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Disaggregating Data to Measure Racial Disparities in COVID-19 Outcomes and Guide Community Response — Hawaii, March 1, 2020–February 28, 2021

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Native Hawaiian and Pacific Islander populations have been disproportionately affected by COVID-19 (*1–3*). Native Hawaiian, Pacific Islander, and Asian populations vary in language; cultural practices; and social, economic, and environmental experiences,† which can affect health outcomes (*4*).§ However, data from these populations are often aggregated in analyses. Although data aggregation is often used as an approach to increase sample size and statistical power when analyzing data from smaller population groups, it can limit the understanding of disparities among diverse Native Hawaiian, Pacific Islander, and Asian subpopulations¶ (*4–7*). To assess disparities in COVID-19 outcomes among Native Hawaiian, Pacific Islander, and Asian populations, a disaggregated, descriptive analysis, informed by recommendations from these communities,** was performed using race data from 21,005 COVID-19 cases and 449 COVID-19–associated deaths reported to the Hawaii State Department of Health (HDOH) during March 1, 2020–February 28, 2021.†† In

Continuing Education examination available at https://www.cdc.gov/mmwr/mmwr_continuingEducation.html

* These authors contributed equally to the report.

† Native Hawaiian persons are indigenous Hawaiians with ancestry to the original inhabitants of these islands. A majority of Pacific Islander persons in Hawaii are Samoan, Tongan, Chamorro or Guamanian, Chuukese, Palauan, and Marshallese persons. The latter three Pacific Islander groups migrated from the Federated States of Micronesia, Palau, and the Marshall Islands through provisions of their respective Compacts of Free Association. Immigration of Filipino persons to Hawaii from the Philippines began in the early 1900s when Filipino persons were recruited for agricultural labor.

§ https://www.cdc.gov/coronavirus/2019-ncov/community/health-equity/race-ethnicity.html#anchor_1595551025605

¶ https://healthpolicy.ucla.edu/publications/Documents/PDF/2021/COVID-19-Data-NHPI-Asians-factsheet-may2021.pdf

** https://48ada3fb-53b7-4311-b1dc-3087b402628b.filesusr.com/ugd/11aeb5_4c461b06f90843a8ba2188dfe1c7e36a.pdf

†† COVID-19 cases included persons who received a laboratory-confirmed positive reverse transcription–polymerase chain reaction (RT-PCR) test result for SARS-CoV-2. COVID-19 deaths included decedents who had received a positive RT-PCR test result and had COVID-19 listed as a cause of death in the death certificate, discharge summary, or coroner's notes.

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Hawaii, COVID-19 incidence and mortality rates per 100,000 population were 1,477 and 32, respectively during this period. In analyses with race categories that were not mutually exclusive, including persons of one race alone or in combination with one or more races, Pacific Islander persons, who account for 5% of Hawaii's population, represented 22% of COVID-19 cases and deaths (COVID-19 incidence of 7,070 and mortality rate of 150). Native Hawaiian persons experienced an incidence of 1,181 and a mortality rate of 15. Among subcategories of Asian populations, the highest incidences were experienced by Filipino persons (1,247) and Vietnamese persons (1,200). Disaggregating Native Hawaiian, Pacific Islander, and Asian race data can aid in identifying racial disparities among specific subpopulations and highlights the importance of partnering with communities to develop culturally responsive outreach teams[§§] and tailored public health interventions and vaccination campaigns to more effectively address health disparities.

Descriptive data of Hawaii state residents reported to HDOH during March 1, 2020–February 28, 2021, were analyzed to determine the number, percentage, and crude rates of COVID-19 cases and deaths using race categories that were not mutually exclusive. Data were analyzed among the five minimum racial origin categories defined by the Office of Management and Budget (American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, and White), and among Native Hawaiian, Pacific Islander, and Asian origin subcategories.[¶¶] Ethnicity was not included in this analysis because data on ethnicity were missing for 32% of reported cases and 9% of deaths. Race information for COVID-19 patients was mostly self-reported; race information for deaths was reported by patients premortem or by an observer (e.g., physician) or a proxy family member. Because a large proportion of Hawaii's population identifies as multiracial,[***] analyses were conducted with groups that were not mutually exclusive, including persons of one race alone or in combination with one or more races (*6*). Using this approach, persons of more than one race were counted multiple times, depending upon the number of race groups recorded. Thus, race categories (e.g., Native Hawaiian and Pacific Islander and Asian) and subcategories (e.g., Marshallese and Filipino) include persons with any mention of those races.

[§§] https://hawaiicovid19.com/wp-content/uploads/2021/03/COVID-19-Race-Ethnicity-Equity-Report.pdf

[¶¶] https://www.govinfo.gov/content/pkg/FR-1997-10-30/pdf/97-28653.pdf

[***] In 2019, 24.2% of Hawaii's population was multiracial, identifying as two or more races using OMB minimum race categories (https://census.hawaii.gov/wp-content/uploads/2020/06/Hawaii-Population-Characteristics-2019.pdf; (https://www.census.gov/prod/cen2010/briefs/c2010br-12.pdf). Using OMB minimum race categories, 19% of cases and 8% of deaths had two or more races indicated; when allowing for specific Native Hawaiian, Pacific Island, and Asian races, 21% of cases and 10% of deaths had two or more races indicated.

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Among 25,480 COVID-19 cases and 450 COVID-19–associated deaths reported in Hawaii during March 2020–February 2021, information on race was available for 21,005 (82%) patients and 449 (>99%) deaths. Information from these records was used to calculate incidence (cases per 100,000 population) and mortality (deaths per 100,000 population) and corresponding 95% confidence intervals (CIs) by population group. Population estimates were calculated using data from the U.S. Census Bureau.[†††] Analyses were conducted using SAS (version 9.4; SAS Institute). To maintain patient privacy, numbers of cases or deaths among racial groups were not reported when the number of cases or deaths was less than 10; rates were not calculated when less than 20 cases or deaths were reported. This public health surveillance activity was reviewed by HDOH and CDC and was conducted consistent with applicable state and federal law and CDC policy.[§§§,¶¶¶]

During March 1, 2020–February 28, 2021, in Hawaii the COVID-19 incidence was 1,477 per 100,000 population and mortality rate was 32 per 100,000 population (Table). In aggregated analyses of incidence, Native Hawaiian and Pacific Islander persons experienced the highest incidences (2,501) across the five minimum race categories. In disaggregated analyses, Pacific Islander persons, who account for 5% of Hawaii's population, represented 22% of cases. Pacific Islander persons had the highest COVID-19 incidence of 7,070; incidence among Native Hawaiian persons was 1,181. After further disaggregation, the highest incidence of cases among all Pacific Islander subcategories occurred among Marshallese persons (10,580), followed by Other Micronesian persons (8,991) and Samoan persons (4,525) (Figure). In disaggregated analyses of crude mortality, Pacific Islander persons experienced a crude mortality rate of 150 deaths per 100,000 population and accounted for 22% of deaths during this period. Mortality rate among Native Hawaiian persons was 15.

Among Asian persons, there was also substantial variation in incidence among subgroups after disaggregation (range = 568 to 1,247 cases per 100,000 population). The highest incidence of cases among Asian persons were among Filipino persons (1,247) and Vietnamese persons (1,200); incidence among Japanese persons was 568. Among Asian subcategories, crude mortality rates ranged from 20 deaths per 100,000 population among Chinese persons to 33 among Japanese persons.

Discussion

Disaggregation of COVID-19 data in Hawaii revealed substantial disparities in COVID-19 case and mortality rates during March 1, 2020–February 28, 2021, among Native Hawaiian, Pacific Islander, and Asian persons that were obscured in the aggregate data. Detailed information on disparities in COVID-19 cases and deaths among Marshallese persons has been reported (*2*,*8*); however, less information has been available regarding other Pacific Islander or Asian subgroups. These findings demonstrate the value of having access to disaggregated data at the state level to identify and reduce disparities and to provide relevant data to communities (*4*,*5*,*7*).

Collection of disaggregated surveillance data was recommended by local Native Hawaiian and Pacific Islander communities and grassroots groups early in the pandemic, resulting in the updating of the COVID-19 case report form by HDOH to collect these data. Patients with COVID-19 whose cases were reported before revision of the case report form were retrospectively contacted by HDOH staff members for detailed race information.[****] During periods of higher incidence, HDOH continued to prioritize obtaining important demographic information, including race, even when conducting abbreviated case interviews. Efforts were designed to achieve a balance between highlighting the concerns of specific populations and inadvertently contributing to the stigmatization of groups who have been marginalized and who experience racism.

Race can serve as a marker for underlying systemic and structural inequities that drive health disparities. The COVID-19 pandemic underscores the need to prevent and reduce inequities in the social determinants of health, access to health care, and health conditions (*8*,*9*). There are simultaneous needs for advancing cultural responsiveness, language access, and sensitivity in public health strategies for preventing COVID-19 among Native Hawaiian, Pacific Islander, and Asian subgroups.[††††] In Hawaii, disaggregation of COVID-19 surveillance data facilitated collaboration between HDOH and community partners equipped with culturally situated knowledge (*8*,*10*) to address disparities through tailored strategies.

[†††] Population estimates for "race alone and in combination with one or more other races" were from the U.S. Census Bureau's American Community Survey population estimates. https://www.census.gov/data/developers/data-sets/acs-5year.html

[§§§] https://health.hawaii.gov/docd/files/2017/01/HAR-Title-11_Chapter-156.pdf

[¶¶¶] 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.

[****] Case information was collected through three possible mechanisms including either a provider form (revised version https://health.hawaii.gov/docd/files/2020/01/COVID-19_Short-Form_Fillable_For_Physicians.pdf), case investigation form, or the HDOH case surveillance system (which uses the CDC Public Health Race Value set: https://phinvads.cdc.gov/vads/ViewValueSet.action?id=67D34BBC-617F-DD11-B38D-00188B398520). For the provider and case investigation forms, persons who provided Pacific Islander race or Other Asian race were given the opportunity to specify which specific Pacific Islander or Asian race with which they identified. Persons with race indicated as Pacific Islander or Filipino race were followed up with by the HDOH Pacific Islander Priority Investigations and Outreach Team.

[††††] https://www.federalregister.gov/documents/2021/01/29/2021-02073/condemning-and-combating-racism-xenophobia-and-intolerance-against-asian-americans-and-pacific?utm_medium

TABLE. Distribution of COVID-19 cases, incidence, deaths, and mortality rates, by race (alone or in combination with one or more other races)*,† — Hawaii, March 1, 2020–February 28, 2021

Race§	Population¶ (%)	No. of cases¶ (%)	Cases per 100,000 population (95% CI)	No. of deaths¶ (%)	Deaths per 100,000 population (95% CI)
All races	**1,422,094**	**21,005**	**1,477 (1,457–1,497)**	**449**	**32 (29–35)**
Native Hawaiian and Pacific Islander	369,956 (26)	9,253 (44)	2,501 (2,451–2,551)	145 (32)	39 (33–46)
Native Hawaiian**	304,167 (21)	3,591 (17)	1,181 (1,142–1,219)	45 (10)	15 (11–19)
Pacific Islander††,§§	65,789 (5)	4,651 (22)	7,070 (6,874–7,265)	99 (22)	150 (121–180)
Samoan	34,674 (2)	1,569 (7)	4,525 (4,306–4,744)	21 (5)	61 (35–87)
Tongan	7,855 (1)	190 (1)	2,419 (2,079–2,759)	<10¶¶ (<1)	—***
Other Polynesian	5,372 (<1)	54 (<1)	1,005 (739–1,272)	<10 (<1)	—
Guamanian or Chamorro	6,185 (<1)	59 (<1)	954 (712–1,196)	<10 (<1)	—
Marshallese	8,960 (1)	948 (5)	10,580 (9,944–11,217)	19 (4)	—
Other Micronesian	20,198 (1)	1,816 (9)	8,991 (8,597–9,386)	49 (11)	243 (175–310)
Fijian	816 (<1)	17 (<1)	—***	0 (—)	0 (—)
Other Melanesian	64 (<1)	<10 (<1)	—	0 (—)	0 (—)
Other Pacific Islander, not specified	3,725 (<1)	148 (1)	3,973 (3,346–4,600)	<10 (<1)	—
Asian†††	802,551 (56)	8,807 (42)	1,097 (1,075–1,120)	272 (61)	34 (30–38)
Japanese	310,397 (22)	1,762 (8)	568 (541–594)	101 (22)	33 (26–39)
Filipino	367,291 (26)	4,579 (22)	1,247 (1,211–1,283)	108 (24)	29 (24–35)
Chinese	205,126 (14)	1,448 (7)	706 (670–742)	42 (9)	20 (14–27)
Korean	52,410 (4)	339 (2)	647 (578–716)	14 (3)	—
Vietnamese	14,998 (1)	180 (1)	1,200 (1,026–1,374)	<10 (<1)	—
White	611,108 (43)	5,790 (28)	947 (923–972)	52 (12)	9 (6–11)
Black	50,593 (4)	702 (3)	1,388 (1,286–1,490)	<10 (<1)	—
American Indian or Alaska Native	34,512 (2)	203 (1)	588 (508–669)	<10 (<1)	—
Other race§§§	36,646 (3)	1,347 (6)	3,676 (3,483–3,868)	10 (2)	—

Abbreviations: CI = confidence interval; HDOH = Hawaii State Department of Health.

* Data analyzed included 21,005 (82%) of 25,480 cases and 449 (>99%) of 450 deaths, for whom information on race was available, reported to the HDOH during March 1, 2020–February 28, 2021. Incidence was calculated using the following equation: (cases/population) x 100,000 persons. Crude death rates were calculated using the following equation: (deaths/population) x 100,000 persons. 95% CIs were computed using normal approximation for standard errors for proportions. Population estimates were from the U.S. Census Bureau's American Community Survey population estimates.

† Data from race groups were examined without regard to ethnicity. Race information for cases was mostly self-reported; race information for deaths were reported by patients premortem, by an observer (e.g., physician), or by a proxy family member. Analyses were conducted with groups that were not mutually exclusive including persons of a race alone or in combination with one or more races. Using this approach, persons with more than one race indicated were included in the total of each race reported. Thus, all race categories (e.g., Asian) and subcategories (e.g., Filipino) consist of persons with any mention of those race categories or subcategories.

§ Alone or in combination with one or more races.

¶ Category values do not sum to the total count or percentage because categories represent persons of a race alone or in combination with one or more other races. Subcategory values do not sum to category values for the same reason.

** This category includes persons identified as Native Hawaiian alone or in combination with another race.

†† This category includes persons identified as Pacific Islander alone or in combination with another race (e.g., this can include persons identified with both the Native Hawaiian race and a non-Native Hawaiian and Pacific Islander race). This category was calculated by identifying the proportion of population, cases, and deaths that remained from the total Native Hawaiian and Pacific Islander population after considering Native Hawaiian single race data.

§§ Pacific Islander subcategories represent the populations among this group with the largest representation in Hawaii. Persons of more than one specific Pacific Islander race could be in more than one specific Pacific Islander race category. Pacific Islander persons with the Pacific Islander race category selected but who did not have a specific Pacific Islander race listed are included in the "Other Pacific Islander, not specified" category.

¶¶ <10 cases or deaths were reported; excludes zero. To maintain patient privacy, counts of cases or deaths among race groups were not reported when number of cases or deaths were <10.

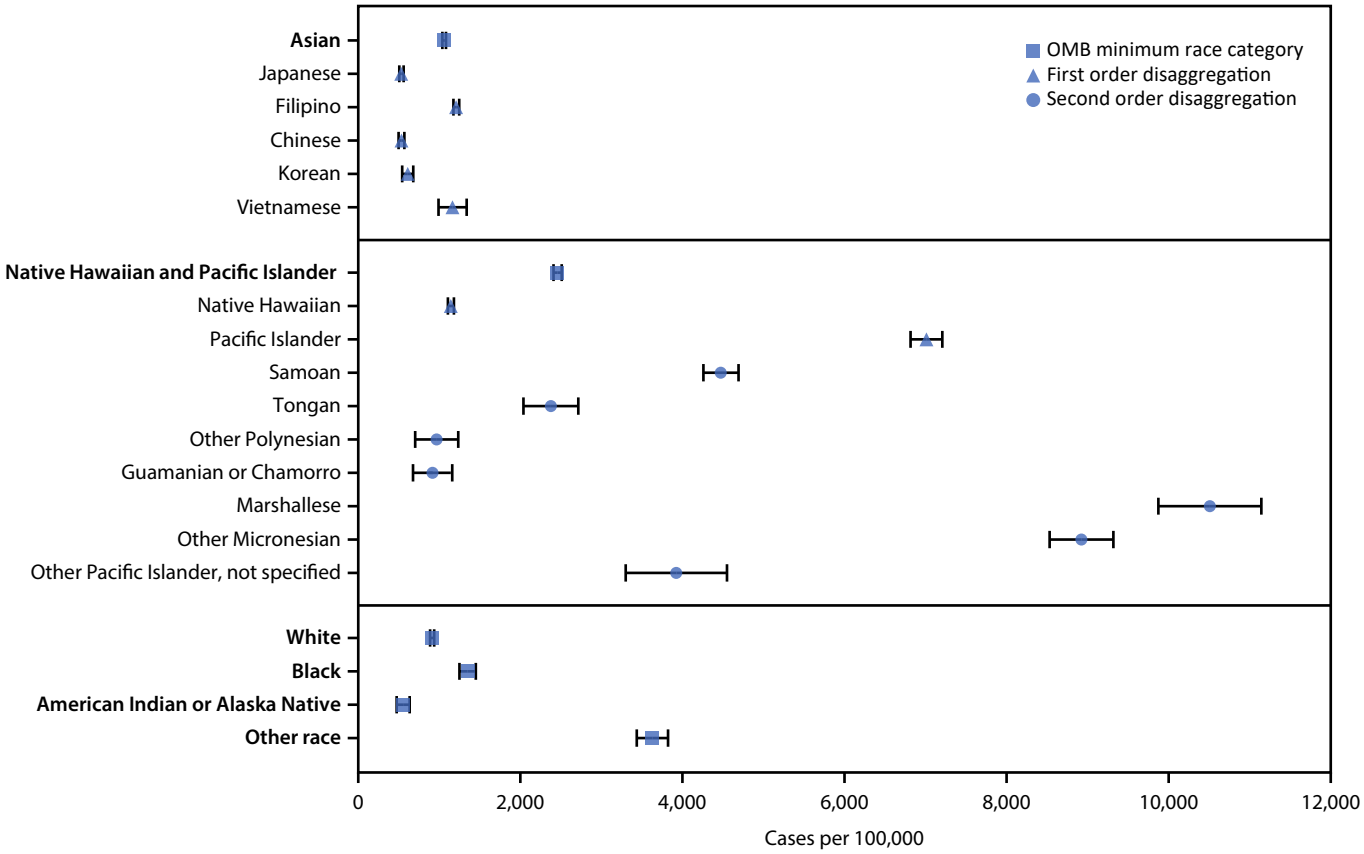
*** Dashes indicate that rates were not calculated where <20 cases or deaths were reported.

††† Asian subcategories represent the populations among this group with the largest representation in Hawaii.

§§§ Other race category includes persons with the "other" race category selected with no further specifications or with specified races that were not listed as a category (e.g., if a person had "Hispanic or Latino" indicated as their "race" or had written in a specific country).

HDOH created the Pacific Islander Priority Investigations and Outreach Team by engaging and training culturally responsive and linguistically diverse case investigators, contact tracers, and community health workers. The team includes staff members from the most affected Pacific Islander communities. This team provided translated prevention information, improved access to resources (e.g., isolation and quarantine facilities and comprehensive social services through community partners), and supported community outreach (e.g., providing interpretation assistance at testing sites). Prevention messaging incorporated cultural values and highlighted messages of protecting community; alternative strategies were encouraged for engaging in important cultural traditions and practices (e.g., cultivating collaborative partnerships to support virtual capacity for religious services). These efforts complemented efforts by

FIGURE. COVID-19 case rates,* by race (alone or in combination with one or more other races)†,§,¶ — Hawaii, March 1, 2020–February 28, 2021



Abbreviations: CI = confidence interval; OMB = Office of Management and Budget.

* Case rates were based on COVID-19 cases reported to the Hawaii State Department of Health during March 1, 2020–February 28, 2021 and were calculated as (cases/population) x 100,000. Population estimates were from the U.S. Census Bureau's American Community Survey population estimates. Data analyzed included 21,005 (82%) of 25,480 patients for whom information on race was available. Bars represent 95% CIs for the rates.

† Data from racial groups were examined without regard to ethnicity. Analyses were conducted with groups that were not mutually exclusive including persons of a race alone or in combination with one or more races; persons of more than one race were included in the total for each race reported. Asian, American Indian or Alaska Native, Black or African American, Native Hawaiian and Other Pacific Islander, and White represent the five minimum race categories required by the OMB. Samoan, Tongan, Other Polynesian, Guamanian or Chamorro, Marshallese, Other Micronesian, and Other Pacific Islander, not specified represent subcategories within the Pacific Islander category.

§ Square markers indicate Other race or OMB's five minimum race categories (American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, and White).

¶ Other race category includes persons with the "other" race category selected with no further specifications or with specified races that were not listed as a category (e.g., if a person had "Hispanic or Latino" indicated as their "race" or had written in a specific country).

advocate organizations and grassroots initiatives within Native Hawaiian, Pacific Islander, and Filipino communities.[§§§§]

The findings in this report are subject to at least six limitations. First, these data could underestimate COVID-19 case rates because of undetected cases and the exclusion of 18% of cases because data on race were missing. Second, case information was not available on characteristics such as occupation, income, and education, which can influence COVID-19 outcomes, and nativity and generational status, which might be associated with access to services and other social determinants of health. Third, the examination of disparities among specific combinations of categories (e.g., persons who are Samoan and White) was not possible because detailed U.S. Census data to calculate these rates were not available. Fourth, differences in the collection of race information between the case surveillance system and U.S. Census forms might have led to overestimation of rates among some race subgroups. For some races, race information was collected using explicit check-box options during case investigations, and in the U.S. Census, race information was collected through written-in free text that was

[§§§§] Advocate organizations and grassroots initiatives within Native Hawaiian, Pacific Islander, and Filipino communities included the Native Hawaiian and Pacific Islander Hawai'i COVID-19 Response Recovery and Resiliency Team. (https://www.nhpicovidhawaii.net/) and the FilCom CARES project (https://www.filcomcares.org), among others.

later coded.¶¶¶¶ This could potentially lead to the reduction of rate denominators among specific race groups. Fifth, age-adjustment or stratification of rates could not be conducted because of lack of age-specific U.S. Census population information and limited sample sizes among specific Native Hawaiian, Pacific Islander, and Asian subgroups. Data on comorbidities, such as obesity, were also not available, limiting the ability to control for medical conditions which might vary across racial groups. Inability to incorporate age and comorbidities in analysis of mortality data could potentially lead to under- or overestimation of disparities in mortality rates.***** Finally, the use of race groups that were not mutually exclusive might limit the ability to make direct comparisons between groups because multiracial persons could be counted in more than one race group. Nonetheless, the use of race groups that were not mutually exclusive is advantageous when analyzing data among multiracial persons.

Substantial disparities in COVID-19 incidence and mortality rates during March 1, 2020–February 28, 2021, were identified through community-informed data disaggregation among Native Hawaiian, Pacific Islander, and Asian subgroups in Hawaii. The disparities identified among Marshallese, Other Micronesian, Samoan, Filipino, and Vietnamese persons, which were obscured in aggregated analysis, highlight the importance of partnering with these populations to develop culturally responsive outreach teams and tailored public health interventions and vaccination campaigns to more effectively address health disparities.

¶¶¶¶ Specific Pacific Islander groups coded in the U.S. Census based on free-text responses are "Tongan," "Other Polynesian," "Marshallese," "Other Micronesian," "Fijian," and "Other Melanesian."

***** Unpublished analysis of COVID-19 mortality data from Hawaii suggests that age adjustment of mortality rates results in more pronounced disparities for COVID-19 mortality among populations with younger age distributions (e.g., Native Hawaiian and Pacific Islander persons) compared with populations with older age distributions (e.g., Japanese or White persons).

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Summary

What is already known about this topic?

Aggregated race data can obscure health disparities among subgroups.

What is added by this report?

During March 2020–February 2021, community-informed data disaggregation in Hawaii indicated Pacific Islander persons, who account for 5% of the Hawaiian population, represented 22% of COVID-19 cases and 22% of COVID-19–related deaths. Among Asian populations, the highest COVID-19 incidences occurred among Filipino and Vietnamese persons.

What are the implications for public health practice?

Disaggregating race data can aid in identifying racial disparities among specific subpopulations and highlights the importance of partnering with communities to develop culturally responsive outreach teams and tailored public health interventions and vaccination campaigns to more effectively address health disparities.

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Post-Acute Sequelae of SARS-CoV-2 Infection Among Adults Aged ≥18 Years — Long Beach, California, April 1–December 10, 2020

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Post-acute sequelae of COVID-19, also known as "long COVID," is used to describe the long-term symptoms that might be experienced weeks to months after primary infection with SARS-CoV-2, the virus that causes COVID-19. Among persons with a previous COVID-19 diagnosis, estimates of the prevalence of sequelae range from 5% among nonhospitalized persons to 80% among hospitalized persons (*1*,*2*). Studies have analyzed the aftereffects of COVID-19, but few have assessed the demographic characteristics associated with long COVID (*3*,*4*). Health disparities resulting from pervasive structural and socioeconomic barriers in the U.S. health care system might contribute to differences in these effects and might continue to exacerbate existing inequities (*5*). To identify trends in post-acute sequelae, the Long Beach Department of Health and Human Services (LBDHHS) interviewed a random sample of 366 persons aged ≥18 years who received a positive SARS-CoV-2 test result during April 1–December 10, 2020. One third of the persons interviewed reported having at least one symptom 2 months after their positive test result, with higher odds of sequelae among persons aged 40–54 years, females, and those with preexisting conditions. Black or African American (Black) participants had higher odds of reporting dyspnea and myalgia/arthralgia compared with other racial/ethnic groups. Persons who were aged ≥40 years, female, Black, or who reported known preexisting conditions also reported higher numbers of distinct sequelae. As the number of recovered COVID-19 patients increases, monitoring the prevalence of post-acute sequelae among larger cohorts in diverse populations will be necessary to understand and manage this condition. Identification of groups disproportionately affected by post-acute COVID-19 sequelae can help develop efforts to prioritize preventions and treatment strategies, including vaccination of groups at higher risk for these long-term sequelae, and access to testing and care for post-acute sequelae.

Data were collected by LBDHHS (California Code of Regulations, Title 17) under the authority of the Long Beach City Health Officer during case investigation and follow-up. Among 28,594 Long Beach residents aged ≥18 years who received a positive SARS-CoV-2 reverse transcription–polymerase chain reaction (RT-PCR) test result during April 1–December 10, 2020, approximately 3% (791) were randomly selected for follow-up interviews. Persons with an intellectual or developmental disability or who had died were excluded from the study. During the first round of sampling, 400 persons with positive test results during April 1–August 26, 2020 were randomly selected. Because of the winter surge in cases, a subsequent round of sampling was conducted during August 27–December 10, 2020, in which 391 persons were selected. The second round of sampling maintained the same proportion of selected persons to all confirmed cases as the first round. Overall, 366 (46.3%) of the 791 selected persons agreed to be interviewed. Participants were interviewed during October 1, 2020–March 3, 2021 by telephone at least 2 months after the positive test result (median = 202 days; range = 78–368 days) using a standardized survey instrument. Interviews were conducted in English, Spanish, or Khmer. Questions were adapted from the 30-item California Reportable Disease Information Exchange COVID-19 case investigation questionnaire. Interviewers recorded questionnaire responses in Veoci, a secured virtual emergency operation center software application.

Multivariable logistic regression was used to assess associations between symptoms experienced 2 months after receiving a positive test result and participant characteristics (demographics and preexisting conditions) by calculating adjusted odds ratios (aORs) for having any sequalae and each of the most common sequelae. Multivariable Poisson regression was used to assess adjusted incidence rate ratios (aIRRs) for the number of reported symptoms.[†] Racial and ethnic groups were combined, and persons identifying as both White and a racial minority group were categorized by their respective racial minority group. Because of limited availability of diagnostic and screening testing during the sampling phase, persons who experienced symptoms within 14 days before and 10 days after testing were classified as being symptomatic at the time of diagnosis.[§] Disease severity at diagnosis was classified according to the National Institutes of Health groupings as mild,

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[†] Multivariable Poisson regression was used to assess adjusted incidence rate ratios (aIRRs) of the number of reported symptoms experienced 2 months after receipt of a positive SARS-CoV-2 test result across participant characteristics. Model assumptions for Poisson regression were assessed. Because of overdispersion, a quasi-Poisson link function was applied; all other assumptions were met. Forward stepwise selection was used to identify confounding variables using significance level of $\alpha = 0.05$. Model selection was based upon minimizing the Akaike information criterion (an estimator of prediction error) as well as considering the public health significance of predictors with strong effect sizes.

[§] These cutoffs were determined based upon previous knowledge that persons infected with SARS-CoV-2 might yield a positive RT-PCR result 2 days before symptom onset and most persons receive negative test results 10–12 days after symptom onset.

moderate, or severe (*6*). Because small sample sizes precluded analysis of specific preexisting conditions, a yes/no variable was used to indicate any preexisting condition.[¶] Persons were given the opportunity to report symptoms not covered in the survey. Responses with related symptoms were combined for analysis.[**] All analyses were conducted in R (version 4.0.5; R Foundation); p-values <0.05 were considered statistically significant. Collection and analysis of human surveillance data fall under routine public health activities in the State of California and were exempt from Institutional Review Board review.

Among the 366 participants, the largest percentages were aged 25–39 years (144; 39%), female (207; 57%), and Hispanic/Latino (240; 66%) (Table 1). These were elevated relative to the general population because persons aged 25–39 years account for approximately 25% of the population, females for 50%, and Hispanic/Latino persons for 40%. Approximately one half (46%) of participants reported having a chronic preexisting condition before their COVID-19 diagnosis. Nineteen (5%) participants were hospitalized because of COVID-19. Participants reported an average of 5.26 symptoms (standard deviation [SD] = 3.82), and most (92.3%) experienced at least one symptom related to COVID-19 around the time of testing. Ageusia, parosmia/anosmia, myalgia/arthralgia, fatigue, and headache, were reported by 54.1%, 50.3%, 51.4%, 48.4%, and 46.4% of participants, respectively (Table 2). Two months after a positive SARS-CoV-2 test result, 128 (35.0%) participants reported an average of 1.30 (SD = 2.40) symptoms. Participants reported fatigue (16.9%), ageusia (12.8%), parosmia/anosmia (12.6%), dyspnea (12.8%), and myalgia/arthralgia (10.9%). The frequency of symptoms reported by persons 2 months after receiving a positive SARS-CoV-2 test result varied with the severity of illness at diagnosis; 55.5% reported severe/critical symptoms, 52.6% reported moderate symptoms, 29% reported mild symptoms, and 3.7% reported

[¶] Preexisting conditions measured in the questionnaire included diabetes, cardiovascular disease, hypertension, asthma, chronic lung disease, chronic kidney disease, chronic liver disease, stroke, neurologic or neurodevelopmental conditions, cancer, immunocompromising conditions, obesity, or history of smoking. Participants were allowed to report other preexisting conditions not directly assessed in the questionnaire. These included anxiety, depression, arthritis, allergies, hypothyroidism, chronic migraine headaches, fibromyalgia, and history of heart surgery.

[**] Responses related to joint pain (e.g., knee pain, joint pain, or bone aches) were categorized as arthralgia and grouped with myalgia for analysis. Responses related to alteration of sense of taste (ageusia) and changes in sense of smell (parosmia and anosmia) were grouped for analysis. Only symptoms reported by ≥40 participants were analyzed at the individual level.

TABLE 1. Characteristics of participants interviewed regarding sequelae after recovery from COVID-19 (N = 366) — Long Beach, California, April 1–December 10, 2020

Characteristic	No. (%)
Age group, yrs	
18–24	42 (11.5)
25–39	144 (39.3)
40–54	111 (30.3)
55–64	39 (10.7)
≥65	30 (8.2)
Sex	
Female	207 (56.6)
Male	158 (43.2)
Genderqueer/Nonbinary	1 (0.3)
Race/Ethnicity*	
Hispanic or Latino	240 (65.6)
White	51 (13.9)
Black or African American	31 (8.5)
Asian	27 (7.4)
Native Hawaiian or Other Pacific Islander	5 (1.4)
American Indian	1 (0.3)
Unknown	11 (3.0)
Hospitalized for COVID-19	
Yes	19 (5.2)
No	347 (94.8)
Chronic preexisting condition	
Yes	170 (46.4)
No	196 (53.6)

* Racial and ethnic groups were combined, and persons identifying as both White and a racial minority group were categorized with their respective racial minority group.

TABLE 2. Frequency of symptoms reported by recovered COVID-19 patients on date of COVID-19 testing, 1 and 2 months after the positive test result, and on the interview date (N = 366) — Long Beach, California, April 1–December 10, 2020

	Time relative to positive test date, no. (%)			
Symptom	Test date*	1 month after	2 months after	Interview date†
Any symptom	**338 (92.3)**	**175 (47.8)**	**128 (35.0)**	**115 (31.4)**
No. of symptoms, mean (SD)	**5.26 (3.82)**	**2.01 (2.98)**	**1.30 (2.40)**	**0.99 (2.04)**
Ageusia	198 (54.1)	84 (23.0)	47 (12.8)	33 (9.0)
Myalgia or arthralgia	188 (51.4)	62 (16.9)	40 (10.9)	30 (8.2)
Parosmia or anosmia	184 (50.3)	80 (21.9)	46 (12.6)	35 (9.6)
Fatigue	177 (48.4)	88 (24.0)	62 (16.9)	50 (13.7)
Headache	170 (46.4)	56 (15.3)	39 (10.7)	28 (7.7)
Cough	152 (41.5)	51 (13.9)	30 (8.2)	20 (5.5)
Chills or shivers	136 (37.2)	31 (8.5)	20 (5.5)	11 (3.0)
Fever	135 (36.9)	33 (9.0)	18 (4.9)	11 (3.0)
Dyspnea	115 (31.4)	65 (17.8)	47 (12.8)	38 (10.4)
Sore throat	96 (26.2)	28 (7.7)	13 (3.6)	7 (1.9)
Rhinorrhea	76 (20.8)	22 (6.0)	11 (3.0)	7 (1.9)
Diarrhea	73 (29.9)	18 (4.9)	11 (3.0)	7 (1.9)
Brain fog	67 (18.3)	36 (9.8)	28 (7.7)	26 (7.1)
Other	69 (18.9)	34 (9.3)	35 (9.6)	39 (10.7)
Nausea	62 (16.9)	16 (4.4)	12 (3.3)	8 (2.2)
Subjective fever	40 (10.9)	10 (2.7)	7 (1.9)	5 (1.4)
Abdominal pain	34 (9.3)	10 (2.7)	3 (0.8)	1 (0.3)
Vomiting	32 (8.7)	5 (1.4)	3 (0.8)	3 (0.8)
Rash/Skin abnormality	8 (2.2)	5 (1.4)	4 (1.1)	4 (1.1)
Blood clots	3 (0.8)	1 (0.3)	1 (0.3)	0 (—)
Did not recall	1 (0.3)	1 (0.3)	2 (0.5)	0 (—)

Abbreviations: RT-PCR = reverse transcription–polymerase chain reaction; SD = standard deviation.

* Symptoms experienced within 14 days before and 10 days after date of first positive test result were classified as related to COVID-19 diagnosis.

† Interview occurred a median of 202 days after collection of the specimen that yielded the RT-PCR result (range 78–368 days).

no symptoms (Supplementary Table 1, https://stacks.cdc.gov/view/cdc/109584). Nearly one third of participants (115; 31.4%) had symptoms at the time of interview; fatigue (50; 13.7%), dyspnea (38; 10.4%), and parosmia (35; 9.6%) were most frequently reported.

In the multivariate regression model, the odds of experiencing symptoms 2 months after a positive SARS-CoV-2 test result were significantly higher among females (aOR = 2.83), persons with at least one preexisting condition (aOR = 2.17), and those aged 40–54 years (versus 25–39 years) (aOR = 1.86) (Table 3). Analyses of the four most common symptoms experienced 2 months after a positive test result (fatigue, dyspnea, parosmia/ageusia, and myalgia/arthralgia) revealed similar findings in persons with at least one preexisting condition, females, and aged ≥40 years. (Supplementary Table 2, https://stacks.cdc.gov/view/cdc/109585). Females had higher adjusted odds of ageusia/parosmia/anosmia and fatigue than did males; whereas persons aged ≥40 years had higher adjusted odds of both, as well as myalgia/arthralgia, compared with persons aged 18–39 years. Persons with at least one preexisting condition had higher adjusted odds of all four of the most common symptoms compared with persons without preexisting conditions. Among Black persons compared with other racial/ethnic groups, the aORs of experiencing dyspnea and myalgia/arthralgia 2 months after testing were 2.52 and 3.67 times higher, respectively.

More symptoms were reported by females (aIRR = 2.13; 95% CI = 1.40–3.25), persons with preexisting conditions (aIRR = 1.96; 95% CI = 1.32–2.91), persons aged ≥40 years (aIRR = 1.73; 95% CI = 1.14–2.63), and Black persons (aIRR = 1.95; CI = 1.02–3.73) than by males, persons without preexisting conditions, persons aged 25–39 years, and non-Hispanic White persons (Table 3).

TABLE 3. Predictors associated with having any symptoms (logistic regression) and number of symptoms (quasi-Poisson regression) 2 months after COVID-19 diagnosis (N = 363)* — Long Beach, California, April 1–December 10, 2020

Characteristic	aOR/aIRR (95% CI)	P-value
Multivariable logistic regression model of predictors (aOR)		
Intercept¶	0.15 (0.09–0.27)	<0.001
Sex		
Female	2.83 (1.74–4.61)	<0.001
At least one preexisting condition	2.17 (1.35–3.5)	0.001
Age group, yrs		
18–24	0.66 (0.26–1.66)	0.38
25–39	Ref	—
40–54	1.86 (1.08–3.21)	0.03
55–64	1.57 (0.73–3.38)	0.24
≥65	1.47 (0.62–3.48)	0.38
Multivariable quasi-Poisson model of predictors (aIRR)		
Intercept†	0.41 (0.21–0.81)	0.01
Preexisting conditions	1.96 (1.32–2.91)	0.001
Age group, yrs		
18–24	0.73 (0.29–1.83)	0.50
25–39	Ref	—
≥40	1.73 (1.14–2.63)	0.01
Race/Ethnicity		
Asian	0.91 (0.41–2.04)	0.82
Black/African American	1.95 (1.02–3.73)	0.04
Hispanic/Latino	0.84 (0.49–1.43)	0.52
Grouped§	1.24 (0.51–3.01)	0.64
White	Ref	—
Sex		
Female	2.13 (1.40–3.25)	<0.001

Abbreviations: aIRR = adjusted incidence rate ratio; aOR = adjusted odds ratio; CI = confidence interval; Ref = referent group.

* Analysis excludes one person who identified as nonbinary and two persons with insufficient outcome data.

† The intercept represents the expected mean aOR if a person identifies with all referent groups (e.g., in the quasi-Poisson model, the intercept represents the expected mean aOR of White males aged 25–39 years without preexisting conditions).

§ Includes American Indian persons, Alaska Native persons, Asian persons, Native Hawaiian or Other Pacific Islander persons, and persons who did not identify a race.

Discussion

In this random sample of adults with a recent history of confirmed COVID-19, one third of participants reported post-acute sequelae 2 months after their SARS-CoV-2 positive test result, with higher odds among persons aged 40–54 years, females, and those with preexisting conditions. Persons aged ≥40 years, females, those with preexisting conditions, and Black persons also reported higher rates of post-acute sequelae. As the number of recovered COVID-19 patients increases, monitoring the prevalence of post-acute sequelae among larger cohorts in diverse populations is important because it can help develop efforts to prioritize prevention and treatment strategies for these populations.

These results are consistent with other published studies regarding age and female sex (*1*,*7*–*9*). Further, the associations between sequelae and preexisting conditions have also been reported by other investigators (*3*,*7*,*8*); however, few reports have assessed variations by race/ethnicity (*10*), which is important because of existing inequities that might lead to higher risk for SARS-CoV-2 exposure, lower access to care and testing, and differences in the prevalence of preexisting conditions in some racial and ethnic groups. The racial/ethnic variations observed in this study underscore the importance of continued efforts to reduce these inequities through prioritizing prevention and treatment strategies.

The findings in this report are subject to at least seven limitations. First, the results are based on a limited sample size, which resulted in large error estimates for some groups, especially for some racial/ethnic minority groups and for persons with certain preexisting conditions. Second, socioeconomic status, which was not assessed, might have resulted in unmeasured confounding away from the null. Third, it was not possible to attribute specific symptoms to SARS-CoV-2 infection,

Summary

What is already known about this topic?

The term "long COVID" is used to describe post-acute sequelae and long-term symptoms that can be experienced from weeks to months by persons recovering from COVID-19.

What is added by this report?

In a random sample of recovered COVID-19 patients in Long Beach, California, one third of participants reported post-acute sequelae 2 months after their positive test result, with higher rates reported among persons aged ≥40 years, females, persons with preexisting conditions, and Black persons.

What are the implications for public health practice?

Identification of populations disproportionately affected by COVID-19 and long COVID can help guide efforts to prioritize prevention and treatment.

and the symptom assessment period (from 14 days before to 10 days after testing) might have included symptoms present before SARS-CoV-2 infection. Fourth, reported symptoms might vary over time because of recall bias. Fifth, severity of symptoms and associated functional impairments were not assessed. Sixth, participation bias might be present because those still experiencing symptoms might be more likely to respond, and hospitalization rates in the sample were relatively low. Finally, because the COVID-19 death rate was higher among all minority groups than among non-Hispanic White persons in Long Beach (LBDHHS, Communicable Disease Control Program, unpublished data, 2020), and because persons who were incapacitated or who had died were excluded from the analysis, the results might be biased by survivorship and access to testing.

Identifying disparities in post-acute COVID-19 sequelae can help guide the allocation of public health resources and improve health equity while groups recover from the long-term effects of the COVID-19 pandemic. Ensuring equitable access to care for persons recovering from long-term sequelae, particularly for those at a higher risk for sequelae, is important. In addition, preventive measures including physical distancing, consistent mask use, vaccination, and outreach can be prioritized or promoted for groups at an increased risk for experiencing long-term sequelae. Further research, including research over longer periods, is warranted to evaluate potential gaps in access to resources and care for persons with long-term sequelae across diverse populations and to better understand the role of the health determinants that drive these disparities.

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Longitudinal Trends in Body Mass Index Before and During the COVID-19 Pandemic Among Persons Aged 2–19 Years — United States, 2018–2020

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Obesity is a serious health concern in the United States, affecting more than one in six children (*1*) and putting their long-term health and quality of life at risk.* During the COVID-19 pandemic, children and adolescents spent more time than usual away from structured school settings, and families who were already disproportionally affected by obesity risk factors might have had additional disruptions in income, food, and other social determinants of health.† As a result, children and adolescents might have experienced circumstances that accelerated weight gain, including increased stress, irregular mealtimes, less access to nutritious foods, increased screen time, and fewer opportunities for physical activity (e.g., no recreational sports) (*2*,*3*). CDC used data from IQVIA's Ambulatory Electronic Medical Records database to compare longitudinal trends in body mass index (BMI, kg/m^2) among a cohort of 432,302 persons aged 2–19 years before and during the COVID-19 pandemic (January 1, 2018–February 29, 2020 and March 1, 2020–November 30, 2020, respectively). Between the prepandemic and pandemic periods, the rate of BMI increase approximately doubled, from 0.052 (95% confidence interval [CI] = 0.051–0.052 to 0.100 (95% CI = 0.098–0.101) kg/m^2/month (ratio = 1.93 [95% CI = 1.90–1.96]). Persons aged 2–19 years with overweight or obesity during the prepandemic period experienced significantly higher rates of BMI increase during the pandemic period than did those with healthy weight. These findings underscore the importance of efforts to prevent excess weight gain during and following the COVID-19 pandemic, as well as during future public health emergencies, including increased access to efforts that promote healthy behaviors. These efforts could include screening by health care providers for BMI, food security, and social determinants of health, increased access to evidence-based pediatric weight management programs and food assistance resources, and state, community, and school resources to facilitate healthy eating, physical activity, and chronic disease prevention.

Data were obtained from IQVIA's Ambulatory Electronic Medical Records database,§ which contains deidentified information recorded during outpatient encounters for a geographically diverse U.S. patient population. BMI was calculated from height and weight measurements¶ and categorized based on sex-specific CDC BMI-for-age percentiles.** To be included, persons had to be aged 2–19 years at their initial BMI measurement and have two or more BMI measurements before the COVID-19 pandemic (with at least one during the year immediately preceding the pandemic, March 1, 2019–February 29, 2020) and one or more BMI measurements after the initial 3 months of the pandemic (June 1, 2020–November 30, 2020).†† The longitudinal cohort included 432,302 persons who had a total of 2.5 million BMI measurements collected from January 1, 2018 through November 30, 2020.

Linear mixed-effects regression models were used to examine differences in the average monthly rate of change in BMI before and during the COVID-19 pandemic. Models accounted for all BMI measurements for each child during the study period and included random intercepts to account for individual-level heterogeneity. Models included a linear time trend (from the start of the pandemic on March 1, 2020), a dichotomous variable designating BMI measurements to the period before or after the start of the pandemic on March 1, 2020, the interaction between the linear time trend and pandemic variable, sex (male or female), age (on March 1, 2020), race and ethnicity (White, Black, Asian, Hispanic, other, or unknown), and initial BMI category (underweight, healthy weight, overweight, moderate obesity, or severe obesity). Models were run on the full cohort and stratified by age group during the pandemic (3–5, 6–11, 12–17, and 18–20 years). Models were also calculated

* https://www.cdc.gov/obesity/childhood/causes.html

† https://www.cdc.gov/socialdeterminants/about.html

§ Version 5, November 2020 data release. IQVIA's Ambulatory Electronic Medical Records database includes data for approximately 74 million persons from all 50 states treated by approximately 100,000 health care providers who are affiliated with approximately 800 ambulatory sites across the United States. The data set contains key clinical variables, including laboratory values, patient vitals, health behaviors, diagnoses, and procedures. All data were extracted using the E360 Software-as-a-Service Platform. https://www.iqvia.com/solutions/real-world-evidence/platforms/e360-real-world-data-platform

¶ Measured height and weight data during January 1, 2018–November 30, 2020 for persons aged 2–20 years in IQVIA were cleaned using growthcleanr (https://github.com/carriedaymont/growthcleanr), an open-source R package for cleaning pediatric growth data. Height and weight values were included if they were measured within 30 days of each other, resulting in data for 3,571,971 persons.

** CDC BMI-for-age percentiles were defined as underweight (<5th percentile), healthy weight (≥5th to <85th percentile), overweight (≥85th to <95th percentile), moderate obesity (≥95th percentile to <120% of the 95th percentile), and severe obesity (≥120% of the 95th percentile). https://www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi.html

†† BMI measurements taken during the initial 3 months of the COVID-19 pandemic (March–May 2020) were included in the mixed effects models, as were all BMI measurements for the 432,302 persons in the longitudinal cohort; however, these measurements were not used to define cohort selection criteria. For example, if a child had a BMI measurement in March 2020, they had to have one in June–November 2020 to meet the "pandemic" BMI selection criterion and be cohort-eligible.

with weight change (pounds per month) and obesity status (BMI ≥95th percentile) as the outcomes.[§§]

To determine changes between the prepandemic and pandemic periods, CDC calculated rate differences as the pandemic slope minus prepandemic slope and rate ratios as the pandemic slope divided by prepandemic slope. Data were analyzed using SAS (version 9.4; SAS Institute Inc.) and Stata (version 15.1; StataCorp); statistical significance was defined as p<0.05. This activity was reviewed by CDC and conducted consistent with applicable federal law and CDC policy.[¶¶]

Among 432,302 persons aged 2–19 years in the longitudinal cohort, 50.7% were male and 65.7% were White (Table 1). The cohort included 45.7% persons from the South, 21.2% from the Midwest, 19.0% from the West, and 14.0% from the Northeast U.S. Census regions.[***] Based on initial BMI, obesity prevalence was 16.1%, including 4.8%with severe obesity. Overall, the monthly rate of BMI increase nearly doubled during the COVID-19 pandemic period compared with that during the prepandemic period (0.100 versus 0.052 kg/m^2; ratio = 1.93) (Table 2). Similarly, the rate of change in the proportion of persons with obesity was 5.3 times as high during the pandemic (0.37 percentage points per month) than before the pandemic (0.07); for example, in this cohort, the estimated proportion of persons aged 2–19 years with obesity was 19.3% (95% CI = 19.1–19.4) in August 2019 and 22.4% (95% CI = 22.3–22.6) in August 2020.

Persons aged 2–19 years in all BMI categories except underweight experienced significant increases in their rate of BMI change during the pandemic (Table 2). Among persons with overweight, moderate obesity, and severe obesity, pandemic rates of BMI increase more than doubled, compared with prepandemic rates (ratios = 2.13, 2.34, and 2.00; differences = 0.06, 0.09, and 0.09, respectively); similar effects were observed for weight change. In contrast, those with healthy weight had a rate of BMI change that increased 0.03 kg/m^2/month during the pandemic (ratio = 1.78).

Compared with other age groups, children aged 6–11 years experienced the largest increase in their rate of BMI change (0.09 kg/m^2/month), with a pandemic rate of change that was 2.50 times as high as the prepandemic rate. Age-stratified analyses revealed that among children aged 3–5 and 6–11 years, the difference in the rate of BMI change increased with increasing BMI category. For example, among children aged 3–5 years,

[§§] The model with weight (pounds per month) as the outcome included height (inches) and height squared as additional covariates. The model with obesity status as the outcome was a generalized linear model with Poisson distribution and log link function.

[¶¶] 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. Sect. 3501 et seq.

[***] IQVIA geographic regions align with U.S. Census regions. https://www.census.gov/prod/1/gen/95statab/preface.pdf

TABLE 1. Characteristics of the longitudinal cohort* of persons aged 2–20 years (N = 432,302) and those with at least one body mass index measurement in the year preceding the COVID-19 pandemic but not during the pandemic — IQVIA Ambulatory Electronic Medical Records Database, United States, January 2018–November 2020

Characteristic	No. (%)	
	Persons aged 2–20 years in the IQVIA longitudinal cohort*	Persons aged 2–20 years in the IQVIA database with ≥1 BMI measurement in the year preceding but not during the pandemic
Total	**432,302 (100.0)**	**1,419,796 (100.0)**
Sex		
Female	213,303 (49.3)	717,568 (50.5)
Male	218,999 (50.7)	702,228 (49.5)
Race/Ethnicity[†]		
White	283,915 (65.7)	840,906 (59.2)
Black	41,466 (9.6)	135,758 (9.6)
Asian	12,427 (2.9)	39,186 (2.8)
Hispanic	4,203 (1.0)	18,001 (1.3)
Unknown	72,010 (16.7)	325,809 (22.9)
Other	18,281 (4.2)	60,136 (4.2)
Age group, yrs[§]		
2–5	106,944 (24.7)	284,872 (20.1)
6–11	155,389 (35.9)	407,720 (28.7)
12–17	144,302 (33.4)	487,031 (34.3)
18–20	25,667 (5.9)	240,173 (16.9)
Initial BMI category[¶]		
Underweight	18,293 (4.2)	58,801 (4.1)
Healthy weight	279,351 (64.6)	877,775 (61.8)
Overweight	65,281 (15.1)	221,749 (15.6)
Obesity	69,377 (16.0)	261,471 (18.4)
Moderate	48,715 (11.3)	172,206 (12.1)
Severe	20,662 (4.8)	89,265 (6.3)
Geographic region[,††]**		
South	197,639 (45.7)	696,998 (49.1)
Northeast	60,677 (14.0)	158,036 (11.1)
Midwest	91,704 (21.2)	275,896 (19.4)
West	82,173 (19.0)	288,244 (20.3)

Abbreviation: BMI = body mass index.

* The longitudinal cohort included persons aged 2–19 years at initial BMI measurement, with ≥2 BMI measurements before the pandemic (with ≥1 measurement during the year immediately preceding the pandemic) and ≥1 BMI measurement after the initial 3 months of the pandemic.

† Race and ethnicity categories are mutually exclusive. IQVIA's Ambulatory Electronic Medical Records database lacks additional information on race and ethnicity because of information being optionally reported in a single composite variable in the electronic health record.

§ Based on age in years on March 1, 2020 (the start of the COVID-19 pandemic period for this analysis). Patients were aged 2–19 years at their initial BMI measurement and aged 3–20 years by March 1, 2020.

¶ Based on initial BMI measurement. BMI categories were defined as underweight (<5th percentile), healthy weight (≥5th to <85th percentile), overweight (≥85th to <95th percentile), moderate obesity (≥95th percentile to <120% of the 95th percentile), and severe obesity (≥120% of the 95th percentile). Moderate obesity and severe obesity are mutually exclusive.

** A total of 109 persons in the longitudinal cohort and 622 persons with one or more BMI measurements in the year preceding but not during the pandemic were missing information on geographic region.

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

TABLE 2. Monthly rate of change in the body mass index and weight of persons aged 2–19 years before and during the COVID-19 pandemic, overall and by body mass index category and age group — IQVIA Ambulatory Electronic Medical Records Database, United States, January 2018–November 2020

	Prepandemic	Pandemic	Pandemic versus prepandemic	
Characteristic	Slope* (95% CI)	Slope (95% CI)	Difference† (95% CI)	Ratio§ (95% CI)
BMI (kg/m2)				
Overall	**0.052 (0.051 to 0.052)**	**0.100 (0.098 to 0.101)**	**0.05 (0.05 to 0.05)**	**1.93 (1.90 to 1.96)**
Initial BMI category¶				
Underweight	0.046 (0.044 to 0.047)	0.051 (0.044 to 0.058)	0.01 (0.00 to 0.01)	1.12 (0.96 to 1.28)
Healthy weight	0.044 (0.044 to 0.044)	0.078 (0.076 to 0.080)	0.03 (0.03 to 0.04)	1.78 (1.73 to 1.82)
Overweight	0.057 (0.056 to 0.058)	0.121 (0.117 to 0.125)	0.06 (0.06 to 0.07)	2.13 (2.06 to 2.20)
Moderate obesity	0.070 (0.069 to 0.071)	0.164 (0.160 to 0.168)	0.09 (0.09 to 0.10)	2.34 (2.28 to 2.40)
Severe obesity	0.089 (0.088 to 0.090)	0.179 (0.173 to 0.185)	0.09 (0.08 to 0.10)	2.00 (1.93 to 2.07)
Age group, yrs**				
3–5	−0.002 (−0.003 to −0.002)	0.040 (0.037 to 0.043)	0.04 (0.04 to 0.05)	—††
6–11	0.059 (0.059 to 0.060)	0.148 (0.145 to 0.150)	0.09 (0.09 to 0.09)	2.50 (2.45 to 2.54)
12–17	0.072 (0.071 to 0.072)	0.106 (0.104 to 0.109)	0.03 (0.03 to 0.04)	1.48 (1.44 to 1.51)
18–20	0.045 (0.044 to 0.046)	0.032 (0.027 to 0.037)	−0.01 (−0.02 to −0.01)	0.70 (0.59 to 0.82)
Weight, lbs				
Overall	**0.356 (0.354 to 0.358)**	**0.595 (0.588 to 0.603)**	**0.24 (0.23 to 0.25)**	**1.67 (1.65 to 1.69)**
Initial BMI category				
Underweight	0.212 (0.205 to 0.218)	0.289 (0.252 to 0.325)	0.08 (0.04 to 0.11)	1.36 (1.19 to 1.54)
Healthy weight	0.282 (0.280 to 0.284)	0.447 (0.438 to 0.457)	0.17 (0.16 to 0.18)	1.59 (1.55 to 1.62)
Overweight	0.409 (0.405 to 0.412)	0.725 (0.706 to 0.744)	0.32 (0.30 to 0.34)	1.78 (1.73 to 1.82)
Moderate obesity	0.544 (0.541 to 0.548)	1.010 (0.989 to 1.032)	0.47 (0.44 to 0.49)	1.86 (1.81 to 1.90)
Severe obesity	0.736 (0.730 to 0.741)	1.217 (1.187 to 1.248)	0.48 (0.45 to 0.51)	1.65 (1.61 to 1.70)
Age group, yrs				
3–5	0.379 (0.374 to 0.383)	0.469 (0.453 to 0.485)	0.09 (0.07 to 0.11)	1.24 (1.20 to 1.28)
6–11	0.365 (0.362 to 0.367)	0.737 (0.724 to 0.750)	0.37 (0.36 to 0.39)	2.02 (1.98 to 2.06)
12–17	0.393 (0.391 to 0.396)	0.623 (0.609 to 0.636)	0.23 (0.22 to 0.24)	1.58 (1.55 to 1.62)
18–20	0.277 (0.272 to 0.282)	0.202 (0.174 to 0.229)	−0.08 (−0.10 to −0.05)	0.73 (0.63 to 0.83)

Abbreviations: BMI = body mass index; CI = confidence interval.

* Measured in kg/m^2/month for BMI analysis, pounds per month for weight analysis.

† Calculated as the pandemic slope minus prepandemic slope. Units are kg/m^2/month; 95% CIs for differences that exclude the null value of 0 are statistically significant.

§ Calculated as the pandemic slope divided by prepandemic slope; 95% CIs for ratios that exclude the null value of 1 are statistically significant.

¶ Based on initial BMI measurement. BMI categories were defined as underweight (<5th percentile), healthy weight (≥5th to <85th percentile), overweight (≥85th to <95th percentile), moderate obesity (≥95th percentile to <120% of the 95th percentile), and severe obesity (≥120% of the 95th percentile). Mixed-effects model included sex, race and ethnicity, age in years on March 1, 2020, and threeway interaction among linear time trend, pandemic indicator variable, and BMI category. Model for weight in pounds also included height in inches and height squared.

** Based on age in years on March 1, 2020, which was the start of the COVID-19 pandemic for this analysis. Persons were aged 2–19 years at their initial BMI measurement and aged 3–20 years by March 1, 2020. Mixed-effects model included sex, race and ethnicity, age in years on March 1, 2020, initial BMI category, and threeway interaction among linear time trend, pandemic indicator variable, and age group. Model for weight in pounds also included height in inches and height squared.

†† Ratio was not calculated because of a prepandemic slope that was very close to zero and slightly negative.

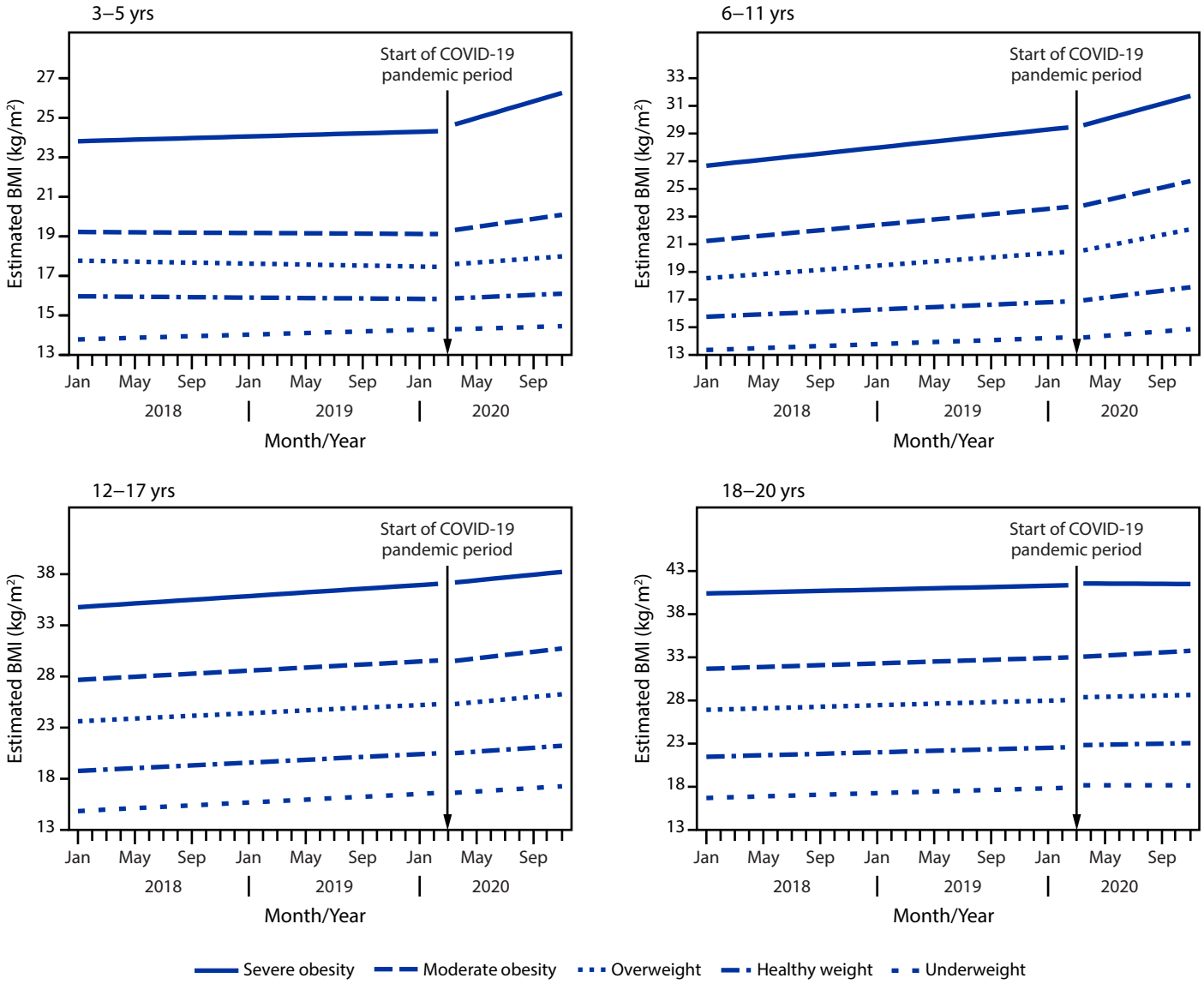
those with healthy weight had an increase in their rate of BMI change of 0.03 kg/m^2/month, whereas those with overweight, moderate obesity, or severe obesity had increases of 0.06, 0.10, and 0.18 kg/m^2/month, respectively (Figure).

Discussion

In a longitudinal cohort of 432,302 persons aged 2–19 years with outpatient visits, the monthly rate of increase in BMI nearly doubled during the COVID-19 pandemic compared with a prepandemic period. The estimated proportion of persons aged 2–19 years with obesity in this care-seeking cohort also increased during the pandemic; for example, 19.3% of persons had obesity in August 2019 compared with 22.4% 1 year later. These findings are consistent with a recent study of Kaiser Permanente data that reported significant weight gain and increased obesity prevalence during the pandemic among children and adolescents aged 5–17 years in Southern California (*4*). The present study is the largest and first geographically diverse analysis to assess the association of the COVID-19 pandemic with BMI and the first to show results by initial BMI category.

Persons aged 2–19 years with moderate or severe obesity before the pandemic experienced significantly higher rates of increase in BMI, which translates to weight gain, compared with those with prepandemic healthy weight. During March–November 2020, persons with moderate or severe obesity gained on average 1.0 and 1.2 pounds per month, respectively. Weight gain at this rate over 6 months is estimated to result in

FIGURE. Estimated body mass index before and during the COVID-19 pandemic, by initial body mass index category, stratified by age group — IQVIA Ambulatory Electronic Medical Records Database, United States, January 1–November 30, 2020



Abbreviation: BMI = body mass index.

6.1 and 7.6 pounds, respectively, compared with 2.7 pounds in a person with healthy weight. Accelerated weight gain, especially among children with overweight or obesity, can cause long-lasting metabolic changes that put children at risk for serious and costly co-occurring conditions, such as type 2 diabetes, hypertension, and depression (*5*,*6*).

In response to pandemic-related concerns and because of the critical role that pediatricians serve in maintenance of healthy child weight (*7*), the American Academy of Pediatrics recommended that pediatricians assess all children for the onset of obesity-related risk factors during the pandemic and provide tailored counseling, including screening for patient and family stress, disordered eating, and social determinants of health.[†††] The large increases in BMI and weight detailed in this report provide additional support for the need for such comprehensive screening and counseling.

Consistent with previous studies (*4*,*8*), this analysis found that preschool and school-aged children, particularly those with obesity, had larger pandemic-associated increases in BMI than did adolescents. During the pandemic, many early child

[†††] https://www.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/clinical-guidance/obesity-management-and-treatment-during-covid-19/

Summary

What is already known about this topic?

The COVID-19 pandemic led to school closures, disrupted routines, increased stress, and less opportunity for physical activity and proper nutrition, leading to weight gain among children and adolescents.

What is added by this report?

Among a cohort of 432,302 persons aged 2–19 years, the rate of body mass index (BMI) increase approximately doubled during the pandemic compared to a prepandemic period. Persons with prepandemic overweight or obesity and younger school-aged children experienced the largest increases.

What are the implications for public health practice?

Obesity prevention and management efforts during and following the COVID-19 pandemic could include health care provider screening for BMI, food security, and social determinants of health, and increased access to evidence-based pediatric weight management programs and food assistance resources.

care and education settings[§§§] and schools[¶¶¶] experienced closures, leading to online or hybrid learning environments. This might have reduced the ability for some children to engage in structured physical activity and receive healthy meals. As venues serving youth reopen, it is important to acknowledge the potential indirect consequences of the pandemic and provide children, adolescents, and families with ample opportunities for proper nutrition and regular physical activity.

The findings in this report are subject to at least five limitations. First, although the longitudinal cohort included a geographically diverse sample of persons with clinically measured BMI data, IQVIA data are not nationally representative; this analysis should be replicated with other data sets, particularly those that are population-based. Second, IQVIA lacks detailed data on race and ethnicity because information was optionally reported in a single composite variable; therefore, ability to assess outcomes by racial and ethnic subpopulations was limited. Third, the number of health care visits with measured BMI was substantially lower during the beginning of the pandemic (March–May 2020) than during comparable months in 2018 and 2019, suggesting potential selection bias for persons who sought health care in 2020; to minimize bias, persons were required to have a BMI measurement during June–November 2020, when health care–seeking behavior began to normalize, to be included in the cohort. Fourth, the observed associations might represent an over- or underestimation if persons who gained weight during the pandemic were more or less likely to see a doctor because of health status or social determinants of health, such as access to care. Finally, the findings could be attributed to other factors that coincided with the pandemic dates selected for this study.

In this large, longitudinal cohort of persons aged 2–19 years, sharp increases in BMI rates occurred during the COVID-19 pandemic; those with overweight or obesity and younger school-aged children experienced the largest increases. These findings underscore the importance of obesity prevention and management efforts during and following the COVID-19 pandemic, as well as during future public health emergencies, including increased access to efforts that promote healthy behaviors. These efforts could include screening for BMI, food security, and other social determinants of health by health care providers; increased access to evidence-based pediatric weight management programs and food assistance resources; and state, community, and school efforts to facilitate healthy eating, physical activity, and chronic disease prevention.[****]

[§§§] https://www.cdc.gov/obesity/strategies/childcareece.html
[¶¶¶] https://www.cdc.gov/healthyschools/index.htm

[****] https://www.cdc.gov/nccdphp/dnpao/state-local-programs/index.html

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Monitoring Incidence of COVID-19 Cases, Hospitalizations, and Deaths, by Vaccination Status — 13 U.S. Jurisdictions, April 4–July 17, 2021

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COVID-19 vaccine breakthrough infection surveillance helps monitor trends in disease incidence and severe outcomes in fully vaccinated persons, including the impact of the highly transmissible B.1.617.2 (Delta) variant of SARS-CoV-2, the virus that causes COVID-19. Reported COVID-19 cases, hospitalizations, and deaths occurring among persons aged ≥18 years during April 4–July 17, 2021, were analyzed by vaccination status across 13 U.S. jurisdictions that routinely linked case surveillance and immunization registry data. Averaged weekly, age-standardized incidence rate ratios (IRRs) for cases among persons who were not fully vaccinated compared with those among fully vaccinated persons decreased from 11.1 (95% confidence interval [CI] = 7.8–15.8) to 4.6 (95% CI = 2.5–8.5) between two periods when prevalence of the Delta variant was lower (<50% of sequenced isolates; April 4–June 19) and higher (≥50%; June 20–July 17), and IRRs for hospitalizations and deaths decreased between the same two periods, from 13.3 (95% CI = 11.3–15.6) to 10.4 (95% CI = 8.1–13.3) and from 16.6 (95% CI = 13.5–20.4) to 11.3 (95% CI = 9.1–13.9). Findings were consistent with a potential decline in vaccine protection against confirmed SARS-CoV-2 infection and continued strong protection against COVID-19–associated hospitalization and death. Getting vaccinated protects against severe illness from COVID-19, including the Delta variant, and monitoring COVID-19 incidence by vaccination status might provide early signals of changes in vaccine-related protection that can be confirmed through well-controlled vaccine effectiveness (VE) studies.

Two surveillance indicators that potentially can be used to monitor and describe vaccine breakthrough COVID-19 cases and severe outcomes are the percentage of vaccinated persons among cases (PVC) and an IRR between unvaccinated and vaccinated patients. PVC increases with increasing vaccination coverage or decreasing VE (*1*,*2*), complicating interpretation of this metric. IRRs are more stable, directly related to VE, and easier to communicate publicly in terms of vaccine impact (*2*). Most jurisdictions focus on assessing COVID-19 outcomes in fully vaccinated persons (≥14 days after completion of all recommended doses of an FDA-authorized COVID-19 vaccine) and have readily implemented comparisons to not fully vaccinated persons, including persons who are partially vaccinated (<14 days since completing the primary series or did not complete the series) or unvaccinated (did not receive any COVID-19 vaccine); some jurisdictions also monitor trends in partially vaccinated persons.

Aggregate weekly numbers of COVID-19 cases and COVID-19–associated hospitalizations and deaths among persons aged ≥18 years with specimen collection dates during April 4–July 17, 2021, were analyzed by age group (18–49, 50–64, and ≥65 years) and vaccination status across 13 public health jurisdictions.* All participating jurisdictions had established processes for linking case surveillance and vaccination data from state/local immunization registries; this method usually assumes that cases among persons not matched to the registry are among unvaccinated persons. Eleven jurisdictions provided hospitalization data, and all submitted mortality data. Standard definitions were used for 1) COVID-19 cases,†

* Alabama, Arizona, Colorado, Indiana, Los Angeles County (California), Louisiana, Maryland, Minnesota, New Mexico, New York City (New York), North Carolina, Seattle/King County (Washington), and Utah. Portions of the population in Colorado (49%), Minnesota (55%), New Mexico (61%), and Utah (35%) and the whole population of Maryland are included as part of the COVID-19–Associated Hospitalization Surveillance Network (COVID-NET). https://www.cdc.gov/coronavirus/2019-ncov/covid-data/covid-net/purpose-methods.html

† A COVID-19 case (confirmed or probable) was defined as the detection of SARS-CoV-2 RNA or antigen in a respiratory specimen collected from a person aged ≥18 years per the Council of State and Territorial Epidemiologists' update to the standardized surveillance case definition and national notification for 2019 novel coronavirus disease (COVID-19) (21-ID-01): https://cdn.ymaws.com/www.cste.org/resource/resmgr/ps/ps2021/21-ID-01_COVID-19.pdf. Known cases of SARS-CoV-2 reinfection were excluded.

2) COVID-19 cases in fully vaccinated or not fully vaccinated persons,[§] 3) COVID-19–associated hospitalizations,[¶] and 4) COVID-19–associated deaths,[**] with specimen collection dates used as time points.

Two analysis periods, April 4–June 19 and June 20–July 17, were designated, based on weeks with <50% or ≥50% weighted prevalence of the SARS-CoV-2 Delta variant for the 13 jurisdictions.[††] The percentages of total cases, hospitalizations, and deaths by vaccination status were calculated for each period and age group. The expected PVC was assessed using the formula: PVC = [PPV–(PPV*VE)]/[1–(PPV*VE)], where PPV is the proportion of the population vaccinated, or vaccination coverage (*1*). PVC was calculated using VE estimates of 80%, 90%, and 95%. Vaccination coverage was estimated by age group using the sum of fully vaccinated persons divided by the 2019 U.S. intercensal population estimates.[§§] Weekly age-specific incidences by vaccination status were calculated as the number of cases, hospitalizations, or deaths divided by the number of persons either fully vaccinated or not fully vaccinated (obtained by subtracting the number of fully vaccinated persons from total population estimates). Average weekly incidence in each period was age standardized using the 2000 U.S. Census standard population.[¶¶] IRRs were calculated by dividing the incidence among persons not fully vaccinated by that among fully vaccinated persons; 95% CIs were calculated to account for variation in weekly rates. To aid interpretation of changes in IRRs, age-standardized crude VE was estimated as (1 – [incidence in vaccinated/incidence in unvaccinated]). A sensitivity analysis examined the impact of excluding partially vaccinated persons from IRRs using data available from nine jurisdictions. SAS (version 9.4; SAS Institute) and R (version 4.0.3; R Foundation) were used to conduct all analyses. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[***]

During April 4–July 17, a total of 569,142 (92%) COVID-19 cases, 34,972 (92%) hospitalizations, and 6,132 (91%) COVID-19–associated deaths were reported among persons not fully vaccinated, and 46,312 (8%) cases, 2,976 (8%) hospitalizations, and 616 (9%) deaths were reported among fully vaccinated persons in the 13 jurisdictions (Table). The weekly prevalence of the SARS-CoV-2 Delta variant increased from <1% to 90% during April 4–July 17. Full vaccination coverage increased from 19% to 54%; in the final week, coverage ranged by age group from 45% (in persons aged 18–49 years) to 73% (≥65 years).

During April 4–June 19, fully vaccinated persons accounted for 5% of cases, 7% of hospitalizations, and 8% of deaths overall; these percentages were higher during June 20–July 17 (18%, 14%, and 16%, respectively). Using the reported 37% vaccination coverage for the 13 jurisdictions during April 4–June 19 and an assumption of 90% VE, vaccinated persons would have been expected to account for 6% of cases (close to the 5% observed). With 53% coverage reported during June 20–July 17, vaccinated persons were expected to account for 10% of cases at a constant VE of 90%; the observed 18% would have been expected at a lower VE of 80%.

Averaged weekly, age-standardized rates (events per 100,000 persons) were higher among persons not fully vaccinated than among fully vaccinated persons for reported cases (112.3 versus 10.1), hospitalizations (9.1 versus 0.7), and deaths (1.6 versus 0.1) during April 4–June 19, as well as during June 20–July 17

[§] A COVID-19 case in a fully vaccinated person (i.e., a breakthrough infection) occurred ≥14 days after completion of the primary series of a COVID-19 vaccine with Food and Drug Administration emergency use authorization per CDC's definition of a fully vaccinated person (https://www.cdc.gov/coronavirus/2019-ncov/vaccines/fully-vaccinated-guidance.html). Fully vaccinated persons were those who received a Pfizer-BioNTech or Moderna mRNA vaccine (92%) or the Janssen (Johnson & Johnson) vaccine (8%). A COVID-19 case in a person who was not fully vaccinated occurred when the person did not receive an FDA-authorized COVID-19 vaccine or received less than a complete primary series or if <14 days had elapsed since completing a primary series of an FDA-authorized vaccine before the specimen collection date. This analysis represents the combined impact of the Pfizer-BioNTech, Moderna, and Janssen vaccines, which had different clinical efficacies against confirmed infection (95%, 94%, and 67%, respectively). Information on different FDA-authorized and approved COVID-19 vaccine products, including clinical efficacy is available at https://www.cdc.gov/coronavirus/2019-ncov/vaccines/different-vaccines.html.

[¶] A COVID-19–associated hospitalization was a COVID-19 case in a person hospitalized within 14 days of a SARS-CoV-2 positive specimen collection ordered by a health care professional. To ascertain COVID-19–associated hospitalization status, two jurisdictions relied upon case investigations, seven relied upon hospital records, two relied upon both case investigations and hospital records, and two did not submit hospitalization data. Four jurisdictions reported hospitalizations only when COVID-19 was the cause, and seven reported COVID-19 cases in persons hospitalized for any cause.

[**] A COVID-19–associated death occurred in a person with a documented COVID-19 diagnosis who died, and whose death local health authorities reviewed to make a determination using vital records, public health investigation, or other data sources. To ascertain COVID-19–associated death status, eight jurisdictions relied upon vital records, and five relied upon a combination of vital records and provider reporting (two), case investigations and vital records (two), and provider reporting, case investigations, and vital records (one). Eleven jurisdictions provided deaths with COVID-19 as a cause, one provided all deaths that occurred within 30 days of attaining case status (without confirming cause), and one provided deaths confirmed with COVID-19 as a cause or within 60 days of a positive specimen collection.

[††] SARS-CoV-2 variant weighted prevalence estimates are based on whole-genome sequencing results submitted to or performed by CDC (https://covid.cdc.gov/covid-data-tracker/#variant-proportions). By jurisdiction, the SARS-CoV-2 Delta variant surpassed ≥50% prevalence, using unweighted estimates, in the weeks ending June 12, 2021 (one); June 19, 2021 (one); June 26, 2021 (two); and July 3, 2021 (nine).

[§§] https://www.census.gov/programs-surveys/popest/data/tables.2019.html

[¶¶] To improve comparability of age-standardized rates across data systems, in 1998, the Secretary of the U.S. Department of Health and Human Services (HHS) issued a policy directing all HHS agencies to use the 2000 Standard Population to age standardize death rates. https://www.cdc.gov/nchs/data/statnt/statnt20.pdf

[***] 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.0 Sect.552a; 44 U.S.C. Sect. 3501 et seq.

(89.1 versus 19.4; 7.0 versus 0.7; 1.1 versus 0.1, respectively). Higher hospitalization and death rates were observed in older age groups, regardless of vaccination status, resulting in a larger impact of age-standardization on overall incidence for these outcomes.

Within each age group, the percentage of vaccinated persons among cases, hospitalizations, and deaths increased with increasing vaccination coverage (Figure 1). As the prevalence of SARS-CoV-2 Delta variant surpassed 50%, the percentage of vaccinated persons among cases in each age group increased at rates corresponding to benchmarks for lower VE (i.e., from approximately 90% to <80%). Increases in the percentages of vaccinated persons aged ≥65 years among COVID-19–associated hospitalizations and deaths also appeared higher than expected. During June 20–July 17, age-standardized rates of cases, hospitalizations, and deaths among persons not fully vaccinated increased weekly; among fully vaccinated persons, case rates increased, but rates of hospitalizations and deaths remained largely unchanged (Figure 2).

Age-standardized IRRs for cases in persons not fully vaccinated versus fully vaccinated decreased from 11.1 (95% CI = 7.8–15.8) during April 4–June 19 to 4.6 (95% CI = 2.5–8.5) during June 20–July 17, while IRRs decreased slightly from 13.3 (95% CI = 11.3–15.6) to 10.4 (95% CI = 8.1–13.3) for hospitalizations and from 16.6 (95% CI = 13.5–20.4) to 11.3 (95% CI = 9.1–13.9) for deaths during the same two periods. Persons aged ≥65 years had larger declines in IRRs for hospitalization and death than did younger age groups (Table). The change in age-standardized IRRs for cases between the April 4–June 19 and June 20–July 17 periods represented potential changes in crude VE from 91% to 78% for infection, from 92% to 90% for hospitalization, and from 94% to 91% for death (Supplementary Figure 1, https://stacks.cdc.gov/view/cdc/109531). A sensitivity analysis excluding partially vaccinated persons in nine jurisdictions yielded similar trends but higher IRRs and VE estimates for hospitalizations and deaths (Supplementary Table, https://stacks.cdc.gov/view/cdc/109533). Variability in IRRs was also observed among jurisdictions (Supplementary Figure 2, https://stacks.cdc.gov/view/cdc/109532).

Discussion

In 13 U.S. jurisdictions, rates of COVID-19 cases, hospitalizations, and deaths were substantially higher in persons not fully vaccinated compared with those in fully vaccinated persons, similar to findings in other reports (*2*,*3*). After the week of June 20, 2021, when the SARS-CoV-2 Delta variant became predominant, the percentage of fully vaccinated persons among cases increased more than expected for the given vaccination coverage and a constant VE. The IRR for cases among persons not fully vaccinated versus fully vaccinated decreased substantially; IRRs for hospitalizations and deaths changed less overall, but moderately among adults aged ≥65 years. Findings from this crude analysis of surveillance data are consistent with recent studies reporting decreased VE against confirmed infection but not hospitalization or death, during a period of Delta variant predominance and potential waning of vaccine-induced population immunity (*4*–*6*).†††

The findings in this report are subject to at least five limitations. First, combining unvaccinated and partially vaccinated persons resulted in lower IRR and VE estimates. Second, variable linkage of case surveillance, vaccination, hospitalization, and mortality data might have resulted in misclassifications that could influence IRR estimates; no substantial differences in ascertainment of outcomes by vaccination status were noted in jurisdictions that were able to assess this. Lags in reporting of deaths might have affected the second period differentially. Third, this was an ecological study in which IRRs lacked multivariable adjustments and causality could not be assessed (i.e., possible differences in testing or behaviors in vaccinated and unvaccinated persons). VE is being assessed through ongoing controlled studies. Fourth, the period when the SARS-CoV-2 Delta variant reached ≥50% overall prevalence was assumed to be the first week when most cases were infected with the Delta variant, but the week varied by jurisdiction. Finally, the data assessed from 13 jurisdictions accounted for 25% of the U.S. population, and therefore might not be generalizable.

Monitoring COVID-19 outcomes in populations over time by vaccination status is facilitated through reliable linkage of COVID-19 case surveillance and vaccination data. However, interpreting state-level variation by week might be challenging, especially for severe outcomes with small numbers. The framework used in this analysis allows for comparisons of observed IRRs and percentages of vaccinated cases, hospitalizations, and deaths to expected values. The data might be helpful in communicating the real-time impact of vaccines (e.g., persons not fully vaccinated having >10 times higher COVID-19 mortality risk) and guiding prevention strategies, such as vaccination and nonpharmacologic interventions.

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††† https://www.medrxiv.org/content/10.1101/2021.08.11.21261885v1; https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3909743; https://www.medrxiv.org/content/10.1101/2021.08.06.21261707v3

TABLE. Numbers, percentages, incidence rates, and incidence rate ratios * (in not fully vaccinated versus fully vaccinated persons) of COVID-19 cases, hospitalizations,† and deaths,§ by age group and vaccination status¶ — 13 U.S. jurisdictions, April 4–June 19 and June 20–July 17, 2021††**

	Cases		Hospitalizations		Deaths	
Age group, yrs	Not fully vaccinated	Fully vaccinated	Not fully vaccinated	Fully vaccinated	Not fully vaccinated	Fully vaccinated
Totals	**569,142 (92)**	**46,312 (8)**	**34,972 (92)**	**2,976 (8)**	**6,132 (91)**	**616 (9)**
April 4–June 19						
Total no. (% of total)						
18–49	331,151 (97)	10,346 (3)	10,526 (97)	295 (3)	609 (99)	7 (1)
50–64	93,474 (94)	5,850 (6)	9,158 (95)	444 (5)	1,380 (96)	58 (4)
≥65	42,884 (85)	7,307 (15)	9,199 (88)	1,286 (12)	3,137 (90)	363 (10)
All ages	467,509 (95)	23,503 (5)	28,883 (93)	2,025 (7)	5,126 (92)	428 (8)
Average weekly incidence (events per 100,000 population)						
18–49	122.4	10.9	4.6	0.3	0.2	0.0
50–64	98.3	9.1	11.4	0.8	1.5	0.1
≥65	91.6	8.5	22.8	1.8	6.7	0.4
All ages (crude)	113.4	9.6	8.3	1.0	1.2	0.2
All ages (age standardized)	112.3	10.1	9.1	0.7	1.6	0.1
Average weekly IRR (95% CI)						
18–49	11.3 (6.7–18.8)		13.4 (9.5–18.8)		30.7 (11.5–81.5)	
50–64	10.8 (7.4–15.7)		14.0 (11.2–17.6)		16.0 (11.2–22.8)	
≥65	10.7 (8.3–13.9)		12.8 (10.0–16.4)		15.8 (12.2–20.4)	
All ages (crude)	11.8 (8.1–17.2)		8.7 (6.4–11.8)		7.1 (4.9–10.2)	
All ages (age standardized)	11.1 (7.8–15.8)		13.3 (11.3–15.6)		16.6 (13.5–20.4)	
June 20–July 17						
Total no. (% of total)						
18–49	76,237 (85)	13,030 (15)	2,666 (95)	146 (5)	155 (96)	7 (4)
50–64	17,303 (77)	5,027 (23)	1,755 (88)	234 (12)	290 (93)	23 (7)
≥65	8,093 (63)	4,752 (37)	1,668 (74)	571 (26)	561 (78)	158 (22)
All ages	101,633 (82)	22,809 (18)	6,089 (86)	951 (14)	1,006 (84)	188 (16)
Average weekly incidence (per 100,000 population)						
18–49	101.9	22.4	4.3	0.3	0.2	0.0
50–64	72.4	14.8	8.7	0.8	1.2	0.1
≥65	61.8	13.6	14.7	1.9	4.3	0.5
All ages (crude)	90.9	17.9	6.5	0.9	0.9	0.1
All ages (age standardized)	89.1	19.4	7.0	0.7	1.1	0.1
Average weekly IRR (95% CI)						
18–49	4.5 (2.0–10.4)		15.2 (10.7–21.6)		17.2 (9.4–31.7)	
50–64	4.9 (2.4–10.1)		10.9 (6.9–17.2)		17.9 (10.6–30.3)	
≥65	4.6 (2.4–8.7)		7.6 (5.2–9.6)		9.6 (7.4–10.8)	
All ages (crude)	5.1 (2.3–11.1)		7.6 (5.1–11.3)		6.1 (4.7–8.0)	
All ages (age standardized)	4.6 (2.5–8.5)		10.4 (8.1–13.3)		11.3 (9.1–13.9)	

Abbreviations: CI = confidence interval; FDA = Food and Drug Administration; IRR = incidence rate ratio.

* Average weekly incidence rates and rate ratios are provided by age group and overall, including crude values and values standardized by age, according to the enumerated 2000 U.S. Census age distribution.

† To ascertain COVID-19–associated hospitalizations, two jurisdictions relied upon case investigations; seven jurisdictions relied upon hospital records; two jurisdictions relied upon both case investigations and hospital records; and two did not submit hospitalization data. Four jurisdictions reported hospitalizations only when COVID-19 was the cause, and seven reported COVID-19 cases in persons hospitalized for any cause.

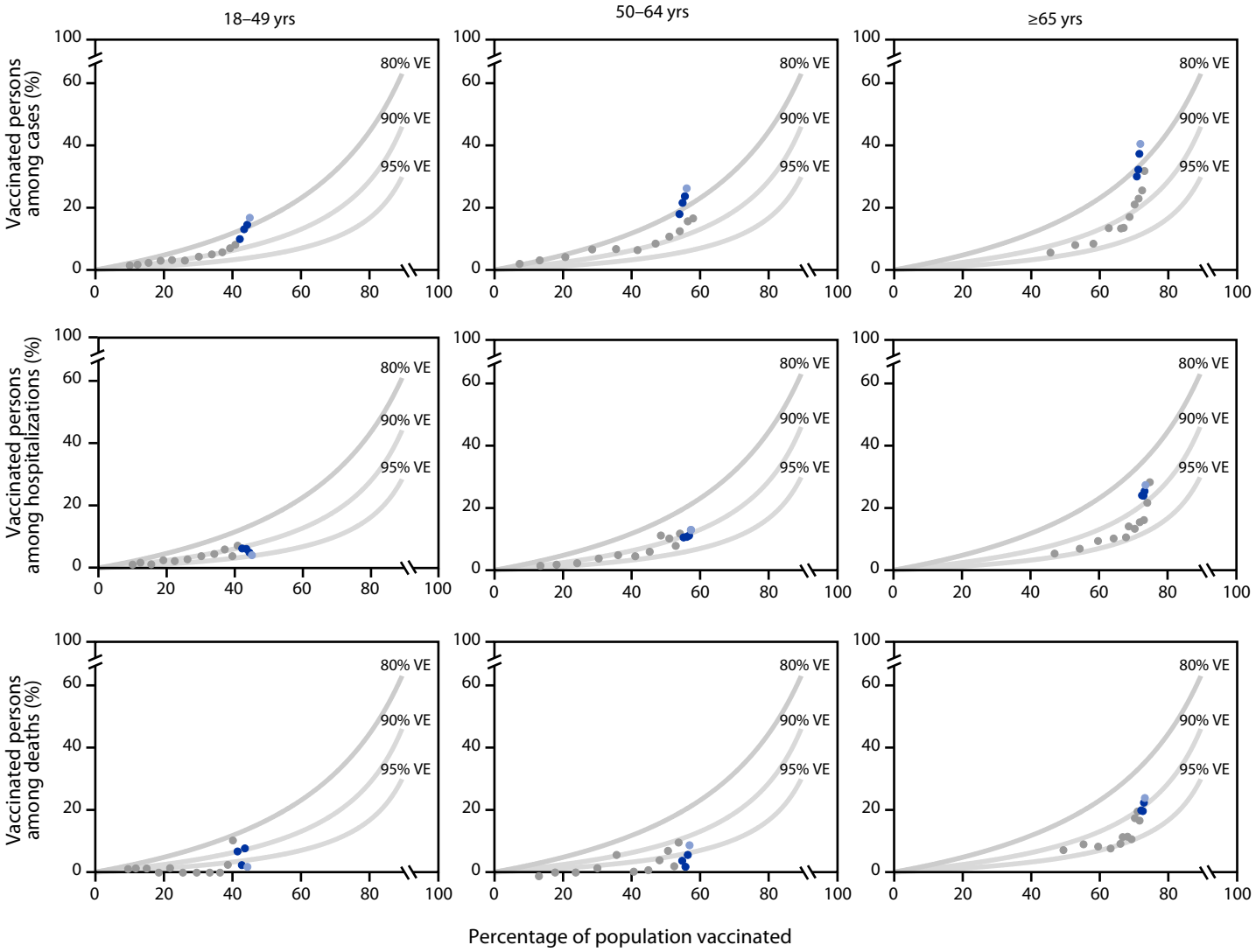
§ To ascertain COVID-19–associated deaths, eight jurisdictions relied upon vital records; and five jurisdictions relied upon a combination of vital records and provider reporting (two), case investigations and vital records (two), and provider reporting, case investigations, and vital records (one). Eleven jurisdictions provided deaths with COVID-19 as a cause; one provided all deaths that occurred within 30 days of becoming a case (without confirming cause); and one provided deaths confirmed with COVID-19 as a cause or within 60 days of positive specimen collection.

¶ Fully vaccinated persons are those who are ≥14 days postcompletion of the primary series of an FDA-authorized COVID-19 vaccine. Not fully vaccinated persons are those who did not receive an FDA-authorized COVID-19 vaccine or who received vaccine but are not yet considered fully vaccinated.

** Alabama, Arizona, Colorado, Indiana, Los Angeles County (California), Louisiana, Maryland, Minnesota, New Mexico, New York City (New York), North Carolina, Seattle/King County (Washington), and Utah.

†† Two analysis periods, April 4–June 19 and June 20–July 17, were designated based on the threshold week when the weighted percentage of lineages from whole-genome sequencing results submitted to or performed by CDC reached 50% for the SARS-CoV-2 B.1.617.2 (Delta) variant across the 13 jurisdictions.

FIGURE 1. Observed versus expected percentage of fully vaccinated persons among COVID-19 cases, hospitalizations, and deaths based on population vaccination coverage* and assumed 80%–95% vaccine effectiveness,† by week§ and age group — 13 U.S. jurisdictions,¶ April 4–July 17, 2021



Abbreviations: PVC = percentage of vaccinated persons occurring among outcomes; PPV = proportion of the population that is vaccinated; VE = vaccine effectiveness.

* Vaccination coverage was estimated using the sum of fully vaccinated persons (submitted by the jurisdictions) divided by the combined 2019 U.S. intercensal population estimates by age group.

† The expected PVC, represented by the light gray lines, was assessed using the formula: PVC = [PPV-(PPV*VE)]/1-(PPV*VE), where benchmarks are added at different VE values (80%, 90%, and 95%). Observed values that approach or go above the 80% VE line indicate decreased VE.

§ Two analysis periods, April 4–June 19 and June 20–July 17, were designated based on the threshold week when the weighted percentage of lineages from whole-genome sequencing results submitted to or performed by CDC reached 50% for the SARS-CoV-2 B.1.617.2 (Delta) variant across the 13 jurisdictions. Weekly values are plotted, with the two analysis periods and most recent week for the analysis period shown.

¶ Alabama, Arizona, Colorado, Indiana, Los Angeles County (California), Louisiana, Maryland, Minnesota, New Mexico, New York City (New York), North Carolina, Seattle/King County (Washington), and Utah.

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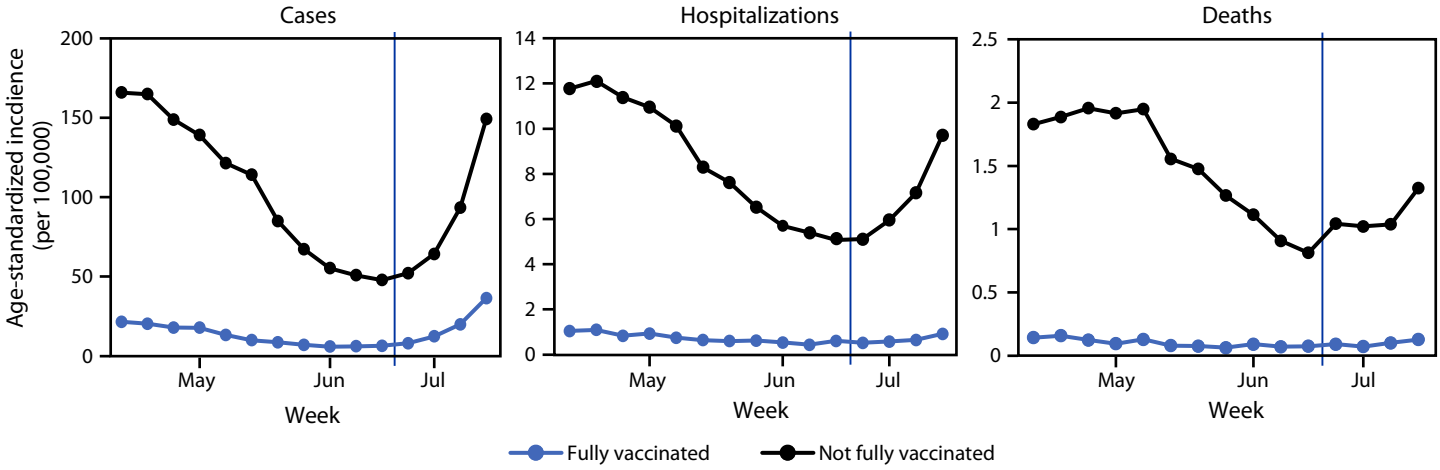
FIGURE 2. Weekly trends in age-standardized incidence* of COVID-19 cases, hospitalizations,† and deaths,§ by vaccination status¶ — 13 U.S. jurisdictions, April 4–July 17, 2021**



* Rates are standardized by age, according to the enumerated 2000 U.S. Census age distribution. Blue vertical lines indicate when the B.1.617.2 (Delta) variant reached a threshold of >50%, using weighted estimates for 13 jurisdictions combined.

† To ascertain COVID-19–associated hospitalizations, two jurisdictions relied upon case investigations; seven jurisdictions relied upon hospital records; two jurisdictions relied upon both case investigations and hospital records; and two did not submit hospitalization data. Four jurisdictions reported hospitalizations only where COVID-19 was the cause, and seven reported COVID-19 cases in persons hospitalized for any cause.

§ To ascertain COVID-19–associated deaths, eight jurisdictions relied upon vital records, and five jurisdictions relied upon a combination of vital records and provider reporting (two), case investigations and vital records (two), and provider reporting, case investigations, and vital records (one). Eleven jurisdictions provided deaths with COVID-19 as a cause; one provided all deaths that occurred within 30 days of becoming a case (without confirming cause); and one provided deaths confirmed with COVID-19 as a cause or within 60 days of positive specimen collection.

¶ Fully vaccinated persons are those who are ≥14 days postcompletion of the primary series of a COVID-19 vaccine with Food and Drug Administration emergency use authorization. Not fully vaccinated persons are those who did not receive a COVID-19 vaccine with Food and Drug Administration emergency use authorization or who received a COVID-19 vaccine but are not yet considered fully vaccinated.

** Alabama, Arizona, Colorado, Indiana, Los Angeles County (California), Louisiana, Maryland, Minnesota, New Mexico, New York City (New York), North Carolina, Seattle/King County (Washington), and Utah.

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Summary

What is already known about this topic?

The incidence of SARS-CoV-2 infection, hospitalization, and death is higher in unvaccinated than vaccinated persons, and the incidence rate ratios are related to vaccine effectiveness.

What is added by this report?

Across 13 U.S. jurisdictions, incidence rate ratios for hospitalization and death changed relatively little after the SARS-CoV-2 B.1.617.2 (Delta) variant reached predominance, suggesting high, continued vaccine effectiveness against severe COVID-19. Case IRRs decreased, suggesting reduced vaccine effectiveness for prevention of SARS-CoV-2 infections.

What are the implications for public health practice?

Getting vaccinated protects against severe illness from COVID-19, including the Delta variant. Monitoring COVID-19 incidence by vaccination status might provide early signals of potential changes in vaccine effectiveness that can be confirmed through robust controlled studies.

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Morbidity and Mortality Weekly Report

Interim Estimates of COVID-19 Vaccine Effectiveness Against COVID-19–Associated Emergency Department or Urgent Care Clinic Encounters and Hospitalizations Among Adults During SARS-CoV-2 B.1.617.2 (Delta) Variant Predominance — Nine States, June–August 2021

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On September 10, 2021, this report was posted as an MMWR *Early Release on the* MMWR *website (https://www.cdc.gov/mmwr).*

Data on COVID-19 vaccine effectiveness (VE) since the B.1.617.2 (Delta) variant of SARS-CoV-2, the virus that causes COVID-19, became the predominant circulating strain in the United States are limited (*1*–*3*). CDC used the VISION Network* to examine medical encounters (32,867) from 187 hospitals and 221 emergency departments (EDs) and urgent care (UC) clinics across nine states during June–August 2021, beginning on the date the Delta variant accounted for >50% of sequenced isolates in each medical facility's state. VISION Network methods have been published (*4*).

Eligible medical encounters were defined as those among adults aged ≥18 years who had received SARS-CoV-2 molecular testing (primarily reverse transcription–polymerase chain reaction assay within 14 days before or 72 hours after the admission or encounter) and a COVID-19–like illness discharge diagnosis. Vaccination status was documented in electronic health records and immunization registries. Full vaccination was defined as receipt of the second dose of BNT162b2 (Pfizer-BioNTech) or mRNA-1273 (Moderna) mRNA vaccines, or a single dose of Ad26.COV2 (Janssen [Johnson & Johnson]) vaccine ≥14-days before the testing or encounter date. Patients who had received no COVID-19 vaccine doses were considered unvaccinated. Patients who had received 1 mRNA dose only or had received the second dose <14 days before testing or encounter date were excluded. VE was estimated using a test-negative design, calculating the odds of receiving a positive SARS-CoV-2 test result comparing fully vaccinated and unvaccinated patients (referent group). VE was adjusted for age, geographic region, calendar time (days from January 1 to medical event), and virus circulation, and weighted for inverse propensity to be vaccinated or unvaccinated (calculated separately for each VE model). VE estimates with 95% confidence intervals (CIs) that did not overlap were considered statistically different. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.†

Among fully vaccinated patients, the proportion who had received each vaccine product among hospitalizations and ED/UC encounters, respectively, were Pfizer-BioNTech, 55.3% and 53.6%; Moderna, 38.8% and 36.1%; and Janssen, 6.0% and 10.3%. The median interval from becoming fully vaccinated to the hospital admission or ED/UC encounter, respectively, were 110 and 93 days (Pfizer-BioNTech), 106 and 96 days (Moderna), and 94 and 94 days (Janssen).

Among adults hospitalized with COVID-19–like illness (14,636; median patient age = 65 years, interquartile range [IQR] = 48–77 years), laboratory-confirmed SARS-CoV-2 infections were identified among 18.9% (1,316 of 6,960) of unvaccinated and 3.1% (235 of 7,676) of fully vaccinated patients. Overall, VE against COVID-19 hospitalization was 86% (95% CI = 82%–89%). VE was significantly lower among adults aged ≥75 years (76%) than among those aged 18–74 years (89%) (Table). The difference in VE point estimates between age groups was similar for Pfizer-BioNTech and Moderna vaccines. Across all ages, VE was significantly higher among Moderna vaccine recipients (95%) than among Pfizer-BioNTech (80%) or Janssen (60%) vaccine recipients.

Among adults with ED/UC encounters for COVID-19–like illness (18,231; median patient age = 43 years, IQR = 29–62 years), laboratory-confirmed SARS-CoV-2 infections were identified among 28.9% (3,145 of 10,872) of unvaccinated and 7.0% (512 of 7,359) of fully vaccinated patients. VE against COVID-19 ED/UC encounters was 82% (95% CI = 81%–84%). VE was highest among Moderna vaccine recipients (92%), followed by Pfizer-BioNTech vaccine recipients (77%), and was lowest (65%) for Janssen vaccine recipients (Table).

In this multistate interim analysis of 32,867 medical encounters among adults of all ages during June–August 2021, when the Delta variant was predominant in the United States, VE of all three authorized COVID-19 vaccines combined remained high against hospitalization (86%) and ED/UC encounters (82%). These overall VE estimates were similar to those during

* Funded by CDC, the VISION network includes Columbia University Irving Medical Center (New York), HealthPartners (Minnesota and Wisconsin), Intermountain Healthcare (Utah), Kaiser Permanente Northern California (California), Kaiser Permanente Northwest (Oregon and Washington), Regenstrief Institute (Indiana), and University of Colorado (Colorado).

† 45 C.F.R. part 46; 21 C.F.R. part 56.

TABLE. COVID-19 vaccine effectiveness* against laboratory-confirmed COVID-19–associated emergency department and urgent care clinic encounters and hospitalizations† among adults during SARS-CoV-2 B.1.617.2 (Delta) variant predominance,§ by outcome, age group, and vaccine — nine states,¶ June–August 2021

Outcome	Total	No. of SARS-CoV-2–positive tests (row %)	VE, % (95% CI)
All adults (aged ≥18 yrs), any COVID-19 vaccine			
COVID-19 hospitalizations			
Unvaccinated (ref)	**6,960**	1,316 (18.9)	—
Fully vaccinated**	**7,676**	235 (3.1)	86 (82–89)
COVID-19 ED/UC encounters			
Unvaccinated (ref)	**10,872**	3,145 (28.9)	—
Fully vaccinated**	**7,359**	512 (7.0)	82 (81–84)
COVID-19 hospitalizations, any COVID-19 vaccine, by age			
Age group = 18–74 yrs			
Unvaccinated (ref)	**5,708**	1,185 (20.8)	—
Fully vaccinated**	**4,551**	134 (2.9)	89 (85–92)
Age group = ≥75 yrs			
Unvaccinated (ref)	**1,252**	131 (10.5)	—
Fully vaccinated**	**3,125**	101 (3.2)	76 (64–84)
COVID-19 hospitalizations by COVID-19 vaccine			
BNT162b2 (Pfizer-BioNTech)			
Unvaccinated (ref)	**6,960**	1,316 (18.9)	—
Fully vaccinated**	**4,243**	135 (3.2)	80 (73–85)
mRNA-1273 (Moderna)			
Unvaccinated (ref)	**6,960**	1,316 (18.9)	—
Fully vaccinated**	**2,975**	70 (2.4)	95 (92–97)
Ad26.COV2.S (Janssen)			
Unvaccinated (ref)	**6,960**	1,316 (18.9)	—
Fully vaccinated**	**458**	30 (6.5)	60 (31–77)
COVID-19 ED/UC encounters by COVID-19 vaccine			
BNT162b2 (Pfizer-BioNTech)			
Unvaccinated (ref)	**10,872**	3,145 (28.9)	—
Fully vaccinated**	**3,946**	314 (8.0)	77 (74–80)
mRNA-1273 (Moderna)			
Unvaccinated (ref)	**10,872**	3,145 (28.9)	—
Fully vaccinated**	**2,656**	98 (3.7)	92 (89–93)
Ad26.COV2.S (Janssen)			
Unvaccinated (ref)	**10,872**	3,145 (28.9)	—
Fully vaccinated**	**757**	100 (13.2)	65 (56–72)

Abbreviations: CI = confidence interval; ED = emergency department; HHS = U.S. Department of Health and Human Services; Janssen = Johnson & Johnson vaccine; Ref = referent group; UC = urgent care; VE = vaccine effectiveness.

* VE was estimated using a test-negative design, adjusted for age, geographic region, calendar time (cubic spline with quartile knots), and virus circulation (percentage of SARS-CoV-2–positive results from testing within the counties surrounding the facility on the date of the event) and weighted for inverse propensity to be vaccinated or unvaccinated (calculated separately for each of the 10 VE models) using facility characteristics, sociodemographics, and underlying medical conditions.

† Medical events with a discharge code consistent with COVID-19-like illness were included, such as acute respiratory illness (e.g., COVID-19, respiratory failure, or pneumonia) or related signs or symptoms (cough, fever, dyspnea, vomiting, or diarrhea) using diagnosis codes from the ninth and tenth revisions of the *International Classification of Diseases*. Clinician-ordered molecular assays (e.g., real-time reverse transcription–polymerase chain reaction) for SARS-CoV-2 occurring ≤14 days before to <72 hours after hospital admission or ED/UC encounter were included.

§ Medical events occurred when Delta variant was predominant (>50%) in each state, according to data from network partners, CDC COVID data tracker (https://covid.cdc.gov), and HHS Protects Public Data Hub (https://protect-public.hhs.gov).

¶ Partners contributing both ED/UC encounters and hospitalizations in 2021 were in Indiana (range of earliest to latest medical event: July 3–26), Oregon and Washington (June 30–August 4), and Utah (June 1–July 24). Partners contributing hospitalizations only were in California (June 23–August 4), Colorado (June 3–July 20), Minnesota and Wisconsin (July 1–August 2), and New York (June 30–July 25).

** Full vaccination was defined as index testing or admission date ≥14 days after second dose of BNT162b2 (Pfizer-BioNTech) or mRNA-1273 (Moderna) or after a single dose of Ad26.COV2 (Janssen) vaccines.

the months before Delta became predominant (*2*,*4*). However, VE against COVID-19 hospitalization among adults aged ≥75 years was significantly lower than that among adults aged <75 years, which had not been observed previously from this data source (*4*). This moderate decline should be interpreted with caution and might be related to changes in SARS-CoV-2, waning of vaccine-induced immunity with increased time since vaccination, or a combination of factors. Differences in VE between the two mRNA vaccines, which had not been observed previously in the VISION Network (*4*), are consistent with another recent finding.§ Further examination of the magnitude and sources of product-specific VE differences are also warranted.

§ https://www.medrxiv.org/content/10.1101/2021.08.06.21261707v2

The findings in this report are subject to at least three limitations. First, VE by time since vaccination was not examined; further evaluation of possible waning of vaccine protection is currently underway. Second, VE for partial vaccination was not assessed. Finally, although the facilities in this study serve heterogenous populations in nine states, the findings might not be generalizable to the U.S. population.

These findings reaffirm the high protection of COVID-19 vaccines against moderate and severe COVID-19 resulting in ED, UC, and hospital visits and underscore the importance of full COVID-19 vaccination and continued benefits of COVID-19 vaccination during Delta variant predominance.

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Morbidity and Mortality Weekly Report

Effectiveness of COVID-19 mRNA Vaccines Against COVID-19–Associated Hospitalization — Five Veterans Affairs Medical Centers, United States, February 1–August 6, 2021

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On September 10, 2021, this report was posted as an MMWR *Early Release on the* MMWR *website (https://www.cdc.gov/mmwr).*

COVID-19 mRNA vaccines (Pfizer-BioNTech and Moderna) have been shown to be highly protective against COVID-19–associated hospitalizations (*1*–*3*). Data are limited on the level of protection against hospitalization among disproportionately affected populations in the United States, particularly during periods in which the B.1.617.2 (Delta) variant of SARS-CoV-2, the virus that causes COVID-19, predominates (*2*). U.S. veterans are older, more racially diverse, and have higher prevalences of underlying medical conditions than persons in the general U.S. population (*2*,*4*). CDC assessed the effectiveness of mRNA vaccines against COVID-19–associated hospitalization among 1,175 U.S. veterans aged ≥18 years hospitalized at five Veterans Affairs Medical Centers (VAMCs) during February 1–August 6, 2021. Among these hospitalized persons, 1,093 (93.0%) were men, the median age was 68 years, 574 (48.9%) were non-Hispanic Black (Black), 475 were non-Hispanic White (White), and 522 (44.4%) had a Charlson comorbidity index score of ≥3 (*5*). Overall adjusted vaccine effectiveness against COVID-19–associated hospitalization was 86.8% (95% confidence interval [CI] = 80.4%–91.1%) and was similar before (February 1–June 30) and during (July 1–August 6) SARS-CoV-2 Delta variant predominance (84.1% versus 89.3%, respectively). Vaccine effectiveness was 79.8% (95% CI = 67.7%–87.4%) among adults aged ≥65 years and 95.1% (95% CI = 89.1%–97.8%) among those aged 18–64 years. COVID-19 mRNA vaccines are highly effective in preventing COVID-19–associated hospitalization in this older, racially diverse population of predominately male U.S. veterans. Additional evaluations of vaccine effectiveness among various age groups are warranted. To prevent COVID-19–related hospitalizations, all eligible persons should receive COVID-19 vaccination.

During February 1–August 6, 2021, adults aged ≥18 years hospitalized at five VAMCs (in Atlanta, Georgia; Bronx, New York; Houston, Texas; Los Angeles, California; and Palo Alto, California) were screened for inclusion in this test-negative case-control assessment.† Patients were eligible for inclusion if they had COVID-19–like illness (i.e., fever, new or worsened cough or shortness of breath, loss of taste or smell, oxygen saturation on room air <94%, requirement for noninvasive ventilation or endotracheal intubation with mechanical ventilation, or chest radiograph or computed tomography pulmonary findings consistent with pneumonia) (*1*) and a molecular test (reverse transcription–polymerase chain reaction [RT-PCR] or isothermal nucleic acid amplification test) for SARS-CoV-2 performed within 14 days before admission or during the first 72 hours of hospitalization. The first SARS-CoV-2 test within this eligibility period was considered the qualifying test. Patients with COVID-19–like illness who received a positive SARS-CoV-2 test result were included as case-patients, and those with COVID-19–like illness with negative SARS-CoV-2 test results were included as controls.

Electronic health records were reviewed to obtain data on demographic characteristics, underlying medical conditions, presenting illness, SARS-CoV-2 test results, COVID-19 vaccination history, and clinical course during hospitalization. In the Atlanta and Houston VAMCs, COVID-19 vaccination status was further verified through a review of state immunization registries. Full vaccination was defined as receipt of both doses of an mRNA vaccine (Pfizer-BioNTech or Moderna) ≥14 days before the qualifying SARS-CoV-2 test. Participants who received only 1 dose of an mRNA COVID-19 vaccine, 2 mRNA doses with receipt of the second dose <14 days before the qualifying SARS-CoV-2 test, mixed mRNA vaccine products (i.e., a different product for each dose), or the Janssen (Johnson & Johnson) COVID-19 vaccine were excluded from the analysis. Available residual clinical respiratory specimens were collected from case-patients at all sites and sent to CDC for testing. Specimens were tested using CDC's 2019-Novel Coronavirus RT-PCR Diagnostic Panel§; those with cycle threshold values <33 were submitted for SARS-CoV-2 whole genome sequencing (*6*). In addition, results from SARS-CoV-2 whole genome sequencing conducted by VAMC laboratories on clinical specimens from Atlanta, Palo Alto, and Bronx VAMCs were also reported to CDC.

* These authors contributed equally to this report.

† The test-negative study design included controls with the same clinical syndrome as case-patients to reduce bias from differences in health care–seeking behavior as well as access to testing and care.

§ https://www.fda.gov/media/134922/download

Vaccine effectiveness (1 – adjusted odds ratio [aOR] × 100)[¶] to prevent COVID-19–associated hospitalization was estimated by using multivariable logistic regression to compare the odds of full vaccination between case-patients and controls. Models were adjusted for VAMC site, admission date and age (with the use of cubic splines), sex, and race/ethnicity. Additional factors were included if they changed the aOR by ≥5% when added individually to the base model. Vaccine effectiveness was compared between subgroups using 95% confidence intervals (CIs). Analyses were conducted using SAS (version 9.4; SAS Institute). Protocols were reviewed and approved by the VAMC Research and Development Committee at each site. The activity was also reviewed by CDC and conducted consistent with applicable federal law and CDC policy.[**]

During February 1–August 6, 2021, a total of 1,494 hospitalized U.S. veterans met inclusion criteria. After excluding 319 ineligible persons (67 with missing demographic data or vaccination date or product information, 230 who received only 1 dose of mRNA COVID-19 vaccine or 2 doses <14 days before the qualifying SARS-CoV-2 test, one who received mixed mRNA COVID-19 vaccine products, and 21 who received the Janssen COVID-19 vaccine), 388 case-patients and 787 controls were included in the analysis. Among these 1,175 patients, 1,093 (93.0%) were men, the median age was 68 years (interquartile range [IQR] = 59–75 years), 574 (48.9%) were Black, and 93 (7.9%) were Hispanic (Table 1). Prevalence of underlying medical conditions was high and included obesity (46.8%), diabetes (43.8%), atherosclerotic cardiovascular disease (29.2%), and chronic obstructive pulmonary disease (25.4%) (Table 1). Overall, 54 (13.9%) case-patients and 378 (48.0%) controls were fully vaccinated. Among fully vaccinated persons, the median interval between the second COVID-19 vaccine dose and the qualifying SARS-CoV-2 test was 83 days (IQR = 49–129). Among 171 case-patients with SARS-CoV-2 lineage determined,[††] Delta became the predominant variant across all sites in July 2021 (Figure).

The adjusted effectiveness of full vaccination in preventing COVID-19–associated hospitalization during the entire evaluation period (February 1–August 6, 2021) was 86.8% (95% CI = 80.4%–91.1%) (Table 2). The adjusted vaccine effectiveness among persons admitted to the hospital before Delta variant predominance (February 1–June 30) (84.1%; 95% CI = 74.1%–90.2%) was similar to vaccine effectiveness during Delta variant predominance (July 1–August 6) (89.3%; 95% CI = 80.1%–94.3%). The estimated vaccine effectiveness among persons aged ≥65 years (79.8%; 95% CI = 67.7%–87.4%) was lower than among persons aged 18–64 years (95.1%; 95% CI = 89.1%–97.8%), and no difference was found between persons who had completed the full vaccination series <90 days (86.1%; 95% CI = 76.5%–91.8%) versus ≥90 days (87.2%; 95% CI = 78.2%–92.5%) before their SARS-CoV-2 test date. Adjusted vaccine effectiveness estimates were also similar for Black (86.9%; 95% CI = 76.9%–92.6%) and White persons (88.1%; 95% CI = 77.4%–93.8%), as well as for Pfizer-BioNTech (83.4%; 95% CI = 74.0%–89.4%) and Moderna vaccines (91.6%; 95% CI = 83.5%–95.7%).

Discussion

Among U.S. veterans hospitalized at five VAMCs, mRNA vaccines were 86.8% effective in preventing COVID-19–associated hospitalizations and remained highly effective during a period of Delta variant predominance. The mRNA vaccines were effective against COVID-19–associated hospitalization among all age groups, although lower effectiveness (79.8%) was observed among veterans aged ≥65 years. These findings support current evidence that COVID-19 mRNA vaccines are highly effective in preventing COVID-19–associated hospitalization (*1*–*3*) and reinforce the importance of vaccination, including among veterans, who are at high risk for COVID-19 hospitalization because they are older and have a higher prevalence of underlying medical conditions compared with persons in the general U.S. population (*2*,*4*).

Consistent with national trends,[§§] Delta became the predominant SARS-CoV-2 variant in this cohort in July 2021. Protection against COVID-19–associated hospitalization remained high despite the emergence of Delta as the predominant variant in the United States; protection was similar during periods before (February–June 2021; 84.1%) and during (July–August 2021; 89.3%) Delta variant predominance. Recent reports have shown that COVID-19 vaccine protection against SARS-CoV-2 infection is lower in areas with increasing Delta variant transmission (*7*,*8*); however, protection against severe disease outcomes, including hospitalization, remains high (*7*,*9*).

Although the observed vaccine effectiveness in this study is similar to that reported by other studies measuring protection against COVID-19–associated hospitalization, significantly lower vaccine effectiveness among older adults has not previously been observed (*1*,*2*,*9*). This might be a result of differences in the populations evaluated; periods of vaccine effectiveness assessment, including differences in vaccine coverage, variant circulation, and time since vaccination; and variability in unmeasured confounding. Decreased immunogenicity with increasing age has been reported after vaccination with COVID-19 mRNA vaccines (*10*). Because one fourth of adults included in this evaluation were aged

[¶] https://www.who.int/publications/i/item/WHO-2019-nCoV-vaccine_effectiveness-measurement-2021.1

[**] 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.

[††] Among case-patients with COVID-19–like illness and any COVID-19 vaccination status.

[§§] https://covid.cdc.gov/covid-data-tracker/#variant-proportions

TABLE 1. Characteristics of COVID-19 case-patients and controls among hospitalized veterans — five Veterans Affairs Medical Centers, United States, February 1–August 6, 2021

Characteristic	No. (%)		
	Total (N = 1,175)	Case-patients (n = 388)	Controls (n = 787)
Male sex	**1,093 (93.0)**	**353 (91.0)**	**740 (94.0)**
Age, yrs, median (IQR)	**68 (59–75)**	64 (53–73)	69 (62–76)
Age group, yrs			
18–49	**132 (11.2)**	74 (19.1)	58 (7.4)
50–64	**342 (29.1)**	125 (32.2)	217 (27.6)
65–74	**401 (34.1)**	110 (28.4)	291 (37.0)
75–84	**207 (17.6)**	53 (13.7)	154 (19.6)
≥85	**93 (7.9)**	26 (6.7)	67 (8.5)
Race/Ethnicity			
Black, non-Hispanic	**574 (48.9)**	195 (50.3)	379 (48.2)
White, non-Hispanic	**475 (40.4)**	141 (36.3)	334 (42.4)
Hispanic, any race	**93 (7.9)**	40 (10.3)	53 (6.7)
Other, non-Hispanic*	**33 (2.8)**	12 (3.1)	21 (2.7)
Resident in long-term care facility† (unknown = 58)	**66 (5.9)**	14 (3.8)	52 (7.0)
VAMC study site			
Atlanta, Georgia	**362 (30.8)**	121 (31.2)	241 (30.6)
Bronx, New York	**83 (7.1)**	26 (6.7)	57 (7.2)
Houston, Texas	**410 (34.9)**	180 (46.4)	230 (29.2)
Los Angeles, California	**223 (19.0)**	44 (11.3)	179 (22.7)
Palo Alto, California	**97 (8.3)**	17 (4.4)	80 (10.2)
Month of hospital admission			
February	**275 (23.4)**	101 (26.0)	174 (22.1)
March	**174 (14.8)**	51 (13.1)	123 (15.6)
April	**202 (17.2)**	63 (16.2)	139 (17.7)
May	**138 (11.7)**	29 (7.5)	109 (13.9)
June	**99 (8.4)**	26 (6.7)	73 (9.3)
July	**224 (19.1)**	87 (22.4)	137 (17.4)
August	**63 (5.4)**	31 (8.0)	32 (4.1)
Fully vaccinated for COVID-19§	**432 (36.8)**	54 (13.9)	378 (48.0)
COVID-19 vaccine product among fully vaccinated			
BNT162b2 (Pfizer-BioNTech)	**285 (66.0)**	43 (79.6)	242 (64.0)
mRNA-1273 (Moderna)	**147 (34.0)**	11 (20.4)	136 (36.0)
Days between second vaccine dose and SARS-CoV-2 test among fully vaccinated, median (IQR)	**83 (49–129)**	**126 (68–144)**	**77 (47–123)**
Underlying medical condition			
Cardiovascular			
Atherosclerotic cardiovascular disease¶	**335 (29.2)**	78 (20.9)	257 (33.2)
Atrial fibrillation	**168 (14.3)**	50 (12.9)	118 (15.0)
Congestive heart failure	**289 (24.6)**	54 (13.9)	235 (29.9)
Hypertension	**822 (70.0)**	258 (66.5)	564 (71.7)
Venous thromboembolism**	**69 (5.9)**	20 (5.2)	49 (6.2)
Metabolic			
Diabetes	**515 (43.8)**	162 (41.8)	353 (44.9)
Dyslipidemia	**464 (39.5)**	152 (39.2)	312 (39.6)
Obesity†† (unknown = 3)	**549 (46.8)**	208 (53.9)	341 (43.4)
Pulmonary			
Asthma	**86 (7.3)**	19 (4.9)	67 (8.5)
Chronic obstructive pulmonary disease or emphysema	**299 (25.4)**	55 (14.2)	244 (31.0)
Obstructive sleep apnea	**214 (18.2)**	75 (19.3)	139 (17.7)
Neurologic			
Dementia	**79 (6.7)**	25 (6.4)	54 (6.9)
Stroke or transient ischemic attack	**125 (10.6)**	33 (8.5)	92 (11.7)
Renal			
Chronic kidney disease	**239 (20.3)**	66 (17.0)	173 (22.0)
End stage kidney disease on dialysis	**59 (5.0)**	14 (3.6)	45 (5.7)
Liver			
Liver disease	**113 (9.6)**	28 (7.2)	85 (10.8)
Immunocompromising condition			
Immunocompromising condition or therapy§§	**212 (18.4)**	36 (9.6)	176 (22.7)

See table footnotes on the next page.

TABLE 1. (*Continued*) Characteristics of COVID-19 case-patients and controls among hospitalized veterans — five Veterans Affairs Medical Centers, United States, February 1–August 6, 2021

Characteristic	No. (%) Total (N = 1,175)	Case-patients (n = 388)	Controls (n = 787)
Charlson comorbidity index score¶¶			
0	**215 (18.3)**	120 (30.9)	95 (12.1)
1–2	**438 (37.3)**	146 (37.6)	292 (37.1)
3–4	**306 (26.0)**	81 (20.9)	225 (28.6)
≥5	**216 (18.4)**	41 (10.6)	175 (22.2)
Tobacco use***			
Current	**242 (20.6)**	49 (12.6)	193 (24.5)
Former	**365 (31.1)**	93 (24.0)	272 (34.6)
Hospitalizations in past year (unknown = 31)			
0	**671 (58.7)**	267 (70.6)	404 (52.7)
1	**238 (20.8)**	66 (17.5)	172 (22.5)
2	**93 (8.1)**	18 (4.8)	75 (9.8)
≥3	**142 (12.4)**	27 (7.1)	115 (15.0)
Intensive care unit admission (unknown = 29)	**242 (21.0)**	85 (23.2)	157 (20.1)
Death (unknown = 28)	**61 (5.3)**	28 (7.7)	33 (4.2)

Abbreviations: IQR = interquartile range; VAMC = Veterans Affairs Medical Center.

* Includes non-Hispanic American Indian and Alaska Native, non-Hispanic Asian and Pacific Islander, non-Hispanic multiple-race, and non-Hispanic other race persons.

† Includes residence before admission at VAMC and non-VAMC nursing facilities as well as other VAMC long-term housing (e.g., Domiciliary Care Program facilities).

§ COVID-19 vaccination status includes unvaccinated, defined as no receipt of any COVID-19 vaccine, and fully vaccinated, defined as receipt of both doses of an mRNA COVID-19 vaccine (Pfizer-BioNTech or Moderna) ≥14 days before the first SARS-CoV-2 test performed within 14 days before admission or during the first 72 hours of hospitalization.

¶ Includes coronary artery disease, myocardial infarction, peripheral vascular disease, and carotid artery stenosis.

** Includes history of deep venous thrombosis and pulmonary embolism

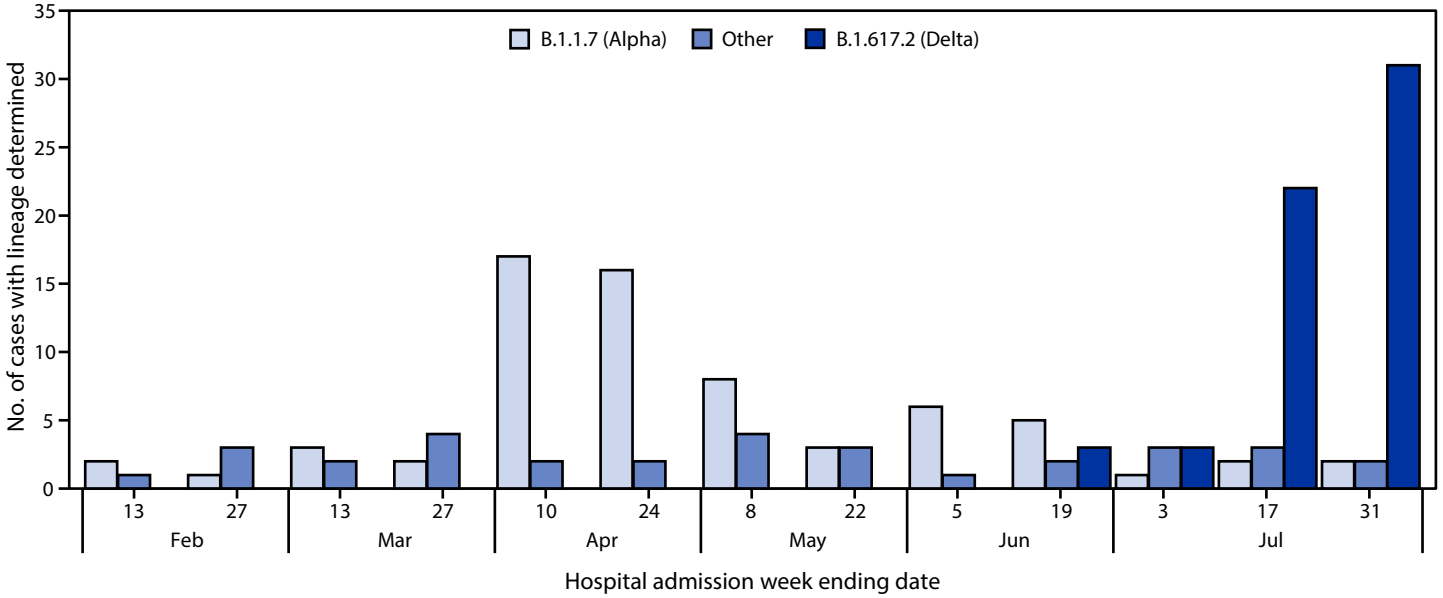
†† Body mass index ≥30 kg/m^2.

§§ Includes HIV/AIDS, malignancy, history of solid organ or stem cell transplant, ulcerative colitis, Crohn's disease, systemic lupus erythematosus, rheumatoid arthritis, systemic sclerosis, and receipt of immunosuppressive therapy (systemic steroids, chemotherapy, or other immunosuppressive therapy) within 1 month of SARS-CoV-2 test.

¶¶ Modified from King JT, Jr., Yoon J, Rentsch CT, et al. Development and validation of a 30-day mortality index based on pre-existing medical administrative data from 13,323 COVID-19 patients: The Veterans Health Administration COVID-19 (VACO) Index. PLoS ONE 2020;15:e0241825.

*** Tobacco use was defined as smoking cigarettes, cigars, or pipes. Current tobacco use was use within the 12 months before hospitalization; former use was >12 months before hospitalization.

FIGURE. SARS-CoV-2 whole genome sequencing lineage results* for specimens from veterans aged ≥18 years hospitalized with COVID-19 — five Veterans Affairs Medical Centers,† United States, February 1–August 6, 2021§



* Residual clinical respiratory specimens with SARS-CoV-2 detected by reverse transcription–polymerase chain reaction with a cycle threshold <33 for at least one of two nucleocapsid gene targets were submitted for whole genome sequencing using a combination of Sanger and Illumina sequencing to maximize genome coverage. In addition, sequencing conducted at Veterans Affairs Medical Center laboratories (Clear Labs platform and Thermo Fisher Scientific Ion Torrent next-generation sequencing platform) were also included. The percentage of case-patient specimens sequenced varied over time and was lowest during February–March 2021.

† Atlanta, Georgia; Bronx, New York; Houston, Texas; Los Angeles, California; and Palo Alto, California.

§ Sequencing conducted through July 31, 2021.

TABLE 2. Adjusted effectiveness* of full vaccination† with mRNA COVID-19 vaccines against COVID-19–associated hospitalization among veterans, by characteristics of case-patients and controls — five Veterans Affairs Medical Centers,§ United States, February 1–August 6, 2021

Characteristic	n/N (%)		Adjusted vaccine effectiveness % (95% CI)
	Case-patients vaccinated/total	Controls vaccinated/total	
Overall	**54/388 (13.9)**	**378/787 (48.0)**	**86.8 (80.4–91.1)**
Age group, yrs			
18–64	10/199 (5.0)	93/275 (33.8)	95.1 (89.1–97.8)
≥65	44/189 (23.3)	285/512 (55.7)	79.8 (67.7–87.4)
Race/Ethnicity¶			
Black, non-Hispanic	24/195 (12.3)	169/379 (44.6)	86.9 (76.9–92.6)
White, non-Hispanic	21/141 (14.9)	171/334 (51.2)	88.1 (77.4–93.8)
COVID-19 vaccine product among fully vaccinated			
BNT162b2 (Pfizer-BioNTech)	43/388 (11.1)	242/787 (30.7)	83.4 (74.0–89.4)
mRNA-1273 (Moderna)	11/388 (2.8)	136/787 (17.3)	91.6 (83.5–95.7)
Date of hospital admission			
February 1–June 30	22/270 (8.1)	249/618 (40.3)	84.1 (74.1–90.2)
July 1–August 6	32/118 (27.1)	129/169 (76.3)	89.3 (80.1–94.3)
No. of days since fully vaccinated			
<90 days	19/388 (4.9)	215/787 (27.3)	86.1 (76.5–91.8)
≥90 days	35/388 (9.0)	163/787 (20.7)	87.2 (78.2–92.5)

Abbreviation: CI = confidence interval.
* All nonstratified models adjusted for study site, time (admission date), age, sex, and race/ethnicity. Stratified models exclude adjustment for stratification variable.
† Full vaccination was defined as receipt of both doses of an mRNA COVID-19 vaccine (Pfizer-BioNTech or Moderna) ≥14 days before the first SARS-CoV-2 test performed within 14 days before admission or during the first 72 hours of hospitalization.
§ Atlanta, Georgia; Bronx, New York; Houston, Texas; Los Angeles, California; and Palo Alto, California.
¶ Because of small numbers of veterans in other racial/ethnic groups, vaccine effectiveness was estimated only for non-Hispanic Black and non-Hispanic White persons.

Summary

What is already known about this topic?

mRNA COVID-19 vaccines are effective in preventing severe COVID-19 outcomes, including hospitalization.

What is added by this report?

During February 1–August 6, 2021, vaccine effectiveness among U.S. veterans hospitalized at five Veterans Affairs Medical Centers was 87%. mRNA COVID-19 vaccines remain highly effective, including during periods of widespread circulation of the SARS-CoV-2 B.1.617.2 (Delta) variant. Vaccine effectiveness in preventing COVID-19–related hospitalization was 80% among adults aged ≥65 years compared with 95% among adults aged 18–64 years.

What are the implications for public health practice?

To protect against COVID-19–related hospitalization, all eligible persons should receive COVID-19 vaccination. Additional studies are needed to understand differences in COVID-19 vaccine effectiveness across age groups.

≥75 years, age-related differences in immunogenicity might have significantly contributed to lower estimated effectiveness in older persons. Additional evaluations of vaccine effectiveness across age groups, including the relationship between age and duration of protection, are warranted.

The findings in this report are subject to at least four limitations. First, although the five VAMCs included in this assessment were in diverse geographic locations, they are not representative of the entire veteran population or the general U.S. population. Second, despite the inclusion of 1,175 participants, the statistical power was insufficient to detect potential differences in vaccine effectiveness among all subgroups. Third, vaccine effectiveness estimates might be confounded by certain unmeasured behaviors, including mask use or time spent in congregate settings. Finally, the number of veterans in this sample who received the Janssen COVID-19 vaccine was too small to assess the effectiveness of this vaccine in preventing COVID-19–associated hospitalization.

These findings show that the COVID-19 mRNA vaccines remain highly effective for preventing COVID-19–associated hospitalization in this older, racially diverse population of predominantly male U.S. veterans, including during periods of widespread circulation of the SARS-CoV-2 Delta variant. However, vaccine effectiveness was lower among veterans aged ≥65 years than among those aged 18–64 years. Additional evaluations, particularly among older adults with high prevalences of underlying conditions, are important to assess vaccine effectiveness in these populations. COVID-19 vaccination of all eligible persons is essential to prevent COVID-19–associated hospitalizations.

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Surveillance Platform for Enteric and Respiratory Infectious Organisms at the VA (SUPERNOVA) COVID-19 Surveillance Group

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Notes from the Field

Xylazine Detection and Involvement in Drug Overdose Deaths — United States, 2019

Mbabazi Kariisa, PhD[1]; Priyam Patel, MSPH[1,2]; Herschel Smith, MPH[1,2]; Jessica Bitting, MS[1,3]

Xylazine is a drug used in veterinary medicine as an animal sedative with muscle relaxant and analgesic properties (*1*). It is not approved by the Food and Drug Administration for use in humans, in whom it acts as a central nervous system depressant and can cause respiratory depression, slowed heart rate, and hypotension (*2*). When used as a toxic adulterant in illicitly produced opioids such as fentanyl or heroin (*3*), xylazine might potentiate sedation and respiratory depression, increasing the risk for fatal overdose. In addition, because xylazine is not an opioid, it does not respond to opioid reversal agents such as naloxone; therefore, if illicit opioid products containing xylazine are used, naloxone might be less effective in fully reversing an overdose. Several states have reported increases in xylazine-involved overdose deaths; however, the prevalence of xylazine involvement in drug overdose deaths (overdose deaths) has not been extensively studied, particularly in the United States (*4*). To better understand the impact of xylazine adulteration on the evolving drug overdose epidemic in the United States, CDC analyzed unintentional and undetermined intent overdose death data from the State Unintentional Drug Overdose Reporting System (SUDORS) in 38 states and the District of Columbia (DC).*,†

A SUDORS case was defined as xylazine-positive if xylazine was detected on postmortem toxicology or if xylazine was listed on the death certificate as a contributing cause of death by the medical examiner or coroner based on postmortem toxicology detection, evidence of drug use at the scene, or witness reports of drug use. SUDORS cases in which xylazine is listed on the death certificate as a contributing cause of death by the medical examiner or coroner were defined as xylazine-involved. Thus, a xylazine-involved case would also be considered to be xylazine-positive by definition; however, a xylazine-positive case would not always mean that xylazine contributed to the death (i.e., xylazine-involved). Using data from 38 states and DC, CDC examined xylazine-positive and xylazine-involved overdose deaths that occurred during 2019. In addition, detailed narrative text for each case was reviewed for information about xylazine use or presence among drug products or paraphernalia found at the scene.

Among 45,676 overdose deaths reported to SUDORS during January–December 2019, xylazine-positive (826; 1.8%), and xylazine-involved (531; 1.2%) deaths were identified in 25 and 23 states, respectively. Xylazine was listed as a cause of death in 64.3% of deaths in which it was detected. The majority of xylazine-involved deaths were among males (73.1%), non-Hispanic White persons (75.4%), and from states in the Northeast Census region (67.0%).§ Among all xylazine-involved deaths, one or more other drugs, particularly illicit drugs, were also listed as a cause of death, and 98.7% of xylazine-positive deaths and 99.1% of xylazine-involved deaths had fentanyl (including analogs) listed as a cause of death. Cocaine and heroin were listed as a cause of death in 32.1% and 26.0% of xylazine-positive deaths respectively and in 29.6% and 28.4% of xylazine-involved deaths respectively (Table).

The findings in this report are subject to at least one limitation. Estimates of xylazine detection in overdose deaths might be underestimated. Data reviews revealed instances where xylazine presence was noted at the scene of the overdose but not detected on postmortem toxicology. Routine postmortem toxicology panels might not have included tests for xylazine, and current testing protocols for xylazine are not standard, which could result in missed detection (*5*).

During 2019, fewer than 2% of SUDORS overdose deaths from 38 states and DC were xylazine-positive. Xylazine contributed to death in approximately one half of deaths in which it was detected and was primarily co-involved with fentanyl. The detection of xylazine and its involvement in overdose deaths in multiple jurisdictions is concerning and warrants continued surveillance to inform overdose response and

*SUDORS captures data on fatal unintentional and undetermined intent overdoses. For all captured overdose deaths, SUDORS records all drugs detected by postmortem toxicology, even those not ruled by a medical examiner or coroner to have contributed to the death. A drug was recorded as contributing to death when the death certificate or medical examiner or coroner report listed the drug as a contributing factor.

†Thirty-eight states and DC reported data during January 2019–December 2019. Twenty-nine jurisdictions reported deaths that occurred during the entire period: Alaska, California, Connecticut, District of Columbia, Delaware, Georgia, Illinois, Indiana, Kentucky, Maine, Massachusetts, Minnesota, Missouri, Nevada, New Hampshire, New Jersey, New Mexico, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, Tennessee, Utah, Vermont, Virginia, Washington, West Virginia, and Wisconsin. Four additional states only reported deaths that occurred during January–June 2019: Florida, Louisiana, Maryland, and Michigan. Six states only reported deaths that occurred during July–December 2019: Arizona, Colorado, Kansas, Montana, Oregon, and South Dakota. Thirty-one jurisdictions abstracted data on all drug overdose deaths within the jurisdiction and seven states (California, Florida, Illinois, Indiana, Louisiana, Missouri, and Washington) abstracted data on deaths within a subset of counties accounting for at least 75% of that state's overdose deaths in 2017, or at least 1,500 overdose deaths. Data were current as of December 10, 2020.

§Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.

TABLE. Characteristics of drug overdose decedents with xylazine detected on postmortem toxicology (xylazine-positive) or listed as a cause of death (xylazine-involved) — State Unintentional Drug Overdose Reporting System, 38 states and the District of Columbia,* 2019

Characteristic	Classification of deaths, no. (%)	
	Xylazine-positive† (n = 826)	Xylazine-involved§ (n = 531)
Sex		
Male	602 (72.9)	388 (73.1)
Female	224 (27.1)	143 (26.9)
Race¶		
White, non-Hispanic	604 (74.8)	396 (75.4)
Black, non-Hispanic	106 (13.1)	68 (13.0)
Hispanic	90 (11.1)	—**
Other	11 (1.4)	—**
Age group, yrs		
15–24	60 (7.3)	41 (7.7)
25–34	265 (32.1)	181 (34.1)
35–44	227 (27.5)	138 (26.1)
45–54	147 (17.8)	91 (17.1)
55–64	109 (13.2)	—**
≥65	18 (2.2)	—**
U.S. Census region††		
Northeast	568 (68.8)	356 (67.0)
Midwest	144 (17.4)	91 (17.1)
South	104 (12.6)	—**
West	10 (1.2)	—**
Co-occurring drugs listed as a cause of death§§,¶¶		
Any fentanyl (including analogs)	815 (98.7)	526 (99.1)
Heroin***	215 (26.0)	151 (28.4)
Benzodiazepines	141 (17.1)	105 (19.8)
Prescription opioids†††	94 (11.4)	71 (13.4)
Cocaine	265 (32.1)	157 (29.6)
Alcohol	98 (11.9)	67 (12.6)
Methamphetamine	102 (12.4)	62 (11.7)

prevention efforts. Naloxone administration might not be as effective at fully reversing overdose-related signs and symptoms when xylazine and highly potent opioids such as fentanyl are present, although naloxone should always be administered. No pharmaceutical antidote is specific to xylazine, and immediate supportive care, especially respiratory and cardiovascular support, is critical in the event of an overdose when the presence of xylazine is suspected. Implementing routine standardized postmortem toxicology testing protocols for xylazine could help better elucidate the role of xylazine in drug overdose deaths.

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TABLE. (*Continued*) Characteristics of drug overdose decedents with xylazine detected on postmortem toxicology (xylazine-positive) or listed as a cause of death (xylazine-involved) — State Unintentional Drug Overdose Reporting System, 38 states and the District of Columbia,* 2019

Abbreviation: SUDORS = State Unintentional Drug Overdose Reporting System.

* Thirty-nine jurisdictions reported data during January–December 2019, including 29 that reported deaths that occurred during the entire period: Alaska, California, Connecticut, District of Columbia, Delaware, Georgia, Illinois, Indiana, Kentucky, Maine, Massachusetts, Minnesota, Missouri, Nevada, New Hampshire, New Jersey, New Mexico, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, Tennessee, Utah, Vermont, Virginia, Washington, West Virginia, and Wisconsin. Four additional states only reported deaths that occurred during January–June 2019: Florida, Louisiana, Maryland, and Michigan. Six states only reported deaths that occurred during July–December 2019: Arizona, Colorado, Kansas, Montana, Oregon, and South Dakota. Thirty-one jurisdictions abstracted data on all drug overdose deaths within the jurisdiction and seven states (California, Florida, Illinois, Indiana, Louisiana, Missouri, and Washington) abstracted data on deaths within a subset of counties accounting for at least 75% of that state's overdose deaths in 2017, or at least 1,500 overdose deaths. Data were current as of December 10, 2020.

† A SUDORS case was defined as xylazine-positive if xylazine was detected on postmortem toxicology or if xylazine was listed as a contributing cause of death by the medical examiner or coroner on the death certificate. The medical examiner or coroner determines if xylazine was involved or contributed to the death based on postmortem toxicology detection, evidence of drug use at the scene or witness reports of drug use.

§ SUDORS cases that had xylazine listed as a contributing cause of death by the medical examiner or coroner were defined as xylazine-involved. Thus, a xylazine-involved case would also be considered to be xylazine-positive by definition; however, a xylazine-positive case would not always mean that xylazine contributed to the death (i.e., xylazine-involved).

¶ Race and ethnicity data were missing for 15 xylazine-positive decedents. Race and ethnicity data were missing for six xylazine-involved decedents.

** Cells with ≤9 deaths are not reported. Some cells are not reported to prevent calculation of another suppressed cell.

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

§§ Identified as a cause of death by a medical examiner or coroner.

¶¶ Multiple drugs could be listed as a cause of death; therefore, drugs are not mutually exclusive.

*** Drugs coded as heroin were heroin and 6-monoacetylmorphine. In addition, morphine was coded as heroin if detected along with 6-acetylmorphine or if scene, toxicology, or witness evidence indicated presence of heroin impurities or other illicit drugs, injection, illicit drug use, or a history of heroin use.

††† Drugs coded as prescription opioids were alfentanil, buprenorphine, codeine, dextrorphan, hydrocodone, hydromorphone, levorphanol, loperamide, meperidine, methadone, morphine, noscapine, oxycodone, oxymorphone, pentazocine, prescription fentanyl, propoxyphene, remifentanil, sufentanil, tapentadol, and tramadol. Also included as prescription opioids were brand names (e.g., Opana) and metabolites (e.g., nortramadol) of these drugs and combinations of these drugs and nonopioids (e.g., acetaminophen-oxycodone). Morphine was included as prescription only if scene or witness evidence did not indicate likely heroin use and if 6-acetylmorphine was not also detected. Fentanyl was coded as a prescription opioid based on scene, toxicology, or witness evidence.

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Notes from the Field

Xylazine, a Veterinary Tranquilizer, Identified as an Emerging Novel Substance in Drug Overdose Deaths — Connecticut, 2019–2020

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Xylazine, a clonidine analog, is a nonopioid veterinary tranquilizer not intended for human use. Recreational drugs such as cocaine, heroin, and fentanyl are often adulterated with agents such as xylazine to enhance drug effects or increase street value by increasing net weight (*1*). Xylazine is known to cause hypotension and bradycardia when used in humans (*2*). Although not a controlled substance in the United States, xylazine cannot be purchased without a veterinary license. Misuse of xylazine was reported in Puerto Rico in the early 2000s (*3*). Recreational use of xylazine can occur via oral ingestion, inhalation or sniffing, or intravenous injection; however, injection is the most common route of administration (*2*). The effects of xylazine when used contemporaneously with other illicit drugs such as heroin, cocaine, and fentanyl are still not widely known (*2*). No antidote is recommended for the effects of xylazine overdose (*4*). One recent study suggests that high doses of naloxone might reverse the effects of a clonidine overdose (*5*). However, given that this finding is from a single study of a small cohort of pediatric patients, it might not be generalizable to the broader population (*5*). Furthermore, no reports specific to xylazine and naloxone exist regarding reversal of effects.

Routine drug screening is conducted for all suspected drug overdose deaths investigated by the Connecticut Office of the Chief Medical Examiner, and xylazine has been included in toxicology panels since 2013. Antemortem and postmortem specimens are collected by the Office of the Chief Medical Examiner; toxicology analysis is performed using liquid chromatography time-of-flight mass spectrometry and liquid chromatography-tandem mass spectrometry by National Medical Services Laboratories in Horsham, Pennsylvania.

During 2019, a total of 1,200 deaths from unintentional drug overdoses were reported in Connecticut; test results for 70 (5.8%) decedents were positive for xylazine. During January–July 2020, 666 deaths from drug overdoses were reported in Connecticut; test results for 76 (11.4%) were positive for xylazine. Among 146 xylazine-positive deaths during 2019 and 2020 (Table), test results for all but one (99.3%) were positive for fentanyl. Xylazine-associated deaths occurred primarily among males (80.9%) and non-Hispanic White

TABLE. Characteristics, circumstances, and co-occurring substances among overdose decedents with xylazine detected in postmortem toxicology — Connecticut, 2019–July 2020

Characteristic/Circumstance	No. (%)
Total	146 (100)
Sex	
Male	118 (80.9)
Female	28 (19.2)
Race/Ethnicity	
White, non-Hispanic	108 (74.0)
Black, non-Hispanic	10 (6.8)
Hispanic*	25 (17.1)
Other, non-Hispanic†	2 (1.4)
Unknown	1 (0.7)
Age group, yrs	
<25	8 (5.5)
25–34	41 (28.1)
35–44	39 (26.7)
45–54	24 (16.4)
≥55	34 (23.3)
Location of injury	
Home	110 (75.3)
Motel/Hotel	11 (7.5)
Residential institutes	6 (4.1)
Motor vehicle	4 (2.7)
Other§	15 (10.3)
Location of death	
Home	83 (56.8)
Hospital (DOA/ED/Inpatient)	38 (26.0)
Motel/Hotel	10 (6.8)
Friend's house	8 (5.5)
Other¶	7 (4.8)
History of substance misuse reported (opioid/nonopioid)	
Evidence	98 (67.1)
No evidence	48 (32.9)
Naloxone administration	
Naloxone given	27 (18.5)
Naloxone not given or unknown	119 (81.5)
Route of administration**	
Injection	58 (39.7)
Snorting	22 (15.1)
Smoking	20 (13.7)
Ingestion	6 (4.1)
Unknown	43 (29.5)
Co-occurrence of fentanyl	**145 (99.3)**
Fentanyl only	21 (14.4)
Fentanyl plus one or more other substances	124 (85.6)
Fentanyl and cocaine††	50 (34.2)
Fentanyl and heroin††	44 (30.1)
Fentanyl and alcohol††	33 (22.6)
Fentanyl and benzodiazepines††	38 (26.0)
Fentanyl and gabapentin††	18 (12.3)

Source: Office of the Chief Medical Examiner, Farmington, Connecticut.
Abbreviations: DOA = dead on arrival; ED = emergency department.
* Hispanic or Latino.
† Non-Hispanic American Indian or Alaska Native, Asian, or Native Hawaiian or Other Pacific Islander.
§ Park; vacant places; outdoor area; or unknown.
¶ Motor vehicle; park; halfway house; or outdoor area.
** Based on drug paraphernalia present at the scene.
†† Subgroups total to more than 100% because test results for some decedents were positive for multiple substances.

persons (74.0%). Mortality was highest among persons aged 25–34 years (28.1%), followed by those aged 35–44 (26.7%) and ≥55 years (23.3%). Fifty-seven percent of xylazine-associated deaths occurred at home, which was also the predominant location of overdose (75.3%). Twenty-six percent of deaths occurred at the hospital; naloxone was administered 18.5% of the time. Sixty-seven percent of decedents had a prior history of substance misuse. Based on drug paraphernalia found at the location of overdose, routes of administration were injection (39.7%), unknown (29.5%), snorting (15.1%), smoking (13.7%), and ingestion (4.1%). Toxicology analysis revealed that 85.6% of xylazine-fentanyl deaths included other substances: cocaine (34.2%), heroin (30.1%), benzodiazepines (26.0%), ethanol (22.6%), and gabapentin (12.3%).

These findings demonstrate a rising prevalence of xylazine-involved unintentional overdose deaths in Connecticut. The combination of xylazine with opioids or other recreational drugs might increase their toxic effects by potentiating sedation and causing respiratory depression, hypotension, and bradycardia (*1*,*2*). Awareness among health care professionals of issues related to xylazine is important because xylazine intoxication is unaffected by standard doses of naloxone, which is the usual treatment for suspected opioid intoxication (*6*). Xylazine intoxication might require additional interventions and appropriate supportive measures, which include blood pressure support with intravenous fluids, atropine, and extended hospital observation because of cardiac effects (*7*). The effects of xylazine when combined with fentanyl, heroin, or cocaine need further research to clarify adverse interactions and identify effective therapies. Given that xylazine is often reported in combination with fentanyl and heroin, naloxone administration is still advisable for suspected intoxications involving xylazine to treat the effects of opioids.

With funding from CDC, the State Public Health Laboratory is now capable of testing for xylazine and other illicit drugs in urine samples persons who experience nonfatal drug overdoses; the goals are to improve the timeliness of xylazine detection and better enable tracking of emerging drug trends in Connecticut. The testing of seized drugs by the Division of Scientific Services' forensic laboratory allows law enforcement agencies to track specific distributors of fentanyl-xylazine combinations. Because recent xylazine overdoses have occurred in Rhode Island and New Jersey, communicating and collaborating with other states will help identify drug trends, provide information that will enhance surveillance efforts to track emerging substances and guide prevention initiatives, and aid health care professionals to treat patients in a more timely and effective manner.

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Correction and Republication: New COVID-19 Cases and Hospitalizations Among Adults, by Vaccination Status — New York, May 3–July 25, 2021

On, August 18, 2021, *MMWR* published "New COVID-19 Cases and Hospitalizations Among Adults, by Vaccination Status — New York, May 3–July 25, 2021" (*1*). On August 25, 2021, the authors informed *MMWR* that some analyses were inaccurate because vaccination records of persons with a birth date between two vaccination dates could be counted as two distinct persons with different ages. This resulted in an artificial inflation of the population of partially vaccinated persons, which in turn affected the number of unvaccinated persons because that number is estimated as the total population size minus the fully vaccinated and the partially vaccinated groups. Programming code was adjusted to address this issue as well as three uncommon issues that had a relatively minor impact on findings. First, unvaccinated persons who received positive test results for SARS-CoV-2 who subsequently received a first vaccination dose were not always counted towards the tally of unvaccinated COVID-19 cases. Second, persons who received additional doses before such doses were authorized had their date of full vaccination assigned based on final dose date, rather than series completion date. Third, persons who received doses in both New York City and the other areas of New York required additional deduplication. Using current data from the continuously updated surveillance databases, the authors have corrected the *MMWR* report accordingly and confirmed that the interpretation and the conclusions of the original report were not affected by these changes (the updated results are highly similar to those of the primary analysis and sensitivity analyses as reported in the original paper). *MMWR* has republished the report (*2*), which includes the original report with clearly marked corrections in supplementary materials.

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New COVID-19 Cases and Hospitalizations Among Adults, by Vaccination Status — New York, May 3–July 25, 2021

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On August 18, 2021, this report was posted as an MMWR *Early Release on the* MMWR *website (https://www.cdc.gov/mmwr).*

Data from randomized clinical trials and real-world observational studies show that all three COVID-19 vaccines currently authorized for emergency use by the Food and Drug Administration* are safe and highly effective for preventing COVID-19–related serious illness, hospitalization, and death (*1*,*2*). Studies of vaccine effectiveness (VE) for preventing new infections and hospitalizations attributable to SARS-CoV-2, the virus that causes COVID-19), particularly as the B.1.617.2 (Delta) variant has become predominant, are limited in the United States (*3*). In this study, the New York State Department of Health linked statewide immunization, laboratory testing, and hospitalization databases for New York to estimate rates of new laboratory-confirmed COVID-19 cases and hospitalizations by vaccination status among adults, as well as corresponding VE for full vaccination in the population, across all three authorized vaccine products. During May 3–July 25, 2021, the overall age-adjusted VE against new COVID-19 cases for all adults declined from 91.8% to 75.0%. During the same period, the overall age-adjusted VE against hospitalization was relatively stable, ranging from 89.5% to 95.1%. Currently authorized vaccines have high effectiveness against COVID-19 hospitalization, but effectiveness against new cases appears to have declined in recent months, coinciding with the Delta variant's increase from <2% to >80% in the U.S. region that includes New York and relaxation of masking and physical distancing recommendations. To reduce new COVID-19 cases and hospitalizations, these findings support the implementation of a layered approach centered on vaccination, as well as other prevention strategies such as masking and physical distancing.

Four databases (the Citywide Immunization Registry, New York State Immunization Information System, Electronic Clinical Laboratory Reporting System, and Health Electronic Response Data System [HERDS]) were linked to construct a surveillance-based cohort of adults aged ≥18 years residing in New York by using individual name-based identifiers, date of birth, and zip code of residence. The Citywide Immunization Registry and the New York State Immunization Information System are used to collect and store all COVID-19 provider vaccination data for persons residing in New York City and the rest of the state, respectively (excluding selected settings such as Veterans Affairs and military health care facilities); persons were considered fully vaccinated ≥14 days after receipt of the final vaccine dose.† The Electronic Clinical Laboratory Reporting System collects all reportable COVID-19 test results (nucleic acid amplification test [NAAT] or antigen) in New York (*4*); a new COVID-19 case was defined as the receipt of a new positive SARS-CoV-2 NAAT or antigen test result, but not within 90 days of a previous positive result. HERDS includes a statewide, daily electronic survey of all inpatient facilities in New York; new admissions with a laboratory-confirmed COVID-19 diagnosis are entered into HERDS daily by trained hospital staff members.

After a period of phased COVID-19 vaccine eligibility based on age, occupation, setting, or comorbidities beginning in December 2020, all New York residents aged ≥60 years were eligible for vaccination by March 10, 2021; eligibility was expanded to persons aged ≥30 years by March 30, and to all adults aged ≥18 years by April 6.§ To allow time for a large portion of vaccinated persons to achieve full immunity, this study was restricted to the week beginning May 3 through the week beginning July 19, 2021.

Breakthrough infections were defined as new cases among persons who were fully vaccinated on the day of specimen collection. Hospitalizations among persons with breakthrough infection were defined as new hospital admissions among persons fully vaccinated on the reporting day. The total adult state population that was fully vaccinated and unvaccinated¶ was assessed for each day and stratified by age group (18–49 years, 50–64 years, and ≥65 years). Persons who were partially vaccinated were excluded from analyses. For each week and age group, the rates of new cases and hospitalizations were calculated among fully vaccinated and unvaccinated persons, by respectively dividing the counts for each group by the

*As of the publication date of this report, COVID-19 vaccines by Pfizer-BioNTech, Moderna, and Janssen (Johnson & Johnson) have been authorized by the Food and Drug Administration under Emergency Use Authorization.

† Final dose was the second dose for Pfizer-BioNTech and Moderna vaccines, first dose for Janssen vaccine.

§ https://www.governor.ny.gov/news/governor-cuomo-announces-new-yorkers-30-years-age-and-older-will-be-eligible-receive-covid-19

¶ The total adult state population that was unvaccinated was calculated as the total U.S. Census population, minus fully or partially vaccinated persons. Persons who were partially vaccinated were defined as those who initiated a vaccine series but did not complete it or were within 14 days after completion.

fully vaccinated and unvaccinated person-days in that week. Age-adjusted VE each week was estimated as the population-weighted mean of the age-stratified VE.** The interval between completing vaccination and positive SARS-CoV-2 test result date was summarized using the median, interquartile range (IQR), and percentage tested ≥7 days from being fully vaccinated.†† The ratio of hospitalizations to cases was computed for each vaccination group to understand the relative severity of cases. Statistical testing was not performed because the study included the whole population of interest and was not a sample.

By July 25, 2021, a total of 10,145,974 (65.6%) New York adults aged ≥18 years were fully vaccinated; 860,640 (5.6%) were partially vaccinated. Among fully vaccinated adults, 51.3% had received Pfizer-BioNTech, 39.9% had received Moderna, and 8.8% had received Janssen (Johnson & Johnson) vaccines. During May 3–July 25, a total of 9,664 new cases (1.31 per 100,000 person-days) occurred among fully vaccinated adults, compared with 42,507 (9.80 per 100,000 person-days) among unvaccinated adults (Table). Most (97.8%) new cases among fully vaccinated persons occurred ≥7 days after being classified fully vaccinated (median = 77 days; IQR = 49–103). During May 3–July 25, case rates among fully vaccinated persons were generally similar across age groups, as were case rates among unvaccinated persons, declining through the end of June before increasing in July (Figure 1). Weekly estimated VE against new laboratory-confirmed infection during May 3–July 25 for all age groups generally declined, going from 91.8% to 71.6% for persons aged 18–49 years, 92.9% to 78.0% for persons aged 50–64 years, and 90.5% to 80.0% for persons aged ≥65 years. During May 3–July 25, the overall, age-adjusted VE against infection declined from 91.8% to 75.0% (Figure 1) (Table).

A total of 1,285 new COVID-19 hospitalizations (0.17 per 100,000 person-days) occurred among fully vaccinated adults, compared with 7,288 (1.68 per 100,000 person-days) among unvaccinated adults (Table). Hospitalization rates generally declined through the week of July 5, but increased the weeks of July 12 and July 19, and were higher among fully vaccinated and unvaccinated persons aged ≥65 years compared with younger age groups (Figure 2). Age group–specific estimated VE against hospitalization remained stable, ranging from 89.1% to 97.1% for persons aged 18–49 years, from 89.8% to 96.1% for persons aged 50–64 years, and from 86.5% to 94.2% for persons aged ≥65 years. During May 3–July 25, the overall, age-adjusted VE against hospitalization was generally stable from 89.5% to 95.1% (Figure 2) (Table). The ratio of hospitalizations to cases was moderately lower among fully vaccinated (13.3 hospitalizations per 100 cases) compared with unvaccinated (17.1 hospitalizations per 100 cases) groups.

** For both outcomes, VE at each week and age group was calculated as 1-(Ratevaccinated / Rateunvaccinated).

†† The percentage tested ≥7 days from being fully vaccinated was included to inform possible undiagnosed infection before full vaccination was achieved.

TABLE. Vaccination coverage, new COVID-19 cases, and new hospitalizations with laboratory-confirmed COVID-19 among fully vaccinated and unvaccinated adults, and estimated vaccine effectiveness — New York, May 3–July 25, 2021

	Population*			New cases†					New hospitalizations§				
				Fully vaccinated		Unvaccinated			Fully vaccinated		Unvaccinated		
Week starting	Average no. fully vaccinated¶	Average no. unvaccinated	Full vaccination coverage, %	No.	Rate*	No.	Rate*	Estimated vaccine effectiveness, %	No.	Rate*	No.	Rate*	Estimated vaccine effectiveness, %
May 3	6,225,937	6,176,926	40.2	685	1.57	8,853	20.47	91.8	157	0.36	1,474	3.41	94.3
May 10	6,918,649	5,929,937	44.7	579	1.20	6,733	16.22	92.4	147	0.30	1,143	2.75	94.0
May 17	7,610,155	5,655,798	49.2	542	1.02	4,703	11.88	91.2	133	0.25	968	2.45	95.1
May 24	8,190,035	5,409,414	52.9	428	0.75	3,059	8.08	90.8	140	0.24	748	1.98	92.4
May 31	8,658,888	5,247,446	56.0	359	0.59	2,244	6.11	90.2	89	0.15	549	1.49	93.4
Jun 7	9,002,566	5,106,617	58.2	345	0.55	1,627	4.55	87.9	99	0.16	443	1.24	91.4
Jun 14	9,240,752	4,983,758	59.7	342	0.53	1,338	3.84	86.0	89	0.14	320	0.92	89.5
Jun 21	9,484,737	4,875,026	61.3	395	0.59	1,288	3.77	83.6	63	0.09	283	0.83	92.6
Jun 28	9,715,900	4,779,103	62.8	542	0.80	1,510	4.51	80.4	71	0.10	286	0.85	91.6
Jul 5	9,881,062	4,696,156	63.9	941	1.36	2,325	7.07	78.7	73	0.11	269	0.82	92.5
Jul 12	10,003,980	4,608,129	64.6	1,725	2.46	3,323	10.30	73.1	90	0.13	339	1.05	92.9
Jul 19	10,105,628	4,509,581	65.3	2,781	3.93	5,504	17.44	75.0	134	0.19	466	1.48	93.6
Total	—	—	—	**9,664**	**1.31**	**42,507**	**9.80**	—	**1,285**	**0.17**	**7,288**	**1.68**	—

* Population sizes fully vaccinated and unvaccinated were computed daily. For display purposes, the average populations fully vaccinated and unvaccinated are shown for each week. Rate calculations were conducted using daily population sizes and are expressed per 100,000 person-days. Persons partially vaccinated were excluded from analyses.

† New cases were defined as a new positive SARS-CoV-2 nucleic acid amplification test or antigen test result, not within 90 days of a previous positive result, reported to the Electronic Clinical Laboratory Reporting System, which collects all reportable COVID-19 test results in New York.

§ New hospitalizations were determined by a report of a hospital admission with a confirmed COVID-19 diagnosis, entered into the Health Electronic Response Data System, which includes a statewide, daily electronic survey of all inpatient facilities in New York.

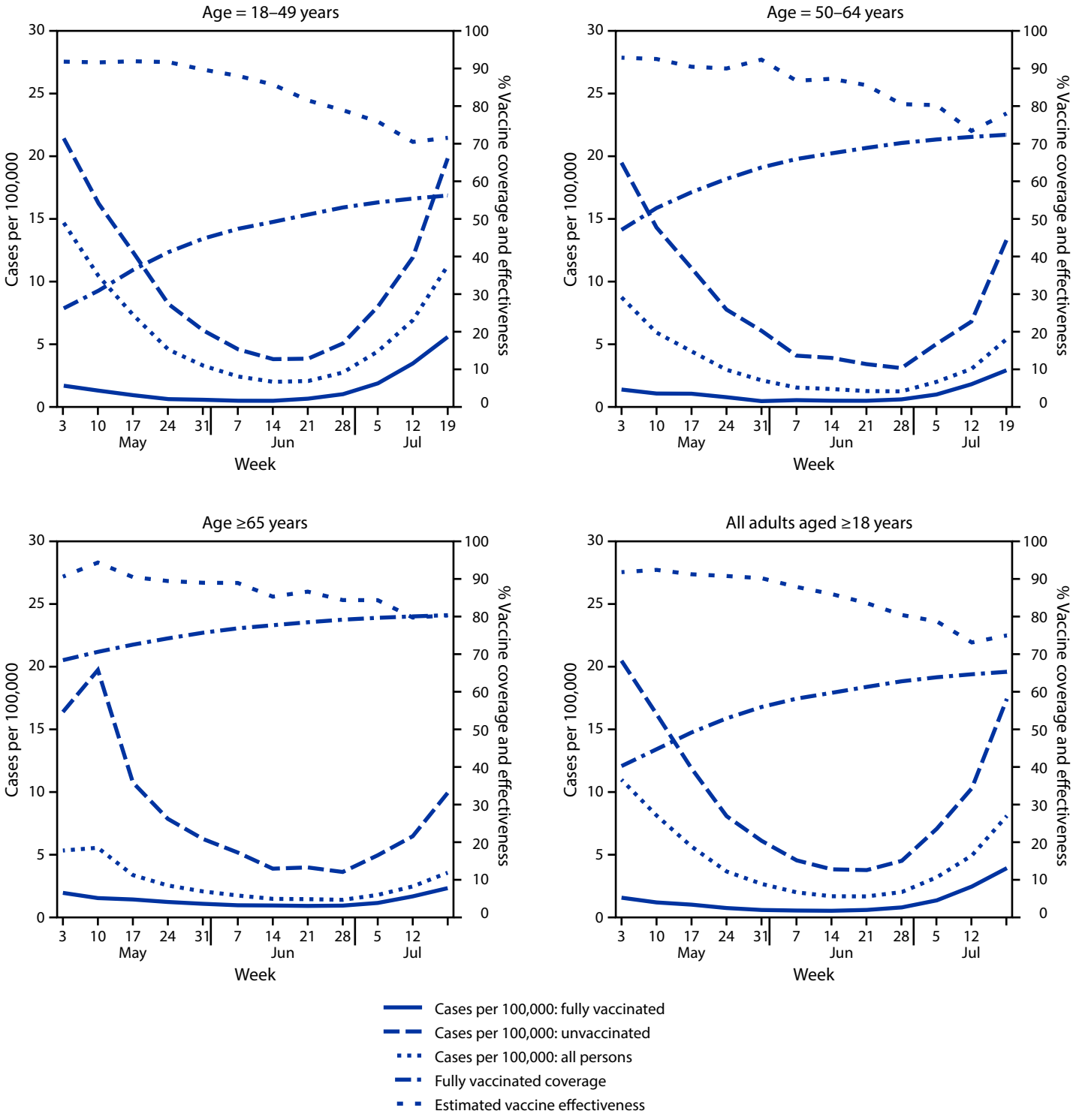
¶ Persons were determined to be fully vaccinated following 14 days after final vaccine-series dose receipt, per the Citywide Immunization Registry and the New York State Immunization Information System, which collect and store all COVID-19 vaccine receipt data by providers for persons residing in New York City and the rest of New York, respectively.

Discussion

In this study, current COVID-19 vaccines were highly effective against hospitalization (VE >89%) for fully vaccinated New York residents, even during a period during which prevalence of the Delta variant increased from <2% to >80% in the U.S. region that includes New York, societal public health restrictions eased,[§§] and adult full-vaccine coverage in

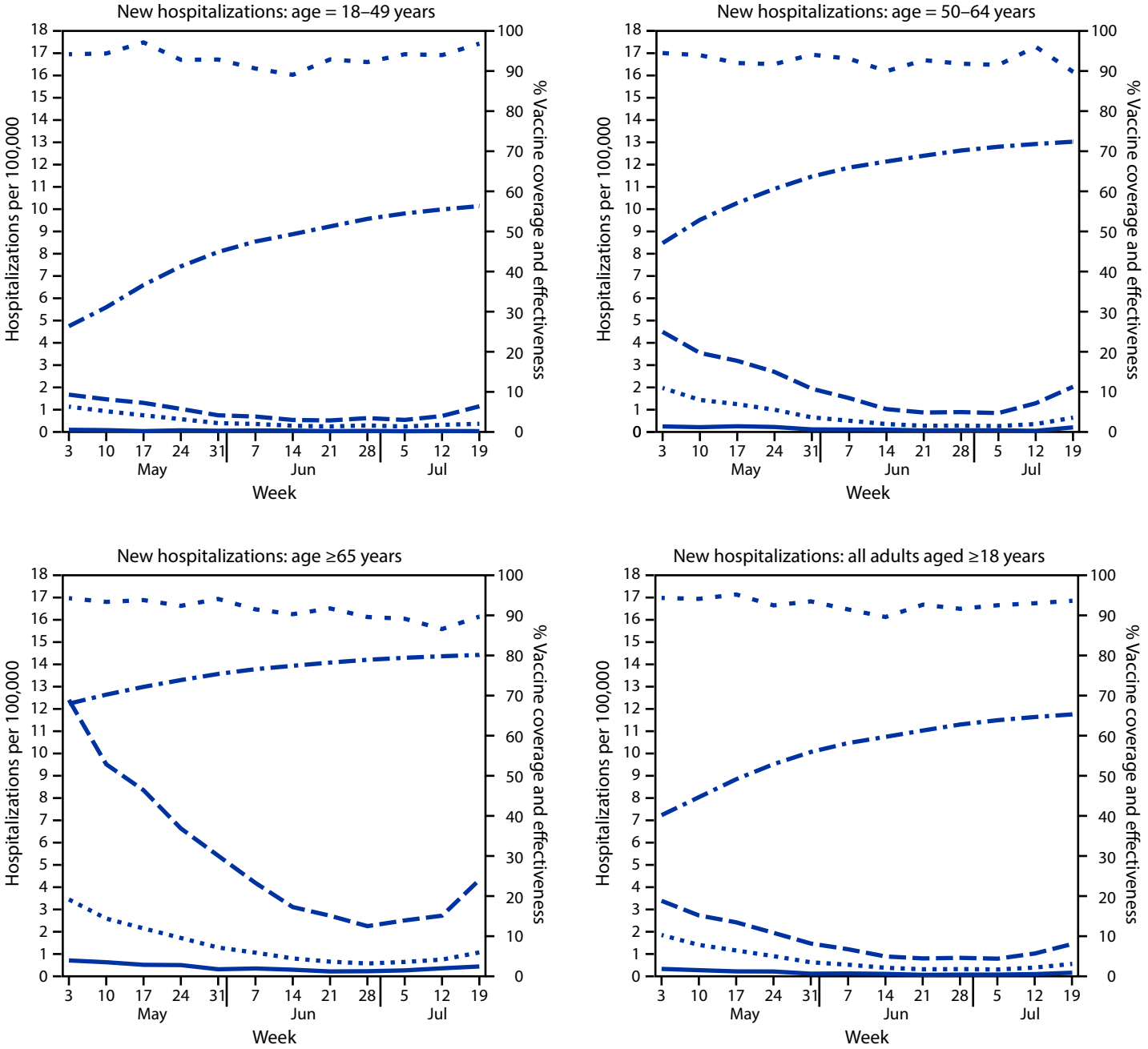
[§§] https://covid.cdc.gov/covid-data-tracker/#variant-proportions

FIGURE 1. New COVID-19 cases among fully vaccinated and unvaccinated adults, vaccine coverage, and estimated vaccine effectiveness, by age — New York, May 3–July 25, 2021



New York reached 65%. However, during the assessed period, rates of new cases increased among both unvaccinated and fully vaccinated adults, with lower relative rates among fully vaccinated persons. Moreover, VE against new infection declined from 91.8% to 75.0%. To reduce new COVID-19 cases and hospitalizations, these findings support the implementation of a layered approach centered on vaccination, as well as other prevention strategies.

FIGURE 2. New hospitalizations with laboratory-confirmed COVID-19 among fully vaccinated and unvaccinated adults, vaccine coverage, and estimated vaccine effectiveness, by age — New York, May 3–July 25, 2021



Summary

What is already known about this topic?

Real-world studies of population-level vaccine effectiveness against laboratory-confirmed SARS-CoV-2 infection and COVID-19 hospitalizations are limited in the United States.

What is added by this report?

During May 3–July 25, 2021, the overall age-adjusted vaccine effectiveness against hospitalization in New York was relatively stable 89.5%–95.1%). The overall age-adjusted vaccine effectiveness against infection for all New York adults declined from 91.8% to 75.0%.

What are the implications for public health practice?

These findings support the implementation of multicomponent approach to controlling the pandemic, centered on vaccination, as well as other prevention strategies such as masking and physical distancing.

The findings from this study are consistent with those observed in other countries. Israel has reported 90% VE for the Pfizer-BioNTech vaccine against hospitalization; however, a decline in VE against new diagnosed infections occurred during June 20–July 17 (decreasing to <65%) (*5*). Another study in the United Kingdom found higher VE against infection with the Delta variant for Pfizer-BioNTech (88%), which was lower than VE against the B.1.1.7 (Alpha) variant (94%) (*6*).

The factors driving the apparent changes in VE, including variations by age, are uncertain. Changes in immune protection from current vaccine product dosing regimens are under investigation,¶¶ with additional doses being considered (*7*). Increased Delta variant viral load might underpin its increased transmissibility and could potentially lead to reduced vaccine-induced protection from infection (*8*). Further, variations from clinical trial findings could be because the trials were conducted during a period before the emergence of new variants and when nonpharmaceutical intervention strategies (e.g., wearing masks and physically distancing) were more stringently implemented, potentially lessening the amount of virus to which persons were exposed. Other factors that could influence VE include indirect protective effects of unvaccinated persons by vaccinated persons and an increasing proportion of unvaccinated persons acquiring some level of immunity through infection (*9*).

The findings in this report are subject to at least six limitations. First, although limiting the analysis period to after universal adult vaccine eligibility and age stratification likely helped to reduce biases, residual differences between fully vaccinated and unvaccinated groups have the potential to reduce estimated VE. Second, the analysis excluded partially vaccinated persons, to robustly assess VE for fully vaccinated compared with that of unvaccinated persons. A supplementary sensitivity analysis that included partially vaccinated persons as unvaccinated yielded conservative VE for laboratory-confirmed infection (declining from 89.0% to 71.4%) and for hospitalizations (ranging from 87.7% to 93.6%). Third, exact algorithms were used to link databases; some persons were possibly not linked because matching variables were entered differently in the respective systems. Fourth, this study did not estimate VE by vaccine product, and persons were categorized fully vaccinated at 14 days after final dose, per CDC definitions; however, the Janssen vaccine might have higher efficacy at 28 days.*** Given that Janssen vaccine recipients accounted for 9% of fully vaccinated persons and the observed time period from full vaccination to infection (median 77 days), this would minimally affect the findings. Fifth, information on reasons for testing and hospitalization, including symptoms, was limited. However, a supplementary analysis found that among 1,285 fully vaccinated adults and 7,288 unvaccinated adults, 553 (43.0%) and 4,231 (58.1%), respectively, were reported to have been admitted for COVID-19 by hospital staff members using nonstandardized definitions. A sensitivity analysis of hospitalization VE limited to those admitted for COVID-19, found similar results (VE range = 92.5%–96.8%), suggesting that the extent of bias was limited. Finally, data were too sparse to reliably estimate VE for COVID-19-related deaths.

This study's findings suggest currently available vaccines have high effectiveness for preventing laboratory-confirmed SARS-CoV-2 infection and COVID-19 hospitalization. However, VE against infection appears to have declined in recent months in New York, coinciding with a period of easing societal public health restrictions††† and increasing Delta variant circulation (*8*). These findings support a multipronged approach to reducing new COVID-19 hospitalizations and cases, centered on vaccination, and including other approaches such as masking and physical distancing.

¶¶ https://www.medrxiv.org/content/10.1101/2021.07.28.21261159v1

*** https://www.fda.gov/media/146338/download

††† https://coronavirus.jhu.edu/data/state-timeline/new-confirmed-cases/new-york/205

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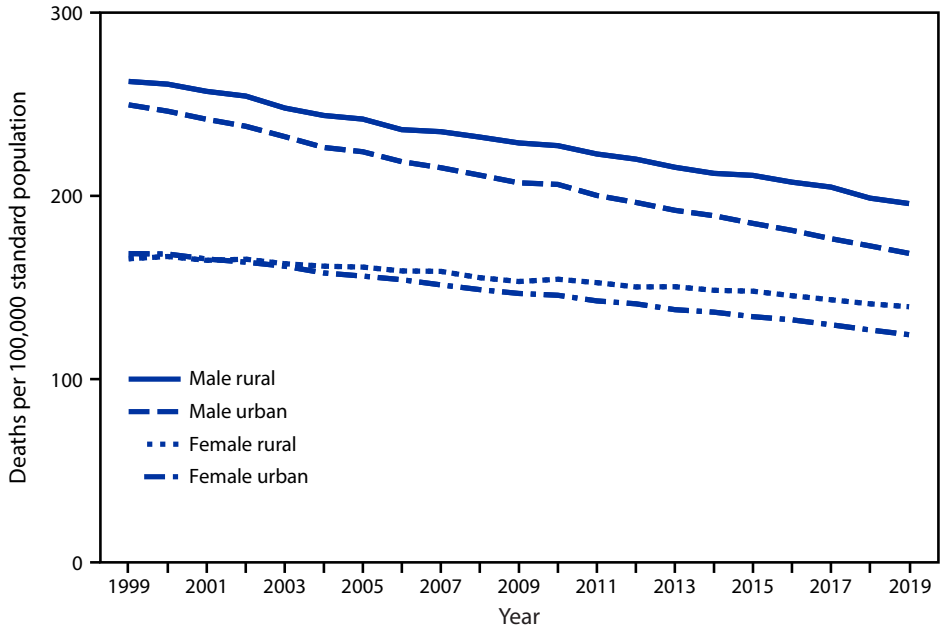
QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Age-Adjusted Death Rates* for Cancer, by Urban-Rural Status† and Sex — National Vital Statistics System, United States, 1999–2019



* Age-adjusted rates per 100,000 based on the 2000 U.S. standard population.
† Urban-rural status is determined by the Office of Management and Budget's February 2013 delineation of metropolitan statistical areas (MSAs), in which each MSA must have at least one urban area of ≥50,000 inhabitants. Areas with <50,000 inhabitants are grouped into the rural category.

Cancer death rates declined among males and females during 1999–2019 in urban areas from 249.6 per 100,000 to 168.4 for males and from 168.2 to 123.9 for females. Rates also declined in rural areas from 262.4 to 195.6 for males and from 165.4 to 139.2 for females. Throughout the period, cancer death rates were higher for males than females and in rural compared with urban areas, and the urban-rural differences widened over the period for both males and females.

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

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For more information on this topic, CDC recommends the following link: https://www.cdc.gov/cancer/dcpc/prevention/

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