based on calendar weeks during which the variant accounted for >50% of sequenced viruses that had lineage determination from whole-genome sequencing.

Summary

What is already known about this topic?

COVID-19 mRNA vaccines provide protection against COVID-19 hospitalization among adults. However, how well mRNA vaccines protect against the most severe outcomes of COVID-19–related illness, including use of invasive mechanical ventilation (IMV) or death, is uncertain.

What is added by this report?

Receiving 2 or 3 doses of an mRNA COVID-19 vaccine was associated with a 90% reduction in risk for COVID-19–associated IMV or death. Protection of 3 mRNA vaccine doses during the period of Omicron predominance was 94%.

What are the implications for public health practice?

COVID-19 mRNA vaccines are highly effective in preventing the most severe forms of COVID-19. CDC recommends that all persons eligible for vaccination get vaccinated and stay up to date with COVID-19 vaccination.

case-patients likely to receive IMV or die while in the hospital. In a sensitivity analysis restricting control-patients to those who received IMV or died from causes not related to COVID-19, results were similar. Fourth, although representing 18 states, patients in this study might not be entirely representative of the general U.S. adult population. Most hospitalized patients had multiple chronic medical conditions, and the overall VE observed in this analysis might underestimate protection in healthier populations. VE against COVID-19–associated IMV or in-hospital death in adults without chronic medical conditions was highest at 98%. Finally, although VE was lower for adults with immunocompromising conditions, most of these persons had not received the third mRNA vaccine dose recommended as part of a primary vaccine series for immunocompromised persons.

Through February 2022, nearly 1 million COVID-19–associated deaths have occurred in the United States, primarily in unvaccinated persons (*9*). COVID-19 vaccination is likely to prevent a majority of COVID-19–associated deaths and other life-threatening outcomes. CDC recommends that all persons eligible for vaccination get vaccinated and stay up to date with COVID-19 vaccination (*4*).

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COVID-19–Associated Hospitalizations Among Adults During SARS-CoV-2 Delta and Omicron Variant Predominance, by Race/Ethnicity and Vaccination Status — COVID-NET, 14 States, July 2021–January 2022

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Beginning the week of December 19–25, 2021, the B.1.1.529 (Omicron) variant of SARS-CoV-2 (the virus that causes COVID-19) became the predominant circulating variant in the United States (i.e., accounted for >50% of sequenced isolates).* Information on the impact that booster or additional doses of COVID-19 vaccines have on preventing hospitalizations during Omicron predominance is limited. Data from the COVID-19–Associated Hospitalization Surveillance Network (COVID-NET)† were analyzed to compare COVID-19–associated hospitalization rates among adults aged ≥18 years during B.1.617.2 (Delta; July 1–December 18, 2021) and Omicron (December 19, 2021–January 31, 2022) variant predominance, overall and by race/ethnicity and vaccination status. During the Omicron-predominant period, weekly COVID-19–associated hospitalization rates (hospitalizations per 100,000 adults) peaked at 38.4, compared with 15.5 during Delta predominance. Hospitalizations rates increased among all adults irrespective of vaccination status (unvaccinated, primary series only, or primary series plus a booster or additional dose). Hospitalization rates during peak Omicron circulation (January 2022) among unvaccinated adults remained 12 times the rates among vaccinated adults who received booster or additional doses and four times the rates among adults who received a primary series, but no booster or additional dose. The rate among adults who received a primary series, but no booster or additional dose, was three times the rate among adults who received a booster or additional dose. During the Omicron-predominant period, peak hospitalization rates among non-Hispanic Black (Black) adults were nearly four times the rate of non-Hispanic White (White) adults and was the highest rate observed among any racial and ethnic group during the pandemic. Compared with the Delta-predominant period, the proportion of unvaccinated hospitalized Black adults increased during the Omicron-predominant period. All adults should stay up to date (*1*) with COVID-19 vaccination to reduce their risk for COVID-19–associated hospitalization. Implementing strategies that result in the equitable receipt of COVID-19 vaccinations, through building vaccine confidence, raising awareness of the benefits of vaccination, and removing barriers to vaccination access among persons with disproportionately higher hospitalizations rates from COVID-19, including Black adults, is an urgent public health priority.

COVID-NET conducts population-based surveillance for laboratory-confirmed COVID-19–associated hospitalizations in 99 counties across 14 states.§ COVID-19–associated hospitalizations are those occurring among residents of a predefined surveillance catchment area who have a positive real-time reverse transcription–polymerase chain reaction (RT-PCR) or rapid antigen detection test result for SARS-CoV-2 during hospitalization or the 14 days preceding admission.

This analysis describes weekly hospitalization rates during Delta- and Omicron-predominant periods. Among nonpregnant and pregnant adults aged ≥18 years,¶ hospitalization rates were calculated overall, and by race/ethnicity and COVID-19 vaccination status. Age-adjusted rates were calculated by dividing the number of hospitalized COVID-19 patients by population estimates for race/ethnicity, and vaccination status in the catchment area. Vaccination status (unvaccinated, receipt of a primary series only, or receipt of a primary series plus a booster or additional dose) was determined for individual hospitalized patients and for the catchment population using state immunization information systems data (*2*).** Monthly incidence among adults who received booster or additional doses was calculated by summing the total number of COVID-19 patients with booster or additional doses hospitalized over all days of

* https://covid.cdc.gov/covid-data-tracker/#variant-proportions

† https://www.cdc.gov/coronavirus/2019-ncov/covid-data/covid-net/purpose-methods.html

§ Selected counties in California, Colorado, Connecticut, Georgia, Iowa, Maryland, Michigan, Minnesota, New Mexico, New York, Ohio, Oregon, Tennessee, and Utah (https://www.cdc.gov/mmwr/volumes/69/wr/mm6915e3.htm). Iowa did not provide immunization data but is included in the overall population-based hospitalization rates. Maryland did not contribute data after December 4, 2021, but did contribute data for previous weeks.

¶ Rates cannot be stratified by pregnancy status because the underlying population of pregnant women in the catchment area is unknown. Rates are calculated using the CDC National Center for Health Statistics' vintage 2020 bridged-race postcensal population estimates for the counties included in surveillance. https://www.cdc.gov/nchs/nvss/bridged_race.htm

** https://www.medrxiv.org/content/10.1101/2021.08.27.21262356v1

the month and dividing by the sum of adults with booster or additional doses in the underlying population for each day of the month.[††] This method was also used for calculations in unvaccinated persons and those who received a primary series but not a booster or additional dose.[§§]

Using previously described methods (*3*), investigators collected clinical data on a representative sample of adult patients (7.9%) hospitalized during July 1, 2021–January 31, 2022, stratified by age and COVID-NET site. Surveillance officers abstracted data on sampled patients from medical charts. Pregnant women were excluded because their reasons for hospital admission (*4*) might differ from those for nonpregnant persons.

Variances were estimated using Taylor series linearization method. Chi-square tests were used to compare differences between the Delta- and Omicron-predominant periods; p-values <0.05 were considered statistically significant. Percentages presented were weighted to account for the probability of selection for sampled cases (*3*). Analyses were conducted using SAS statistical software survey procedures (version 9.4; SAS Institute). This activity was reviewed by CDC and conducted consistent with applicable federal law and CDC policy.[¶¶]

During the Omicron-predominant period, overall weekly adult hospitalization rates peaked at 38.4 per 100,000, exceeding the previous peak on January 9, 2021 (26.1) and the peak rate during the Delta-predominant period (15.5) (Figure 1). Age-adjusted hospitalization rates among Black adults peaked at 94.7 (January 8, 2022), higher than that among all other racial and ethnic groups, 3.8 times the rate among White adults (24.8) for the same week, and 2.5 times the previous peak (January 16, 2021) among Black adults (37.2). This was the highest age-adjusted weekly rate observed among any racial and ethnic group during the pandemic. During the Omicron-predominant period, hospitalization rates increased among unvaccinated persons and those who completed a primary series, with and without receipt of a booster or additional dose (Figure 2). Weekly rates among unvaccinated adults and adults who received a primary COVID-19 vaccination series with a booster or additional dose peaked at 149.8 (January 8, 2022) and 11.7 (January 22, 2022), respectively. The cumulative monthly age-adjusted hospitalization rate during January 2022 among unvaccinated adults (528.2) was 12 times the rates among those who had received a booster or additional dose (45.0) and four times the rates among adults who received a primary series, but no booster or additional dose (133.5). The rate among adults who received a primary series, but no booster or additional dose (133.5), was three times the rate among adults who received a booster or additional dose (45.0).

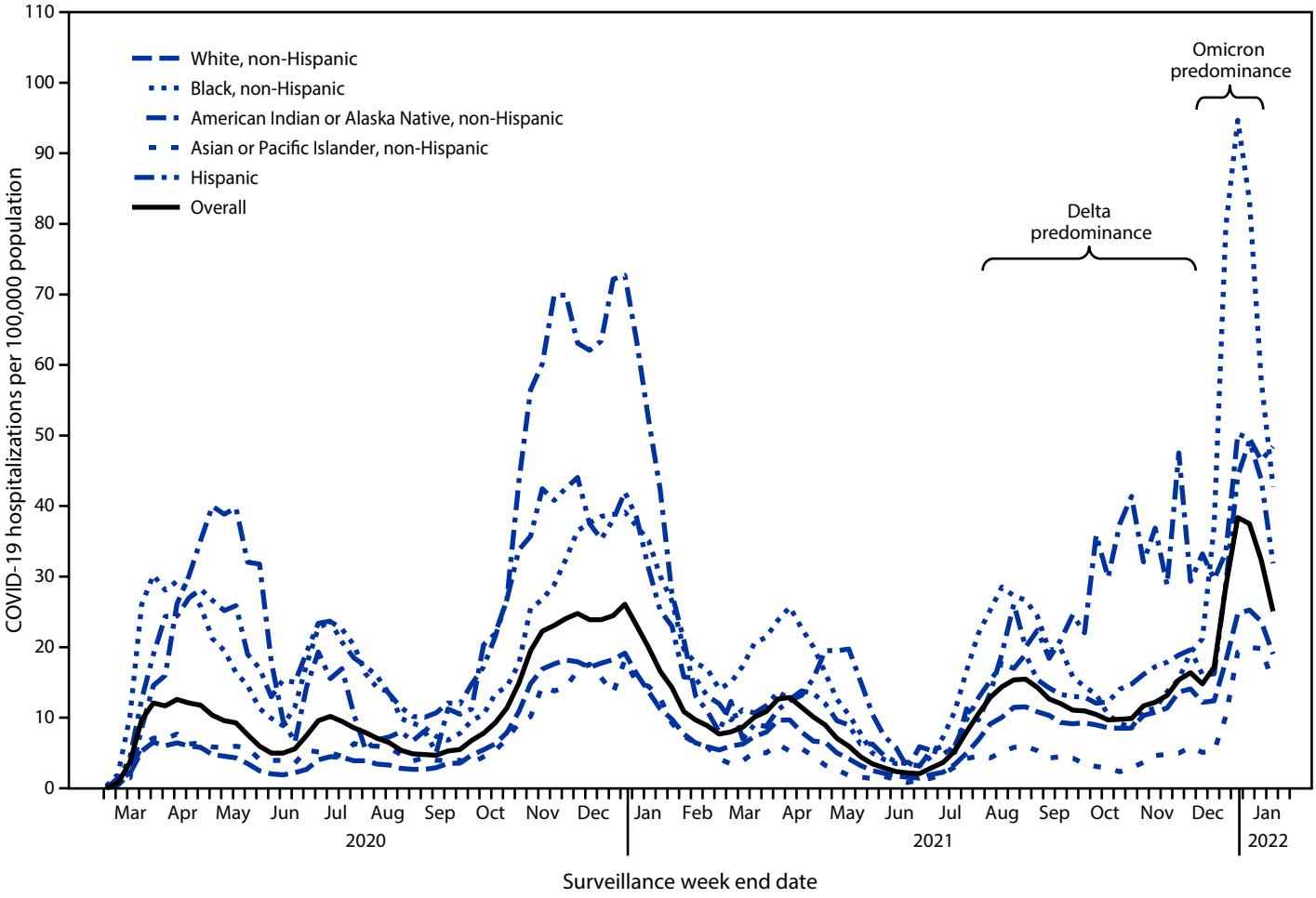
Clinical information was abstracted for 5,681 adults with COVID-19–associated hospitalization during July 1, 2021–January 31, 2022 (Table). Black adults accounted for a higher percentage of hospitalizations during the Omicron-predominant period (26.7%) than during the Delta-predominant period (22.2%, p = 0.05). Among all adults, relative to the Delta-predominant period, COVID-19–related illness was the primary reason for admission for a smaller percentage of hospitalizations (87.5% versus 95.5%, p<0.01), and median length of stay was shorter (4 versus 5 days, p<0.01) during the Omicron-predominant period; during this period, the proportion of patients admitted to an intensive care unit,

[††] On August 13, 2021, CDC's Advisory Committee on Immunization Practices (ACIP) issued the first of several recommendations for additional or booster doses of COVID-19 vaccine. Additional recommendations followed and data availability on booster-dose status varies by age because not all age groups were recommended by ACIP to receive booster doses at the same time. https://www.cdc.gov/mmwr/volumes/70/wr/mm7050e2.htm

[§§] Adults who completed their primary COVID-19 vaccination series were defined as those who had received the second dose of a 2-dose primary vaccination series or a single dose of a 1-dose primary vaccine product ≥14 days before receipt of a positive SARS-CoV-2 test result associated with their hospitalization but received no additional or booster dose. Adults who received booster doses were classified as those who completed their primary vaccination series and received an additional or booster dose of vaccine on or after August 13, 2021, at any time after the completion of their primary series, and ≥14 days before a positive test result for SARS-CoV-2, because COVID-19–associated hospitalizations are a lagging indicator, and time passed after receipt of a booster dose has been shown to be associated with reduced rates of COVID-19 infection (https://www.nejm.org/doi/full/10.1056/NEJMoa2114255). Monthly incidence is based on SARS-CoV-2 positive test result date or, if not known, hospital admission date. Because the immune status of all patients is not known, an additional dose (recommended for persons with a weakened immune system) cannot be distinguished from a booster dose. This is a relevant consideration because vaccines can be less effective in persons with a weakened immune system. Persons who received only 1 vaccine dose of a 2-dose series ≥14 days before the SARS-CoV-2 test date or had received a single dose of either a 1- or 2-dose vaccination series <14 days before the positive SARS-CoV-2 test result were considered partially vaccinated and were not included in rates by vaccination status. Persons who received no doses of any COVID-19 vaccine were considered unvaccinated. The population of unvaccinated adults is determined by subtracting the number of adults who received any dose of vaccine, as previously defined, from the population. When possible, CDC associates a person's primary vaccination series and booster dose with that person. However, linking is sometimes not possible because CDC does not receive personally identifiable information about vaccine doses. This can lead to overestimates of first doses and underestimates of subsequent doses, and underestimates of hospitalization rates in persons who received additional or booster doses. A continuity correction has been applied to the denominators by capping the percent population vaccination coverage at 95% by assuming that at least 5% of each age group would always be unvaccinated in each jurisdiction. This correction ensures that there is always a reasonable denominator for the unvaccinated population that would prevent hospitalization rates from growing unrealistically large because of potential overestimates of vaccination coverage. To ensure stability and reliability of rates by vaccination status, data are presented beginning 14 days after at least 5% of the age group-specific population of the COVID-NET surveillance catchment area has received an additional or booster dose. Additional COVID-NET methods for determining vaccination status have been described previously. https://medrxiv.org/cgi/content/short/2021.08.27.21262356v1

[¶¶] 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 1. Weekly COVID-19–associated hospitalization rates* among adults aged ≥18 years, by race and ethnicity — COVID-19–Associated Hospitalization Surveillance Network, 14 states,† March 2020–January 2022



* Overall rates are unadjusted; rates presented by racial and ethnic group are age-adjusted.
† Selected counties in California, Colorado, Connecticut, Georgia, Iowa, Maryland, Michigan, Minnesota, New Mexico, New York, Ohio, Oregon, Tennessee, and Utah (https://www.cdc.gov/mmwr/volumes/69/wr/mm6915e3.htm). Starting the week ending December 4, 2021, Maryland data are not included in weekly rate calculations but are included in previous weeks.

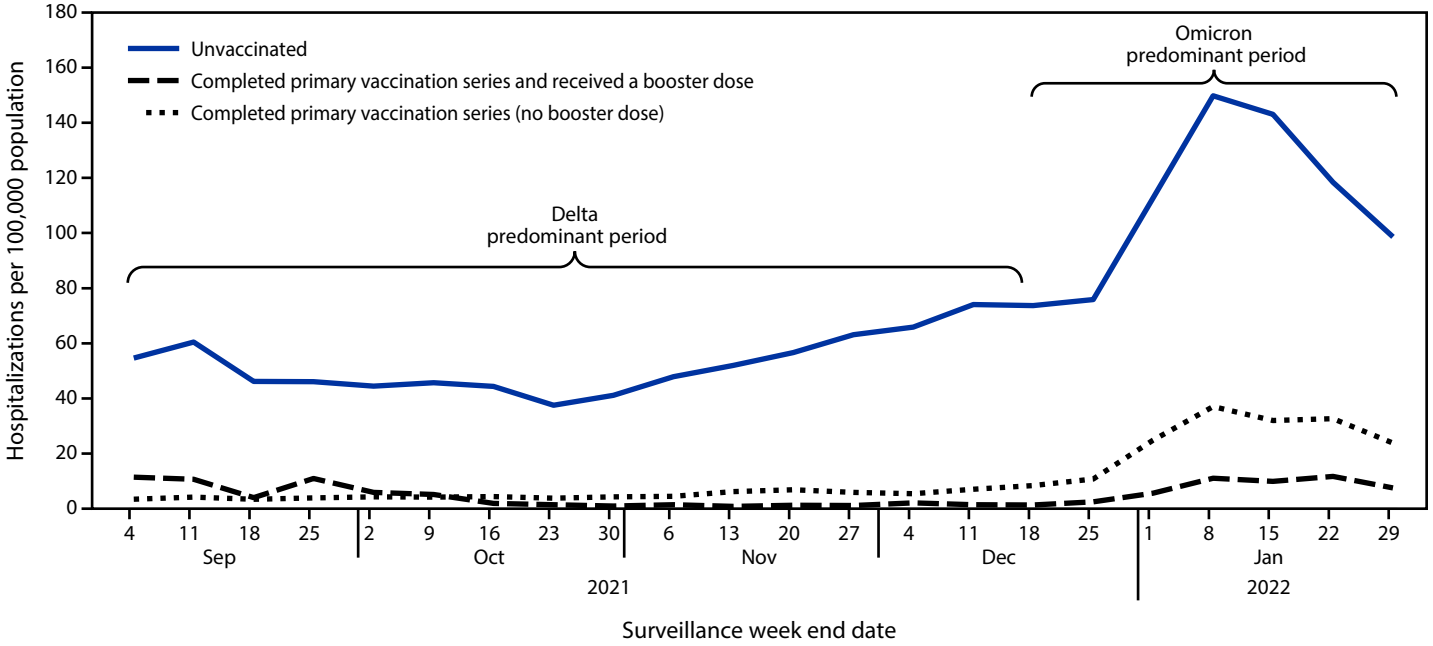
who received invasive mechanical ventilation, and who died in-hospital decreased significantly (all p<0.01).

Among 829 adults hospitalized during the Omicron-predominant period, 49.4% were unvaccinated, compared with 69.5% during the Delta-predominant period (p<0.01). The proportion of hospitalized adults who received booster or additional doses increased from 1.3% during the Delta-predominant period to 13.4% during the Omicron-predominant period (p<0.01)***; among these, 10.7% were long-term care facility residents and 69.5% had an immunosuppressive condition.††† Black adults accounted for 25.2% of all unvaccinated persons hospitalized during the Delta-predominant period; that proportion increased by 23%, to 31.0% during the Omicron-predominant period. Relative to the Delta-predominant period, the proportion of cases in non-Hispanic Asian or Pacific Islanders also increased, whereas the proportion in all other racial and ethnic groups decreased. The proportion of hospitalized Black adults who received a primary COVID-19 vaccination series with or without a booster or additional dose increased from 4.7% and 14.9%, respectively, during the Delta-predominant period to 14.8% and 25.5%, respectively, during the Omicron-predominant period; Hispanic adults experienced smaller increases.

*** An additional 172 (3.4%, 95% CI = 2.7%–4.2%) adults were partially vaccinated, 69 (0.9%, 95% CI = 0.6–1.2) received a primary vaccination series <14 days before receiving a positive SARS-CoV-2 test result, and 186 (4.1%) had unknown vaccination status; these groups are not further described in this analysis.

††† Includes current treatment or recent diagnosis within the previous 12 months of an immunosuppressive condition or use of an immunosuppressive therapy.

FIGURE 2. Weekly age-adjusted rates of COVID-19–associated hospitalizations among adults aged ≥18 years, by vaccination status* — COVID-19–Associated Hospitalization Surveillance Network, 13 states,† September 4, 2021–January 29, 2022§



Abbreviation: COVID-NET = COVID-19–Associated Hospitalization Surveillance Network.

* Adults who completed a primary vaccination series were defined as those who had received the second dose of a 2-dose primary vaccination series or a single dose of a 1-dose product ≥14 days before a positive SARS-CoV-2 test associated with their hospitalization but received no booster dose. Adults who received booster doses were classified as those who completed the primary series and received an additional or booster dose on or after August 13, 2021, at any time after completion of the primary series, and ≥14 days before a positive test result for SARS-CoV-2, because COVID-19–associated hospitalizations are a lagging indicator and time passed after receipt of a booster dose has been shown to be associated with reduced rates of COVID-19 infection (https://www.nejm.org/doi/full/10.1056/NEJMoa2114255). Adults with no documented receipt of any COVID-19 vaccine dose before the test date were considered unvaccinated.

† Selected counties in California, Colorado, Connecticut, Georgia, Maryland, Michigan, Minnesota, New Mexico, New York, Ohio, Oregon, Tennessee, and Utah (https://www.cdc.gov/mmwr/volumes/69/wr/mm6915e3.htm). Iowa does not provide data on vaccination status.

§ Starting the week ending December 4, 2021, Maryland data are not included in weekly rate calculations but are included in previous weeks. To ensure stability and reliability of rates by vaccination status, data are presented beginning when 14 days have passed since at least 5% of the population of adults aged ≥18 years in the COVID-NET surveillance catchment area had received an additional or booster dose.

Discussion

During the period of Omicron predominance, hospitalization rates increased most sharply among Black adults in the United States relative to all other racial and ethnic groups examined and reached the highest rate observed among all racial and ethnic groups since the beginning of the pandemic. Relative to the Delta-predominant period, a larger proportion of hospitalized Black adults were unvaccinated. Although hospitalization rates increased for all adults, rates were highest among unvaccinated adults and lowest among adults who had received a primary series and a booster or additional dose. Hospitalization rates during peak Omicron circulation (January 2022) among unvaccinated adults remained 12 times the rates among vaccinated adults who received booster or additional doses and four times the rates among adults who received a primary series, but no booster or additional dose. The rate among adults who received a primary series, but no booster or additional dose, was three times the rate among adults who received a booster or additional dose. This is consistent with data showing the incidence of positive SARS-CoV-2 test results or death from COVID-19 is higher among unvaccinated adults and adults who have not received a booster than among those who have received a booster or additional dose (*5*).

Relative to the Delta-predominant period, a significantly shorter median length of hospital stay was observed during the Omicron-predominant period and smaller proportions of hospitalizations with intensive care unit admission, receipt of invasive mechanical ventilation, or in-hospital death. Other studies found similarly decreased proportions of severe outcomes among hospitalized patients with COVID-19 during this period (*6*).[§§§]

The prevalence of primary COVID-19 vaccination and of receipt of a booster dose were lower among Black adults compared with White adults. As of January 26, 2022, 39.6% of Black persons received a primary vaccine series; of those, 43.9% of adults received a booster dose once eligible. These proportions are lower compared with 47.3% of White persons

§§§ https://www.medrxiv.org/content/10.1101/2022.01.11.22269045v1

TABLE. Demographic characteristics and clinical interventions and outcomes in COVID-19–associated hospitalizations among nonpregnant adults aged ≥18 years (N = 5,681),* by vaccination status† and period of SARS-CoV-2 variant predominance§ — COVID-NET, 14 states,¶ July 2021–January 2022

Characteristic	Variant predominance period, no. (%)								
				Vaccination status					
	Total hospitalizations**			Unvaccinated		Primary series, no booster		Primary series, plus booster	
	Delta (Jul 1–Dec 18)	Omicron (Dec 19–Jan 31)	p-value††	Delta (Jul 1–Dec 18)	Omicron (Dec 19–Jan 31)	Delta (Jul 1–Dec 18)	Omicron (Dec 19–Jan 31)	Delta (Jul 1–Dec 18)	Omicron (Dec 19–Jan 31)
Overall§§	**4,852 (64.1)**	**829 (35.9)**	—	**3,269 (71.8)**	**409 (28.2)**	**1,183 (58.0)**	**255 (42.0)**	**45 (15.3)**	**93 (84.7)**
Median age, yrs, (IQR)	60 (47–72)	64 (49–77)	<0.01	56 (43–67)	60 (46–77)	71 (61–80)	66 (52–78)	75 (69–82)	69 (59–79)
Age group, yrs									
18–49	1,419 (28.7)	251 (25.6)	0.01	1,185 (36.6)	141 (30.3)	140 (10.1)	71 (21.1)	2 (1.3)	13 (13.2)
50–64	1,723 (30.4)	265 (26.6)		1,274 (33.7)	142 (28.8)	310 (21.2)	77 (26.3)	7 (9.5)	23 (21.1)
≥65	1,710 (40.9)	313 (47.9)		810 (29.7)	126 (40.9)	733 (68.6)	107 (52.5)	36 (89.2)	57 (65.7)
Sex									
Men	2,574 (52.7)	435 (52.2)	0.83	1,751 (52.7)	225 (51.5)	610 (53.2)	127 (50.8)	21 (38.4)	50 (60.8)
Women	2,278 (47.3)	394 (47.8)		1,518 (47.3)	184 (48.5)	573 (46.8)	128 (49.2)	24 (61.6)	43 (39.2)
Race/Ethnicity¶¶									
White, non-Hispanic	2,917 (54.4)	474 (47.6)	0.05	1,852 (50.2)	222 (40.7)	817 (63.1)	137 (46.4)	41 (87.9)	71 (70.8)
Black, non-Hispanic	943 (22.2)	185 (26.7)		687 (25.2)	98 (31.0)	169 (14.9)	60 (25.5)	3 (4.7)	11 (14.8)
American Indian or Alaska Native, non-Hispanic	63 (1.5)	8 (1.0)		46 (1.5)	5 (1.5)	15 (1.9)	3 (1.0)	0 (0.0)	0 (0.0)
Asian or Pacific Islander, non-Hispanic	133 (3.6)	19 (4.6)		88 (3.4)	9 (5.4)	36 (4.6)	7 (11.8)	0 (0.0)	3 (5.9)
Hispanic	589 (12.3)	43 (8.2)		447 (13.7)	52 (12.9)	101 (9.3)	33 (11.2)	1 (7.4)	6 (7.9)
LTCF residence***	264 (5.6)	53 (7.2)	0.18	76 (2.8)	14 (4.3)	155 (12.4)	24 (9.3)	9 (18.4)	11 (10.7)
Any underlying medical condition†††	4,195 (88.5)	729 (91.0)	0.18	2,705 (85.1)	337 (87.7)	1,126 (96.8)	242 (96.3)	44 (99.1)	84 (89.6)
Immunosuppressive condition§§§	505 (11.0)	132 (16.9)	<0.01	240 (7.7)	45 (10.4)	215 (18.6)	50 (21.7)	18 (44.7)	26 (69.5)
Reason for admission									
Likely COVID-19–related	4,487 (95.5)	712 (87.5)	<0.01	3,046 (96.3)	356 (89.5)	1,069 (93.0)	215 (85.3)	42 (94.4)	79 (85.5)
Inpatient surgery	33 (0.4)	12 (1.4)		14 (0.2)	4 (0.7)	17 (1.0)	5 (2.6)	0 (0.0)	2 (1.3)
Psychiatric admission requiring medical care	75 (1.5)	32 (3.9)		50 (1.6)	14 (3.5)	18 (1.3)	12 (4.7)	0 (0.0)	3 (5.1)
Trauma	69 (1.1)	23 (2.7)		37 (0.8)	13 (3.4)	27 (1.9)	5 (1.1)	1 (3.6)	2 (1.6)
Other	68 (1.3)	28 (4.1)		29 (0.8)	7 (2.6)	31 (2.6)	15 (6.3)	2 (2.0)	4 (5.2)
Unknown	13 (0.2)	3 (0.3)		7 (0.2)	2 (0.4)	6 (0.1)	0 (0.0)	0 (0.0)	1 (1.2)
COVID-19–related signs or symptoms on admission¶¶¶									
Yes	4,503 (95.7)	739 (91.9)	<0.01	3,072 (97.0)	368 (93.6)	1,069 (92.9)	225 (90.3)	38 (89.5)	82 (90.6)
No	244 (4.3)	73 (8.1)		113 (3.0)	29 (6.4)	98 (7.1)	27 (9.7)	7 (10.5)	9 (9.4)
Hospitalization outcome									
Length of stay, days, median (IQR)	5 (3–10)	4 (2–9)	<0.01	5 (3–11)	5 (3–9)	5 (3–10)	4 (2–9)	6 (3–18)	4 (2–10)
ICU admission****,††††	1,148 (24.2)	149 (16.8)	<0.01	820 (25.3)	83 (17.4)	256 (22.7)	41 (16.1)	7 (21.1)	13 (16.8)
IMV§§§§	626 (13.6)	70 (7.6)	<0.01	467 (14.9)	36 (6.6)	124 (11.2)	21 (8.2)	5 (16.7)	6 (9.2)
In-hospital death¶¶¶¶	540 (12.6)	72 (7.0)	<0.01	385 (12.6)	42 (7.2)	123 (12.3)	19 (7.1)	5 (19.5)	7 (8.4)

See table footnotes on the next page.

who received a primary series and 54.5% of eligible adults who received a booster dose.¶¶¶ Relative to the Delta-predominant period, Black adults accounted for a larger proportion of unvaccinated adults during the Omicron-predominant period, and age-adjusted hospitalization rates for Black adults increased to the highest rate among all racial and ethnic groups for any week during the pandemic. A previous study conducted before the Omicron-predominant period that showed increased risk for COVID-19–associated hospitalization among certain racial and ethnic groups, including Black adults, and suggested the increased hospitalization rates were likely multifactorial and could include increased prevalence of underlying medical conditions, increased community-level exposure to and incidence of COVID-19, and poor access to health care in these groups (*7*). The increase in transmissibility of the Omicron variant might have amplified these risks for hospitalization, resulting in increased hospitalization rates among Black adults compared with White adults, irrespective of vaccination status. Taken together, these findings suggest that the increased risk for hospitalization among Black adults during the Omicron-predominant period might also be due, in part, to lower proportions of Black adults receiving both the primary vaccination series and booster doses.

¶¶¶ https://data.cdc.gov/Vaccinations/COVID-19-Vaccination-Demographics-in-the-United-St/km4m-vcsb

TABLE. (*Continued*) Demographic characteristics and clinical interventions and outcomes in COVID-19–associated hospitalizations among nonpregnant adults aged ≥18 years (N = 5,681),* by vaccination status† and period of SARS-CoV-2 variant predominance§ — COVID-NET, 14 states,¶ July 2021–January 2022

	Variant predominance period, no. (%)								
				Vaccination status					
	Total hospitalizations**			Unvaccinated		Primary series, no booster		Primary series, plus booster	
Characteristic	Delta (Jul 1–Dec 18)	Omicron (Dec 19–Jan 31)	p-value††	Delta (Jul 1–Dec 18)	Omicron (Dec 19–Jan 31)	Delta (Jul 1–Dec 18)	Omicron (Dec 19–Jan 31)	Delta (Jul 1–Dec 18)	Omicron (Dec 19–Jan 31)
Vaccination status***									
Unvaccinated	3,269 (69.5)	409 (49.4)	<0.01	NA	NA	NA	NA	NA	NA
Primary series, no booster	1,183 (25.0)	255 (32.7)		NA	NA	NA	NA	NA	NA
Primary series, plus booster	45 (1.3)	93 (13.4)		NA	NA	NA	NA	NA	NA
Days since last vaccination dose received before positive SARS-CoV-2 test result†††††									
15–60	NA	NA	NA	NA	NA	19 (0.9)	3 (1.1)	22 (52.9)	23 (31.2)
61–120	NA	NA		NA	NA	88 (7.7)	14 (7.6)	11 (30.8)	45 (49.3)
121–180	NA	NA		NA	NA	336 (26.6)	20 (5.9)	2 (6.3)	12 (13.9)
>180	NA	NA		NA	NA	560 (64.9)	183 (85.4)	8 (10.0)	4 (5.5)

Abbreviations: COVID-NET = COVID-19–Associated Hospitalization Surveillance Network; ICU = intensive care unit; IMV = invasive mechanical ventilation; LTCF = long-term care facility; NA = not applicable.

* Data are from a weighted sample of hospitalized nonpregnant adults with completed medical record abstractions and a discharge disposition. Sample sizes presented are unweighted with weighted percentages.

† Vaccination status is based on state immunization information system data. Adults who completed a primary vaccination series were persons who had received the second dose of a 2-dose COVID-19 vaccination series or a single dose of a 1-dose product ≥14 days before a positive SARS-CoV-2 test associated with their hospitalization but received no booster or additional dose. Adults who received booster doses were classified as those who completed the primary series and received an additional or booster dose on or after August 13, 2021, at any time after completion of the primary series, and ≥14 days before a positive test result for SARS-CoV-2, as COVID-19–associated hospitalizations are a lagging indicator and time passed after receipt of a booster dose has been shown to be associated with reduced rates of COVID-19 infection (https://www.nejm.org/doi/full/10.1056/NEJMoa2114255). Adults with a positive result whose SARS-CoV-2 test date was ≥14 days after the first dose of a 2-dose series but <14 days after receipt of the second dose were considered partially vaccinated. Partially vaccinated adults, and those who received a single dose of a 1-dose product <14 days before the positive SARS-CoV-2 test result were not included in analyses by vaccination status but were included in rates and overall proportions that were not stratified by vaccination status. Adults with no documented receipt of any COVID-19 vaccine dose before the test date were considered unvaccinated. If the SARS-CoV-2 test date was not available, hospital admission date was used. Adults whose vaccination status had not yet been verified using the immunization information system data were considered to have unknown vaccination status and were included in total proportions but not stratified by vaccination status. Vaccination status is not available for Iowa and cases from Iowa are excluded from analyses that examined vaccination status. Additional COVID-NET methods for determining vaccination status have been described previously. https://www.medrxiv.org/content/10.1101/2021.08.27.21262356v1

§ Delta period: July 1, 2021–December 18, 2021, reflects the time when Delta was the predominant circulating variant; Omicron period: December 19, 2021–January 31, 2022, reflects the time when Omicron was the predominant circulating variant.

¶ Selected counties in California, Colorado, Connecticut, Georgia, Iowa, Maryland, Michigan, Minnesota, New Mexico, New York, Ohio, Oregon, Tennessee, and Utah (https://www.cdc.gov/mmwr/volumes/69/wr/mm6915e3.htm). Iowa does not provide data on vaccination status. Starting the week ending December 4, 2021, Maryland data are not included in calculations but are included in previous weeks.

** Total hospitalizations include data from selected counties in 14 COVID-NET states irrespective of vaccination status and includes adults with partial or unknown vaccination status. As a result, the number of total hospitalizations exceeds the sum of unvaccinated adults, adults who received a primary series without a booster or additional dose, and adults who received a primary series with a booster or additional dose.

†† Proportions between the pre-Delta and Delta period were compared using chi-square tests; p-values <0.05 were considered statistically significant, adjusted for multiple comparisons using the Bonferroni correction method.

§§ Percentages presented for the overall number are weighted row percentages. Percentages presented for demographic characteristics are weighted column percentages.

¶¶ If ethnicity was unknown, non-Hispanic ethnicity was assumed. Persons with multiple, unknown, or missing race accounted for 6.9% (weighted) of all cases. These persons are excluded from the proportions of race/ethnicity but are included in other analyses.

*** LTCF residents include hospitalized adults who were identified as residents of a nursing home/skilled nursing facility, rehabilitation facility, assisted living/residential care, long-term acute care hospital, group/retirement home, or other LTCF upon hospital admission. A free-text field for other types of residences was examined; patients with an LTCF-type residence were also categorized as LTCF residents.

††† Defined as one or more of the following: chronic lung disease including asthma, chronic metabolic disease including diabetes mellitus, blood disorder/hemoglobinopathy, cardiovascular disease, neurologic disorder, immunocompromising condition, renal disease, gastrointestinal/liver disease, rheumatologic/autoimmune/inflammatory condition, obesity, feeding tube dependency, and wheelchair dependency.

§§§ Includes current treatment or recent diagnosis of an immunosuppressive condition or use of an immunosuppressive therapy during the preceding 12 months.

¶¶¶ COVID-19–associated signs and symptoms included respiratory symptoms (congestion or runny nose, cough, hemoptysis or bloody sputum, shortness of breath or respiratory distress, sore throat, upper respiratory infection, influenza-like illness, and wheezing) and non-respiratory symptoms (abdominal pain, altered mental status or confusion, anosmia or decreased smell, chest pain, conjunctivitis, diarrhea, dysgeusia or decreased taste, fatigue, fever or chills, headache, muscle aches or myalgias, nausea or vomiting, rash, and seizures). Symptoms are abstracted from the medical chart and might not be complete.

**** ICU admission and IMV are not mutually exclusive categories, and patients could have received both.

†††† ICU admission status was missing in 1.3% (weighted) of hospitalizations; these hospitalizations are included in other analyses.

§§§§ IMV status was missing in 1.4% (weighted) of hospitalizations; these hospitalizations are otherwise included elsewhere in the analysis.

¶¶¶¶ In-hospital death status was missing in 1.4% (weighted) of hospitalizations; these hospitalizations are otherwise included elsewhere in the analysis.

***** An additional 172 (3.4%, 95% CI = 2.7%–4.2%) adults were partially vaccinated, 69 (0.9%, 95% CI = 0.6–1.2) received a primary vaccination series <14 days before a positive for SARS-CoV-2 test result, and 186 (4.1%) had unknown vaccination status; these groups are not further described in this analysis.

††††† If SARS-CoV-2 test date was missing, hospitalization admission date was used.

Summary

What is already known about this topic?

SARS-CoV-2 infections can result in COVID-19–associated hospitalizations, even among vaccinated persons.

What is added by this report?

In January 2022, unvaccinated adults and those vaccinated with a primary series, but no booster or additional dose, were 12 and three times as likely to be hospitalized, respectively, as were adults who received booster or additional doses. Hospitalization rates among non-Hispanic Black adults increased more than rates in other racial/ethnic groups.

What are the implications for public health practice?

All adults should stay up to date with COVID-19 vaccination to reduce their risk for COVID-19–associated hospitalization. Implementing strategies that result in the equitable receipt of COVID-19 vaccinations among persons with disproportionately higher hospitalizations rates, including non-Hispanic Black adults, is an urgent public health priority.

The findings in this report are subject to at least four limitations. First, COVID-19–associated hospitalizations might have been missed because of hospital testing practices and test availability. Second, vaccination status is subject to misclassification; this might affect estimation of rates by vaccination status. Third, because immunocompromise status is not always known, it is not possible to distinguish between booster and additional doses; this could have influenced observed rates. Finally, the COVID-NET catchment areas include approximately 10% of the U.S. population; thus, these findings might not be nationally generalizable.

Coinciding with Omicron variant predominance, COVID-19–associated hospitalization rates among adults increased in late December 2021 and peaked in January 2022; rates increased more among Black adults relative to rates among adults of other racial and ethnic groups. Rates were highest among unvaccinated adults and lowest among those who had received a booster or additional dose. All adults should stay up to date (*1*) with COVID-19 vaccination to reduce their risk for COVID-19–associated hospitalization. Implementing strategies that result in the equitable receipt of COVID-19 vaccinations, though building vaccine confidence, raising awareness of the benefits of vaccination, and removing barriers to vaccination access among persons with disproportionately higher hospitalizations rates from COVID-19, including Black adults, is an urgent public health priority.

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Erratum

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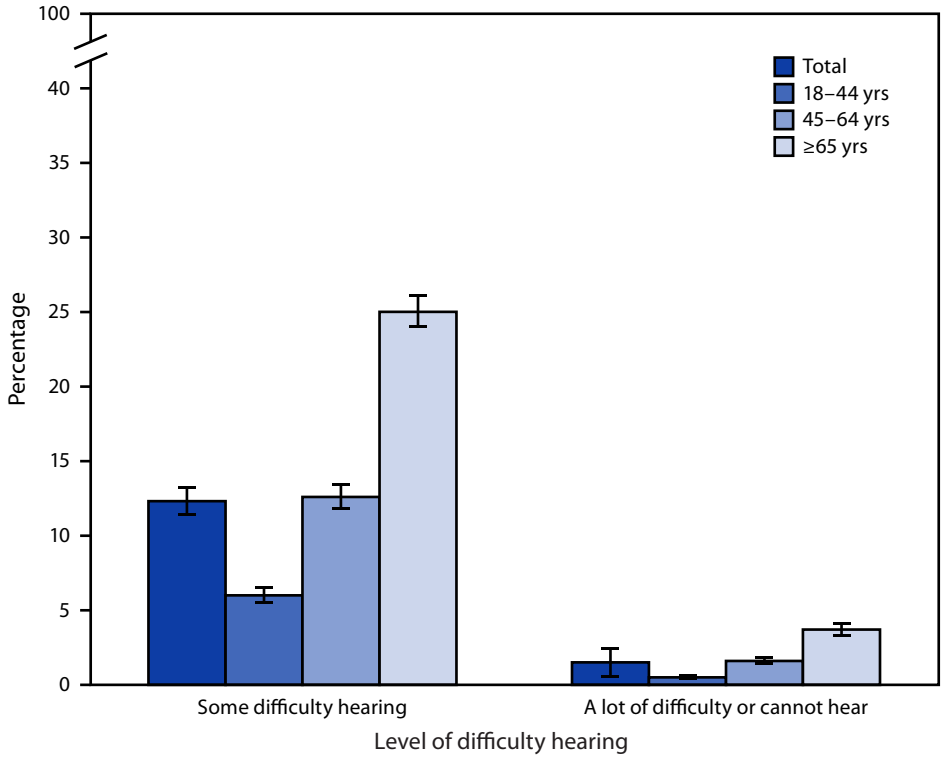
In the report, "Characteristics and Adverse Events of Patients for Whom Nifurtimox Was Released Through CDC-Sponsored Investigational New Drug Program for Treatment of Chagas Disease — United States, 2001–2021," on page 371, the 11th sentence in the first paragraph should have read, "On August **6**, 2020, the Food and Drug Administration (FDA) announced approval of a nifurtimox product, Lampit (Bayer), for treatment of Chagas disease in patients aged <18 years weighing ≥5.5 lbs (≥2.5 kg)."

QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Percentage* of Adults Aged ≥18 Years Who Have Difficulty Hearing Even When Using a Hearing Aid,† by Age Group — National Health Interview Survey, United States, 2020§



* With 95% CIs indicated by error bars.
† Based on responses to the survey question, "Do you have difficulty hearing even when using a hearing aid? Would you say no difficulty, some difficulty, a lot of difficulty, or you cannot do this at all?"
§ Estimates are based on household interviews of a sample of the civilian, noninstitutionalized U.S. population.

In 2020, 12.3% of adults aged ≥18 years had some difficulty hearing even when using a hearing aid and 1.5% had a lot of difficulty or could not hear at all. The percentage of adults who had some difficulty hearing increased with age, from 6.0% among those aged 18–44 years, to 12.6% among those aged 45–64 years, and to 25.0% among those aged ≥65 years. The percentage of adults who had a lot of difficulty hearing or were unable to hear at all also increased with age, from 0.5% among those aged 18–44 years, to 1.6% among those aged 45–64 years, and to 3.7% among those aged ≥65 years.

Source: National Center for Health Statistics, National Health Interview Survey, 2020. https://www.cdc.gov/nchs/nhis.htm

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