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Progress Toward Rubella Elimination — World Health Organization European Region, 2005–2019

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In 2005, the Regional Committee of the World Health Organization (WHO) European Region (EUR) passed a resolution calling for the regional elimination of measles, rubella, and congenital rubella syndrome (CRS) (*1*). In 2010, all 53 countries in EUR* reaffirmed their commitment to eliminating measles, rubella, and CRS (*2*); this goal was included in the European Vaccine Action Plan 2015–2020 (*3*,*4*). Rubella, which typically manifests as a mild febrile rash illness, is the leading vaccine-preventable cause of birth defects. Rubella infection during pregnancy can result in miscarriage, fetal death, or a constellation of malformations known as CRS, which usually includes one or more visual, auditory, or cardiac defects (*5*). The WHO-recommended measles and rubella elimination strategies in EUR include 1) achieving and maintaining ≥95% coverage with 2 doses of measles- and rubella-containing vaccine (MRCV) through routine immunization services; 2) providing measles and rubella vaccination opportunities, including supplementary immunization activities (SIAs), to populations susceptible to measles or rubella; 3) strengthening surveillance by conducting case investigations and confirming suspected cases and outbreaks with laboratory results; and 4) improving the availability and use of evidence to clearly communicate the benefits and risks of preventing these diseases through vaccination to health professionals and the public (*6*). This report updates a previous report and describes progress toward rubella and CRS elimination in EUR during 2005–2019 (*7*). In 2000, estimated coverage with the first dose of a rubella-containing vaccine (RCV1) in EUR was 60%, and 621,039 rubella cases were reported (incidence = 716.9 per 1 million population). During 2005–2019, estimated regional coverage with RCV1 was 93%–95%, and in 2019, 31 (58%) countries achieved ≥95% coverage with the RCV1. During 2005–2019, approximately 38 million persons received an RCV during SIAs in 20 (37%) countries. Rubella incidence declined by >99%, from 234.9 cases per 1 million population (206,359 cases) in 2005 to 0.67 cases per 1 million population (620 cases) by 2019. CRS cases declined by 50%, from

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

* The European Region, with a population of approximately 900 million, is one of six WHO regions and comprises 53 countries: Albania, Andorra, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Luxembourg, Malta, Moldova, Monaco, Montenegro, Netherlands, North Macedonia, Norway, Poland, Portugal, Romania, Russia, San Marino, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Tajikistan, Turkey, Turkmenistan, Ukraine, United Kingdom, and Uzbekistan.

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16 cases in 2005 to eight cases in 2019. For rubella and CRS elimination in EUR to be achieved and maintained, measures are needed to strengthen immunization programs by ensuring high coverage with an RCV in every district of each country, offering supplementary rubella vaccination to susceptible adults, maintaining high-quality surveillance for rapid case detection and confirmation, and ensuring effective outbreak preparedness and response.

Immunization Activities

Since 2009, all 53 countries in EUR have included 2 RCV doses as part of a combination vaccine with measles and mumps (MMR)[†] or measles, mumps, and varicella (MMRV) vaccine in their routine childhood vaccination schedules. WHO and the United Nations Children's Fund (UNICEF) estimate annual vaccination coverage for all countries in the region using government-reported administrative coverage data (calculated as the number of doses administered divided by the estimated target population) and vaccination coverage surveys. During 2005–2019, estimated regional coverage with RCV1 was 93%–95%, and in 2019, 31 (58%) countries achieved ≥95% coverage with the first dose of RCV. In 2005, estimated regional coverage with the second dose of RCV was 76%; and in 2019, second dose coverage had risen to 91% (Table). In 2019, estimated national RCV2 coverage ranged from 76% to 99%. During 2005–2019, >38 million persons received RCV in 71 SIAs conducted in 20 (37%) countries.

Surveillance Activities

Rubella surveillance data are reported monthly to WHO from all EUR countries either directly or via the European Centre for Disease Prevention and Control. As of 2019, 47 (89%) countries reported case-based rubella surveillance data, and six (11%) countries reported aggregate data. Suspected rubella cases are investigated and classified as laboratory-confirmed, epidemiologically linked to a laboratory-confirmed case, clinically compatible, or discarded[§] (*6*). The WHO European Measles and Rubella Laboratory Network provides

[†] In November 2020, Tajikistan finalized transition from measles-rubella vaccine to MMR, resulting in the entire region using MMR.

[§] A suspected rubella case is one with signs and symptoms consistent with rubella clinical criteria: 1) maculopapular rash, and 2) cervical, suboccipital or post-auricular adenopathy, or arthralgia/arthritis. A laboratory-confirmed rubella case is a suspected case that meets the laboratory criteria for rubella surveillance case confirmation. An epidemiologically linked rubella case is a suspected case that has not been adequately tested by laboratory and that was in contact with a laboratory-confirmed rubella case 12–23 days before onset of the disease. A clinically compatible rubella case is a suspected case that has not been adequately tested by laboratory and has not been epidemiologically linked to a confirmed rubella case. A discarded case is a suspected case that was investigated and discarded, either through negative results of adequate laboratory testing for rubella or by an epidemiological link to a laboratory-confirmed case to another disease; in addition, IgM-positive cases in recent vaccine recipients can be discarded if they meet all of the following criteria: 1) history of vaccination with relevant vaccine 7 days to 6 weeks before specimen collection, 2) onset of rash 7–14 days after vaccination, 3) no evidence of virus transmission revealed by active search in community, and 4) no history of travel to areas in which the virus is known to be circulating.

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TABLE. Year of introduction, age at vaccination, and estimated coverage with the first and second doses of rubella–containing vaccine,* and number of rubella cases† and incidence,§ and congenital rubella syndrome cases, by country — World Health Organization European Region, 2005, 2015, and 2019

Country (year RCV introduced into routine immunization schedule)	2019 RCV schedule, age¶		2005				2015				2019			
			% Coverage		No. of rubella cases (incidence)§	No. of CRS cases	% Coverage		No. of rubella cases (incidence)§	No. of CRS cases	% Coverage		No. of rubella cases (incidence)§	No. of CRS cases
	1st dose	2nd dose	RCV1	RCV2			RCV1	RCV2			RCV1	RCV2		
Albania (2001)	12 mos	5 yrs	97	97	0 (—)	0	97	98	0 (—)	NR	95	**96**	0 (—)	0
Andorra (1988)	12 mos	3 yrs	94	NR	0 (—)	0	96	88	0 (—)	0	99	95	0 (—)	0
Armenia (2002)	12 mos	6 yrs	94	92	620 (207.9)	NR	97	97	0 (—)	0	95	96	0 (—)	0
Austria (1973)	9 mos	+1 mo after 1st dose	75	54	NR	NR	96	88	0 (—)	0	94	84	0 (—)	NR
Azerbaijan (2003)	12 mos	6 yrs	67	67	1,025 (120.0)	0	98	98	0 (—)	0	98	97	2 (0.2)	1
Belarus (1996)	12 mos	6 yrs	99	98	3,812 (398.6)	NR	99	99	1 (0.1)	0	98	98	0 (—)	0
Belgium (1985)	12 mos	10–12 yrs	88	NR	NR	0	96	85	0 (—)	0	96	95	0 (—)	0
Bosnia and Herzegovina (1980)	12 mos	6 yrs	90	90	43 (11.4)	0	83	88	12 (3.1)	NR	68	76	3 (0.9)	NR
Bulgaria (1993)	13 mos	12 yrs	96	92	1,968 (256.0)	0	92	87	0 (—)	5	93	87	0 (—)	0
Croatia (1975)	12 mos	4–6 yrs	96	98	3 (0.7)	0	93	96	0 (—)	0	93	95	0 (—)	0
Cyprus (1974)	12–15 mos	4–6 yrs	86	NR	0	0	90	88	2 (1.7)	0	86	88	0 (—)	0
Czechia (1983)	13 mos	5 yrs	97	98	8 (0.8)	0	99	99	1 (0.1)	0	92	94	0 (—)	0
Denmark (1987)	15 mos	4 yrs	95	91	0 (—)	0	91	80	0 (—)	0	96	90	0 (—)	0
Estonia (1992)	12 mos	13 yrs	96	98	6 (4.4)	0	93	92	0 (—)	0	88	90	0 (—)	0
Finland (1975)	12 mos	6 yrs	97	NR	0 (—)	0	95	93	10 (1.5)	1	96	93	0 (—)	0
France (1983)	12 mos	18 mos	87	NR	NR	NR	91	79	0 (—)	2	90	83	0 (—)	NR
Georgia (2004)	12 mos	5 yrs	90	87	1,841 (437.3)	1	96	91	100 (25.0)	0	99	97	9 (2.3)	0
Germany (1980)	11–14 mos	15–23 mos	96	91	NR	0	97	93	91 (1.1)	0	97	93	56 (0.7)	0
Greece (1995)	12–15 mos	2–3 yrs	96	NR	16 (1.4)	0	97	83	0 (—)	0	97	83	0 (—)	0
Hungary (1989)	15 mos	11 yrs	99	99	32 (3.2)	0	99	99	0 (—)	0	99	99	0 (—)	0
Iceland (1979)	18 mos	12 yrs	90	90	0 (—)	0	93	94	0 (—)	0	93	95	0 (—)	0
Ireland (1971)	12 mos	4–5 yrs	84	NR	17 (4.1)	0	93	91	9 (1.9)	0	92	90	0 (—)	0
Israel (1995)	12 mos	6 yrs	94	96	23 (3.5)	0	98	97	1 (0.1)	0	98	96	0 (—)	NR
Italy (1990)	13–15 mos	6 yrs	87	NR	171 (2.9)	NR	85	83	39 (0.6)	0	94	88	22 (0.4)	0
Kazakhstan (2004)	12 mos	6 yrs	99	96	8,783 (570.2)	0	99	98	2 (0.1)	0	99	98	5 (0.3)	0
Kyrgyzstan (2001)	12 mos	6 yrs	99	98	1 (0.2)	0	99	96	100 (16.8)	0	96	98	2 (0.3)	0
Latvia (1993)	12 mos	7 yrs	98	99	35 (15.5)	0	96	92	0 (—)	0	99	96	1 (0.5)	0
Lithuania (1992)	15–16 mos	6–7 yrs	97	95	118 (35.3)	0	94	92	0 (—)	0	93	93	0 (—)	0
Luxembourg (1995)	12 mos	15–23 mos	95	NR	NR	NR	99	86	0 (—)	0	99	90	0 (—)	NR
Malta (1985)	13 mos	3–4 yrs	86	60	6 (14.8)	0	89	91	0 (—)	0	96	95	0 (—)	0
Monaco (1970)	12 mos	16 mos	96	NR	NR	NR	89	79	0 (—)	NR	88	79	0 (—)	0
Montenegro (1994)	13 mos	6 yrs	NR	NR	NR	NR	64	94	0 (—)	NR	42	86	0 (—)	NR
Netherlands (1974)	14 mos	9 yrs	95	93	364 (22.2)	4	95	92	1 (0.6)	0	94	90	0 (—)	0
North Macedonia (1982)	12 mos	6 yrs	96	95	31 (15.0)	NR	89	93	1 (0.5)	NR	75	94	0 (—)	NR
Norway (1978)	15 mos	11 yrs	90	91	1 (0.2)	0	95	91	0 (—)	0	97	95	0 (—)	0
Poland (1994)	13–15 mos	10 yrs	98	90	7,946 (207.1)	0	96	94	2,029 (52.5)	–NR	93	92	292 (7.7)	NR
Portugal (1984)	12 mos	5 yrs	93	87	227 (21.6)	0	98	95	8 (0.7)	4	99	96	0 (—)	0
Moldova (2002)	12 mos	7 yrs	97	98	32 (7.7)	0	89	90	0 (—)	0	97	95	0 (—)	0
Romania (2004)	12 mos	5 yrs	97	96	6,801 (317.5)	1	86	80	18 (0.9)	4	90	76	4 (0.2)	7
Russia (2000)	12 mos	6 yrs	99	97	144,985 (1,009.0)	2	98	97	14 (0.1)	1	98	97	34 (0.2)	0
San Marino (1995)	15 mos	10 yrs	94	94	1 (430.3)	0	84	86	0 (—)	NR	86	79	0 (—)	0
Serbia (1993)	24 mos	7 yrs	96	98	153 (16.6)	NR	86	86	0 (—)	NR	87	91	0 (—)	0
Slovakia (1985)	14 mos	10 yrs	98	98	1 (0.2)	0	95	98	0 (—)	0	96	98	0 (—)	0
Slovenia (1972)	12 mos	5 yrs	94	99	0 (—)	0	94	96	0 (—)	0	94	94	0 (—)	0
Spain (1978)	12 mos	3–4 yrs	97	92	592 (13.4)	5	96	94	4 (0.1)	NR	98	94	4 (0.1)	0
Sweden (1982)	18 mos	6–8 yrs	96	95	0 (—)	0	98	95	0 (—)	0	97	95	0 (—)	0
Switzerland (1973)	12 mos	15–23 mos	87	71	NR	0	94	87	3 (0.4)	0	95	90	0 (—)	NR
Tajikistan (2009)	12 mos	6 yrs	85	92	1,231 (181.3)	NR	97	94	1 (0.1)	NR	98	97	0 (—)	NR
Turkey (1998)	12 mos	6 yrs	91	98	2,245 (33.1)	2	97	86	0 (—)	0	97	88	45 (0.5)	0
Turkmenistan (2007)	12–15 mos	6 yrs	98	99	498 (104.7)	NR	99	99	0 (—)	0	99	99	0 (—)	0
Ukraine (2001)	12 mos	6 yrs	96	96	22,248 (4,743.9)	0	56	57	0 (—)	NR	93	92	138 (3.14)	0
United Kingdom (1970)	12 mos	3–4 yrs	82	75	35 (0.6)	1	93	89	10 (0.2)	2	91	87	3 (<0.1)	0
Uzbekistan (2006)	12 mos	6 yrs	99	81	440 (16.6)	0	99	99	0 (—)	0	98	99	0 (—)	0
Total	—	—	—	—	**206,359 (234.9)**	**16**	**89**	**94**	**2,457 (2.7)**	**19**	**91**	**96**	**620 (0.7)**	**8**

Abbreviations: ASUs = annual status update reports; CRS = congenital rubella syndrome; NR = no report; RCV = rubella-containing vaccine; RCV1 = first RCV dose; RCV2 = second RCV dose; WHO = World Health Organization.

* Based on data from WHO–UNICEF Estimates of National Immunization Coverage, WHO–UNICEF Joint Reporting Form and ASUs from the Regional Verification Commission for measles and rubella elimination process. https://apps.who.int/immunization_monitoring/globalsummary/timeseries/tswucoveragedtp3.html

† Includes clinically compatible cases, laboratory confirmed cases, and epidemiologic linkage cases, as reported to the WHO European Regional Office database. https://www.euro.who.int/en/health–topics/disease–prevention/vaccines–and–immunization/publications/surveillance–and–data/who–epidata

§ Cases per 1 million population.

¶ WHO vaccine-preventable diseases monitoring systems. Last updated July 15, 2020. https://apps.who.int/immunization_monitoring/globalsummary/schedules?sc%5Br%5D%5B%5D=EURO&sc%5Bd%5D=&sc%5Bv%5D%5B%5D=MMR&sc%5Bv%5D%5B%5D=MMRV&sc%5Bv%5D%5B%5D=MR&sc%5Bv%5D%5B%5D=RUBELLA&sc%5BOK%5D=OK

laboratory confirmation and genotyping of rubella virus isolates from patients with reported cases (*7*). Important rubella case-based surveillance performance indicators include 1) the number of suspected cases discarded as nonmeasles or nonrubella (target: ≥2 per 100,000 population); 2) the percentage of case investigations conducted within 48 hours of report (target: ≥80%); 3) the percentage of suspected cases (excluding those that are epidemiologically linked) with an adequate specimen collected within 28 days of rash onset and tested in a WHO-accredited or proficient laboratory (target: ≥80%); and 4) the percentage of cases for which the origin of infection (i.e., the source of the virus) is determined (target: ≥80%) (*6*). During 2014–2019, the number of EUR countries that met the target for suspected cases discarded as nonrubella at the national level, a measure of surveillance sensitivity, increased from six (11%) in 2014 to 13 (25%) in 2019. From 2014 to 2019, the number of countries achieving the targets for timely investigations of suspected cases and adequate specimen collection increased from 29 (54%) to 34 (64%) and from 11 (21%) to 35 (65%), respectively.

Rubella Incidence and Genotypes

During 2005–2019, annual regional rubella incidence decreased from 234.9 per 1 million population (206,359 cases) in 2005 to 0.67 per 1 million population (620 cases) in 2019 (Table) (Figure 1). The highest rubella incidences in 2019 were in Poland, with 7.7 cases per 1 million population (292 cases) and Ukraine, with 3.1 cases per 1 million population (138 cases). The last documented rubella outbreaks in the region during this period were reported from Romania in 2012 (1,873 cases) and Poland in 2013 (38,548 cases). During 2013–2019, reported rubella cases dropped substantially and occurred as sporadic cases or small clusters, rather than as ongoing transmission or outbreaks. In 2005, 16 CRS cases were reported from seven countries; in 2019, only eight CRS cases were reported from Azerbaijan (one case) and Romania (seven cases) (Table). Genotyping of rubella viruses in the region has been limited; during 2005-2019, EUR reported only 143 rubella virus sequences to the WHO global rubella nucleotide sequence database, providing insufficient data to contribute substantially to determination of elimination of endemic rubella virus transmission nationally or regionally.

Regional Verification Commission and Progress Toward Elimination

The European Regional Verification Commission for Measles and Rubella Elimination (EU-RVC) was established in 2011 to evaluate the status of measles and rubella elimination in EUR countries based on documentation submitted annually by national verification committees (*8,9*). By the end of 2019, 45 (85%) countries had sustained interruption for ≥36 months and were verified to have eliminated endemic rubella virus transmission (Figure 2).

Discussion

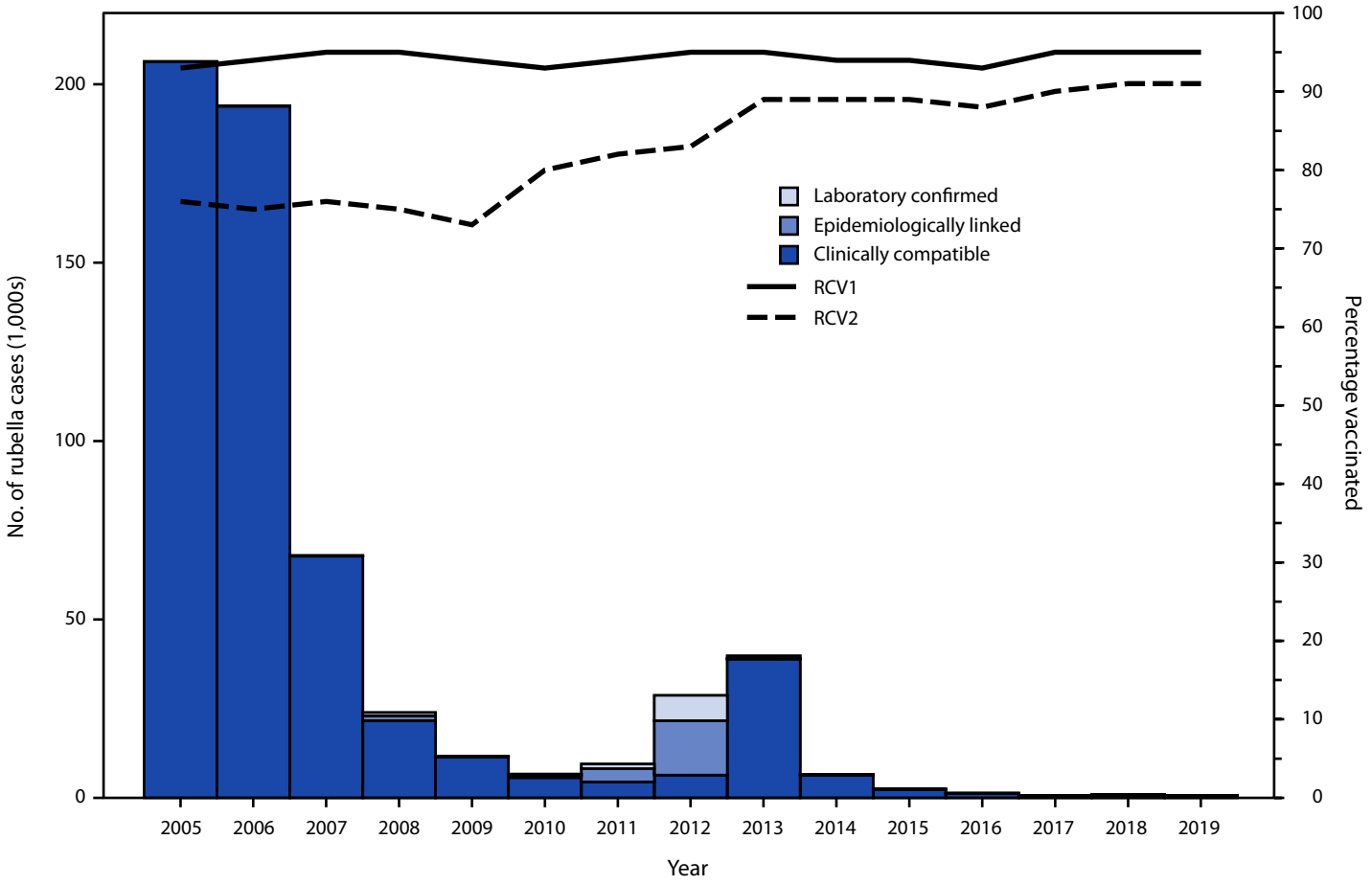
After the 2005 WHO Regional Committee resolution that called for regional elimination of rubella and CRS, EUR has made substantial progress with high reported regional RCV coverage, low rubella incidence, and verification that nearly all countries have achieved elimination of endemic transmission of rubella viruses. EUR countries have shown their commitment to the elimination of measles and rubella and CRS with the Regional Committee resolution in 2005 and reaffirmed that commitment with resolutions in 2010 and 2014 (*1–3*). All EUR countries have longstanding 2-dose routine RCV immunization schedules that have provided a substantial foundation for establishing population immunity against rubella viruses. Regional rubella coverage with the first and second doses of RCVs has exceeded 93% and 80%, respectively, for the past 10 years. Immunization gaps account for sporadic rubella cases reported in 2019 and have not resulted in confirmed ongoing transmission of rubella viruses.

One of the considerable challenges with verifying rubella elimination has been classifying the large number of clinically compatible rubella cases. In part because rubella is typically a mild disease, a laboratory test is not always performed to confirm a diagnosis, and testing varies considerably across the region according to public health systems, clinical practice, and laboratory capacities. Without a confirmatory laboratory test result, suspected cases are classified as clinically compatible. Increased testing and efficiencies of subnational laboratory networks have contributed to improvements in the surveillance indicators and case classification, but additional efforts are needed.

Rubella population immunity estimates across the region based on longstanding national immunization coverage rates are well above the rubella herd immunity threshold of 83%–86%, which should disrupt chains of transmission and stop or slow the spread of disease (*10*). However, subnational immunization gaps pose a risk for importation and circulation of rubella viruses. Efforts to eliminate endemic transmission of rubella have benefited substantially from the national and subnational outbreak response immunization campaigns for measles cases with combined measles- and rubella-containing vaccines, particularly for large measles outbreaks during 2017–2020.

Retrospective rubella reviews for the verification process provided an opportunity to focus on the specific documentation needed to support the elimination of endemic rubella virus transmission and consisted of an in-depth analysis of

FIGURE 1. Confirmed rubella cases,* by year of rash onset and confirmation method, and estimated regional coverage through routine vaccination programs with first and second doses of rubella-containing vaccine† — World Health Organization European Region, 2005–2019



Abbreviations: RCV1 = first dose of a rubella-containing vaccine; RCV2 = second dose of a rubella-containing vaccine; WHO = World Health Organization.

* Confirmed rubella cases reported by countries and areas to WHO. A case of rubella was laboratory-confirmed when rubella-specific immunoglobulin M antibody was detected in serum, rubella-specific RNA was detected by polymerase chain reaction testing, or rubella virus was isolated in cell culture in a person who had not been vaccinated in the 30 days before rash onset; a case of rubella was confirmed by epidemiologic linkage when a case of febrile rash illness was linked in time and place to a laboratory-confirmed rubella case. A clinically compatible rubella case is a suspected case that has not been adequately tested by laboratory and has not been epidemiologically linked to a confirmed rubella case.

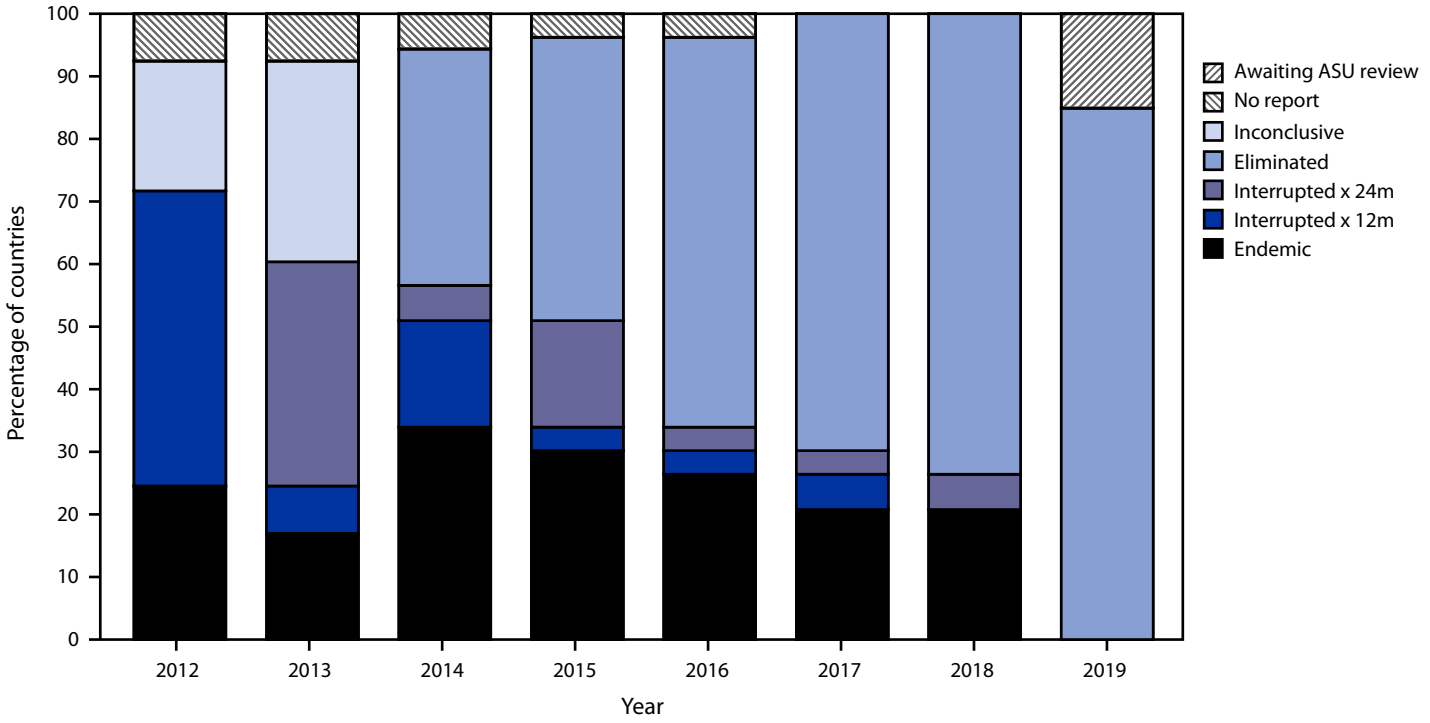
† WHO and United Nations Children's Fund Estimates of National Immunization Coverage, July 15, 2020. https://apps.who.int/immunization_monitoring/globalsummary/timeseries/tswucoveragedtp3.html

information provided in the annual status update reports and supplementary information from national immunization programs, surveillance networks, and the measles-rubella laboratory networks. The retrospective reviews were shared with the EU-RVC members on an ad hoc basis and provided an opportunity to ask for clarification or additional information before drawing conclusions about a country's rubella elimination status. Data to complete the rubella retrospective reviews for the last four countries with endemic rubella transmission (Bosnia and Herzegovina, Italy, Poland, and Ukraine) are being collected, analyzed, and formatted for submission to the RVC for their determination.

The findings in this report are subject to at least three limitations. First, sensitivity of integrated measles and rubella surveillance might be lower for rubella than it is for measles because it is a milder illness, resulting in possible detection of fewer cases. Second, direct comparisons between countries might not be valid because of variations in their historic approach to diagnosis, case investigation, and laboratory testing. Finally, the region comprises countries with widely different population sizes and compositions, making regional successes and challenges difficult to measure.

Substantial progress toward rubella elimination has been made in EUR. Verification of elimination is nearly complete, which would make EUR the second WHO region to achieve

FIGURE 2. Rubella elimination status, by verification category* — World Health Organization European Region, 2012–2019



Abbreviation: ASU = annual status update; WHO = World Health Organization.

* Verification categories as determined by the European Verification Commission for Measles and Rubella (EU-RVC). *Elimination*: Sustained interruption of rubella virus chains of transmission for >36 months. *Interrupted x 24m*: Sustained interruption of rubella virus chains of transmission for >24 months. *Interrupted x 12m*: Sustained interruption of rubella virus chains of transmission for >12 months. *Endemic*: Continuous transmission of rubella virus(es) that persist for >12 months. *Inconclusive*: ASU submitted but the EU-RVC was unable to reach a conclusion regarding elimination. *No report*: No ASU submitted for review by the EU-RVC. *Awaiting ASU review*: ASU not submitted to the EU-RVC but with plans to submit. Delays in submission of 2019 ASU were because of COVID-19 response activities and limited staff member availability; additional time and support has been provided to these countries by the WHO Regional Office.

Summary

What is already known about this topic?

In 2000, estimated coverage with the first dose of a rubella-containing vaccine (RCV1) in the World Health Organization European Region (EUR) was 60%, and 621,039 rubella cases were reported (incidence = 716.9 per 1 million population).

What is added by this report?

During 2005–2019, estimated EUR RCV1 coverage was 93%–95%. In 2019, 31 (58%) countries had achieved ≥95% RCV1 coverage. Rubella incidence declined from 234.9 cases per 1 million population in 2005 to 0.7 cases per 1 million population by 2019.

What are the implications for public health practice?

Sustaining regional rubella elimination will require maintaining high coverage with rubella-containing vaccines through routine immunization, offering supplementary rubella vaccination to susceptible adults, and maintaining high-quality surveillance.

rubella elimination, the first being the Region of the Americas. Sustaining regional rubella elimination will require maintaining high coverage with RCVs through routine immunization programs at the national and subnational levels, offering supplementary rubella vaccination to susceptible adults, maintaining high-quality laboratory-supported rubella and CRS surveillance for outbreak detection and response, and a fully functioning Regional Verification Commission. Because of the COVID-19 pandemic, additional efforts might be needed to strengthen surveillance systems and fill in the immunity gaps.

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Impact of the COVID-19 Pandemic on Administration of Selected Routine Childhood and Adolescent Vaccinations — 10 U.S. Jurisdictions, March–September 2020

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After the March 2020 declaration of the COVID-19 pandemic in the United States, an analysis of provider ordering data from the federally funded Vaccines for Children program found a substantial decrease in routine pediatric vaccine ordering (*1*), and data from New York City and Michigan indicated sharp declines in routine childhood vaccine administration in these areas (*2*,*3*). In November 2020, CDC interim guidance stated that routine vaccination of children and adolescents should remain an essential preventive service during the COVID-19 pandemic (*4*,*5*). To further understand the impact of the pandemic on routine childhood and adolescent vaccination, vaccine administration data during March–September 2020 from 10 U.S. jurisdictions with high-performing* immunization information systems were assessed. Fewer administered doses of routine childhood and adolescent vaccines were recorded in all 10 jurisdictions during March–September 2020 compared with those recorded during the same period in 2018 and 2019. The number of vaccine doses administered substantially declined during March–May 2020, when many jurisdictions enacted stay-at-home orders. After many jurisdictions lifted these orders, the number of vaccine doses administered during June–September 2020 approached prepandemic baseline levels, but did not increase to the level that would have been necessary to catch up children who did not receive routine vaccinations on time. This lag in catch-up vaccination might pose a serious public health threat that would result in vaccine-preventable disease outbreaks, especially in schools that have reopened for in-person learning. During the past few decades, the United States has achieved a substantial reduction in the prevalence of vaccine-preventable diseases driven in large part to the ongoing administration of routinely recommended pediatric vaccines. These efforts need to continue even during the COVID-19 pandemic to reduce the morbidity and mortality from vaccine-preventable diseases. Health care providers should assess the vaccination status of all pediatric patients, including adolescents, and contact those who are behind schedule to ensure that all children are fully vaccinated.

Immunization information systems are confidential, computerized, population-based databases that consist of consolidated data on provider-administered vaccinations collected from 64 jurisdictions† nationwide. Information from these systems can be used to track administered vaccines and measure vaccination coverage (*6*). Data were analyzed from 10 jurisdictions (Idaho, Iowa, Louisiana, Michigan, Minnesota, New York City, North Dakota, Oregon, Washington, and Wisconsin) with high-performing immunization information systems.

Numbers of vaccine doses administered weekly were measured during two periods: March–May 2020, and June–September 2020. These two periods were selected because many jurisdictions implemented and then lifted stay-at-home orders during these periods. During March–May 2020, eight of the 10 jurisdictions implemented some form of stay-at-home order (no orders were issued in Iowa and North Dakota) (Supplementary Table, https://stacks.cdc.gov/view/cdc/106855) (*7*). For each jurisdiction, the weekly percent change between the number of vaccine doses administered in 2020 and those administered in 2018 and 2019 was calculated. In addition, for each jurisdiction, the median and range of the weekly percent change for March–May 2020 and June–September 2020 were calculated. Finally, the overall median of the median weekly percentage was calculated for each period (referred to as the median in this report) to determine the overall impact across all 10 jurisdictions. The following routinely recommended childhood and adolescent vaccines,§ by targeted age groups, were analyzed: diphtheria, tetanus, and acellular pertussis (DTaP) for children aged 0–23 months and children aged 2–6 years; measles, mumps, and rubella (MMR) for children aged 12–23 months and children aged 2–8 years;

* A high-performing immunization information system was defined as a system with vaccine estimates within 10 percentage points of those from the 2018 National Immunization Survey-Child and National Immunization Survey-Teen immunization information systems, and which recorded ≥90% of doses administered to persons aged <19 years that were submitted and processed within 30 days of vaccine administration.

† The 64 immunization information systems jurisdictions consist of 50 U.S. states, eight U.S. territories and freely associated states (Puerto Rico, U.S. Virgin Islands, American Samoa, Northern Mariana Islands, Guam, Marshall Islands, Palau, and the Federated States of Micronesia), and six local jurisdictions (Chicago, Illinois; Houston, Texas; San Antonio, Texas; Philadelphia, Pennsylvania; New York City, New York; and Washington, DC).

§ https://www.cdc.gov/vaccines/schedules/hcp/imz/child-adolescent.html

human papillomavirus (HPV) for children aged 9–12 years and adolescents aged 13–17 years; and tetanus, diphtheria and acellular pertussis (Tdap) for adolescents aged 13–17 years. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.¶

During March–May 2020, vaccine doses administered to children and adolescents substantially decreased for all vaccines examined across the 10 jurisdictions compared with the same period in 2018 and 2019 (Table 1) (Table 2). Among children aged <24 months and children aged 2–6 years, DTaP doses administered declined an overall median of 15.7% and 60.3%, respectively, across all jurisdictions compared with the same period during 2018 and 2019 (Table 1). During March–May 2020, MMR doses administered to children aged 12–23 months and children aged 2–8 years declined a median of 22.4% and 63.1%, respectively. Among children aged 9–12 years and adolescents aged 13–17 years, HPV doses administered declined a median of 63.6% and 71.3%, respectively during March–May 2020 compared with doses administered during the same period in 2018 and 2019 (Table 2). Doses of Tdap administered during this period in 2020 decreased a median of 66.4% among children aged 9–12 years and 61.4% among adolescents aged 13–17 years compared with 2018 and 2019.

During June–September 2020, after most stay-at-home orders had been lifted, the number of weekly routine pediatric vaccine doses administered increased initially, approaching or even surpassing baseline prepandemic levels in most of the 10 jurisdictions, with some differences by jurisdiction, vaccine type, and age. However, across all age groups and across all vaccine types, none of the jurisdictions demonstrated a sustained or prolonged increase in the number of weekly doses administered above prepandemic administration levels, which would have been necessary to catch up children and adolescents who missed routine vaccinations (Figure). Among children aged

¶ 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.

TABLE 1. Median weekly percent change* in diphtheria, tetanus, and acellular pertussis vaccine doses administered to children aged <24 months and aged 2–6 years and in measles, mumps, and rubella vaccine doses administered to children aged 12–23 months and aged 2–8 years compared with the average number of doses administered during the same period in 2018 and 2019 — 10 U.S. jurisdictions, March–September 2020

	% Change, median (range)			
Vaccine/Age/U.S. jurisdiction	**Mar–May**		**Jun–Sep**	
DTaP vaccine				
Age group	**<24 mos**	**2–6 yrs**	**<24 mos**	**2–6 yrs**
Idaho	−8.7 (−32.1 to 7.0)	−39.2 (−75.2 to −11.2])	−11.0 (−23.2 to 4.8)	−4.3 (−28.3 to 42.7)
Iowa	−15.7 (−35.7 to 1.1)	−51.5 (−75.3 to 0.6)	−10.4 (−32.5 to 9.7)	−10.5 (−31.4 to 33.9)
Louisiana	−11.6 (−46.3 to 9.9)	−57.9 (−85.3 to 7.2)	−9.0 (−36.6 to 14.5)	−4.3 (−39.2 to 29.5)
Michigan	−21.6 (−55.6 to −6.1)	−62.6 (−88.2– to −7.8)	−6.9 (−24.4 to 15.7)	−10.7 (−33.6 to 26.5)
Minnesota	−15.7 (−41.2 to −6.7)	−63.4 (−91.0 to 7.0)	−10.5 (−33.6 to 16.7)	−7.0 (−28.2 to 25.9)
New York City	−27.2 (−66.1 to −3.6)	−74.9 (−94.5 to −4.1)	−7.5 (−26.8 to 4.1)	−6.4 (−37.2 to 16.1)
North Dakota	−11.1 (−41.3 to 0.0)	−20.5 (−76.7 to 23.6)	−6.5 (−18.6 to 19.6)	24.9 (−6.9 to 106.3)
Oregon	−14.1 (−38.3 to −3.9)	−60.6 (−81.1 to −12.3)	−9.2 (−41.5 to 10.4)	−8.4 (−51.4 to 18.9)
Washington	−17.0 (−42.1 to −5.0)	−60.1 (−82.9 to −20.0)	−8.5 (−30.4 to −0.6)	−9.0 (−28.0 to 6.5)
Wisconsin	−21.6 (−38.8 to 9.2)	−70.8 (−90.3 to −7.2)	−9.5 (−22.8 to 2.1)	−5.3 (−27.4 to 27.3)
Median of medians†	**−15.7**	**−60.3**	**−9.1**	**−6.7**
MMR vaccine				
Age group	**12–23 mos.**	**2–8 yrs**	**12–23 mos**	**2–8 yrs**
Idaho	−15.3 (−48.8 to 12.4)	−39.8 (−77.5 to −11.3)	−8.8 (−20.7 to 11.5)	−7.1 (−30.4 to 42.5)
Iowa	−23.7 (−38.8 to −4.7)	−52.4 (−74.9 to 0.7)	−8.8 (−30.5 to 17.2)	−11.6 (−32.1 to 34.3)
Louisiana	−18.0 (−53.5 to 4.3)	−59.9 (−85.1 to 4.5)	−12.1 (−47.6 to 12.0)	−5.1 (−41.4 to 27.2)
Michigan	−32.3 (−66.4 to −6.9)	−65.3 (−90.9 to −8.9)	−6.8 (−25.3 to 29.0)	−16.9 (−34.6 to 20.8)
Minnesota	−22.5 (−51.5 to −9.5)	−66.5 (−92.3 to −2.9)	−9.0 (−31.4 to 9.1)	−3.4 (−26.8 to 33.1)
New York City	−42.8 (−80.6 to −10.4)	−82.2 (−95.5 to −17.4)	−7.1 (−25.9 to 8.0)	−20.5 (−52.2 to 11.5)
North Dakota	−22.3 (−47.0 to 21.0)	−55.3 (−80.4 to 6.0)	−7.2 (−18.5 to 35.5)	−11.0 (−22.0 to 46.0)
Oregon	−20.8 (−58.4 to 4.4)	−62.7 (−82.4 to −24.5)	−9.8 (−43.1 to 12.8)	−15.6 (−54.8 to 7.7)
Washington	−19.2 (−55.7 to −2.3)	−63.5 (−85.3 to −27.8)	−9.3 (−32.8 to −1.3)	−17.2 (−37.3 to −2.5)
Wisconsin	−25.2 (−54.7 to 19.2)	−74.4 (−91.1 to −11.0)	−5.2 (−28.3 to 23.5)	−8.0 (−28.3 to 22.5)
Median of medians†	**−22.4**	**−63.1**	**−8.8**	**−11.3**

Abbreviations: DTaP = diphtheria, tetanus, and acellular pertussis; MMR = measles, mumps, and rubella.

* For each jurisdiction, the weekly percentage change between the number of vaccine doses administered March–September 2020 and those administered March–September in 2018 and 2019 was calculated. In addition, for each jurisdiction the median and range of the weekly percentage change for March–May 2020 and June–September 2020 were calculated.

† The overall median of the median weekly percentage was calculated for each period to determine the overall impact across all 10 jurisdictions

<24 months and aged 2–6 years, administration of DTaP vaccine declined a median of 9.1% and 6.7%, respectively during June–September 2020, compared with the same period during 2018 and 2019. Among children aged 12–23 months and aged 2–8 years, administration of MMR vaccine decreased 8.8% and 11.3%, respectively compared with 2018 and 2019. During the same period, among children aged 9–12 years and adolescents aged 13–17 years, administration of HPV vaccine decreased a median of 12.2% and 28.1%, respectively, and among the same age groups, Tdap vaccine administration decreased a median of 21.3% and 30.0%, respectively, compared with the average during the same period in 2018 and 2019.

Discussion

In 10 U.S. jurisdictions with high-performing immunization information systems, vaccine administration data indicated that administered doses of routine childhood and adolescent vaccines were substantially lower during March–May 2020 compared with the average administered during the same period in 2018 and 2019. This decline, which is consistent with other data sources indicating a similar decrease in routine pediatric vaccine ordering, corresponded to the enactment of stay-at-home orders in many jurisdictions (*1*). Although vaccine administration rebounded during June–September 2020, approaching prepandemic levels in most jurisdictions, this increase was not sufficient to achieve the catch-up vaccination needed to address the many months when children missed routine vaccination.

Several factors might explain this lag in catch-up vaccination. Depending on case rates in certain jurisdictions, fear of contracting COVID-19 in the health care facility or the community during the pandemic might have prevented some parents from seeking routine pediatric care for their children (*8*). Jurisdictions might have differed in the duration or enforcement of stay-at-home orders or in the prevalence of COVID-19 cases at different time points. In addition, the rapid transition to virtual learning because of the COVID-19

TABLE 2. Median weekly percent change* in human papillomavirus vaccine doses administered to children aged 9–12 years and adolescents aged 13–17 years and change in tetanus, diphtheria, and acellular pertussis vaccine doses administered to children aged 9–12 years and adolescents aged 13–17 years compared with the average number of doses administered during the same period in 2018 and 2019 — 10 U.S. jurisdictions, March–September 2020

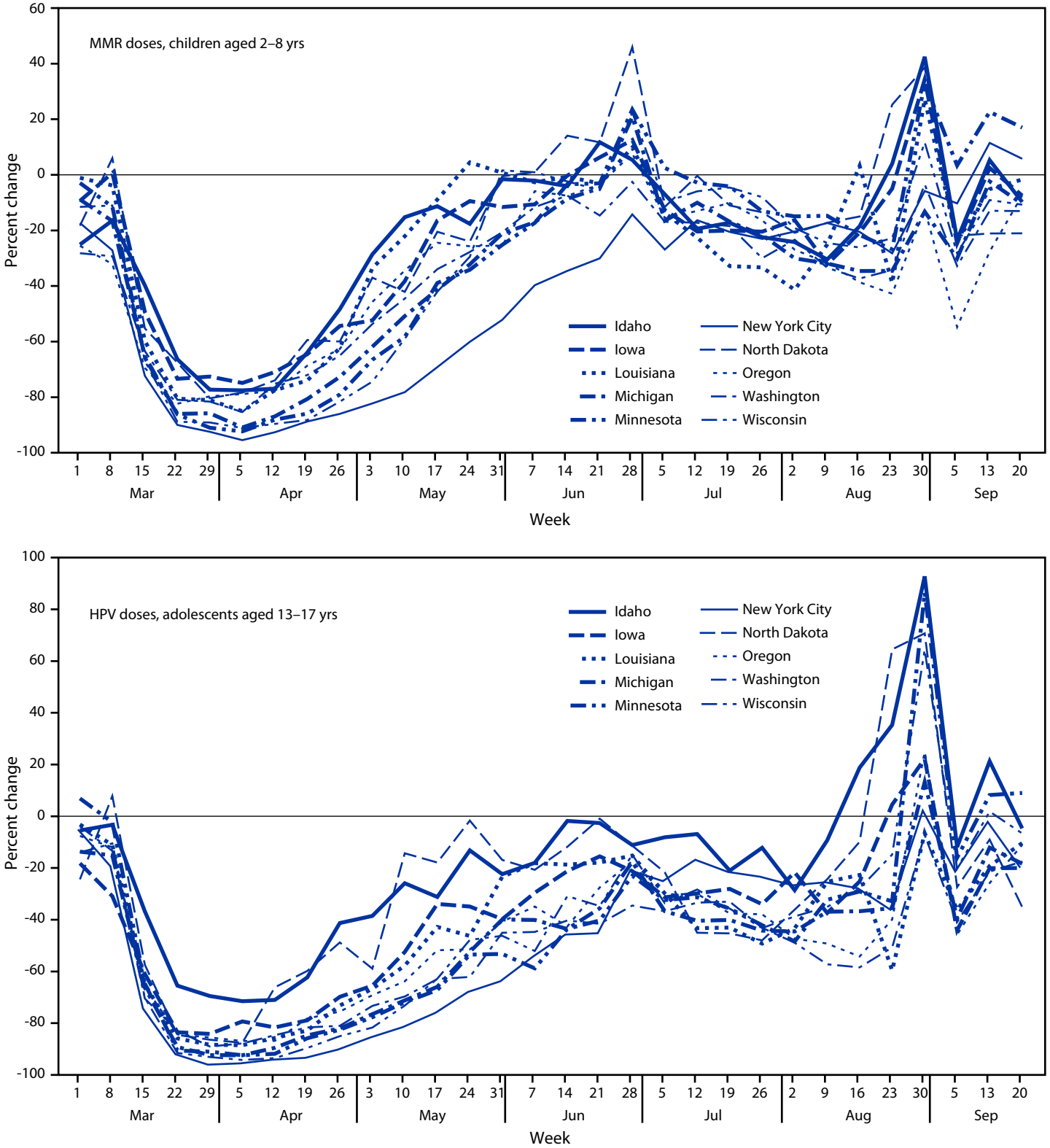
	% Change, median (range)			
Vaccine/Age/U.S. jurisdiction	**Mar–May**		**Jun–Sep**	
HPV vaccine				
Age group	**9–12 yrs**	**13–17 yrs**	**9–12 yrs**	**13–17 yrs**
Idaho	−25.8 (−63.8 to 14.3)	−38.5 (−71.5 to −3.3)	−3.8 (−34.5 to 94.3)	−8.1 (−28.6 to 92.7)
Iowa	−55.6 (−79.0 to 9.4)	−65.5 (−84.1 to −18.2)	−3.0 (−29.0 to 90.4)	−25.2 (−44.1 to 22.2)
Louisiana	−54.1 (−86.7 to 0.3)	−66.7 (−88.5 to −3.2)	−13.9 (−46.5 to 17.0)	−23.4 (−59.6 to −6.5)
Michigan	−69.7 (−89.2 to 1.5)	−76.5 (−92.4 to −13.7)	−14.7 (−30.7 to 48.1)	−36.9 (−44.5 to 13.2)
Minnesota	−66.1 (−88.5 to 21.2)	−77.7 (−92.4 to 6.9)	−14.0 (−38.4 to 134.5)	−32.4 (−58.8 to 86.5)
New York City	−82.5 (−95.5 to 8.3)	−85.5 (−96.0 to −5.1)	−8.4 (−50.2 to 13.8)	−25.1 (−63.8 to 2.2)
North Dakota	−44.2 (−87.3 to 26.3)	−57.4 (−87.6 to 7.8)	−1.9 (−26.8 to 84.3)	−20.7 (−48.0 to 70.7)
Oregon	−65.0 (−85.5 to 17.5)	−69.2 (−86.9 to −7.6)	−12.8 (−38.3 to 42.2)	−37.6 (−54.2 to 24.9)
Washington	−62.1 (−89.4 to −4.2)	−73.3 (−89.0 to −3.9)	−28.2 (−60.5 to −2.6)	−40.9 (−58.4 to −7.2)
Wisconsin	−75.2 (−92.2 to 6.8)	−81.7 (−94.2 to −10.5)	−11.6 (−30.8 to 78.0)	−30.9 (−52.1 to 64.4)
Median of medians†	**−63.6**	**−71.3**	**−12.2**	**−28.1**
TdaP vaccine				
Age group	**9–12 years**	**13–17 years**	**9–12 years**	**13–17 years**
Idaho	−36.9 (−67.7 to 3.3)	−31.5 (−59.6 to 13.3)	−13.8 (−43.2 to 101.3)	−4.7 (−33.3 to 60.7)
Iowa	−60.3 (−79.7 to 4.6)	−61.9 (−84.7 to −25.9)	−7.7 (−29.4 to 87.0)	−33.3 (−43.5 to 16.7)
Louisiana	−60.1 (−88.5 to −7.8)	−58.9 (−81.3 to 10.9)	−22.0 (−47.2 to 16.8)	−30.1 (−55.0 to 20.6)
Michigan	−68.1 (−89.8 to −2.7)	−63.0 (−79.6 to 8.9)	−21.9 (−38.8 to 39.8)	−39.6 (−50.1 to −14.7)
Minnesota	−72.3 (−89.8 to 2.5)	−74.4 (−82.5 to 6.2)	−27.8 (−46.3 to 113.8)	−29.8 (−50.9 to 13.2)
New York City	−83.9 (−96.4 to −4.6)	−91.2 (−95.3 to 1.0)	−18.2 (−51.2 to 0.3)	−54.6 (−73.9 to −40.3)
North Dakota	−44.1 (−85.9 to 22.8)	−22.2 (−58.8 to 92.3)	−5.8 (−25.8 to 106.1)	59.4 (−51.4 to 210.5)
Oregon	−66.9 (−87.5 to −1.9)	−60.8 (−79.1 to −8.3)	−22.5 (−49.2 to 24.7)	−41.8 (−59.0 to −19.4)
Washington	−65.9 (−88.8 to −17.8)	−65.5 (−78.0to 27.5)	−38.1 −70.8 to−20.7)	−26.7 (−51.7 to 5.2)
Wisconsin	−74.5 (−92.3 to 0.5)	−49.6 (−73.8 to 3.5)	−20.7 (−35.9 to 70.6)	−21.5 (−40.9 to 21.1)
Median of medians†	**−66.4**	**−61.4**	**−21.3**	**−30.0**

Abbreviations: HPV = human papillomavirus; TdaP = tetanus, diphtheria, and acellular pertussis.

* For each jurisdiction, the weekly percentage change between the number of vaccine doses administered March–September 2020 and those administered March–September in 2018 and 2019 was calculated. In addition, for each jurisdiction the median and range of the weekly percentage change for March–May 2020 and June–September 2020 were calculated.

† The overall median of the median weekly percentage was calculated for each period to determine the overall impact across all 10 jurisdictions.

FIGURE. Percent change in measles, mumps, and rubella vaccine doses administered to children aged 2–8 years and in human papillomavirus vaccine doses administered to adolescents aged 13–17 years compared with the average number of doses administered during the same period in 2018 and 2019 — 10 U.S. jurisdictions,* March–September 2020



Abbreviations: HPV = human papillomavirus; MMR = measles, mumps, and rubella.
* During March–May 2020, eight of the 10 jurisdictions implemented some form of stay-at-home order; no orders were issued in Iowa and North Dakota.

Summary

What is already known about this topic?

Early reports during the COVID-19 pandemic documented a marked decline in pediatric vaccine ordering and administration, placing U.S. children and adolescents at risk for vaccine-preventable diseases.

What is added by this report?

Analysis of immunization information systems data from 10 U.S. jurisdictions indicated a substantial decrease in administered vaccine doses during March–May 2020 compared with the same period during 2018 and 2019. Although administered doses increased during June–September 2020, this increase was not sufficient to achieve catch-up coverage.

What are the implications for public health practice?

To prevent outbreaks of vaccine-preventable diseases, health care providers should assess the vaccination status of all pediatric patients, including adolescents, and contact those who are behind schedule to ensure that all children and adolescents are fully vaccinated.

pandemic might have resulted in a lack of enforcement of immunization requirements for school attendance.

Routine child and adolescent vaccination remains an important cornerstone of public health practice and is a critical frontline tool in the prevention of morbidity and mortality in younger populations. Even a transient decline in vaccination coverage can compromise herd immunity and result in the propagation of outbreaks. During 2018–2019, a measles outbreak occurred in Rockland County, New York and nearby counties. Measles vaccination coverage in schools in the affected area was only 77%, far below the 93%–95% coverage needed to sustain measles herd immunity (*9*,*10*). Pediatric outbreaks of vaccine-preventable diseases have the potential to derail efforts to reopen schools for the 2021–22 academic year and further delay nationwide efforts to return students to the classroom. Health care systems and other social institutions are already overburdened by the COVID-19 pandemic, and vaccine preventable disease outbreaks can lead to loss of in-person learning and further overwhelm community resources and contribute to morbidity and mortality. As COVID-19 vaccinations become readily available to pediatric populations, CDC recommends providers consider co-administering COVID-19 vaccines with other routinely recommended vaccines, especially when patients are behind or might fall behind on routine recommended vaccines.[**]

The findings in this report are subject to at least three limitations. First, vaccination data from only 10 U.S. jurisdictions were analyzed and, therefore, these findings might not be generalizable to the entire United States. Second, immunization information systems were the only type of system analyzed, and vaccination information was not corroborated with other surveillance programs, such as National Immunization Survey-Child[††] or National Immunization Survey-Teen.[§§] Finally, the specific reasons for the decrease in vaccine administration during March–May 2020, or the rebound in vaccine administration during June–September 2020 in any of the 10 jurisdictions could not be determined. Vaccine administration could have increased because stay-at-home orders were lifted, the jurisdiction actively conducted catch-up campaigns, or the jurisdiction faced issues with vaccine storage and handling, which would have required revaccination of those patients who received invalid doses, among other reasons.

To facilitate the safe reopening of schools for in-person learning, CDC issued a call to action[¶¶] in early 2021 encouraging health care systems, health care providers, schools, parents, and state and local governments to work together to ensure that students are caught up on all routinely recommended vaccinations. High vaccination coverage rates help protect pediatric populations and ensure that herd immunity is maintained for all vaccine-preventable diseases. The COVID-19 pandemic has substantially disrupted routine medical care in the United States, requiring a consolidated and coordinated effort among multiple partners to promote catching up and staying up to date on routine vaccinations for children of all ages. Health care providers should assess the vaccination status of all pediatric patients, including adolescents, and contact those who are behind schedule to ensure that all children are fully vaccinated.

[**] https://www.cdc.gov/vaccines/covid-19/info-by-product/clinical-considerations.html

[††] https://www.cdc.gov/vaccines/imz-managers/coverage/childvaxview/index.html
[§§] https://www.cdc.gov/vaccines/imz-managers/coverage/teenvaxview/index.html
[¶¶] https://www.cdc.gov/vaccines/partners/index.html

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The 10 jurisdictions (Idaho, Iowa, Louisiana, Michigan, Minnesota, New York City, North Dakota, Oregon, Washington, and Wisconsin) that provided data.

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Genomic Surveillance for SARS-CoV-2 Variants Circulating in the United States, December 2020–May 2021

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SARS-CoV-2, the virus that causes COVID-19, is constantly mutating, leading to new variants (*1*). Variants have the potential to affect transmission, disease severity, diagnostics, therapeutics, and natural and vaccine-induced immunity. In November 2020, CDC established national surveillance for SARS-CoV-2 variants using genomic sequencing. As of May 6, 2021, sequences from 177,044 SARS-CoV-2–positive specimens collected during December 20, 2020–May 6, 2021, from 55 U.S. jurisdictions had been generated by or reported to CDC. These included 3,275 sequences for the 2-week period ending January 2, 2021, compared with 25,000 sequences for the 2-week period ending April 24, 2021 (0.1% and 3.1% of reported positive SARS-CoV-2 tests, respectively). Because sequences might be generated by multiple laboratories and sequence availability varies both geographically and over time, CDC developed statistical weighting and variance estimation methods to generate population-based estimates of the proportions of identified variants among SARS-CoV-2 infections circulating nationwide and in each of the 10 U.S. Department of Health and Human Services (HHS) geographic regions.* During the 2-week period ending April 24, 2021, the B.1.1.7 and P.1 variants represented an estimated 66.0% and 5.0% of U.S. SARS-CoV-2 infections, respectively, demonstrating the rise to predominance of the B.1.1.7 variant of concern† (VOC) and emergence of the P.1 VOC in the United States. Using SARS-CoV-2 genomic surveillance methods to analyze surveillance data produces timely population-based estimates of the proportions of variants circulating nationally and regionally. Surveillance findings demonstrate the potential for new variants to emerge and become predominant, and the importance of robust genomic surveillance. Along with efforts to characterize the clinical and public health impact of SARS-CoV-2 variants, surveillance can help guide interventions to control the COVID-19 pandemic in the United States.

With high levels of SARS-CoV-2 transmission globally, continued emergence of new variants is expected. Variants have potential impacts on COVID-19 severity, transmission, diagnostics, therapeutics, and natural and vaccine-induced immunity (*1*). The emergence and rapid expansion of multiple SARS-CoV-2 variants of interest§ (VOIs) and VOCs, and the potential for variants of high consequence,¶ (VOHCs) (Supplementary Table 1, https://stacks.cdc.gov/view/cdc/106690) indicate the need for robust genomic surveillance to monitor circulating viruses and help guide the public health response to the COVID-19 pandemic.

CDC's national SARS-CoV-2 genomic surveillance program includes genomic sequences from the National SARS-CoV-2 Strain Surveillance (NS3) program and contracted commercial laboratories. Each week, public health laboratories from all U.S. jurisdictions (50 states, the District of Columbia, and eight U.S. territories and freely associated states) are requested to submit a target number of specimens representative of the geographic and demographic diversity in each jurisdiction collected during the preceding 7 days, which can be achieved through random selection.** Specimens are submitted to CDC for assessment, sequencing, and genomic analysis. SARS-CoV-2 lineages are assigned using the Phylogenetic Assignment of Named Global Outbreak Lineages software (PANGOLIN; version 3.03; Rambaut Laboratory) (*2*).

In December 2020, CDC expanded the volume of SARS-CoV-2 sequencing through contracts with large commercial diagnostic laboratories, which were selected based on geographic coverage and specimen volume. Commercial laboratories submit random samples of geographically diverse sequences with limited demographic data to CDC weekly. Specimen sources for these laboratories include retail pharmacies, community testing sites, and inpatient and outpatient

* https://www.hhs.gov/about/agencies/iea/regional-offices/index.html

† A variant for which there is evidence of an increase in transmissibility, more severe disease (e.g., increased hospitalizations or deaths), significant reduction in neutralization by antibodies generated during previous infection or vaccination, reduced effectiveness of treatments or vaccines, or diagnostic detection failures.

§ A variant with specific genetic markers that have been associated with changes to receptor binding, reduced neutralization by antibodies generated against previous infection or vaccination, reduced efficacy of treatments, potential diagnostic impact, or predicted increase in transmissibility or disease severity.

¶ A variant with clear evidence of significantly reduced effectiveness of prevention measures or medical countermeasures relative to previously circulating variants.

** https://www.aphl.org/programs/preparedness/Crisis-Management/Documents/2021.04.09_NS3_REVISED.pdf

health care settings served by large commercial laboratories; any type of specimen tested for SARS-CoV-2 by reverse transcription–polymerase chain reaction (RT-PCR) may be submitted. Commercial laboratories use a variety of platforms and approaches to conduct sequencing; all SARS-CoV-2 sequence data are submitted to CDC for quality assessment, genomic analysis, and database upload. Sequences generated by both NS3 and commercial laboratories are deposited into public repositories (National Center for Biotechnology Information [NCBI] and Global Initiative on Sharing All Influenza Data [GISAID]). Data from genomic surveillance based on specimens received from NS3 and commercial laboratories were analyzed weekly to monitor SARS-CoV-2 variants circulating in the United States. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[††]

The estimated proportions of variant lineages among circulating SARS-CoV-2 viruses are calculated based on specimen collection date. Proportions of all lineages accounting for >1% of sequences nationally during the preceding 12 weeks as well as all VOIs and VOCs identified among circulating viruses are estimated nationally and for all 10 HHS regions and are updated weekly to CDC's COVID Data Tracker.[§§]

Because the proportion of sequenced SARS-CoV-2 infections varies geographically and over time, proportions of variants at the jurisdiction level and by week of specimen collection are weighted to generate population-based national and regional estimates of the proportion of each circulating variant among all SARS-CoV-2 infections. Weighting accounts for the inverse probability that 1) a specimen from a positive RT-PCR test was sequenced (w_p), and 2) a person with SARS-CoV-2 infection was tested by RT-PCR (w_i) (i.e., the infection was diagnosed). To calculate w_p, first the number of positive RT-PCR tests is divided by the number of sequences in the sample to obtain a weight to represent all RT-PCR positive cases; this weight is then adjusted for a known sampling bias (oversampling of S-gene target failure [SGTF] results by one laboratory) using a logistic regression model that assumes no sampling bias in the remainder of the laboratories. Second, w_i is calculated to account for variations in probability of RT-PCR testing among persons with SARS-CoV-2 infection. SARS-CoV-2 infection incidence is estimated as the geometric mean of the incidence of test-positive cases and the percentage of positive test results.[¶¶] The estimated number of infections, divided by the number of RT-PCR–positive cases, yields w_i. The final weight is the inverse of the probability that a person with SARS-CoV-2 infection contributes to the sample of sequences and is calculated as w_p multiplied by w_i. Variance is estimated for 95% confidence intervals (CIs) using a survey design-based approach. HHS regions are designated as survey strata, and data sources within each state are designated clusters (i.e., NS3 or each commercial laboratory).

Because the time from specimen collection to sequence availability currently is approximately 3 weeks, projections extending beyond the time frame of available data are made to enable estimation of current variant proportions during this 3-week interval. These projections, termed "nowcasts," and their 95% prediction intervals, are generated by using a multinomial logistic regression model fit to weighted sequencing data. The nowcast model is a multivariant extension to a two-variant framework previously described (*3*). Nowcast estimates are projections and might differ from weighted estimates that are subsequently generated for the same periods.[***]

As of May 6, 2021, a total of 177,044 SARS-CoV-2 viral sequences for specimens collected during December 20, 2020–May 6, 2021 from 55 U.S. states and territories had been generated by NS3 or reported to CDC by contract laboratories; these included 3,275 sequences from specimens collected during the 2-week period ending January 2, 2021, compared with a sixfold increase to 25,000 sequences from specimens collected during the 2-week period ending April 24, 2021 (accounting for 0.1% and 3.1% of positive RT-PCR tests reported to CDC, respectively) (Figure). The proportion of specimens with sequences varied across states (Supplementary Table 2, https://stacks.cdc.gov/view/cdc/106690); weighting methods generated regional- and national-level estimates of variant proportions over time.

The B.1.1.7 VOC represented an estimated 0.2% of U.S. infections during the 2-week period ending January 2 and increased to 66.0% during the 2-week period ending April 24 (Table). During this period, estimated proportions of B.1.1.7 infections varied across HHS regions, from 50.9% in HHS Region 1 to 74.1% in HHS Region 6 (Supplementary Table 2, https://stacks.cdc.gov/view/cdc/106690). This rapid expansion is consistent with a model-based prediction that B.1.1.7 could become a predominant variant (*3*). The nowcast model estimated that B.1.1.7 represents 72.4% (95% prediction interval = 67.4%–77.1%) of infections for the 2-week period April 25–May 8, 2021 (Table). The P.1 VOC first appeared the 2 weeks ending January 30; by the 2-week period ending April 24, the P.1 variant represented an estimated 5.0% of infections, ranging from 1.6% in HHS Region 3 to 7.7% in

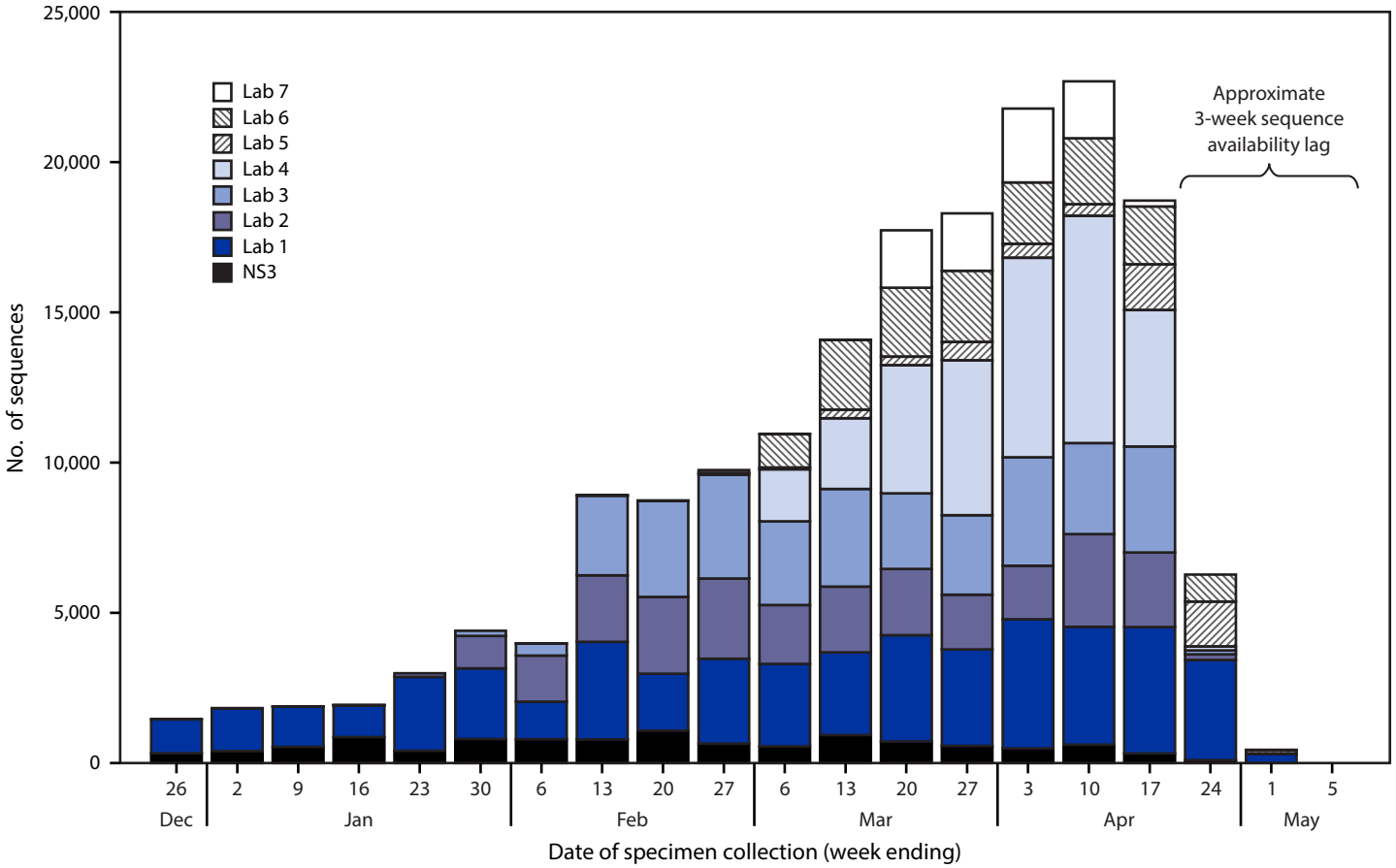
[††] 45 C.F.R. part 46.102(l)(2), 21 C.F.R. part 56; 42 U.S.C. Sect.241(d); 5 U.S.C.0 Sect.552a; 44 U.S.C. Sect. 3501 et seq.

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

[¶¶] https://www.medrxiv.org/content/10.1101/2020.10.07.20208504v2.full

[***] Supplementary materials, including R code and sample data, are available at https://github.com/CDCgov/SARS-CoV-2_Genomic_Surveillance.

FIGURE. Number of SARS-CoV-2 genomic sequences generated by National SARS-CoV-2 Strain Surveillance or reported to CDC by commercial laboratories* for specimens collected December 20, 2020—May 6, 2021, by laboratory source — United States, May 6, 2021



Abbreviation: NS3 = National SARS-CoV-2 Strain Surveillance.

* Sequences generated by or reported to CDC through NS3 and contract laboratories do not include the >5,000 sequences per week produced by public health laboratories and other U.S. institutions, which are not currently integrated into CDC's surveillance for SARS-CoV-2 variants using genomic sequencing. https://covid.cdc.gov/covid-data-tracker/#published-covid-sequences

HHS Region 5 (Table). Uncertainty around point estimates, as captured by confidence and prediction intervals, differed substantially by variant, time period, and region (Table).

Discussion

The distribution of circulating SARS-CoV-2 variants in the United States changed rapidly during December 2020–May 2021. The expansion of the B.1.1.7 VOC to become the predominant variant in all U.S. regions within a 4-month period, and the more recent emergence of the P.1 VOC in all regions, underscore the critical need for robust and timely genomic surveillance. These findings are consistent with reports of potential increased transmission of the B.1.1.7 and P.1 variants††† (*4*). In addition, there is evidence of potential impact of B.1.1.7 on diagnostics (i.e., SGTF in at least one RT-PCR–based diagnostic assay) (*5*) and disease severity and potential impact of P.1 on therapeutics and immunity (*1*). Four additional VOIs or VOCs (B.1.526, B.1.526.1, B.1.429, and B.1.427) are estimated to each account for >1% of circulating infections domestically as of the 2-week period ending April 24. Currently, there is no variant listed as a VOHC.

The findings in this report are subject to at least four limitations. First, although U.S. SARS-CoV-2 genomic sequencing has rapidly expanded in volume and in geographic coverage since late 2020, assessments of the national and regional representativeness of sequence data are needed. Second, although the weighting and variance estimation methods used for this analysis adjust these data to generate population-based estimates of variant proportions and quantify uncertainty, the methods assume that, within strata and clusters, sequence reporting is random. This assumption might be inaccurate; the true representativeness of sequenced specimens within each jurisdiction

††† https://virological.org/t/genomic-characterisation-of-an-emergent-sars-cov-2-lineage-in-manaus-preliminary-findings/586

TABLE. Weighted proportions of SARS-CoV-2 infections attributable to B.1.1.7 and P.1 variants among all estimated SARS-CoV-2 infections in the United States during December 20, 2020–April 24, 2021 and nowcast* projected proportions during April 25–May 8, 2021, by 2-week period and U.S. Health and Human Services Region† — United States, December 20, 2020–May 8, 2021

Variant/ HHS region no.	Weighted % (95% CI)									Projected % (95% PI§)
	Dec 20–Jan 2	Jan 3–16	Jan 17–30	Jan 31–Feb 13	Feb 14–27	Feb 28–Mar 13	Mar 14–27	Mar 28–Apr 10	Apr 11–24	Apr 25–May 8 (nowcast§)
B.1.1.7										
All	**0.2 (0.1–0.4)**	**0.3 (0.1–0.9)**	**1.2 (0.7–2.1)**	**4.5 (2. 9–6.9)**	**11.4 (8.2–15.6)**	**27.3 (22.1–33.2)**	**44.6 (39.3–50.1)**	**59.5 (54.9–64.0)**	**66.0 (62.0–69.8)**	**72.4 (67.4–77.1)**
1	—¶	—	0.4 (0.1–2.9)	3.4 (2.0–5.7)	11.5 (7.6–17.2)	21.6 (16.1–28.4)	37.0 (30.8–43.7)	44.3 (35.4–53.6)	50.9 (43.4–58.3)	57.2 (42.6–70.2)
2	0.8 (0.3–2.2)	—	2.9 (2.3–3.7)	9.9 (1.6–42.8)	14.6 (9.0–23.0)	28.5 (23.1–34.5)	37.1 (27.4–48.0)	48.2 (37.3–59.3)	54.5 (36.6–71.4)	52.8 (31.8–72.7)
3	—	0.7 (0.1–8.2)	0.9 (0.3–2.7)	2.1 (0.7–5.9)	9.8 (4.8–19.0)	25.0 (18.8–32.5)	46.2 (39.1–53.5)	62.1 (55.8–68.0)	66.5 (61.0–71.6)	73.8 (60.5–86.8)
4	—	0.6 (0.1–3.9)	1.8 (0.4–8.3)	6.6 (2.7–15.1)	15.0 (6.8–29.8)	36.5 (22.7–52.9)	54.5 (43.2–65.3)	65.8 (59.9–71.2)	70.5 (64.8–75.5)	78.6 (67.3–89.1)
5	0.2 (0.0–3.6)	0.5 (0.1–4.7)	0.6 (0.3–1.6)	3.1 (1.7–5.5)	8.1 (2.9–21.1)	26.5 (15.0–42.4)	49.9 (32.9–67.0)	67.6 (54.8–78.3)	73.1 (59.7–83.3)	79.1 (67.4–90.7)
6	—	0.1 (0.0–2.6)	1.4 (0.9–2.0)	4.2 (2.7–6.6)	14.3 (7.4–26.0)	33.0 (24.9–42.3)	50.5 (40.5–60.5)	69.3 (65.6–72.7)	74.1 (70.6–77.2)	82.5 (68.6–94.3)
7	—	—	—	1.6 (0.3–8.1)	7.7 (2.6–20.3)	13.6 (2.9–45.6)	13.6 (2.9–45.6)	63.8 (53.3–73.2)	72.4 (59.7–82.3)	77.0 (61.5–92.3)
8	1.7 (0.1–32.5)	—	—	2.9 (0.5–14.0)	4.7 (1.8–12.1)	18.7 (12.0–28.1)	35.4 (24.1–48.5)	53.7 (43.2–63.8)	56.8 (45.9–67.0)	63.6 (48.7–79.5)
9	—	—	0.3 (0.3–0.4)	1.8 (1.5–2.2)	4.8 (3.5–6.4)	13.1 (8.9–18.8)	25.1 (20.7–30.1)	43.4 (34.6–52.6)	57.7 (48.9–66.0)	62.6 (43.3–80.0)
10	—	—	1.9 (1.0–3.3)	0.6 (0.1–6.5)	7.9 (1.4–34.3)	10.4 (2.3–36.4)	25.9 (15.9–39.2)	36.6 (23.8–51.7)	52.3 (38.5–65.9)	65.4 (46.4–82.1)
P.1										
All	**—**	**—**	**0.1 (0.0–0.2)**	**0.03 (0.0–0.1)**	**0.1 (0.0–0.2)**	**0.6 (0.3–1.2)**	**1.6 (1.0–2.7)**	**3.6 (2.3–5.5)**	**5.0 (3.3–7.5)**	**6.2 (3.7–9.1)**
1	—	—	—	—	0.1 (0.0–0.4)	1.0 (0.2–4.6)	4.0 (1.2–12.3)	5.9 (2.4–13.4)	6.5 (2.0–19.0)	10.9 (2.1–21.3)
2	—	—	—	—	—	0.2 (0.01–5.3)	0.7 (0.3–1.7)	2.3 (1.9–2.9)	3.1 (1.4–6.5)	3.1 (0.0–13.6)
3	—	—	—	—	—	—	0.5 (0.2–0.9)	1.7 (1.2–2.3)	1.6 (0.7–3.3)	2.0 (0.0–7.9)
4	—	—	0.2 (0.0–1.0)	0.1 (0.0–0.4)	0.2 (0.2–3.0)	0.8 (0.2–3.0)	2.3 (0.8–6.2)	4.3 (2.0–9.1)	4.9 (2.5–9.6)	7.1 (1.8–14.5)
5	—	—	—	0.1 (0.0–0.7)	0.1 (0.0–1.6)	1.2 (0.1–10.2)	2.4 (0.5–11.0)	4.9 (0.9–21.9)	7.7 (1.6–30.8)	8.6 (2.3–18.6)
6	—	—	—	—	0.04 (0.0–0.1)	0.2 (0.1–0.6)	0.7 (0.4–1.3)	3.2 (1.9–5.6)	4.6 (3.3–6.2)	5.7 (0.0–14.3)
7	—	—	—	—	—	—	0.6 (0.1–3.6)	2.8 (1.1–7.0)	7.0 (1.3–29.4)	5.7 (0.0–15.4)
8	—	—	—	—	—	0.7 (0.2–2.1)	0.9 (0.6–1.3)	1.4 (0.7–2.7)	3.8 (1.9–7.5)	3.3 (0.0–10.3)
9	—	—	—	—	0.1 (0.0–0.3)	0.7 (0.3–1.4)	2.5 (1.8–3.4)	4.9 (4.1–5.9)	6.9 (3.6–12.9)	9.4 (0.0–20.0)
10	—	—	1.0 (0.1–9.1)	0.2 (0.0–9.9)	0.2 (0.0–6.6)	0.4 (0.0–3.8)	2.0 (0.5–8.4)	3.1 (1.1–8.4)	5.0 (2.7–8.9)	6.5 (0.0–17.9)

Abbreviations: CI = confidence interval; HHS = U.S. Department of Health and Human Services; PI = prediction interval.

* Because the time from specimen collection to sequence availability is approximately 3 weeks, "nowcast" projections (those that extend beyond the time frame of available data) were made to enable estimation of current variant proportions. Nowcasts and 95% PIs are generated using a multinomial logistic regression model fit to weighted sequencing data.

† *Region 1:* Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont; *Region 2:* New Jersey, New York, Puerto Rico, and the U.S. Virgin Islands; *Region 3:* Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia; *Region 4:* Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee; *Region 5:* Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin; *Region 6:* Arkansas, Louisiana, New Mexico, Oklahoma, and Texas; *Region 7:* Iowa, Kansas, Missouri, and Nebraska; *Region 8:* Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming; *Region 9:* Arizona, California, Hawaii, Nevada, American Samoa, Northern Mariana Islands, Federated States of Micronesia, Guam, Marshall Islands, and Palau; *Region 10:* Alaska, Idaho, Oregon, and Washington.

§ Nowcasts and 95% PIs are generated using a multinomial logistic regression model fit to weighted sequencing data.

¶ Dashes indicate that the number of estimated SARS-CoV-2 infections = 0.

is unknown. Linking sequencing with epidemiologic data, for example from national case-based surveillance, might provide a better understanding of representativeness, so that specimen selection and weighting methods can be further adjusted as needed. Analyses at state and local levels have demonstrated the utility of linking sequencing with sentinel or population-based surveillance data to characterize new SARS-CoV-2 variants (*6*,*7*). Third, sequencing data from many state and local public health laboratories that are conducting SARS-CoV-2 surveillance sequencing apart from NS3[§§§] are not yet available for inclusion in national estimates. Efforts to integrate such state and local genomic surveillance data into national surveillance and further improve national and regional surveillance are in progress. Finally, as sequence data become more complete over time, national and regional weighted estimates might change.

To respond to emerging SARS-CoV-2 variants, CDC rapidly expanded national genomic surveillance to monitor trends in

[§§§] https://covid.cdc.gov/covid-data-tracker/#published-covid-sequences

Summary

What is already known about this topic?

SARS-CoV-2 variants have the potential to affect transmission, disease severity, diagnostics, therapeutics, and natural and vaccine-induced immunity.

What is added by this report?

CDC's genomic surveillance for SARS-CoV-2 variants generates population-based estimates of the proportions of variants among all SARS-CoV-2 infections in the United States. During April 11–24, 2021, the B.1.1.7 and P.1 variants represented an estimated 66.0% and 5.0% of U.S. infections, respectively, demonstrating the potential for new variants to emerge and become predominant.

What are the implications for public health practice?

Robust genomic surveillance can help guide prevention strategies (e.g., enhanced vaccination coverage efforts) and clinical management decisions (e.g., monoclonal antibody distribution) to control the COVID-19 pandemic in the United States.

circulating SARS-CoV-2 variants nationally and regionally. Along with efforts to characterize the clinical and public health impact of variants, surveillance can help guide interventions to mitigate the COVID-19 pandemic in the United States by informing prevention strategies (e.g., enhanced vaccination coverage efforts) and clinical management decisions (e.g., monoclonal antibody distribution).

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Hospitalization of Adolescents Aged 12–17 Years with Laboratory-Confirmed COVID-19 — COVID-NET, 14 States, March 1, 2020–April 24, 2021

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Most COVID-19–associated hospitalizations occur in older adults, but severe disease that requires hospitalization occurs in all age groups, including adolescents aged 12–17 years (*1*). On May 10, 2021, the Food and Drug Administration expanded the Emergency Use Authorization for Pfizer-BioNTech COVID-19 vaccine to include persons aged 12–15 years, and CDC's Advisory Committee on Immunization Practices recommended it for this age group on May 12, 2021.* Before that time, COVID-19 vaccines had been available only to persons aged ≥16 years. Understanding and describing the epidemiology of COVID-19–associated hospitalizations in adolescents and comparing it with adolescent hospitalizations associated with other vaccine-preventable respiratory viruses, such as influenza, offers evidence of the benefits of expanding the recommended age range for vaccination and provides a baseline and context from which to assess vaccination impact. Using the Coronavirus Disease 2019-Associated Hospitalization Surveillance Network (COVID-NET), CDC examined COVID-19–associated hospitalizations among adolescents aged 12–17 years, including demographic and clinical characteristics of adolescents admitted during January 1–March 31, 2021, and hospitalization rates (hospitalizations per 100,000 persons) among adolescents during March 1, 2020–April 24, 2021. Among 204 adolescents who were likely hospitalized primarily for COVID-19 during January 1–March 31, 2021, 31.4% were admitted to an intensive care unit (ICU), and 4.9% required invasive mechanical ventilation; there were no associated deaths. During March 1, 2020–April 24, 2021, weekly adolescent hospitalization rates peaked at 2.1 per 100,000 in early January 2021, declined to 0.6 in mid-March, and then rose to 1.3 in April. Cumulative COVID-19–associated hospitalization rates during October 1, 2020–April 24, 2021, were 2.5–3.0 times higher than were influenza-associated hospitalization rates from three recent influenza seasons (2017–18, 2018–19, and 2019–20) obtained from the Influenza Hospitalization Surveillance Network (FluSurv-NET). Recent increased COVID-19–associated hospitalization rates in March and April 2021 and the potential for severe disease in adolescents reinforce the importance of continued COVID-19 prevention measures, including vaccination and correct and consistent wearing of masks by persons not yet fully vaccinated or when required by laws, rules, or regulations.†

COVID-NET is a population-based surveillance system of laboratory-confirmed COVID-19–associated hospitalizations in 99 counties across 14 states,§ covering approximately 10% of the U.S. population.¶ Included in surveillance are COVID-19–associated hospitalizations among residents in a predefined surveillance catchment area who had a positive real-time reverse transcription–polymerase chain reaction or rapid antigen detection test result for SARS-CoV-2 (the virus that causes COVID-19) during hospitalization or ≤14 days before admission (*2*). Clinical and demographic data, updated monthly, were analyzed for adolescents aged 12–17 years hospitalized during January 1–March 31, 2021. Clinical and demographic characteristics were analyzed separately for patients whose primary reason for admission was likely COVID-19 and those whose primary reason for admission might not have been primarily related to COVID-19, despite receiving a positive SARS-CoV-2 laboratory test result.** Hospitalization rate data, updated weekly, were analyzed during March 1, 2020–April 24, 2021, to describe cumulative COVID-19–associated hospitalization rates in adolescents aged 12–17 years and adults aged ≥18 years and weekly COVID-19–associated hospitalization rates in children aged 0–4 years and 5–11 years and adolescents aged 12–17 years. In

* https://www.fda.gov/news-events/press-announcements/coronavirus-covid-19-update-fda-authorizes-pfizer-biontech-covid-19-vaccine-emergency-use; https://www.cdc.gov/media/releases/2021/s0512-advisory-committee-signing.html

† https://www.cdc.gov/coronavirus/2019-ncov/vaccines/fully-vaccinated.html

§ California, Colorado, Connecticut, Georgia, Iowa, Maryland, Michigan, Minnesota, New Mexico, New York, Ohio, Oregon, Tennessee, and Utah.

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

** Those excluded were patients admitted for 1) labor and delivery (pregnant) (5.6%), 2) inpatient procedures/surgery (6.4%), 3) psychiatric reasons but requiring medical care (20.2%), 4) trauma (5.9%), and 5) other or unknown reasons (7.8%) with no recorded COVID-19–associated symptoms upon admission and who might have been identified through routine testing upon admission.

addition, cumulative COVID-19–associated hospitalization rates among adolescents aged 12–17 years during October 1, 2020–April 24, 2021 (covering most of the typical October 1–April 30 season for influenza-associated hospitalization surveillance), were compared with influenza-associated hospitalization rates in the same age group across three influenza seasons (2017–18, 2018–19, and 2019–20) using data from FluSurv-NET†† (*3*). Rate calculations are unadjusted and include all persons meeting the case definition (*2*). SAS statistical software (version 9.4; SAS Institute) was used for analyses. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.§§

Among 376 adolescents hospitalized during January 1–March 31, 2021, who received a positive SARS-CoV-2 laboratory test result, 172 (45.7%) were analyzed separately because their primary reason for admission might not have been directly COVID-19–related (Table). Among the 204 patients who were likely admitted primarily for COVID-19–related illness, 52.5% were female, 31.4% were Hispanic or Latino (Hispanic), and 35.8% were non-Hispanic Black. Overall, 70.6% had one or more underlying medical conditions, the most common of which were obesity (35.8%), chronic lung disease, including asthma (30.9%), and neurologic disorders (14.2%); 31.4% of patients required ICU admission and 4.9% required invasive mechanical ventilation, but there were no associated deaths.

During March 1, 2020–April 24, 2021, the cumulative COVID-19–associated adolescent hospitalization rate (49.9) was 12.5 times lower than that in adults aged ≥18 years (675.6). Weekly COVID-19–associated adolescent hospitalization rates (3-week moving average) were comparable to rates among those aged 0–4 years, but higher than rates among children aged 5–11 years (Figure 1). Weekly adolescent hospitalization rates peaked at 2.1 per 100,000 during the week ending January 9, 2021, declined to 0.6 during the week ending March 13, 2021, then increased to 1.3 and 1.2 for the weeks ending April 17 and 24, 2021, respectively. Rates among adolescents in two of 14 sites (Maryland and Michigan) were highest during April 2021 compared with all other weeks within their respective sites since surveillance began on March 1, 2020. Cumulative COVID-19–associated hospitalization rates during October 1, 2020–April 24, 2021, were 2.5–3.0 times higher than seasonal influenza-associated hospitalization rates during three recent influenza seasons (October 1–April 30) (Figure 2).

†† FluSurv-NET, which has similar methods for case ascertainment and catchment areas as COVID-NET, conducts seasonal laboratory-confirmed influenza-associated hospitalization surveillance during October 1–April 30 annually.

§§ 45 C.F.R. part 46, 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.

Discussion

COVID-NET data indicate that COVID-19–associated hospitalization rates were lower in adolescents aged 12–17 years compared with those in adults but exceeded those among children aged 5–11 years during March 1, 2020–April 24, 2021. Moreover, COVID-19–associated hospitalization rates among adolescents increased during March–April 2021, and nearly one third of 204 recently hospitalized adolescents required ICU admission. Rates of COVID-19–associated hospitalization among adolescents also exceeded historical rates of seasonal influenza-associated hospitalization during comparable periods. Recent increased hospitalization rates and the potential for severe disease reinforce the importance of continued COVID-19 prevention measures among adolescents, including vaccination and correct and consistent wearing of masks.

After declines in January and February 2021, weekly population-based rates of COVID-19–associated hospitalization among adolescents increased during March and April, and in two COVID-NET sites (Maryland and Michigan) the highest adolescent COVID-19–associated hospitalization rates in their respective sites since the start of the COVID-19 pandemic occurred during this period. This trend contrasts with hospitalization rates among persons aged ≥65 years, the group with the highest COVID-19 vaccination coverage, among whom hospitalization rates in COVID-NET stabilized during the same period.¶¶ Increased hospitalization rates among adolescents might be related, in part, to circulation of particularly transmissible SARS-CoV-2 variants,*** the larger numbers of children returning to school or other in-person indoor activities, and changes in physical distancing, wearing masks, and other COVID-19 prevention behaviors (*4*). SARS-CoV-2 transmission occurs more easily in high schools than in elementary schools (*4*), and outbreaks have been associated with high school extracurricular activities (*5*). Vaccination of adolescents is expected to reduce the risk for COVID-19 in these settings.

Population-based COVID-19–associated hospitalization rates among adolescents were lower than were those in adults, a finding consistent with studies showing that illness is generally milder in children than in adults (*6*). Nevertheless, severe disease does occur, including that requiring ICU admission and invasive mechanical ventilation. Most (70.6%) adolescents in this study whose primary reason for hospitalization was COVID-19–associated illness had at least one underlying medical condition, which is lower than the percentage of hospitalized adults with an underlying medical condition (92%) (*7*). Nearly 30% of these adolescents had no reported underlying medical

¶¶ https://gis.cdc.gov/grasp/COVIDNet/COVID19_3.html

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

TABLE. Demographic and clinical characteristics and outcomes among adolescents aged 12–17 years with laboratory-confirmed COVID-19–associated hospitalizations, by primary reason for admission — COVID-NET, 14 states,* January 1, 2021–March 31, 2021

Characteristic	No. of hospitalizations (%)		
	Total	Primary reason for admission COVID-19–related	Primary reason for admission not clearly COVID-19–related
Total no. of hospitalized adolescents	**376 (100.0)†**	**204 (100.0)†**	**172 (100.0)†**
Age, yrs, median (IQR)	14.9 (13.4–15.9)	14.8 (13.3–15.9)	15.0 (13.5–16.0)
Sex			
Male	156 (41.5)	97 (47.5)	59 (34.3)
Female	220 (58.5)	107 (52.5)	113 (65.7)
Race/Ethnicity§			
Hispanic	115 (30.6)	64 (31.4)	51 (29.7)
Black, non-Hispanic	117 (31.1)	73 (35.8)	44 (25.6)
White, non-Hispanic	114 (30.3)	52 (25.5)	62 (36.0)
Asian/Pacific Islander, non-Hispanic	14 (3.7)	6 (2.9)	8 (4.7)
Persons of all other races¶	3 (0.8)	3 (1.5)	0 (—)
Unknown race/ethnicity	13 (3.5)	6 (2.9)	7 (4.1)
Residence type			
Private residence	344 (94.8)	195 (95.6)	149 (93.8)
Congregate setting, other, or unknown residence type**	19 (5.2)	9 (4.4)	10 (6.3)
Primary reason for admission			
Likely COVID-19-related	204 (54.3)	204 (100.0)	0 (—)
Obstetrics	21 (5.6)	0 (—)	21 (12.2)
Inpatient surgery	24 (6.4)	0 (—)	24 (14.0)
Psychiatric admission requiring medical care	76 (20.2)	0 (—)	76 (44.2)
Trauma	22 (5.9)	0 (—)	22 (12.8)
Other reason	13 (3.5)	0 (—)	13 (7.6)
Unknown reason	16 (4.3)	0 (—)	16 (9.3)
COVID-19-related symptoms at admission††			
Yes, symptomatic	259 (71.9)	192 (94.1)	67 (42.9)
Hospitalization outcomes			
Length of hospital stay, days, median (IQR)	2.7 (1.2–6.1)	2.4 (1.1–5.7)	3.2 (1.4–6.7)
ICU admission	93 (25.6)	64 (31.4)	29 (18.2)§§
Invasive mechanical ventilation	21 (5.8)	10 (4.9)	11 (6.9)§§
In-hospital death	0 (—)	0 (—)	0 (—)
Underlying medical condition			
≥1 underlying medical condition¶¶	207 (55.1)	144 (70.6)	63 (36.6)
Obesity***	101 (27.9)	73 (35.8)	28 (17.7)
Chronic lung disease, including asthma	87 (24.0)	63 (30.9)	24 (15.2)
Neurologic disorders	43 (11.9)	29 (14.2)	14 (8.9)
Chronic metabolic disease, including diabetes	32 (8.8)	24 (11.8)	8 (5.1)
Immunocompromised condition	20 (5.5)	14 (6.9)	6 (3.8)
Blood disorder, including sickle cell anemia	21 (5.8)	19 (9.4)	2 (1.3)
Cardiovascular disease	15 (4.1)	9 (4.4)	6 (3.8)

Abbreviations: COVID-NET = Coronavirus Disease 2019–Associated Hospitalization Surveillance Network; ICU = intensive care unit; IQR = interquartile range.

* Includes persons admitted to a hospital with an admission date between January 1, 2021 and March 31, 2021. Counties included in COVID-NET surveillance: California (Alameda, Contra Costa, and San Francisco counties); Colorado (Adams, Arapahoe, Denver, Douglas, and Jefferson counties); Connecticut (Middlesex and New Haven counties); Georgia (Clayton, Cobb, DeKalb, Douglas, Fulton, Gwinnett, Newton, and Rockdale counties); Iowa (one county represented); Maryland (Allegany, Anne Arundel, Baltimore, Baltimore City, Calvert, Caroline, Carroll, Cecil, Charles, Dorchester, Frederick, Garrett, Harford, Howard, Kent, Montgomery, Prince George's, Queen Anne's, St. Mary's, Somerset, Talbot, Washington, Wicomico, and Worcester counties); Michigan (Clinton, Eaton, Genesee, Ingham, and Washtenaw counties); Minnesota (Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, and Washington counties); New Mexico (Bernalillo, Chaves, Doña Ana, Grant, Luna, San Juan, and Santa Fe counties); New York (Albany, Columbia, Genesee, Greene, Livingston, Monroe, Montgomery, Ontario, Orleans, Rensselaer, Saratoga, Schenectady, Schoharie, Wayne, and Yates counties); Ohio (Delaware, Fairfield, Franklin, Hocking, Licking, Madison, Morrow, Perry, Pickaway and Union counties); Oregon (Clackamas, Multnomah, and Washington counties); Tennessee (Cheatham, Davidson, Dickson, Robertson, Rutherford, Sumner, Williamson, and Wilson counties); and Utah (Salt Lake County).

† Data are missing for <5 percent of observations for all variables.

§ If ethnicity was unknown, non-Hispanic ethnicity was assumed.

¶ Includes non-Hispanic persons reported as other or multiple races.

** Unknown residence types are those which have not yet been ascertained from the medical chart but have not been determined to be missing.

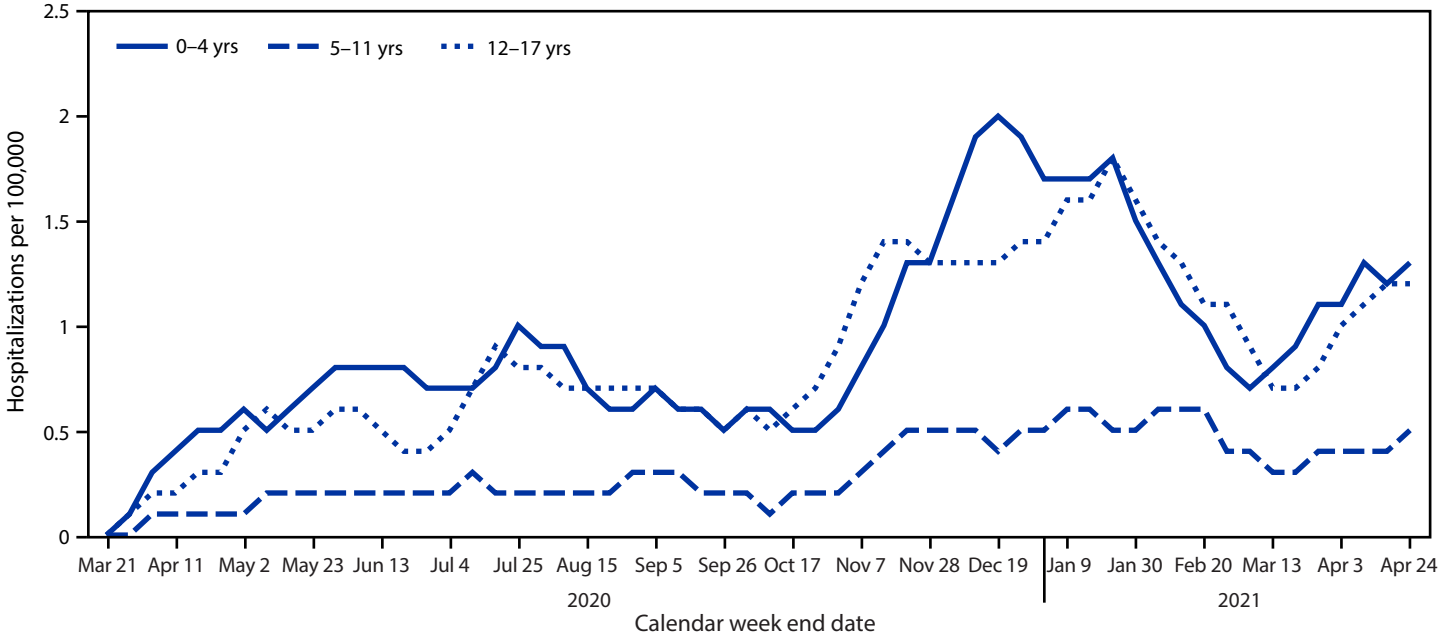
†† COVID-19-related symptoms included respiratory symptoms (congested/runny nose, cough, hemoptysis/bloody sputum, shortness of breath/respiratory distress, sore throat, upper respiratory infection, influenza-like illness, wheezing) and non-respiratory symptoms (abdominal pain, altered mental status/confusion,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

§§ ICU admission and invasive mechanical ventilation are not mutually exclusive categories, and patients could have received both. Of the 31 patients whose primary reason for admission was not COVID-19-related but who were admitted to the ICU or received invasive mechanical intervention, nine (29.0%) were admitted because of trauma and 14 (45.2%) were admitted for a psychiatric admission requiring medical care, including suicide attempts or overdoses.

¶¶ Defined as ≥1 of the following: chronic lung disease, chronic metabolic disease, blood disorder/hemoglobinopathy, cardiovascular disease, neurologic disorder, immunocompromised condition, renal disease, gastrointestinal/liver disease, rheumatologic/autoimmune/inflammatory condition, obesity, feeding tube dependency, wheelchair dependency, or pregnancy.

*** Obesity is defined as body mass index (kg/m^2) ≥95th percentile for age and sex based on CDC growth charts among children, a discharge diagnosis of obesity indicated by *International Classification of Diseases, Tenth Edition, Clinical Modification* (ICD-10-CM) codes, or obesity is indicated as an underlying condition on the COVID-NET case report form for adolescents who were not pregnant at the time of admission.

FIGURE 1. Three-week moving average COVID-19–associated hospitalization rates* among children and adolescents aged <18 years, by age group — COVID-NET, 14 states,† March 1, 2020–April 24, 2021



Abbreviation: COVID-NET = Coronavirus Disease 2019–Associated Hospitalization Surveillance Network.
* Number of patients with laboratory-confirmed COVID-19–associated hospitalizations per 100,000 population.
† COVID-NET sites are in the following 14 states: California, Colorado, Connecticut, Georgia, Iowa, Maryland, Michigan, Minnesota, New Mexico, New York, Ohio, Oregon, Tennessee, and Utah.

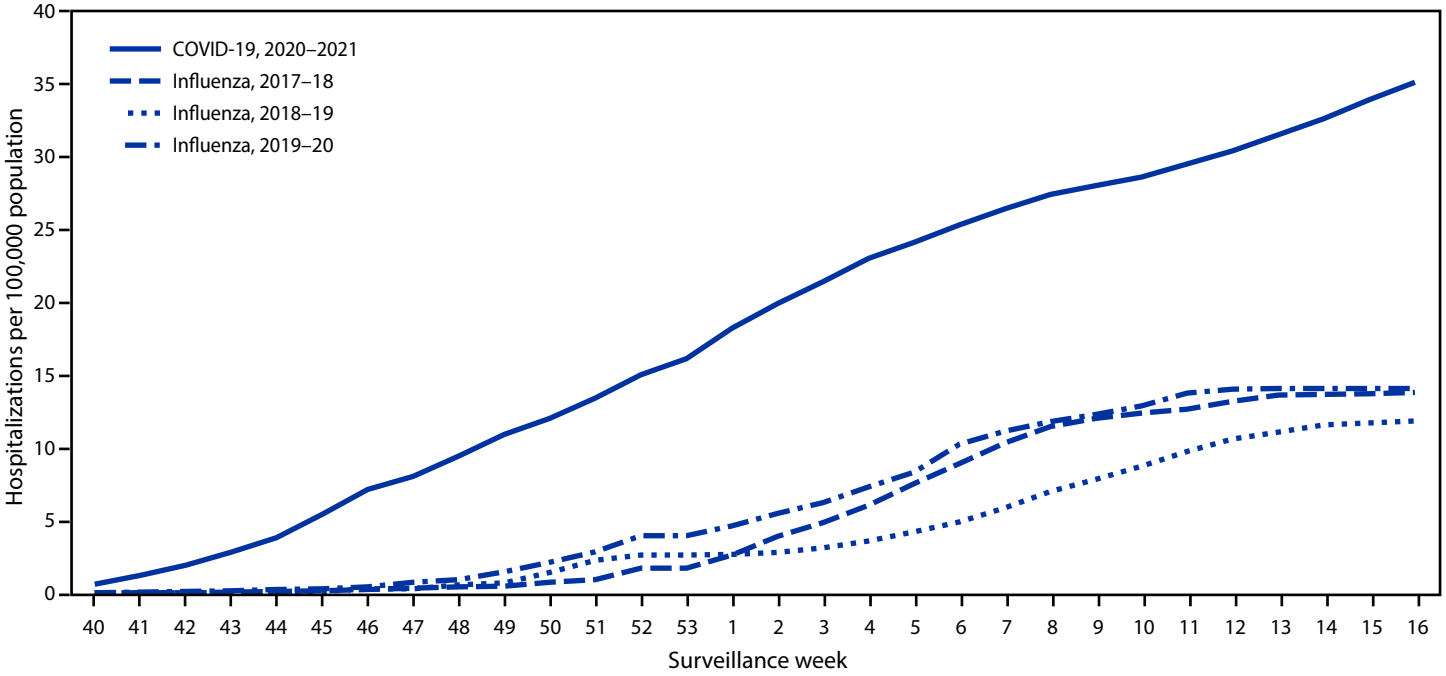
condition, indicating that healthy adolescents are also at risk for severe COVID-19–associated disease. In addition, approximately two thirds of adolescents hospitalized with COVID-19 were Hispanic or non-Hispanic Black persons, consistent with studies showing an increased incidence of COVID-19 among racial and ethnic minority populations and signifying an urgent need to ensure equitable access to vaccines for these groups (*8*). Vaccination is effective in preventing hospitalization among adults (*9*); similarly, widespread vaccination of adolescents will likely reduce COVID-19–associated hospitalizations, and potential sequelae from COVID-19 in adolescents, including multisystem inflammatory syndrome in children (MIS-C), a rare but serious complication of COVID-19 (*10*).

During a comparable period, adolescent hospitalization rates associated with COVID-19 exceeded those for seasonal influenza, another respiratory virus that can cause hospitalization and death in adolescents and for which a vaccine is recommended in this age group.††† This widespread circulation of SARS-CoV-2 occurred despite containment measures such as school closures, wearing masks, and physical distancing, none of which had been enacted during the historical influenza seasons. Without these containment measures, the rates of COVID-19–associated hospitalization might have been substantially higher.

The findings in this report are subject to at least five limitations. First, the primary reason for hospital admission was not always clear, and some (45.7%) adolescents who met the COVID-NET case definition were hospitalized for reasons that might not have been primarily related to COVID-19, despite a positive SARS-CoV-2 laboratory test result; these hospitalizations were included in rate calculations. Thus, rates of hospitalizations for COVID-19 might be overestimated. Second, laboratory confirmation depends on clinician-ordered testing and hospital testing policies for SARS-CoV-2 (COVID-NET) and influenza (FluSurv-NET); consequently, hospitalization rates might also be underestimated. Given more widespread testing for SARS-CoV-2 compared with influenza, the lack of adjustment for testing practices likely disproportionately affects influenza rates compared with COVID-19 rates. Third, adolescents hospitalized with MIS-C might not be identified if testing occurred >14 days before admission, potentially leading to an underestimate of severe COVID-19–associated disease. Fourth, the Pfizer-BioNTech COVID-19 vaccine had been approved for and administered to adolescents aged 16–17 years during this study period; therefore, rates of COVID-19–associated hospitalization in adolescents aged 16–17 years might differ from those in adolescents aged 12–15 years who were not previously eligible for vaccination, and could affect the overall hospitalization rate for all adolescents. Finally, hospitalization rates are preliminary and might change as additional data are reported.

††† https://www.cdc.gov/mmwr/volumes/69/rr/rr6908a1.htm

FIGURE 2. Cumulative rates for COVID-19–associated hospitalizations* compared with influenza-associated hospitalizations† among adolescents aged 12–17 years, by surveillance week§ — COVID-NET¶ and FluSurv-NET, 14 states,†† 2017–2021§§**



Abbreviations: COVID-NET = Coronavirus Disease 2019–Associated Hospitalization Surveillance Network; FluSurv-NET = Influenza Hospitalization Surveillance Network.

* Number of patients with laboratory-confirmed COVID-19–associated hospitalizations per 100,000 population.

† Number of patients with laboratory-confirmed influenza-associated hospitalizations per 100,000 population.

§ Surveillance week is based on the epidemiologic week for disease reporting and lasts Sundays through Saturdays. MMWR week numbering is sequential beginning with 1 and incrementing with each week to a maximum of 52 or 53. The three influenza seasons had no surveillance week 53, so values from surveillance week 52 were imputed to surveillance week 53. https://wwwn.cdc.gov/nndss/document/MMWR_week_overview.pdf

¶ COVID-NET is a population-based surveillance system of laboratory-confirmed COVID-19–associated hospitalizations in 99 counties across 14 states. COVID-19–associated hospitalizations among residents in a predefined surveillance catchment area who received a positive test for SARS-CoV-2 (the virus that causes COVID-19) during hospitalization or ≤14 days before admission are included in surveillance.

** FluSurv-NET is a population-based surveillance system of laboratory-confirmed influenza-associated hospitalizations in 81 counties across 13 states (for the period included) and is conducted annually during October 1–April 30. Influenza-associated hospitalizations among residents in a predefined surveillance catchment area who received a positive test for influenza during hospitalization or ≤14 days before admission are included in surveillance.

†† COVID-NET and FluSurv-NET sites were in the following 14 states for the period shown: California, Colorado, Connecticut, Georgia, Iowa (COVID-NET only), Maryland, Michigan, Minnesota, New Mexico, New York, Ohio, Oregon, Tennessee, and Utah.

§§ Cumulative COVID-19–associated hospitalization rates among adolescents aged 12–17 years during October 1, 2020–April 24, 2021, were compared with influenza-associated hospitalization rates in the same age group during October 1–April 30 across three seasons (2017–18, 2018–19, and 2019–20) using data from FluSurv-NET.

Recent increases in COVID-19–associated hospitalization rates and the potential for severe disease requiring ICU admission, including invasive mechanical ventilation, among adolescents indicate an urgent need for vaccination in combination with correct and consistent mask wearing by persons not yet fully vaccinated or when required by laws, rules, or regulations. Highly effective COVID-19 vaccines are now available to adolescents as an additional evidence-based prevention measure (*9*); expansion of COVID-19 vaccination of adolescents, with particular attention to racial and ethnic minority groups disproportionately affected by severe COVID-19, is expected to reduce COVID-19–associated morbidity within this age group.

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Summary

What is already known about this topic?

Most COVID-19–associated hospitalizations occur in adults, but severe disease occurs in all age groups, including adolescents aged 12–17 years.

What is added by this report?

COVID-19 adolescent hospitalization rates from COVID-NET peaked at 2.1 per 100,000 in early January 2021, declined to 0.6 in mid-March, and rose to 1.3 in April. Among hospitalized adolescents, nearly one third required intensive care unit admission, and 5% required invasive mechanical ventilation; no associated deaths occurred.

What are the implications for public health practice?

Recent increased hospitalization rates in spring 2021 and potential for severe disease reinforce the importance of continued COVID-19 prevention measures, including vaccination and correct and consistent mask wearing among persons not fully vaccinated or when required.

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Decreases in COVID-19 Cases, Emergency Department Visits, Hospital Admissions, and Deaths Among Older Adults Following the Introduction of COVID-19 Vaccine — United States, September 6, 2020–May 1, 2021

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Throughout the COVID-19 pandemic, older U.S. adults have been at increased risk for severe COVID-19–associated illness and death (*1*). On December 14, 2020, the United States began a nationwide vaccination campaign after the Food and Drug Administration's Emergency Use Authorization of Pfizer-BioNTech COVID-19 vaccine. The Advisory Committee on Immunization Practices (ACIP) recommended prioritizing health care personnel and residents of long-term care facilities, followed by essential workers and persons at risk for severe illness, including adults aged ≥65 years, in the early phases of the vaccination program (*2*). By May 1, 2021, 82%, 63%, and 42% of persons aged ≥65, 50–64, and 18–49 years, respectively, had received ≥1 COVID-19 vaccine dose. CDC calculated the rates of COVID-19 cases, emergency department (ED) visits, hospital admissions, and deaths by age group during November 29–December 12, 2020 (prevaccine) and April 18–May 1, 2021. The rate ratios comparing the oldest age groups (≥70 years for hospital admissions; ≥65 years for other measures) with adults aged 18–49 years were 40%, 59%, 65%, and 66% lower, respectively, in the latter period. These differential declines are likely due, in part, to higher COVID-19 vaccination coverage among older adults, highlighting the potential benefits of rapidly increasing vaccination coverage.

CDC analyzed the age distribution of COVID-19 vaccination during December 14, 2020–May 1, 2021. To visualize trends before and after vaccine introduction, rates of reported COVID-19 cases, ED visits, hospitalizations, and deaths by age group are presented for September 6, 2020–May 1, 2021. Daily data about COVID-19 vaccine doses administered in the United States, including partial and full vaccination, were collected by vaccination providers and reported to CDC through multiple sources.* Daily COVID-19 case data were obtained from CDC's case-based surveillance system† as reported by jurisdictional health departments. Daily ED visits for patients with a diagnosis of COVID-19§ (COVID-19 ED visit) were obtained from the National Syndromic Surveillance Program. Daily admissions data on persons newly admitted to a hospital with a laboratory-confirmed COVID-19 diagnosis at the time of admission (COVID-19 hospital admission) were obtained from the U.S. Department of Health and Human Services (HHS) Unified Hospital dataset.¶ Weekly COVID-19 death data were collected from CDC's National Vital Statistics System.** U.S. Census Bureau midyear 2019 population estimates (as of July 1, 2020)†† were used to calculate vaccination, case, hospital admission, and death rates per 100,000 population. ED visits were shown as visits with a COVID-19 diagnosis per 100,000 ED visits reported.

* COVID-19 vaccine administration data are reported to CDC by multiple entities using immunization information systems, the Vaccine Administration Management System, pharmacy systems, or direct submission of electronic health records. (https://www.cdc.gov/coronavirus/2019-ncov/vaccines/distributing/about-vaccine-data.html). Persons were considered fully vaccinated if they received the second dose in a 2-dose COVID-19 vaccine series (Pfizer-BioNTech or Moderna) or 1 dose of the single-dose Janssen (Johnson and Johnson) COVID-19 vaccine.

† CDC official counts of COVID-19 cases and deaths, released daily at https://covid.cdc.gov/covid-data-tracker, are aggregate counts from reporting jurisdictions. Some jurisdictions electronically submit standardized information for individual cases of COVID-19 to CDC via a case report form developed for the CDC COVID-19 response (https://www.cdc.gov/coronavirus/2019-ncov/php/reporting-pui.html) or via the CDC National Notifiable Diseases Surveillance System (https://www.cdc.gov/nndss/action/covid-19-response.html). Individual-level case report data were available for approximately 80% of the aggregate number of confirmed cases.

§ The National Syndromic Surveillance Program collects electronic health data, including ED visits with confirmed COVID-19 diagnoses, from a subset of hospitals in 49 states (all but Hawaii) and the District of Columbia (71% of nonfederal EDs in the United States). ED visits for COVID-19 are defined as ED visits with any of the following: *International Classification of Diseases, Tenth Revision* codes U07.1 or J12.82 or Systematized Nomenclature of Medicine codes 840539006, 840544004, or 840533007. https://www.cdc.gov/nssp/overview.html

¶ The HHS Unified Hospital dataset includes data reported by hospitals registered with the Centers for Medicare & Medicaid Services. Data, including counts of new hospital admissions of patients with confirmed COVID-19 by age group, are reported to HHS either directly from facilities or via a state submission; on May 1, 2021, 98.5% of hospitals reported data. This analysis includes Veterans Administration, Defense Health Agency, and Indian Health Services hospitals and excludes psychiatric, rehabilitation, and religious nonmedical hospitals. https://www.hhs.gov/sites/default/files/covid-19-faqs-hospitals-hospital-laboratory-acute-care-facility-data-reporting.pdf

** COVID-19 deaths include deaths for which COVID-19 was listed on the death certificate as a confirmed or presumed underlying cause of death or contributing cause of death (ICD-10 code U07.1). https://www.cdc.gov/nchs/nvss/vsrr/covid19/tech_notes.htm

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

To assess differences by age, CDC calculated the weekly proportion, rate, and rate ratio by age group for COVID-19 outcomes, including cases, ED visits, hospital admissions, and deaths.[§§] Trends were examined by plotting weekly rates by age group and rate ratios comparing persons aged ≥65 years (≥70 years for hospital admissions[¶¶]) with those aged 18–49 years during September 6, 2020–May 1, 2021. Differences in age group–specific average weekly proportions, rates, and rate ratios for COVID-19 outcomes were compared during two periods: November 29–December 12, 2020 (prevaccine) and April 18–May 1, 2021 (most recent data available, accounting for reporting lag); 95% confidence intervals (CIs) and p values for these differences and for rate ratios were constructed by applying the parametric bootstrap method to 10,001 replicate pseudosamples (*3*). Analyses were conducted using R software (version 4.0.0; R Foundation). These activities were reviewed by CDC and were conducted consistent with applicable federal law and CDC policy.[***]

COVID-19 vaccine administration increased from introduction on December 14, 2020, to a peak 7-day moving average of 3.3 million doses per day in mid-April before decreasing to 2.2 million doses per day by May 1, 2021 (Figure 1). Among persons aged ≥65 years, 25% had received ≥1 vaccine dose by February 6, 2021, 50% by March 3, 2021, and 82% by the end of the analysis period, May 1, 2021 (Figure 1). Among persons aged 18–49 years, 7%, 10%, and 42% had received ≥1 vaccine dose by the same dates, respectively. By May 1, 2021, 69% of persons aged ≥65 years and 26% of persons 18–49 years were fully vaccinated.

COVID-19 incidence increased in all age groups during September 6, 2020–January 2, 2021, and then decreased (Figure 2). The weekly rate ratio of COVID-19 incidence among older adults to younger adults was highest in late December and then declined. Compared with the prevaccination period of November 29–December 12, 2020, COVID-19 incidence during April 18–May 1, 2021, was 69% lower among all adults, and 79%, 71%, and 66% lower among persons aged ≥65, 50–64, and 18–49 years respectively (Table). The proportion of COVID-19 cases diagnosed in persons aged ≥65 years decreased from 16.0% to 10.7% (p<0.001). The rate ratio of COVID-19 incidence among persons aged ≥65 years to that among persons aged 18–49 years decreased 40% (p<0.001) from 0.68 (95% CI = 0.67–0.68) to 0.40 (95% CI = 0.40–0.41) (p<0.001).

During September 6, 2020–May 1, 2021, COVID-19 ED visits per 100,000 ED visits peaked among all age groups during the week of January 3–January 9, 2021, approximately 1 week after the peak in incidence (Figure 2). The weekly rate ratio of COVID-19 ED visits among older adults to younger adults was highest in mid-January and then declined. Compared with the prevaccination period of November 29–December 12, 2020, COVID-19 ED visits per 100,000 ED visits during April 18–May 1, 2021, were 59% lower among all adults, with a larger change for persons aged ≥65 years (77%) than for other age groups (Table). During November 29–December 12, 2020, and April 18–May 1, 2021, persons aged ≥65 years accounted for 37.9% and 20.7%, respectively, of adult COVID-19 ED visits. The rate ratio of COVID-19 ED visits per 100,000 ED visits among persons aged ≥65 years to those among persons aged 18–49 years decreased 59% (p<0.001) from 1.99 (95% CI = 1.96–2.01) to 0.82 (95% CI = 0.80–0.84).

Rates of COVID-19 hospital admissions peaked during the week of January 3–January 9, 2021, approximately 1 week after case incidence peaked (Figure 2). The trend in the weekly rate ratio of COVID-19 hospital admissions among older adults to younger adults followed a similar pattern as ED visits. Compared with hospital admissions during the prevaccination period of November 29–December 12, 2020, adult COVID-19 hospital admissions rates were 63% lower among all adults, with the largest change (78%) among adults aged ≥65 years, during April 18–May 1, 2021. Although COVID-19 admissions remained highest among persons aged ≥70 years, the proportion of adult COVID-19 hospital admissions among this age group decreased from 45.6% during November 29–December 12, 2020, to 27.6% during April 18–May 1, 2021 (p<0.001) (Table). The rate ratio of COVID-19 hospital admission rates among persons aged ≥70 years to those among persons aged 18–49 years decreased 65% (p<0.001) from 9.60 (95% CI = 9.45–9.76) to 3.33 (95% CI = 3.26–3.41) (p<0.001).

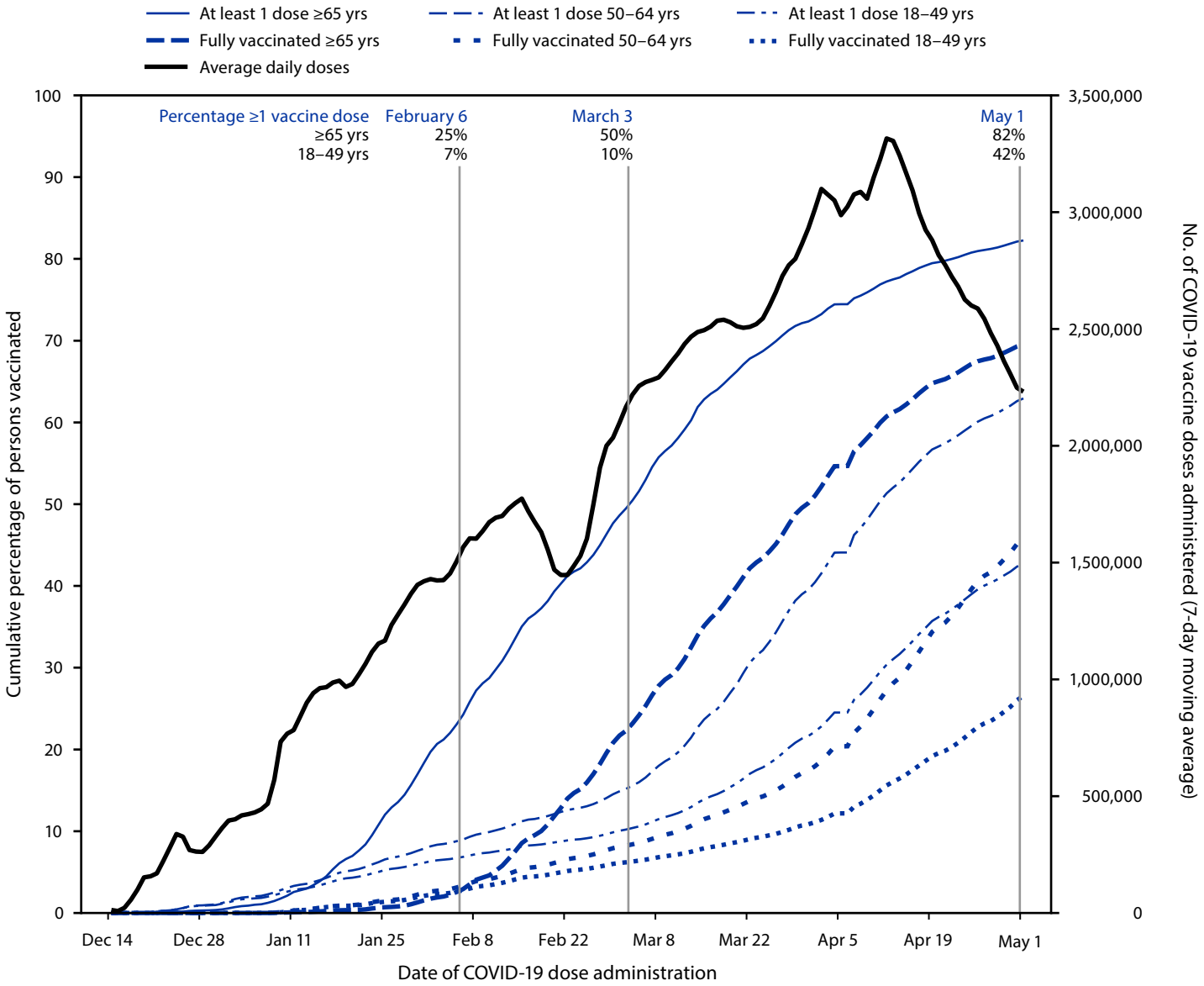
During September 6, 2020–May 1, 2021, weekly COVID-19 death rates peaked between January 3–January 16, 2021, among all age groups and then decreased through May 1, 2021 (Figure 2). The weekly rate ratio of COVID-19 deaths among older adults to those among younger adults was highest in mid-December and then declined. Mortality remained highest for persons aged ≥65 years; however, the proportion of COVID-19 deaths that occurred among this age group decreased from 84.2% during the prevaccination period of November 29–December 12, 2020, to 68.0% during April 18–May 1, 2021 (p<0.001) (Table). The rate ratio of COVID-19 death rates among persons aged ≥65 years to those among persons aged 18–49 years decreased 66% (p<0.001) from 66.93 (95% CI = 62.11–72.29) to 22.43 (95% CI = 20.17–25.18).

[§§] Patient age was unknown for 8% of vaccinated persons, 0.7% of cases, 0.4% of ED visits, 4% of hospital admissions, and <0.01% of deaths.

[¶¶] Hospital admissions were submitted by predefined age group (<18 years, 18–19 years, 10-year age groups from 20–79 years, and ≥80 years) and could not be aggregated from single year of age as was done for cases, ED visits, and deaths.

[***] 45 C.F.R. part 46, 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.

FIGURE 1. Average daily* number of total COVID-19 vaccine doses administered and cumulative percentage of adults aged ≥18 years who received ≥1 dose and who were fully vaccinated, by age group† — United States,§ December 14, 2020–May 1, 2021



Sources: COVID-19 Vaccination Trends in the United States, https://data.cdc.gov/Vaccinations/COVID-19-Vaccination-Trends-in-the-United-States-N/rh2h-3yt2 and COVID-19 Vaccination Demographics in the United States, https://data.cdc.gov/Vaccinations/COVID-19-Vaccination-Demographics-in-the-United-St/km4m-vcsb; accessed May 26, 2021.

* Based on 7-day moving average.

† Age was unknown for 8% of fully vaccinated persons.

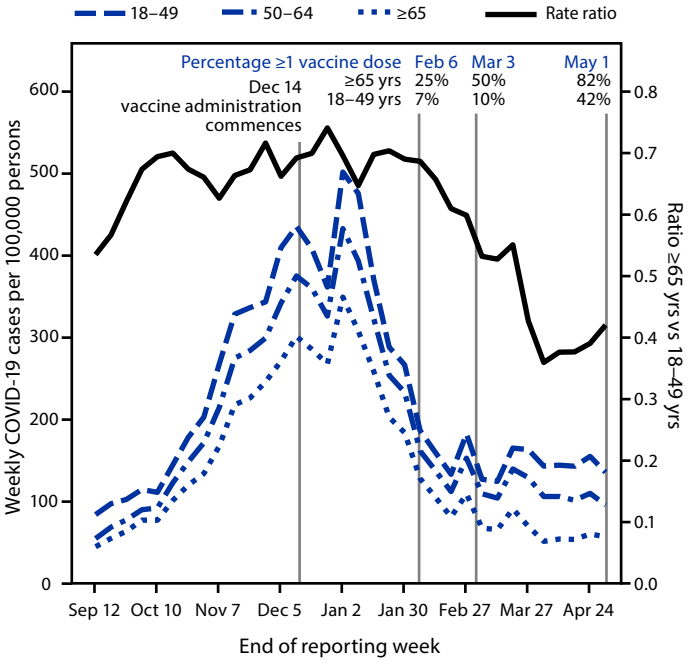
§ Texas does not report demographic-specific dose number information to CDC, so data for Texas are not represented in cumulative percentage of population vaccinated.

Discussion

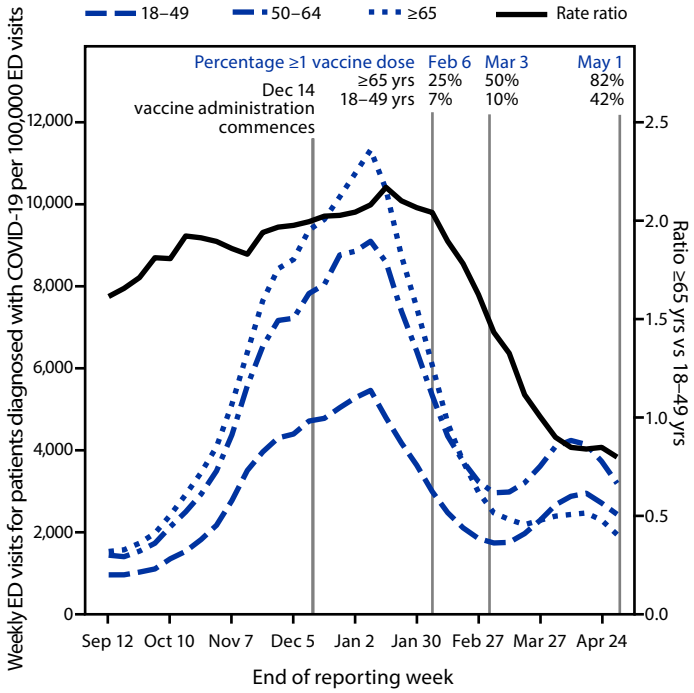
Weekly COVID-19 incidence among adults increased during September 6, 2020–January 2, 2021. After this peak, incidence, followed by rates of ED visits, hospital admissions, and deaths declined among all adult age groups. During September 6–December 14, 2020, before the commencement of vaccine administration, the rate ratios of COVID-19 outcomes among older adults to younger adults were either stable or increasing. The ratio for COVID-19 deaths began to decline in mid-December while rate ratios for COVID-19 incidence, ED visits, and hospital admissions began to decline in late December to mid-January. Comparing the 2-week pre-vaccination period with 2 weeks in late April, declines were significantly greater among older adults, who had higher vaccination coverage, than among younger adults, who had lower coverage. These age-stratified results provide ecologic evidence

FIGURE 2. Weekly COVID-19 rates (A),[*,†,§] emergency department visits for patients with a diagnosis of COVID-19 (B),[¶] hospital admissions with confirmed COVID-19 diagnosis (C),[,††] and COVID-19 deaths (D)[§§,¶¶] among adults, by age group, and rate ratio for persons aged ≥65 or ≥70 years versus 18–49 years — United States, September 6, 2020–May 1, 2021**

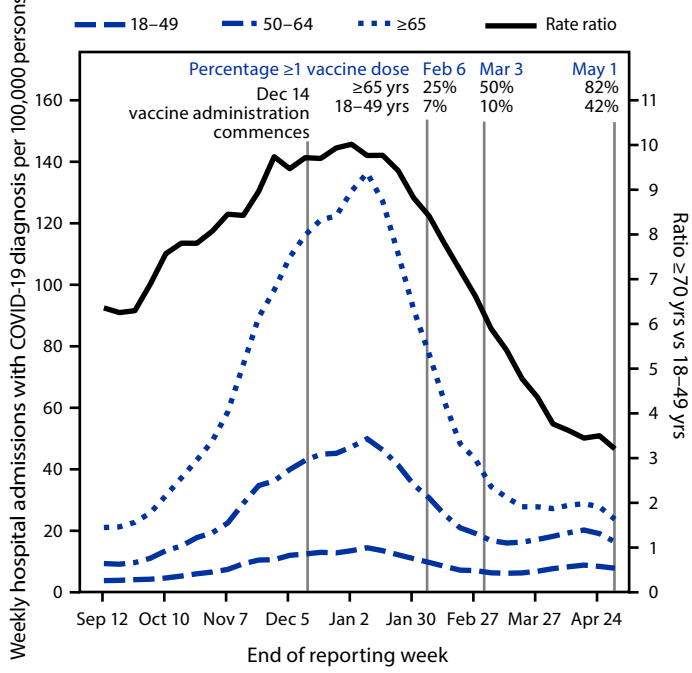
A. Weekly rate of COVID-19 cases, by age group, and rate ratio for persons aged ≥65 yrs vs those aged 18–49 yrs



B. Weekly ED visits for patients diagnosed with COVID-19 per 100,000 ED visits, by age group, and rate ratio for persons aged ≥65 yrs vs those aged 18–49 yrs



C. Weekly rate of hospital admissions with confirmed COVID-19 diagnosis, by age group, and rate ratio for persons aged ≥70 yrs vs those aged 18–49 yrs



D. Provisional weekly rate of COVID-19 deaths, by age group, and rate ratio for persons aged ≥65 yrs vs those aged 18–49 yrs

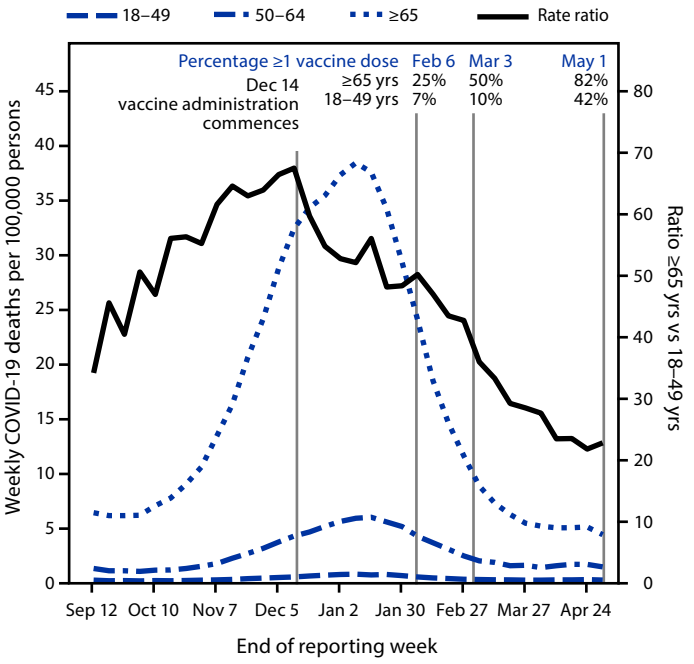


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FIGURE 2. (*Continued*) Weekly COVID-19 rates (A),[*,†,§] emergency department visits for patients with a diagnosis of COVID-19 (B),[¶] hospital admissions with confirmed COVID-19 diagnosis (C),[,††] and COVID-19 deaths (D)[§§,¶¶] among adults, by age group, and rate ratio for persons aged ≥65 or ≥70 and 18–49 years — United States, September 6, 2020–May 1, 2021**

Sources: CDC's case-based COVID-19 surveillance system, accessed May 26, 2021 (A); National Syndromic Surveillance Program; accessed May 26, 2021 (B); U.S. Department of Health and Human Services Unified Hospital dataset, accessed May 26, 2021 (C); National Vital Statistics System, accessed May 26, 2021 (D).
Abbreviation: ED = emergency department.
* COVID-19 cases per 100,000 persons.
† Case classifications for COVID-19 are described in https://ndc.services.cdc.gov/case-definitions/coronavirus-disease-2019-2020-08-05 and https://www.cdc.gov/coronavirus/2019-ncov/covid-data/faq-surveillance.html.
§ Demographic data are based on a subset of COVID-19 cases for whom case-level data have been reported by state and territorial jurisdictions, accounting for approximately 80% of all cases reported to CDC. Patient age was unknown for 0.7% of cases.
¶ ED visits are shown as visits for patients with a diagnosis of COVID-19 per 100,000 ED visits reported. ED visits for patients with a diagnosis of COVID-19 are defined as ED visits with any of the following: *International Classification of Diseases, Tenth Revision* codes U07.1 or J12.82 or Systematized Nomenclature of Medicine 840539006, 840544004, or 840533007. Patient age was unknown for 0.4% of ED visits.
** Hospital admissions with confirmed COVID-19 diagnosis per 100,000 persons.
†† Dataset includes data reported by hospitals registered with the Centers for Medicare & Medicaid Services. Data were reported to the U.S. Department of Health and Human Services directly from facilities or via a state submission; on May 1, 2021, 98.5% of hospitals reported. This analysis includes Veterans Administration, Defense Health Agency, and Indian Health Services hospitals and excludes psychiatric, rehabilitation, and religious nonmedical hospitals. Patient age was unknown for 4% of hospital admissions.
§§ COVID-19 deaths per 100,000 persons.
¶¶ Deaths with confirmed or presumed COVID-19 as an underlying or contributing cause of death, with *International Classification of Diseases, Tenth Revision* code U07.1. Provisional data are incomplete. Decedent age was unknown for <0.01% of deaths.

of the likely contribution of vaccination coverage to reducing COVID-19 outcomes.

These data are consistent with other preliminary reports showing a reduction in COVID-19 cases and severe illness in populations with high vaccination coverage. An ecologic study from Israel found the ratio of COVID-19 patients aged ≥70 years requiring mechanical ventilation to those aged <50 years declined 67% within 3 months of a nationwide vaccination campaign prioritizing persons aged >60 years (*4*). In separate studies analyzing Israeli surveillance data, COVID-19 incidence, hospitalizations, and deaths markedly declined across all age groups as cumulative vaccination coverage increased (*5*), and vaccine effectiveness of 46% for COVID-19 infection, 74% for hospitalization, and 72% for death, was observed during 14–20 days after the first dose (*6*). A CDC evaluation at 24 hospitals found that receipt of COVID-19 vaccine was 64% effective against COVID-19 hospitalization among partially vaccinated adults aged ≥65 years and 94% effective among fully vaccinated adults aged ≥65 years (*7*).

The findings in this report are subject to at least five limitations. First, this was an ecologic analysis based on aggregated data that does not account for variability in reporting or vaccination coverage among jurisdictions, between rural and urban areas, or by race and ethnicity. Second, states and territories adapted ACIP recommendations (*8*); therefore, the populations eligible and timing of each vaccination phase varied across jurisdictions. Third, the case, ED, and hospital data are subsets of total outcomes, and all data are subject to reporting inconsistencies and delays. Fourth, the analysis does not account for concomitant effects, including the spread of more transmissible SARS-CoV-2 variants, the general surge and subsequent decline in COVID-19 cases, the use of recommended therapeutics (*9*), and the implementation and relaxation of community-level prevention policies in individual jurisdictions. However, by analyzing the relative changes in ratios comparing rates between older and younger age groups, these results were less likely to be influenced by population effects that might have affected all age groups similarly. Finally, no attempt was made to quantify the percentage of these differential rate ratio changes that were potentially attributable to vaccination. The decline in the rate ratio for deaths between older and younger adults, for example, began just after vaccine introduction; therefore, vaccine coverage can account for only part of the decline. Time trend analyses, and other analytic approaches, might enhance understanding of the impact of vaccination on population-level dynamics.

From November 29, 2020, to May 1, 2021, COVID-19 incidence, ED visits, hospital admissions, and deaths declined more in older adults, who had higher vaccination coverage, than in younger adults, who had lower coverage. Despite sufficient vaccine supply and expanding eligibility, administration of COVID-19 vaccines has steadily declined in adults since mid-April 2021. These results suggest that tailored efforts by state and local jurisdictions to rapidly increase vaccine coverage among all eligible age groups could contribute to further reductions in COVID-19 cases and severe outcomes. Such efforts include effectively communicating the benefits of vaccination, ensuring equitable access and convenience, empowering trusted messengers, including primary health care providers, and engaging communities.

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TABLE. Number, proportion, rate,* and rate ratio of COVID-19 cases,† emergency department visits for patients with a diagnosis of COVID-19,§ hospital admissions with a confirmed COVID-19 diagnosis, and COVID-19 deaths¶ among adults aged ≥18 years, by age group, for selected 2-week periods — United States, November 29–December 12, 2020, and April 18–May 1, 2021

Period, COVID-19 outcome, and age group (yrs)	Average weekly no. (% by age group)	Average weekly outcome per 100,000	Rate ratio comparing older age groups with age 18–49 yrs (95% CI) **	Change from November 29–December 12, 2020 to April 18–May 1, 2021		
				Absolute change in proportion	Relative change in rate, %	Relative change in rate ratio, %
November 29–December 12, 2020 (prevaccine administration)						
Cases	**964,697 (100.0)**	**378**	**N/A**	**N/A**	**N/A**	**N/A**
≥65	154,829 (16.0)	286	0.68 (0.67–0.68)	N/A	N/A	N/A
50–64	225,715 (23.4)	359	0.85 (0.85–0.85)	N/A	N/A	N/A
18–49	584,154 (60.6)	423	1.0 (referent)	N/A	N/A	N/A
ED visits	**108,689 (100.0)**	**6,409**	**N/A**	**N/A**	**N/A**	**N/A**
≥65	41,208 (37.9)	9,008	1.99 (1.96–2.01)	N/A	N/A	N/A
50–64	28,537 (26.3)	7,513	1.66 (1.64–1.68)	N/A	N/A	N/A
18–49	38,945 (35.8)	4,536	1.0 (referent)	N/A	N/A	N/A
Hospital admissions	**90,349 (100.0)**	**35**	**N/A**	**N/A**	**N/A**	**N/A**
≥70	41,178 (45.6)	112	9.60 (9.45–9.76)	N/A	N/A	N/A
50–69	32,976 (36.5)	41	3.50 (3.45–3.56)	N/A	N/A	N/A
18–49	16,195 (17.9)	12	1.0 (referent)	N/A	N/A	N/A
Deaths	**19,666 (100.0)**	**7.7**	**N/A**	**N/A**	**N/A**	**N/A**
≥65	16,557 (84.2)	30.6	66.93 (62.11–72.29)	N/A	N/A	N/A
50–64	2,477 (12.6)	3.9	8.60 (7.92–9.38)	N/A	N/A	N/A
18–49	633 (3.2)	0.5	1.0 (referent)	N/A	N/A	N/A
April 18–May 1, 2021 (most recent data available at time of report, allowing time for reporting lag)						
Cases	**297,618 (100.0)**	**117**	**N/A**	**N/A**	**−69††**	**N/A**
≥65	31,802 (10.7)	59	0.40 (0.40–0.41)	−5.4††	−79††	−40††
50–64	64,796 (21.8)	103	0.71 (0.70–0.71)	−1.6††	−71††	−17††
18–49	201,021 (67.5)	145	1.0 (referent)	7.0††	−66††	N/A
ED visits	**46,308 (100.0)**	**2,628**	**N/A**	**N/A**	**−59††**	**N/A**
≥65	9,580 (20.7)	2,093	0.82 (0.80–0.84)	−17.2††	−77††	−59††
50–64	13,449 (29.0)	3,437	1.35 (1.33–1.37)	2.8††	−54††	−19††
18–49	23,280 (50.3)	2,550	1.0 (referent)	14.4††	−44††	N/A
Hospital admissions	**33,600 (100.0)**	**13**	**N/A**	**N/A**	**−63††**	**N/A**
≥70	9,260 (27.6)	25	3.33 (3.26–3.41)	−18.0††	−78††	−65††
50–69	13,850 (41.2)	17	2.27 (2.22–2.32)	4.7††	−58††	−35††
18–49	10,490 (31.2)	8	1.0 (referent)	13.3††	−35††	N/A
Deaths	**3,918 (100.0)**	**1.5**	**N/A**	**N/A**	**−80††**	**N/A**
≥65	2,663 (68.0)	4.9	22.43 (20.17–25.18)	−16.2††	−84††	−66††
50–64	952 (24.3)	1.5	6.89 (6.12–7.82)	11.7††	−62††	−20
18–49	304 (7.7)	0.2	1.0 (referent)	4.5††	−52††	N/A

Sources: CDC's case-based COVID-19 surveillance system, National Syndromic Surveillance Program, U.S. Department of Health and Human Services Unified Hospital dataset, National Vital Statistics System; accessed May 26, 2021.

Abbreviations: CI = confidence interval; ED = emergency department; ICD-10 = *International Classification of Diseases, Tenth Revision*; N/A = not applicable.

* COVID-19 cases, hospital admissions with confirmed COVID-19 diagnosis, and COVID-19 deaths per 100,000 persons and ED visits for patients with a diagnosis of COVID-19 per 100,000 ED visits.

† The case classifications for COVID-19 are described in an updated interim COVID-19 position statement and case definition issued by the Council of State and Territorial Epidemiologists on August 5, 2020 (https://ndc.services.cdc.gov/case-definitions/coronavirus-disease-2019-2020-08-05). However, some variation in how jurisdictions implement these case classifications was observed. More information on how CDC collects COVID-19 case surveillance data can be found at https://www.cdc.gov/coronavirus/2019-ncov/covid-data/faq-surveillance.html.

§ ED visits for COVID-19 are defined as ED visits with any of the following: ICD-10 codes U07.1 or J12.82 or Systematized Nomenclature of Medicine codes 840539006, 840544004, or 840533007.

¶ Deaths with confirmed or presumed COVID-19 as an underlying or contributing cause of death with ICD-10 code U07.1. Provisional data are incomplete. Data from May 2021 are less complete because of reporting lags.

** CIs and p values were constructed using the parametric bootstrap method using 10,001 replicate pseudosamples. CIs were formed using the quantiles of the bootstrap distributions, and p values were based on the proportion of pseudosample values below the 0.025 or above the 0.975 quantile.

†† The change in measure from November 29–December 12, 2020, to April 18–May 1, 2021, was statistically significantly different ($p<0.001$).

Summary

What is already known about this topic?

COVID-19 vaccination began in the United States in December 2020, and adults aged ≥65 years were prioritized in early phases.

What is added by this report?

By May 1, 2021, 82%, 63%, and 42% of adults aged ≥65, 50–64, and 18–49 years, respectively, had received ≥1 vaccine dose. From November 29–December 12, 2020 to April 18-May 1, 2021, the rate ratios of COVID-19 incidence, emergency department visits, hospital admissions, and deaths among adults aged ≥65 years (≥70 years for hospitalizations) to adults aged 18–49 years declined 40%, 59%, 65%, and 66%, respectively.

What are the implications for public health practice?

The greater decline in COVID-19 morbidity and mortality in older adults, the age group with the highest vaccination rates, demonstrates the potential impact of increasing population-level vaccination coverage.

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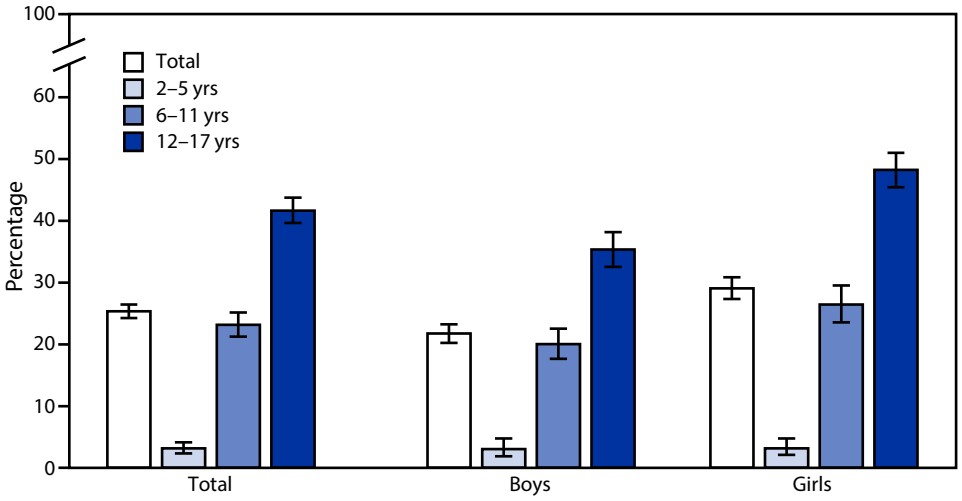
QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Percentage* of Children† Aged 2–17 Years Who Wear Glasses or Contact Lenses,§ by Sex and Age Group — National Health Interview Survey, United States, 2019¶



* With 95% confidence intervals indicated with error bars.
† Children are defined here as children and adolescents (i.e., persons aged 2–17 years).
§ Based on the survey response of "yes" to the question, "Does (child's name) wear eyeglasses or contact lenses?"
¶ Estimates are based on household interviews of a sample of the civilian, noninstitutionalized U.S. population.

In 2019, 25.3% of children aged 2–17 years wore glasses or contact lenses, and the percentage increased with age among both boys and girls. Among boys, 3.0% wore glasses among those aged 2–5 years, 20.0% among those aged 6–11 years, and 35.3% among those aged 12–17 years. Among girls, the corresponding percentages are 3.1, 26.4, and 48.2. The percentage was higher among girls than boys overall and among those aged 6–11 years and 12–17 years, but not in the youngest age group.

Source: National Center for Health Statistics, National Health Interview Survey, 2019. https://www.cdc.gov/nchs/nhis.htm

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