Centers for Disease Control and Prevention
MMWR
Morbidity and Mortality Weekly Report
Weekly / Vol. 71 / No. 11
March 18, 2022

Tobacco Product Use Among Adults — United States, 2020

Monica E. Cornelius, PhD[1]; Caitlin G. Loretan, MPH[1]; Teresa W. Wang, PhD[1]; Ahmed Jamal, MBBS[1]; David M. Homa, PhD[1]

Although cigarette smoking has declined over the past several decades, a diverse landscape of combustible and noncombustible tobacco products has emerged in the United States (*1*–*4*). To assess recent national estimates of commercial tobacco product use among U.S. adults aged ≥18 years, CDC analyzed data from the 2020 National Health Interview Survey (NHIS). In 2020, an estimated 47.1 million U.S. adults (19.0%) reported currently using any commercial tobacco product, including cigarettes (12.5%), e-cigarettes (3.7%), cigars (3.5%), smokeless tobacco (2.3%), and pipes* (1.1%).† From 2019 to 2020, the prevalence of overall tobacco product use, combustible tobacco product use, cigarettes, e-cigarettes, and use of two or more tobacco products decreased. Among those who reported current tobacco product use, 79.6% reported using combustible products (e.g., cigarettes, cigars, or pipes), and 17.3% reported using two or more tobacco products.§ The prevalence of any current commercial tobacco product use was higher among the following groups: 1) men; 2) adults aged <65 years; 3) non-Hispanic American Indian or Alaska Native (AI/AN) adults and non-Hispanic adults categorized as of "Other" race¶; 4) adults in rural (nonmetropolitan) areas; 5) those whose highest level of educational attainment was a general educational development certificate (GED); 6) those with an annual household income <$35,000; 7) lesbian, gay, or bisexual adults; 8) uninsured adults or those with Medicaid; 9) adults living with a disability; and 10) those who regularly had feelings of anxiety or depression. Continued monitoring of tobacco product use and tailored strategies and policies that reduce the effects of inequitable conditions could aid in reducing disparities in tobacco use (*1*,*4*).

* The use of regular pipe, water pipe, or hookahs was assessed together using a single question. Interviewers could read the following sentences if necessary: "A hookah is a type of water pipe. It is sometimes called a 'narghile' (NAR-ge-lee) pipe. Do not include electronic hookahs or e-hookahs"; "Do not include electronic pipes or e-pipes"; "Do not include pipes filled with substances other than tobacco."

† Categories are not mutually exclusive.

§ Current use of two or more tobacco products was defined as use either every day or some days of at least two or more of the following tobacco products: cigarettes (100 or more cigarettes during lifetime); cigars, cigarillos, or filtered little cigars; pipes, water pipes, or hookahs; e-cigarettes; or smokeless tobacco products.

¶ Hispanic persons could be of any race. All other groups were non-Hispanic. The following four non-Hispanic single-race categories were available for sample adults in the 2020 NHIS public use files: 1) White; 2) Black or African American; 3) Asian; and 4) AI/AN. Exclusive from these groups, the "non-Hispanic, Other" category includes those adults who were categorized as "non-Hispanic AI/AN and any other group" or "other single and multiple races."

INSIDE

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

U.S. Department of Health and Human Services
Centers for Disease Control and Prevention

NHIS is an annual, nationally representative household survey of the noninstitutionalized U.S. civilian population.** In 2020, 31,568 adults aged ≥18 years (21,153 from the original 2020 sample [response rate: 48.9%] and 10,415 reinterviewed from 2019 [response rate: 29.6%]) participated†† (*5*). Data were weighted to provide nationally representative estimates, adjusting for differences in selection probability and nonresponse. As used in this report, "tobacco" refers to commercial tobacco products and not to tobacco used for medicinal and spiritual purposes by some American Indian communities. CDC assessed use of five tobacco products: cigarettes, cigars (cigars, cigarillos, or filtered little cigars), pipes (regular pipes, water pipes, or hookahs), e-cigarettes, and smokeless tobacco. Current cigarette smoking was defined as having ever smoked 100 or more cigarettes within one's lifetime and smoking every day or some days at the time of survey. Current use of all other commercial tobacco products was defined as having reported use of these products every day or some days at the time of survey. Prevalence estimates for current use of any tobacco product, any combustible tobacco product, and two or more tobacco products were calculated. For 2020, estimates were calculated overall and by sex, age, race and ethnicity, U.S. Census region,§§ urban-rural designation,¶¶ education (for adults aged ≥25 years), marital status, annual household income,*** sexual orientation,††† health insurance

** https://www.cdc.gov/nchs/nhis/data-questionnaires-documentation.htm

†† Because of the COVID-19 pandemic, data collection procedures in 2020 were disrupted, and from April through June all interviews were conducted by telephone only; from July through December, interviews were attempted by telephone first, with follow-ups to complete interviews by personal visit, when possible. During July–December, in-person data collection took place in selected areas based on COVID-19 rates; however, most interviews remained telephone-only. In addition, approximately one half of the original sample allocated for the last 5 months of 2020 was replaced with a reinterviewed sample (sample adults who completed the 2019 NHIS Sample Adult interview) because of concerns about possible loss of coverage and lower response rates typically associated with telephone interviewing. Additional details about NHIS 2020 interviewing during the COVID-19 pandemic are available at https://www.cdc.gov/nchs/nhis/data-questionnaires-documentation.htm.

§§ https://www.census.gov/programs-surveys/economic-census/guidance-geographies/levels.html; https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf

¶¶ Urban = large central metropolitan, large fringe metropolitan, medium metropolitan, and small metropolitan; rural = nonmetropolitan. Metropolitan statistical areas are based on the 2013 National Center for Health Statistics Urban-Rural Classification Scheme for Counties. https://www.cdc.gov/nchs/data/series/sr_02/sr02_166.pdf

*** Based on the imputed sample adult family income (grouped) variable (n = 31,568).

††† Sexual orientation was determined using the question, "Which of the following best represents how you think of yourself?" Response options included "gay," "straight, that is, not gay," "bisexual," "something else," and "I don't know the answer" among male respondents, and "lesbian or gay," "straight, that is, not lesbian or gay," "bisexual, "something else," and "I don't know the answer" among female respondents. Respondents were considered to be lesbian, gay, or bisexual if they responded "gay," "lesbian or gay," or "bisexual."

The *MMWR* series of publications is published by the Center for Surveillance, Epidemiology, and Laboratory Services, Centers for Disease Control and Prevention (CDC), U.S. Department of Health and Human Services, Atlanta, GA 30329-4027.

Suggested citation: [Author names; first three, then et al., if more than six.] [Report title]. MMWR Morb Mortal Wkly Rep 2022;71:[inclusive page numbers].

coverage,[§§§] disability,[¶¶¶] and regularly had feelings of anxiety or depression.[****]

CDC assessed statistically significant (p<0.05) differences in current cigarette smoking by urban-rural designation among each racial and ethnic group, changes in prevalence of tobacco product use during 2019 and 2020, and changes in average number of cigarettes smoked per day (1–9, 10–19, 20–29, and ≥30 cigarettes) during 2005–2020. SAS-callable SUDAAN software (version 11.0.3; Research Triangle Institute) was used to conduct all analyses. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[††††]

Among U.S. adults in 2020, 19.0% (estimated 47.1 million) currently used any tobacco product, 15.2% (37.5 million) used any combustible tobacco product, and 3.3% (8.1 million) used two or more tobacco products. Cigarettes were the most commonly used tobacco product (12.5%; 30.8 million). Prevalence of use and estimated number of users of other tobacco products in 2020 was as follows: e-cigarettes (3.7%; 9.1 million), cigars (3.5%; 8.6 million), smokeless tobacco (2.3%; 5.7 million), and pipes (1.1%; 2.6 million) (Table). Among persons who currently used any tobacco product, 79.6% used combustible tobacco products, and 17.3% reported using two or more tobacco products. From 2019 to 2020, statistically significant decreases (p<0.05) were observed in the prevalence of use of any tobacco product (20.8% to 19.0%; p<0.001), combustible tobacco products (16.7% to 15.2%; p<0.001), two or more tobacco products (3.9% to 3.3%; p = 0.003), cigarettes (14.0% to 12.5%; p<0.001), and e-cigarettes (4.5% to 3.7%; p<0.001). No statistically significant changes in past-year prevalence were observed among other products, including cigars (3.6% to 3.5%; p = 0.60) and pipes (1.0% to 1.1%; p = 0.44), and smokeless products (2.4% to 2.3%; p = 0.50).

Current cigarette smoking prevalence was higher among persons who resided in rural areas than among those who resided in urban areas among non-Hispanic Black (38% higher), Hispanic (38% higher) and non-Hispanic White (62% higher) adults; in contrast, prevalence among non-Hispanic Asian adults was 32% higher among those in urban areas (p<0.05) (Figure 1). Among adults who smoked cigarettes daily, the percentage who reported smoking 20–29 cigarettes per day decreased from 34.9% in 2005 to 27.9% in 2020, and the percentage who reported smoking 30 or more cigarettes per day decreased from 12.7% to 6.4%; the percentage who reported smoking 1–9 cigarettes per day increased from 16.4% to 25.0%, and the percentage who reported smoking 10–19 cigarettes per day increased from 36.0% to 40.7% (all p<0.001) (Figure 2).

The prevalence of any current tobacco product use was higher among 1) men (24.5%) than among women (13.9%); 2) persons aged 25–44 years (22.9%), 45–64 years (20.4%), or 18–24 years (17.6%) than among those aged ≥65 years (11.8%); 3) non-Hispanic AI/AN (34.9%), non-Hispanic Other (29.1%), non-Hispanic White (21.1%), and non-Hispanic Black (19.4%) adults than among Hispanic (11.7%) and non-Hispanic Asian (11.5%) adults; 4) persons living in the Midwest (22.0%) or the South (21.1%) than among those living in the Northeast (16.6%) or West (15.0%); 5) persons from rural areas (27.3%) than among those from urban areas (17.7%); and 6) persons with a GED (40.5%) than among those with other levels of education (Table). The prevalence of any current tobacco product use was also higher among 1) persons who were divorced/separated/widowed (21.6%) or single/never married/not living with a partner (21.4%) than among those married/living with a partner (17.5%); 2) persons who had an annual household income of <$35,000 (25.2%) than those with higher income; 3) lesbian, gay, or bisexual adults (25.1%) than heterosexual/straight adults (18.8%); 4) persons insured by Medicaid (28.6%) or who were uninsured (27.3%), than those who had some other public insurance (21.3%), private insurance (16.4%) or Medicare only (12.5%); 5) persons with a disability (25.4%) than those who did not (18.4%); and 6) persons who reported regularly

[§§§] Private insurance coverage includes adults who had any comprehensive private insurance plan (including health maintenance organizations and preferred provider organizations). Medicaid for adults aged <65 years includes adults who do not have private coverage, but who have Medicaid or other state-sponsored health plans including Children's Health Insurance Program; for adults aged ≥65 years, Medicaid includes adults aged ≥65 years who do not have any private coverage but have Medicare and Medicaid or other state-sponsored health plans. Medicare coverage only includes adults aged ≥65 years who only have Medicare coverage. Other public insurance includes adults who do not have private insurance, Medicaid, or other public coverage but have any type of military coverage, coverage from other government programs, or Medicare (adults aged <65 years). Uninsured includes adults who have not indicated that they are covered under private health insurance, Medicare, Medicaid, a state-sponsored health plan, other government programs, or military coverage. Insurance coverage is as of time of survey.

[¶¶¶] Disability was defined based on self-reported presence of selected limitations including vision, hearing, mobility, remembering, self-care, and communication. These six questions are based on the short set of questions recommended by the Washington Group on Disability Statistics (https://www.cdc.gov/nchs/washington_group/index.htm). Further information on the coding is available at https://www.washingtongroup-disability.com/fileadmin/uploads/wg/Documents/WG_Resource_Document__4_-_Monitoring_Using_the_WG_Questions.pdf.

[****] Regularly having feelings of anxiety and regularly having feelings of depression was assessed using questions from The Washington Group Short Set on Functioning – Enhanced: Question Specification for question source (https://www.washingtongroup-disability.com/fileadmin/uploads/wg/Documents/Questions/WG_Implementation_Document__4C_-_WG-SS_Enhanced_Question_Specifications.pdf). Further information on the definition is available at https://wwwn.cdc.gov/NHISDataQueryTool/ER_Quarterly/index_quarterly.html.

[††††] 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. Percentage of adults aged ≥18 years who reported tobacco product use "every day" or "some days," by tobacco product and selected characteristics — National Health Interview Survey, United States, 2020

Characteristic	Tobacco product use,* % (95% CI)†							
	Any tobacco product§	Combustible tobacco product¶	Cigarettes**	Cigars††	Pipes§§	E-cigarettes¶¶	Smokeless tobacco products***	Two or more tobacco products†††
Overall	**19.0 (18.4–19.7)**	**15.2 (14.6–15.8)**	**12.5 (11.9–13.0)**	**3.5 (3.2–3.8)**	**1.1 (0.9–1.3)**	**3.7 (3.4–4.0)**	**2.3 (2.1–2.6)**	**3.3 (3.0–3.6)**
Sex								
Men	24.5 (23.5–25.5)	18.8 (17.9–19.8)	14.1 (13.3–14.9)	6.3 (5.8–6.9)	1.5 (1.2–1.8)	4.6 (4.2–5.2)	4.5 (4.0–5.0)	5.2 (4.7–5.8)
Women	13.9 (13.2–14.7)	11.7 (11.1–12.4)	11.0 (10.3–11.6)	0.8 (0.7–1.0)	0.7 (0.5–0.9)	2.8 (2.5–3.2)	0.3 (0.2–0.5)	1.5 (1.2–1.8)
Age group, yrs								
18–24	17.6 (15.5–19.9)	10.9 (9.2–12.9)	7.4 (5.9–9.0)	4.1 (3.1–5.4)	2.1 (1.3–3.1)	9.4 (7.8–11.2)	2.4 (1.6–3.4)	5.7 (4.4–7.2)
25–44	22.9 (21.8–24.0)	18.0 (16.9–19.1)	14.1 (13.1–15.1)	5.0 (4.4–5.6)	1.7 (1.3–2.1)	5.2 (4.6–5.7)	2.8 (2.4–3.3)	4.9 (4.3–5.6)
45–64	20.4 (19.4–21.5)	16.9 (16.0–17.9)	14.9 (14.0–15.9)	2.8 (2.5–3.2)	0.6 (0.4–0.8)	2.2 (1.9–2.6)	2.5 (2.1–3.0)	2.3 (1.9–2.6)
≥65	11.8 (10.9–12.7)	10.4 (9.6–11.3)	9.0 (8.2–9.8)	1.8 (1.5–2.1)	0.3 (0.2–0.5)	0.6 (0.4–0.8)	1.2 (0.9–1.6)	1.0 (0.8–1.3)
Race and ethnicity§§§								
American Indian or Alaska Native, non-Hispanic	34.9 (24.8–46.2)	29.3 (18.8–41.7)	27.1 (17.4–38.6)	—¶¶¶	—¶¶¶	—¶¶¶	6.8 (3.6–11.5)	10.9 (6.4–16.9)
White, non-Hispanic	21.1 (20.4–21.9)	16.3 (15.6–17.0)	13.3 (12.7–14.0)	3.8 (3.4–4.2)	0.9 (0.8–1.2)	4.2 (3.8–4.7)	3.2 (2.8–3.5)	3.6 (3.2–3.9)
Black, non-Hispanic	19.4 (17.4–21.5)	18.0 (16.2–19.9)	14.4 (12.6–16.3)	4.6 (3.7–5.6)	1.6 (1.1–2.3)	1.6 (1.0–2.3)	0.8 (0.4–1.5)	2.9 (2.2–3.9)
Asian, non-Hispanic	11.5 (9.6–13.7)	8.7 (7.0–10.7)	8.0 (6.4–9.9)	0.9 (0.4–1.6)	0.4 (0.1–0.9)	3.4 (2.3–4.7)	0.4 (0.2–0.9)	1.4 (0.8–2.3)
Other, non-Hispanic	29.1 (24.1–34.4)	21.0 (16.3–26.4)	19.5 (14.9–24.7)	—¶¶¶	—¶¶¶	7.8 (5.1–11.2)	3.7 (1.9–6.4)	9.2 (5.3–14.8)
Hispanic	11.7 (10.4–13.1)	9.8 (8.6–11.0)	8.0 (7.0–9.2)	2.2 (1.7–2.8)	0.9 (0.6–1.4)	2.8 (2.2–3.5)	0.4 (0.2–0.7)	2.2 (1.7–2.8)
U.S. Census region****								
Northeast	16.6 (15.0–18.3)	13.4 (12.1–14.8)	10.4 (9.3–11.5)	3.1 (2.5–3.8)	0.8 (0.5–1.2)	3.0 (2.4–3.8)	1.6 (1.1–2.3)	2.1 (1.7–2.6)
Midwest	22.0 (20.6–23.4)	18.2 (16.8–19.6)	15.2 (14.0–16.5)	3.7 (3.1–4.4)	1.3 (0.9–1.8)	4.1 (3.4–4.8)	2.6 (2.1–3.2)	4.1 (3.3–4.9)
South	21.1 (20.0–22.2)	16.9 (15.8–18.0)	14.1 (13.1–15.2)	4.1 (3.6–4.7)	1.1 (0.8–1.4)	3.6 (3.2–4.2)	2.7 (2.3–3.2)	3.7 (3.2–4.3)
West	15.0 (13.9–16.1)	11.1 (10.2–12.0)	9.0 (8.2–9.8)	2.5 (2.1–3.0)	1.1 (0.8–1.5)	4.0 (3.3–4.7)	1.9 (1.5–2.4)	2.8 (2.3–3.3)
Metropolitan statistical area†††								
Urban	17.7 (17.0–18.4)	14.2 (13.5–14.8)	11.4 (10.8–12.0)	3.4 (3.1–3.8)	1.1 (0.9–1.3)	3.7 (3.3–4.0)	1.7 (1.5–2.0)	3.0 (2.7–3.3)
Rural	27.3 (25.5–29.2)	21.3 (19.6–23.1)	19.0 (17.4–20.8)	3.7 (2.9–4.7)	1.0 (0.6–1.5)	3.9 (3.0–5.0)	5.9 (4.8–7.0)	5.0 (4.0–6.1)
Education (adults aged ≥25 yrs)								
0–12 yrs (no diploma)	24.8 (22.3–27.4)	22.7 (20.3–25.2)	21.5 (19.2–24.0)	3.1 (2.2–4.2)	0.7 (0.3–1.3)	1.4 (0.8–2.2)	2.4 (1.7–3.4)	3.6 (2.6–4.9)
GED	40.5 (35.4–45.8)	34.5 (29.5–39.7)	32.0 (27.2–37.2)	5.9 (3.9–8.5)	1.6 (0.5–3.6)	5.4 (3.5–7.9)	3.8 (2.1–6.2)	6.8 (4.7–9.5)
High school diploma	24.2 (22.9–25.6)	19.6 (18.3–20.9)	17.6 (16.4–18.9)	3.1 (2.5–3.6)	0.9 (0.6–1.4)	3.5 (3.0–4.2)	3.3 (2.7–4.0)	3.8 (3.1–4.5)
Some college, no diploma	21.7 (20.2–23.3)	17.3 (15.9–18.7)	14.4 (13.1–15.7)	4.0 (3.3–4.8)	0.8 (0.5–1.2)	4.1 (3.4–5.0)	2.6 (2.0–3.3)	3.5 (2.8–4.3)
Associate degree (academic or technical/vocational)	19.4 (17.8–21.1)	15.3 (13.8–16.8)	12.7 (11.3–14.1)	3.6 (2.8–4.5)	1.0 (0.6–1.6)	3.7 (2.9–4.5)	2.6 (2.0–3.4)	3.3 (2.5–4.2)
Bachelor's degree	11.7 (10.7–12.6)	9.0 (8.2–9.9)	5.6 (5.0–6.3)	3.3 (2.8–3.9)	1.0 (0.7–1.4)	2.4 (2.0–2.9)	1.3 (1.0–1.7)	1.7 (1.4–2.1)
Graduate degree (master's, professional, or doctoral)	8.6 (7.6–9.7)	6.9 (6.0–7.9)	3.5 (2.9–4.1)	3.0 (2.5–3.7)	0.9 (0.5–1.4)	1.5 (1.1–2.1)	0.8 (0.6–1.2)	1.1 (0.8–1.6)
Marital status								
Married/Living with partner	17.5 (16.7–18.2)	13.8 (13.1–14.5)	10.9 (10.3–11.6)	3.6 (3.2–4.0)	0.8 (0.6–1.0)	3.1 (2.7–3.4)	2.6 (2.3–2.9)	2.9 (2.5–3.3)
Divorced/Separated/Widowed	21.6 (20.3–22.9)	18.9 (17.6–20.1)	17.3 (16.1–18.5)	2.3 (1.8–2.8)	0.8 (0.5–1.1)	2.6 (2.1–3.1)	1.6 (1.2–2.1)	2.6 (2.1–3.2)
Single/Never married/ Not living with a partner	21.4 (20.0–23.0)	16.3 (14.9–17.7)	13.0 (11.7–14.4)	4.0 (3.4–4.8)	2.1 (1.6–2.7)	6.2 (5.3–7.1)	2.2 (1.7–2.9)	4.8 (4.1–5.7)
Annual household income, $§§§§								
<35,000	25.2 (23.8–26.5)	22.1 (20.9–23.4)	20.2 (19.0–21.4)	3.0 (2.6–3.5)	1.5 (1.1–2.0)	3.7 (3.1–4.3)	1.9 (1.4–2.4)	4.1 (3.6–4.8)
35,000–74,999	20.3 (19.2–21.5)	16.4 (15.3–17.5)	14.1 (13.1–15.1)	3.6 (3.0–4.1)	0.9 (0.6–1.2)	3.9 (3.3–4.5)	2.3 (2.0–2.8)	3.6 (3.1–4.2)
75,000–99,999	18.4 (16.8–20.1)	13.2 (11.8–14.7)	10.5 (9.3–11.9)	3.3 (2.5–4.1)	1.0 (0.5–1.5)	4.5 (3.6–5.6)	3.1 (2.4–4.0)	3.4 (2.6–4.4)
≥100,000	13.7 (12.8–14.7)	9.9 (9.1–10.7)	6.2 (5.6–6.9)	3.8 (3.4–4.3)	1.0 (0.7–1.4)	3.2 (2.7–3.7)	2.3 (1.9–2.7)	2.3 (1.9–2.8)
Sexual orientation								
Heterosexual/Straight	18.8 (18.2–19.5)	15.0 (14.4–15.6)	12.3 (11.7–12.8)	3.5 (3.2–3.8)	1.0 (0.9–1.2)	3.5 (3.2–3.8)	2.4 (2.2–2.7)	3.2 (2.9–3.5)
Lesbian, gay, or bisexual	25.1 (21.4–29.1)	18.9 (15.3–22.8)	16.1 (12.7–19.9)	4.3 (2.4–7.1)	2.6 (1.2–4.9)	8.7 (6.5–11.4)	0.8 (0.3–1.6)	6.2 (3.9–9.4)
Health insurance coverage¶¶¶¶								
Private insurance	16.4 (15.7–17.2)	12.3 (11.7–12.9)	9.2 (8.6–9.7)	3.5 (3.2–3.9)	0.9 (0.8–1.2)	3.8 (3.4–4.2)	2.4 (2.1–2.7)	2.8 (2.5–3.1)
Medicaid	28.6 (26.5–30.8)	24.6 (22.6–26.6)	22.7 (20.8–24.8)	3.0 (2.3–3.8)	1.9 (1.3–2.8)	4.4 (3.4–5.6)	2.4 (1.7–3.3)	5.0 (3.9–6.2)
Medicare only (aged ≥65 yrs)	12.5 (11.0–14.2)	11.3 (9.8–12.9)	10.2 (8.7–11.8)	1.6 (1.1–2.2)	0.1 (0.0–0.3)	0.7 (0.4–1.0)	1.1 (0.7–1.6)	1.0 (0.6–1.6)
Other public insurance	21.3 (18.9–24.0)	17.7 (15.3–20.3)	14.8 (12.6–17.4)	4.2 (3.1–5.6)	1.0 (0.5–1.7)	2.7 (1.9–3.8)	2.4 (1.6–3.4)	3.1 (2.1–4.2)
Uninsured	27.3 (25.0–29.8)	23.3 (21.1–25.6)	21.2 (19.1–23.4)	4.8 (3.7–6.1)	1.6 (1.0–2.3)	5.1 (4.0–6.4)	2.5 (1.8–3.4)	6.0 (4.8–7.4)
Disability ***								
Yes	25.4 (23.3–27.6)	21.6 (19.6–23.8)	19.8 (17.8–22.0)	3.4 (2.5–4.6)	1.2 (0.8–1.7)	3.5 (2.7–4.5)	2.9 (2.1–4.1)	4.8 (3.6–6.1)
No	18.4 (17.8–19.1)	14.6 (14.0–15.2)	11.8 (11.2–12.3)	3.5 (3.2–3.8)	1.1 (0.9–1.3)	3.7 (3.4–4.1)	2.3 (2.0–2.5)	3.2 (2.8–3.5)

See table footnotes on the next page.

TABLE. (*Continued*) Percentage of adults aged ≥18 years who reported tobacco product use "every day" or "some days," by tobacco product and selected characteristics — National Health Interview Survey, United States, 2020

Characteristic	Tobacco product use,* % (95% CI)†							
	Any tobacco product§	Combustible tobacco product¶	Cigarettes**	Cigars††	Pipes§§	E-cigarettes¶¶	Smokeless tobacco products***	Two or more tobacco products†††
Regularly having feelings of anxiety†††††								
Yes	29.6 (27.7–31.5)	24.1 (22.2–26.0)	21.4 (19.6–23.2)	4.1 (3.3–5.0)	1.8 (1.3–2.6)	7.1 (5.9–8.4)	2.1 (1.5–2.9)	5.6 (4.6–6.6)
No	17.7 (17.0–18.4)	14.0 (13.4–14.7)	11.3 (10.8–11.9)	3.4 (3.1–3.7)	1.0 (0.8–1.2)	3.3 (3.0–3.6)	2.3 (2.1–2.6)	3.0 (2.7–3.3)
Regularly having feelings of depression§§§§§								
Yes	35.6 (32.4–39.0)	29.6 (26.6–32.8)	26.9 (23.9–30.0)	3.7 (2.6–5.1)	2.8 (1.6–4.6)	8.3 (6.4–10.6)	2.6 (1.5–4.3)	6.7 (4.9–9.0)
No	18.3 (17.6–18.9)	14.5 (13.9–15.1)	11.8 (11.2–12.3)	3.5 (3.2–3.8)	1.0 (0.8–1.2)	3.5 (3.2–3.8)	2.3 (2.1–2.6)	3.1 (2.8–3.4)

Abbreviation: GED = general educational development certificate.

* Smoking and tobacco use here refer to use of commercial tobacco products and not to tobacco used for medicinal and spiritual purposes by some American Indian communities.

† 95% Korn-Graubard CIs. National Center for Health Statistics data presentation standards. https://www.cdc.gov/nchs/data/series/sr_02/sr02_175.pdf

§ Any tobacco use was defined as use either "every day" or "some days" of at least one tobacco product. (For cigarettes, users were defined as adults who reported use either "every day" or "some days" and had smoked 100 or more cigarettes during their lifetime).

¶ Any combustible tobacco use was defined as use either "every day" or "some days" of at least one combustible tobacco product: cigarettes; cigars, cigarillos, filtered little cigars; pipes, water pipes, or hookah. (For cigarettes, users were defined as adults who reported use either "every day" or "some days" and had smoked 100 or more times during their lifetime).

** Current cigarette smoking was defined as smoking 100 or more cigarettes during a person's lifetime and now smoking cigarettes "every day" or "some days."

†† Current cigar smoking was defined as smoking cigars, cigarillos, or little filtered cigars at least once during a person's lifetime and now smoking at least one of these products "every day" or "some days."

§§ Current pipe smoking was defined as smoking tobacco in a regular pipe, water pipe, or hookah at least once during a person's lifetime and now smoking at least one of these products "every day" or "some days."

¶¶ Current e-cigarette use was defined as using e-cigarettes at least once during a person's lifetime and now using e-cigarettes "every day" or "some days."

*** Current smokeless tobacco product use was defined as using chewing tobacco, snuff, dip, snus, or dissolvable tobacco at least once during a person's lifetime and now using at least one of these products "every day" or "some days."

††† Current multiple tobacco product use was defined as use "every day" or "some days" for at least two or more of the following tobacco products: cigarettes (100 or more cigarettes during lifetime); cigars, cigarillos, filtered little cigars; pipes, water pipes, or hookahs; e-cigarettes; or smokeless tobacco products.

§§§ Hispanic persons could be of any race. All other groups were non-Hispanic. The following four non-Hispanic single-race categories were available for sample adults in the 2020 National Health Interview Survey public use files: 1) White; 2) Black or African American; 3) Asian, and 4) American Indian or Alaska Native. Exclusive from these groups, the "Other, non-Hispanic" category includes those adults who were categorized as "non-Hispanic American Indian or Alaska Native and any other group" or "other single and multiple races."

¶¶¶ Based on National Center for Health Statistics data presentation standards, estimates were statistically unreliable (https://www.cdc.gov/nchs/data/series/sr_02/sr02_175.pdf). SAS MACRO used for suppression criteria check. https://www.sas.com/content/dam/SAS/support/en/sas-global-forum-proceedings/2019/3659-2019.pdf

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

†††† Urban = large central metropolitan, large fringe metropolitan, medium metropolitan, and small metropolitan; rural = nonmetropolitan. Metropolitan statistical areas are based on the 2013 National Center for Health Statistics Urban-Rural Classification Scheme for Counties. https://www.cdc.gov/nchs/data/series/sr_02/sr02_166.pdf

§§§§ Based on the imputed sample adult family income (grouped) variable.

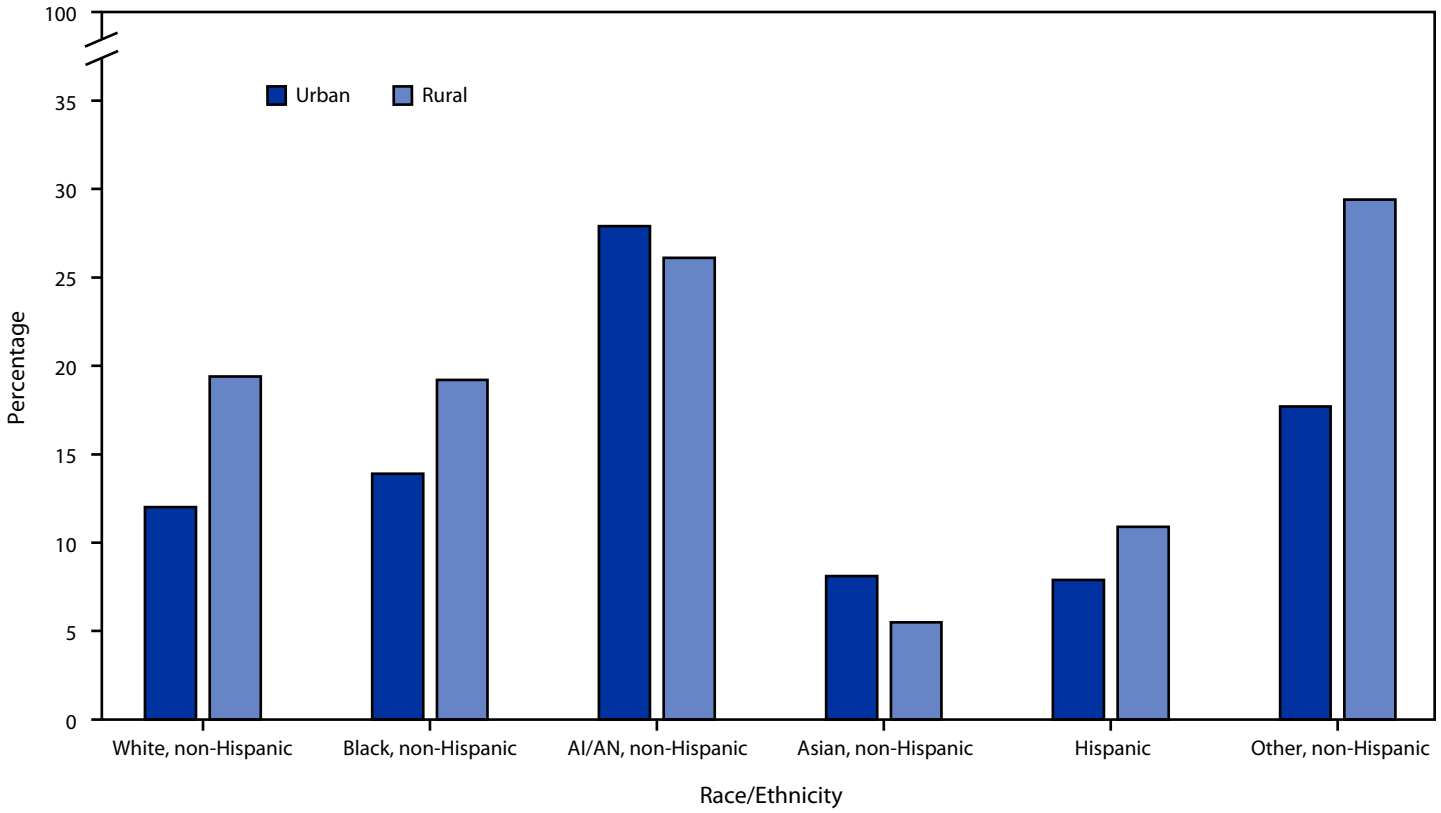
¶¶¶¶ Private insurance coverage includes adults who had any comprehensive private insurance plan (including health maintenance organizations and preferred provider organizations). Medicaid for adults aged <65 years includes adults who do not have private coverage, but who have Medicaid or other state-sponsored health plans including Children's Health Insurance Program; for adults aged ≥65 years, includes adults aged ≥65 years who do not have any private coverage but have Medicare and Medicaid or other state-sponsored health plans. Medicare coverage only includes adults aged ≥65 years who only have Medicare coverage. Other public insurance includes adults who do not have private insurance, Medicaid, or other public coverage but have any type of military coverage, coverage from other government programs, or Medicare (adults aged <65 years). Uninsured includes adults who have not indicated that they are covered under private health insurance, Medicare, Medicaid, a state-sponsored health plan, other government programs, or military coverage. Insurance coverage is as of time of survey.

***** Disability was defined based on self-reported presence of selected limitations including vision, hearing, mobility, remembering or concentrating, self-care, and communication. Respondents had to answer, "A lot of difficulty" or "Cannot do at all/unable to do" to one of the following questions: "Do you have difficulty seeing, even when wearing glasses?," "Do you have difficulty hearing, even when using a hearing aid?," "Do you have any difficulty walking or climbing steps?," "Using your usual language, do you have difficulty communicating, for example, understanding or being understood?," "Do you have difficulty remembering or concentrating?," "Do you have difficulty with self-care, such as washing all over or dressing?" to be coded as living with a disability; those who responded "no difficulty" or "some difficulty" to all six questions were coded as having no disability. Classifications are based on the 2020 National Health Interview Survey Washington Group Short Set Composite Disability Indicator recode, as based on the short set of questions recommended by the Washington Group on Disability Statistics. https://www.cdc.gov/nchs/washington_group/index.htm

††††† Regularly having feelings of anxiety was assessed by the questions, "How often do you feel worried, nervous or anxious? Would you say daily, weekly, monthly, a few times a year, or never?" and "Thinking about the last time you felt worried, nervous or anxious, how would you describe the level of these feelings? Would you say a little, a lot, or somewhere in between?" Respondents indicating 1) feeling worried, nervous, or anxious daily and describing the level of those feelings as "somewhere in between a little and a lot" or "a lot" or 2) feeling worried, nervous, or anxious weekly and describing the level of those feelings as "a lot" were considered as regularly having feelings of anxiety. Those who answered 1) "never" feeling worried, nervous or anxious and who did not answer the question on the level of the feelings, 2) feeling worried, nervous or anxious and daily and described the level of those feelings as "a little," 3) feeling worried, nervous, or anxious weekly and described the level of those feelings as "a little" or "somewhere in between a little and a lot," or 4) feeling worried, nervous, or anxious "monthly" or "a few times a year" and described the level of those feelings as "a little", "a lot" or "somewhere in between a little and a lot" were considered as not regularly having feelings of anxiety. Others not falling within those combinations were excluded. More information on the definition is available at https://wwwn.cdc.gov/NHISDataQueryTool/ER_Quarterly/index_quarterly.html, and more information on the question source is available at https://www.washingtongroup-disability.com/fileadmin/uploads/wg/Documents/Questions/WG_Implementation_Document__4C_-_WG-SS_Enhanced_Question_Specifications.pdf.

§§§§§ Regularly having feelings of depression was assessed by the questions, "How often do you feel depressed? Would you say daily, weekly, monthly, a few times a year, or never?" and "Thinking about the last time you felt depressed, how would you describe the level of these feelings? Would you say a little, a lot, or somewhere in between?" Respondents indicating 1) feeling depressed daily and describing the level of those feelings as "somewhere in between a little and a lot" or "a lot" or 2) feeling depressed weekly and describing the level of those feelings as "a lot" were considered as regularly having feelings of depression. Those who answered 1) "never" feeling depressed and who did not answer the question on the level of the feelings, 2) feeling depressed daily and described the level of those feelings as "a little," 3) feeling depressed weekly and described the level of those feelings as "a little" or "somewhere in between a little and a lot," or 4) feeling depressed "monthly" or "a few times a year" and described the level of those feelings as "a little," "a lot" or "somewhere in between a little and a lot" were considered as not having feelings of depression. Others not falling within those combinations were excluded. More information on the definition is available at https://wwwn.cdc.gov/NHISDataQueryTool/ER_Quarterly/index_quarterly.html, and more information on the question source is available at https://www.washingtongroup-disability.com/fileadmin/uploads/wg/Documents/Washington_Group_Questionnaire__3_-_WG_Short_Set_on_Functioning_-_Enhanced.pdf.

FIGURE 1. Prevalence of current cigarette smoking* among U.S. adults, by urban–rural† designation and race and ethnicity§ — United States, 2020¶



Abbreviation: AI/AN = American Indian or Alaska Native.

* Smoking and tobacco use here refer to use of commercial tobacco products and not to tobacco used for medicinal and spiritual purposes by some American Indian communities.

† Urban = large central metropolitan, large fringe metropolitan, medium metropolitan, and small metropolitan; rural = nonmetropolitan. https://www.cdc.gov/nchs/data/series/sr_02/sr02_166.pdf

§ Hispanic adults could be of any race. All other groups were non-Hispanic. The following four non-Hispanic single-race categories were available for sample adults in the 2020 National Health Interview Survey public use files: 1) White, 2) Black or African American, 3) Asian, and 4) AI/AN. Exclusive from these groups, the "non-Hispanic, Other" category in this report includes those adults who were categorized as "non-Hispanic AI/AN and any other group" or "other single and multiple races." The only multiracial categories available were "non-Hispanic AI/AN and any other group" and "other single and multiple races." https://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2020/srvydesc-508.pdf

¶ $p<0.05$ for differences in urban–rural cigarette smoking prevalence for the following race/ethnicity groups: non-Hispanic Asian, non-Hispanic Black, non-Hispanic White, Hispanic.

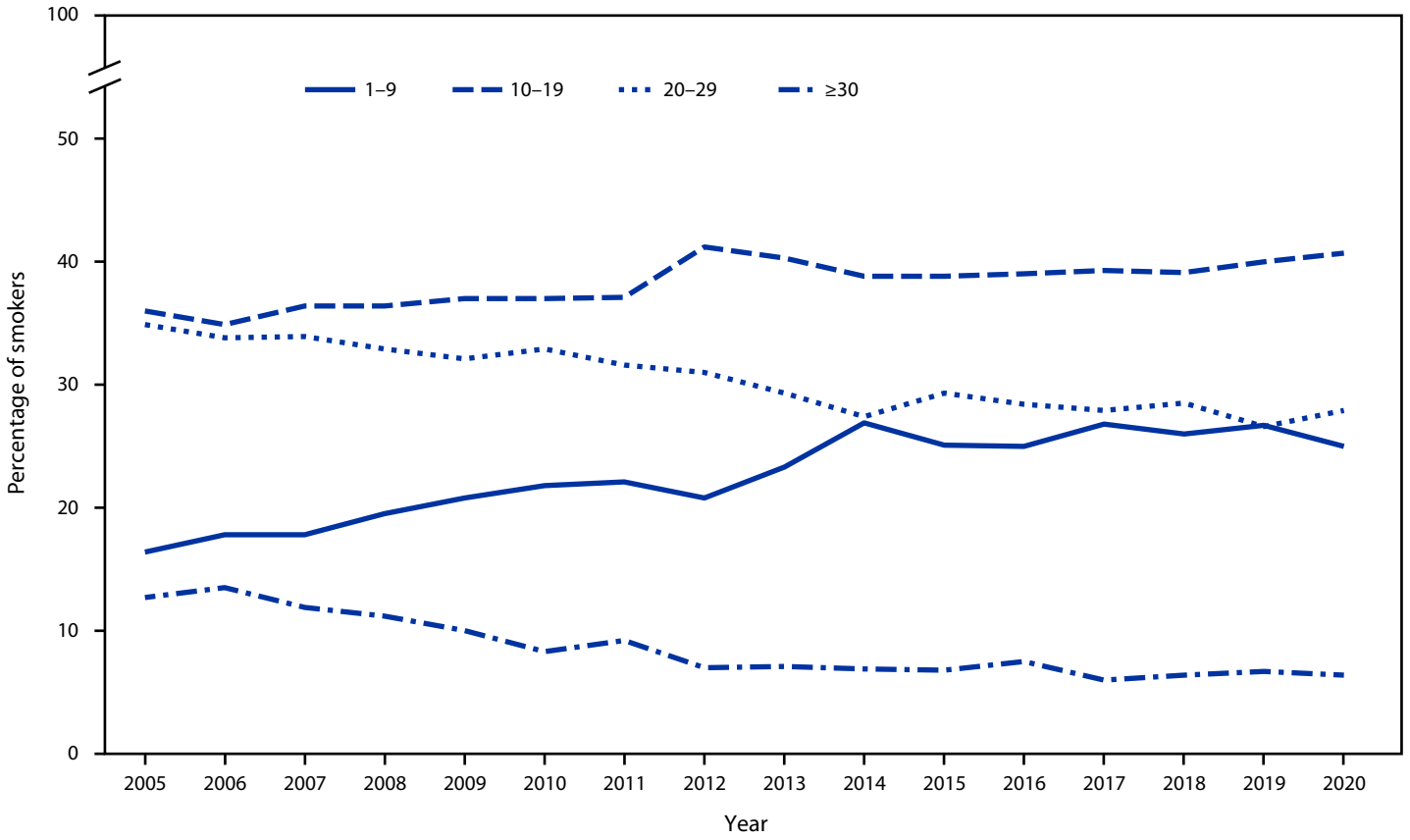
having feelings of anxiety (29.6%) or depression (35.6%) than those who did not.

Discussion

From 2019 to 2020 the prevalence of any commercial tobacco product use and use of certain commercial tobacco products decreased, yet nearly one in five adults (47.1 million) continued to use commercial tobacco products. Approximately three quarters of adults who used tobacco products used combustible products, with 30.8 million adults currently smoking cigarettes. Among all tobacco products, cigarettes and other combustible tobacco products are the predominant cause of tobacco-related morbidity and mortality (*1*). Increasing the use of evidence-based commercial tobacco control interventions (e.g., raising the price of tobacco products, smoke-free policies in public places, and increasing equitable cessation access) can help prevent tobacco product use initiation and increase cessation, further reducing tobacco use prevalence and related disease (*1*,*6*,*7*).

From 2005 to 2020, shifts were seen in cigarette use patterns among adults who smoked daily, with adults generally smoking fewer cigarettes per day in 2020 than in 2005. In 2020, 12.5% of U.S. adults aged ≥18 years smoked cigarettes, the lowest prevalence since data became available starting in 1965 (*1*). Factors that might have contributed to the lower prevalence of tobacco product use include high-impact antitobacco

FIGURE 2. Percentage of adults aged ≥18 years who reported smoking cigarettes* every day, by average number of cigarettes smoked per day — United States, 2005–2020[†,§]



* Smoking and tobacco use here refer to use of commercial tobacco products and not to tobacco used for medicinal and spiritual purposes by some American Indian communities.

† Linear trends were adjusted for sex, age, race, and ethnicity. During 2005–2020, prevalence of adults who smoked daily and smoked 1–9 cigarettes per day and 10–19 cigarettes per day significantly increased ($p<0.05$); prevalence of adults who smoked daily and smoked 20–29 cigarettes per day and ≥30 cigarettes per day significantly deceased ($p<0.05$).

§ Changes in weighting and design methodology for the 2019 National Health Interview Survey could affect comparisons of weighted survey estimates over time; preliminary evaluation showed that the estimate of current cigarette smoking was affected by methodological changes, which might have shifted the estimate upward by 0.5 percentage points. In addition, changes in the 2020 National Health Interview Survey administration from in-person to primarily telephone-based might affect estimates. Under- and overrepresentation of certain groups exists. How this might bias the measured prevalence of current cigarette smoking is uncertain. For these reasons, observed trends should be interpreted cautiously. https://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2019/srvydesc-508.pdf and https://www.cdc.gov/nchs/data/nhis/earlyrelease/EarlyRelease202009-508.pdf

media campaigns (e.g., Tips from Former Smokers and Every Try Counts) and policies (e.g., smoke-free policies in public places and limiting the availability of specific types of tobacco products such as flavored products) at the local, tribal, state, and national level (*1*,*4*,*7*,*8*).

In 2020, marked sociodemographic differences in smoking prevalence among U.S. adults were observed, as well as differences between adults of different races and ethnicities by urban-rural designation. Among non-Hispanic Black, Hispanic, and non-Hispanic White adults, prevalence of cigarette smoking was higher among persons who resided in rural areas than their racial and ethnic counterparts in urban areas. The tobacco industry has historically targeted rural and low-income areas with increased advertising, price promotions, and access to tobacco retailers, thereby contributing to an environment where tobacco use is viewed as normal (*8*). Targeted marking of menthol cigarettes to non-Hispanic Black and Hispanic racial and ethnic groups has also been documented (*8*). Strategies that prohibit the sale of flavored tobacco products, restrict price promotions, and implement culturally tailored antismoking campaigns can aid in reducing tobacco use disparities (*8*,*9*).

The findings in this report are subject to at least seven limitations. First, changes in weighting and design methodology for the 2019 NHIS could affect comparisons of weighted survey estimates over time; preliminary evaluation showed that the estimate of current cigarette smoking was affected by methodological changes, which might have shifted the estimate upward by 0.5 percentage points.[§§§§] This small shift could account for the observed increase from 13.7% in 2018 to 14.2% in 2019. Second, changes in the 2020 NHIS survey administration from in-person to primarily telephone-based might affect estimates. Under- and overrepresentation of certain groups exists. How this might bias the measured prevalence of current cigarette smoking is uncertain[¶¶¶¶] (*5*). For these reasons, observed trends should be interpreted cautiously. Third, there was a low response rate (29.6%) among adults reinterviewed from 2019 for the 2020 NHIS. Fourth, because NHIS is limited to the noninstitutionalized U.S. civilian population, results are not generalizable to institutionalized populations and persons in the military. Fifth, responses to questions were self-reported. However, research has shown that self-reported smoking status correlates highly with biochemical testing for serum cotinine (*10*). Sixth, multivariate analyses were not conducted. Finally, non-Hispanic adults categorized as of "other" races and non-Hispanic AI/AN adults have smaller sample sizes and lower statistical power for assessing differences. Related to this, the current definition of AI/AN excludes persons indicating both AI/AN and another race and ethnicity, further reducing the sample size and statistical power for the AI/AN group assessed in these data.

Summary

What is already known about this topic?

Although cigarette smoking has declined over the past several decades, a diverse landscape of combustible and noncombustible tobacco products has emerged in the United States.

What is added by this report?

In 2020, 19.0% of U.S. adults (47.1 million) used any tobacco product. Cigarettes were the most commonly used tobacco product (12.5%), followed by e-cigarettes (3.7%). From 2019 to 2020, the prevalence of overall tobacco product use, combustible tobacco product use, cigarettes, e-cigarettes, and use of two or more tobacco products decreased.

What are the implications for public health practice?

Continued monitoring of tobacco product use and tailored strategies and policies that reduce the effects of inequitable conditions could aid in reducing disparities in tobacco use.

Continued monitoring of tobacco product use and tailored strategies and policies that reduce the effects of inequitable conditions (e.g., poverty, housing, and access to health care) could further aid in reducing disparities in tobacco use (*4*,*8*). Equitable implementation of comprehensive commercial tobacco control interventions, including smoke-free policies for public places and access to cessation services, is essential for maintaining progress toward reducing tobacco-related morbidity and mortality in the United States (*8*,*9*).

Acknowledgment

S. Sean Hu, Office on Smoking and Health, National Center for Chronic Disease Prevention and Health Promotion, CDC.

Corresponding author: Monica E. Cornelius, yex8@cdc.gov.

[1]Office on Smoking and Health, National Center for Chronic Disease Prevention and Health Promotion, CDC.

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflicts of interest were disclosed.

[§§§§] 2019 NHIS documentation indicates that changes to the nonresponse adjustment approach and the calibration methods for the 2019 NHIS have the potential to affect comparisons of the weighted survey estimates over time. Preliminary evaluation showed that the estimate of current cigarette smoking was affected by the weighting adjustment. Estimates from 2019 might have shifted upward by 0.5 percentage points for the cigarette smoking prevalence estimate. This small shift because of methodological changes might account for the observed increase from 13.7% in 2018 to 14.2% in 2019. Similarly, the change in estimates for e-cigarette use from 3.2% in 2018 to 4.4% in 2019 might be due to methodological changes. Because of the changes in weighting and design methodology, direct comparisons between estimates for 2019 and earlier years should be made with caution because the impact of these changes has not been fully evaluated at this time. https://www.cdc.gov/nchs/data/nhis/earlyrelease/EReval202009-508.pdf; https://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2019/srvydesc-508.pdf; https://www.cdc.gov/nchs/data/nhis/earlyrelease/EarlyRelease202009-508.pdf

[¶¶¶¶] When the reinterviewed cases are re-raked to the 2020 population control totals, the similarity of 2020 estimates based on the reinterviewed cases and the 2020 sample cases, separately, as well as the similarity of reinterview estimates and the overall 2020 combined estimates, suggest that the 2020 combined file (combining reinterview and 2020 sample cases) and the 2020 partial file (regular 2020 sample cases only) are also largely unbiased when weighted by the corresponding adjusted weights. However, the combined file does retain a few biases after weighting adjustments. The combined sample appears to have underrepresented adults living alone, those in the lowest income category, and those who only have mobile phones, while overrepresenting adults living in households with four or more persons or in households with both landline and mobile telephones. https://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2020/nonresponse-report-508.pdf

References

1. US Department of Health and Human Services. The health consequences of smoking—50 years of progress: a report of the Surgeon General. Atlanta, GA: US Department of Health and Human Services, CDC; 2014. https://www.ncbi.nlm.nih.gov/books/NBK179276/pdf/Bookshelf_NBK179276.pdf
2. Cornelius ME, Wang TW, Jamal A, Loretan CG, Neff LJ. Tobacco product use among adults—United States, 2019. MMWR Morb Mortal Wkly Rep 2020;69:1736–42. PMID:33211681 https://doi.org/10.15585/mmwr.mm6946a4
3. Creamer MR, Wang TW, Babb S, et al. Tobacco product use and cessation indicators among adults—United States, 2018. MMWR Morb Mortal Wkly Rep 2019;68:1013–9. PMID:31725711 https://doi.org/10.15585/mmwr.mm6845a2
4. CDC. Best practices for comprehensive tobacco control programs. Atlanta, GA. US Department of Health and Human Services, CDC; 2014. https://www.cdc.gov/tobacco/stateandcommunity/best_practices/pdfs/2014/comprehensive.pdf
5. National Center for Health Statistics. National Health Interview Survey: 2020 survey description. Hyattsville, MD: US Department of Health and Human Services, CDC, National Center for Health Statistics; 2021. https://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2020/srvydesc-508.pdf
6. US Department of Health and Human Services. Smoking cessation: a report of the Surgeon General. Atlanta, GA: US Department of Health and Human Services, CDC; 2020. https://www.hhs.gov/sites/default/files/2020-cessation-sgr-executive-summary.pdf
7. King BA, Graffunder C. The tobacco control vaccine: a population-based framework for preventing tobacco-related disease and death. Tob Control 2018;27:123–4. PMID:29475955 https://doi.org/10.1136/tobaccocontrol-2018-054276
8. Center for Public Health Systems Science. Best practices user guide: health equity in tobacco prevention and control. St. Louis, MO: Center for Public Health Systems Science, Washington University; 2015. https://www.cdc.gov/tobacco/stateandcommunity/best-practices-health-equity/pdfs/bp-health-equity.pdf
9. Kong AY, King BA. Boosting the tobacco control vaccine: recognizing the role of the retail environment in addressing tobacco use and disparities. Tob Control 2021;30:e162–8. PMID:32967986 https://doi.org/10.1136/tobaccocontrol-2020-055722
10. Binnie V, McHugh S, Macpherson L, Borland B, Moir K, Malik K. The validation of self-reported smoking status by analysing cotinine levels in stimulated and unstimulated saliva, serum and urine. Oral Dis 2004;10:287–93. PMID:15315646 https://doi.org/10.1111/j.1601-0825.2004.01018.x

Progress Toward Achieving and Sustaining Maternal and Neonatal Tetanus Elimination — Worldwide, 2000–2020

Florence A. Kanu, PhD[1]; Nasir Yusuf, MD[2]; Modibo Kassogue, MD[3]; Bilal Ahmed, MBBS[3]; Rania A. Tohme, MD[1]

Maternal and neonatal tetanus (MNT)* remains a major cause of neonatal mortality with an 80%–100% case-fatality rate among insufficiently vaccinated mothers after unhygienic deliveries, especially in low-income countries (*1*). In 1989, the World Health Assembly endorsed elimination† of neonatal tetanus; the activity was relaunched in 1999 as the MNT elimination (MNTE)§ initiative, targeting 59¶ priority countries. MNTE strategies include 1) achieving ≥80% coverage with ≥2 doses of tetanus toxoid–containing vaccine (TTCV2+)** among women of reproductive age through routine and supplementary immunization activities (SIAs)†† in high-risk districts,§§ 2) achieving ≥70% of deliveries by a skilled birth attendant,¶¶ and 3) implementing neonatal tetanus case-based surveillance (*2*). This report summarizes progress toward achieving and sustaining MNTE during 2000–2020 and updates a previous report (*3*). By December 2020, 52 (88%) of 59 priority countries had conducted TTCV SIAs. Globally, infants protected at birth*** against tetanus increased from 74% (2000) to 86% (2020), and deliveries assisted by a skilled birth attendant increased from 64% (2000–2006) to 83% (2014–2020). Reported neonatal tetanus cases worldwide decreased by 88%, from 17,935 (2000) to 2,229 (2020), and estimated deaths decreased by 92%, from 170,829 (2000) to 14,230 (2019).††† By December 2020, 47 (80%) of 59 priority countries were validated to have achieved MNTE, five of which conducted postvalidation assessments.§§§ To achieve elimination in the 12 remaining countries and sustain elimination, innovation is needed, including integrating SIAs to cover multiple vaccine preventable diseases and implementing TTCV life course vaccination.

Immunization Activities

To estimate TTCV vaccination coverage delivered through routine immunization services and the number of neonates protected at birth from tetanus, World Health Organization (WHO) and UNICEF use data from administrative records and vaccination coverage surveys reported annually by member countries (*4*). WHO and UNICEF receive summaries of the number of women of reproductive age receiving TTCV during SIAs (*5*). In 2020, 16 (27%) of 59 priority countries achieved ≥80% TTCV2+ coverage, with 34 countries increasing coverage since 2000 (Table). In 2020, among 58 priority countries with available data, 46 (79%) reported ≥80% of infants protected at birth. The global proportion of infants protected at birth increased from 74% (2000) to 86% (2020) (Table).

During 2000–2020, 52 priority countries conducted TTCV SIAs, and 168 million (67%) of the targeted 250 million women of reproductive age received TTCV2+ (Table) (Figure 1). In 2020, 59 million women targeted for protection by TTCV SIAs remained unreached, and TTCV SIA activities aiming to target an estimated 16 million women of reproductive age in five countries were postponed because of COVID-19–related disruptions in immunization services (Figure 1) (*6*).

* Tetanus occurring during pregnancy or within 6 weeks of the end of pregnancy; maternal tetanus infection occurs during abortion, miscarriages, or birth with unhygienic delivery. Neonatal tetanus occurs during the first 28 days of life, either following the cutting of the umbilical cord under nonsterile conditions or applying nonsterile traditional remedies to the umbilical stump in an infant without passively (transplacentally) acquired maternal antibodies.

† The occurrence of less than one neonatal tetanus case per 1,000 live births per year in every district in every country.

§ Neonatal tetanus elimination is considered a proxy for maternal tetanus elimination; the same strategies for elimination are shared.

¶ Initially, the total number of priority countries was 57. The creation of Timor-Leste in 2002 and South Sudan in 2011 increased the number of priority countries to 59.

** Tetanus toxoid (TT2+) or tetanus-diphtheria toxoid (Td2+).

†† Mass vaccination campaigns that aim to administer doses of tetanus toxoid–containing vaccines to women of reproductive age.

§§ Districts considered at high risk because the estimated neonatal tetanus case rate exceeds one per 1,000 live births, clean delivery coverage is <70%, and coverage with 3 tetanus toxoid–containing vaccine doses among pregnant women is <80% during the past 5 years.

¶¶ A doctor, nurse, midwife, or health worker trained in providing lifesaving obstetric care, including giving necessary supervision, care, and advice to women during pregnancy, childbirth, and the postpartum period.

*** The status of an infant born to a mother who received 2 doses of TTCV during the last birth, ≥2 doses with the last dose received ≤3 years before the last delivery, ≥3 doses with the last dose received ≤5 years earlier, ≥4 doses with the last dose received ≤10 years earlier, or receipt of ≥5 previous doses.

††† Neonatal mortality data were unavailable for 2020. http://ghdx.healthdata.org/gbd-results-tool

§§§ A postvalidation assessment comprises a review of data to determine whether MNTE indicator standards are being maintained and to identify districts potentially at risk of not sustaining MNTE. Postvalidation assessments include field visits and interviews at both the facility and community level, cross checking the reported coverage of tetanus toxoid–containing vaccines, antenatal care, and skilled birth delivery. The assessment also includes bottleneck analysis and development of a work plan and time frame for implementing corrective actions, if needed.

TABLE. Indicators of maternal and neonatal tetanus elimination — 59 priority countries, 2000–2020

Country	≥2 TTCV doses among women of reproductive age* (%)			Newborns protected at birth (%)			Women of reproductive age vaccinated during TTCV SIAs		Skilled birth attendant at delivery† (%)			No. of neonatal tetanus cases		
	Year		Change 2000–2020 (%)	Year		Change 2000–2020 (%)	No. of TT2+/Td2+ doses received	Vaccinated (%)	Year		Change 2000–2020 (%)	Year		Change 2000–2020 (%)
	2000	2020		2000	2020				2000†	2020†		2000	2020	
Validated for maternal and neonatal tetanus elimination by end of 2020														
Bangladesh	89	94	6	89	98	10	1,438,374	47	12	59	388	376	41	−89
Benin	81	83	2	87	81	−7	1,399,461	97	66	78	19	52	27	−48
Burkina Faso§	NA	69	NA	57	95	67	2,306,835	91	38	80	111	22	5	−77
Burma	81	83	3	79	90	14	8,170,763	87	57	60	6	41	17	−59
Burundi	28	89	218	51	90	76	679,222	55	25	85	238	16	0	−100
Cambodia	40	77	92	58	95	64	2,099,471	79	32	89	180	295	7	−98
Cameroon	40	62	56	54	83	54	2,687,461	85	56	69	23	279	16	−94
Chad	12	74	520	39	78	100	3,222,840	84	14	24	77	142	251	77
China	NA	NA	NA	NA	NA	NA	NA	NA	97	100	3	3,230	32	−99
Comoros	40	78	95	57	83	46	160,767	55	62	NA	NA	NA	0	NA
Congo	39	72	85	67	87	30	273,003	91	83	91	9	2	54	2,600¶
Côte d'Ivoire	78	75	−3	76	86	13	5,924,527	85	63	74	17	30	17	−43
Democratic Republic of the Congo	25	96	283	45	85	89	10,342,937	92	61	85	40	77	48	−38
Egypt	71	NA	NA	80	86	8	2,518,802	87	61	92	50	321	2	−99
Equatorial Guinea	30	36	20	61	60	−2	26,466	9	65	NA	NA	NA	4	NA
Eritrea	25	65	160	80	99	24	NA	NA	28	NA	NA	4	0	−100
Ethiopia	32	90	181	54	90	67	13,210,107	84	6	50	789	20	45	125
Gabon	16	43	171	39	83	113	79,343	90	86	NA	NA	8	1	−88
Ghana	73	62	−15	69	90	30	1,666,666	87	47	79	68	80	0	−100
Guinea-Bissau	NA	90	NA	49	83	69	312,669	98	32	54	69	NA	3	NA
Haiti	NA	44	NA	41	80	95	2,785,588	88	24	42	75	40	4	−90
India	80	78	−2	85	90	6	7,643,440	94	43	81	92	3,287	162	−95
Indonesia§	81	54	−34	82	85	4	1,442,264	50	66	95	43	466	4	−99
Iraq	55	42	−24	75	73	−3	111,721	96	65	96	47	37	0	−100
Kenya	51	NA	NA	68	88	29	4,463,695	67	43	70	65	1,278	0	−100
Laos	45	40	−12	58	93	60	968,323	90	17	64	286	21	12	−43
Liberia	25	20	−18	51	90	76	288,984	57	51	84	66	152	1	−99
Madagascar	40	52	30	58	75	29	2,705,588	72	47	46	−2	13	42	223
Malawi	61	70	15	84	90	7	NA	NA	56	90	62	12	NA	NA
Mauritania	NA	31	NA	44	83	89	586,277	76	53	69	30	NA	0	NA
Mozambique§	61	88	45	75	86	15	605,640	79	48	73	53	42	155	269
Namibia§	60	96	60	74	90	22	NA	NA	76	NA	NA	10	NA	NA
Nepal	60	80	33	67	89	33	4,537,864	86	12	77	549	134	3	−98
Niger	31	79	155	63	83	32	2,184,277	92	16	39	149	55	1	−98
Philippines	58	39	−33	55	91	65	1,034,080	78	58	84	46	281	28	−90
Rwanda§	NA	70	NA	81	97	20	NA	NA	31	94	201	5	0	−100
Senegal	45	68	51	62	95	53	359,845	92	58	75	29	0	0	NA
Sierra Leone	20	95	377	53	93	75	1,704,814	102	37	87	134	36	7	−81
South Africa	65	NA	NA	68	90	32	NA	NA	91	97	6	11	3	−73
Tanzania	77	92	19	79	91	15	987,575	71	43	64	46	48	2	−96
Timor-Leste	NA	69	NA	NA	83	NA	24,141	53	24	57	136	NA	2	NA
Togo	47	71	52	63	83	32	262,130	87	35	69	96	33	12	−64
Turkey	36	67	85	50	95	90	1,242,674	58	83	97	17	26	0	−100
Uganda	42	65	54	70	83	19	2,448,527	86	36	74	106	470	35	−93
Vietnam§	90	88	−2	86	96	12	367,842	69	59	NA	NA	142	41	−71
Zambia	61	NA	NA	78	85	9	330,030	81	42	80	91	130	26	−80
Zimbabwe	60	62	4	76	87	14	NA	NA	NA	86	NA	16	1	−94

See table footnotes on the next page.

Deliveries Assisted by Skilled Birth Attendants

WHO and UNICEF estimate the percentage of births assisted by a skilled birth attendant from health care facility reports and coverage survey estimates shared by countries (*7*). During 2000–2020, the percentage of deliveries assisted by a skilled birth attendant increased 30%, from 64% (2000–2006) to 83% (2014–2020) (*7*). In 2020, among 50 priority countries with available data, ≥70% of deliveries were assisted by a skilled birth attendant in 28 (58%) countries (Table).

Surveillance Activities

WHO recommends nationwide, case-based surveillance for neonatal tetanus, including zero-case reporting (submission of reports even if no neonatal tetanus cases are observed) and active surveillance through regular site visits (*8*). The number of reported neonatal tetanus cases worldwide decreased by 88% from 17,935 (2000) to 2,229 (2020).¶¶¶ In 2020, among all

¶¶¶ https://immunizationdata.who.int/pages/incidence/ttetanus.html?CODE=Global&DISEASE=NTETANUS&YEAR=

TABLE. (*Continued*) Indicators of maternal and neonatal tetanus elimination — 59 priority countries, 2000–2020

Country	≥2 TTCV doses among women of reproductive age* (%)			Newborns protected at birth (%)			Women of reproductive age vaccinated during TTCV SIAs		Skilled birth attendant at delivery† (%)			No. of neonatal tetanus cases		
	Year		Change 2000–2020 (%)	Year		Change 2000–2020 (%)	No. of TT2+/Td2+ doses received	Vaccinated (%)	Year		Change 2000–2020 (%)	Year		Change 2000–2020 (%)
	2000	2020		2000	2020				2000†	2020†		2000	2020	
Not validated for maternal and neonatal tetanus elimination by end of 2020														
Afghanistan	20	82	308	32	63	97	5,212,394	45	14	59	311	139	NA	NA
Angola	NA	41	NA	60	70	17	7,097,552	84	NA	50	NA	131	156	19
Central African Republic	20	88	341	36	63	75	804,984	30	32	40	27	37	177	378
Guinea	43	84	95	79	83	5	4,773,787	55	49	55	14	245	63	–74
Mali	62	39	–37	50	87	74	4,158,201	49	41	67	66	73	8	–89
Nigeria	NA	32	NA	57	65	14	9,365,295	66	35	43	23	1,643	55	–97
Pakistan	51	62	22	71	85	20	25,405,510	84	23	71	209	1,380	504	–63
Papua New Guinea	10	32	219	24	67	179	450,739	15	39	56	45	138	4	–97
Somalia	22	66	200	47	60	28	497,561	27	19	32	65	966	NA	NA
South Sudan	NA	61	NA	NA	65	NA	6,002,402	64	NA	NA	NA	NA	3	NA
Sudan	34	49	43	61	81	33	7,365,615	86	NA	NA	NA	88	34	–61
Yemen	31	22	–30	54	70	30	3,546,356	53	27	NA	NA	174	91	–48

Sources: Neonatal tetanus data: WHO Global Health Observatory Data Repository (2000–2020), Protected at birth data: WHO/UNICEF Joint Reporting Form on Immunization (2000–2020), Skilled birth attendant data: WHO Global Health Observatory Data Repository (2000–2020), SIA data: WHO/UNICEF Maternal and Neonatal Tetanus Elimination Database, as of January 2022, TTCV data: WHO Global Health Observatory Data Repository (2000–2020).

Abbreviations: NA = not available; SIA = supplementary immunization activity; TT2+/Td2+ = ≥2 doses of tetanus toxoid/tetanus-diphtheria toxoid; TTCV = tetanus toxoid–containing vaccine; WHO = World Health Organization.

* Includes first-year SIA conducted in Bangladesh in 1999 and first- and second-year SIAs conducted in Ethiopia in 1999.

† Includes skilled birth attendant surveys conducted within 5 years for year 2000 and year 2020.

§ Administrative data of TTCV coverage with ≥2 doses among women of reproductive age were used when official data were unavailable for select country.

¶ The increase in neonatal tetanus cases seen from 2000 to 2020 might be the result of improvement in surveillance.

59 priority countries, 10 (17%) reported zero cases, whereas seven countries (Angola, Central African Republic, Chad, Congo, Ethiopia, Madagascar, and Mozambique) reported more cases in 2020 than in 2000 (Table).

Most neonatal tetanus deaths occur in remote communities, which leads to underreporting. Hence, mathematical models are used to better estimate the number of neonatal tetanus deaths (*9*). The estimated number of neonatal tetanus deaths decreased by 92% from 170,829 (2000) to 14,230 (2019) (Figure 2). In 2019, tetanus accounted for 0.4% of all neonatal deaths, a decrease from 7% in 2000.

Validation of Maternal and Neonatal Tetanus Elimination

When a country believes it has eliminated MNT, validation activities are implemented, consisting of review of district-level core indicators, including reported neonatal tetanus cases per 1,000 live births and review of the surveillance system, percentage of clean deliveries assisted by a skilled birth attendant, and TTCV2+ coverage among pregnant women (*6*); the country also uses supplementary indicators, including TTCV SIA coverage, antenatal care coverage,**** infant coverage with 3 doses of the diphtheria, tetanus, and pertussis (DTP) vaccine, socioeconomic indices, urban versus rural status, field visits to assess the performance of the health system, validation surveys of poorly performing districts, and assessment of long-term plans for sustaining elimination.†††† During 2000–2020, 47 (80%) of 59 priority countries were validated to have achieved MNTE, and 12 remain to be validated (Table) (Figure 1). In addition, by 2020, three countries were partially validated to have achieved elimination in some regions: Mali (Southern regions), Nigeria (Southeast and Southwest zones), and Pakistan (Punjab province).§§§§

Sustainability of Maternal and Neonatal Tetanus Elimination

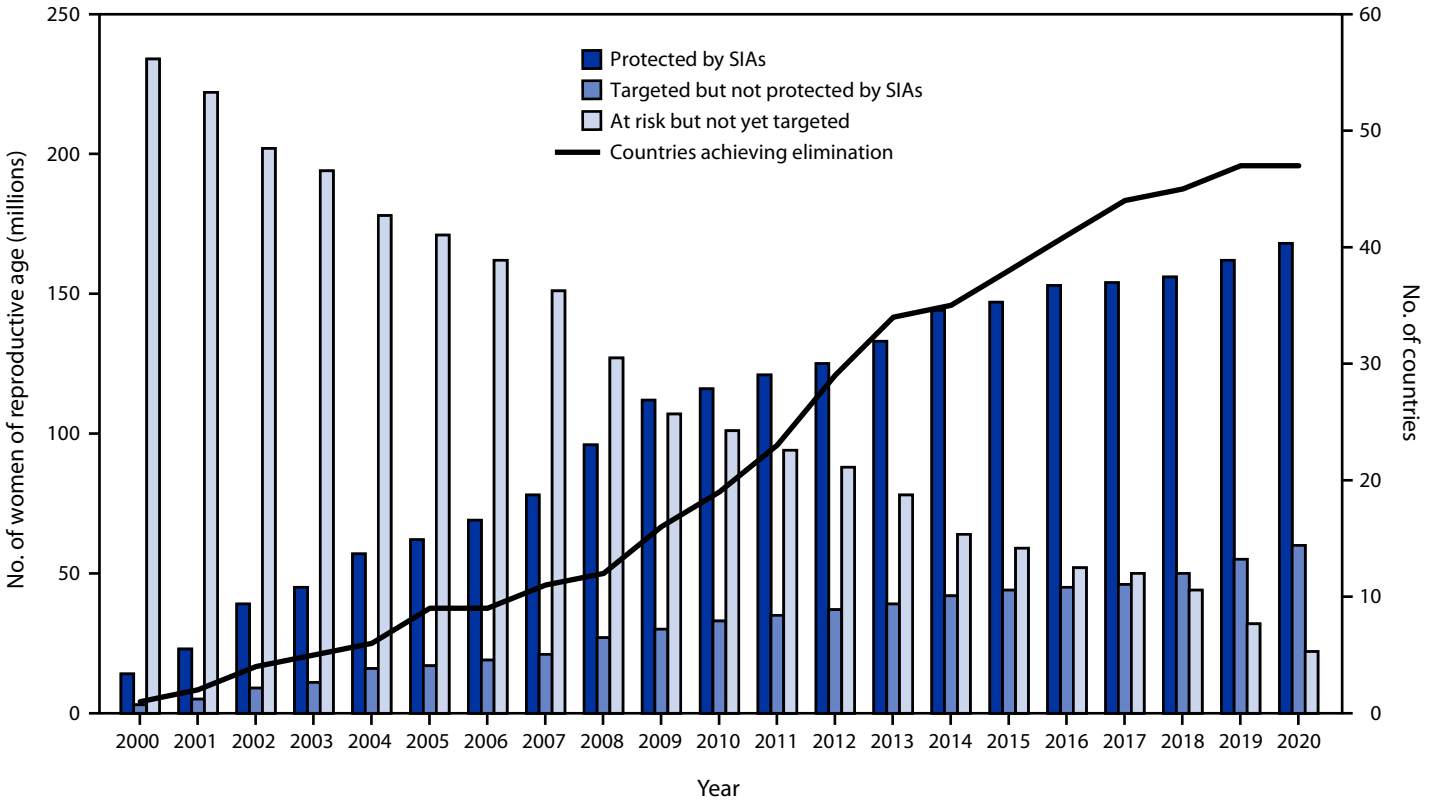
Once countries are validated for MNTE, WHO recommends four strategies to sustain elimination: 1) providing 3 primary doses of DTP during infancy and 3 TTCV booster doses at ages 12–23 months, 4–7 years, and 9–15 years; 2) checking maternal tetanus vaccination status during antenatal care and providing TTCV2+ to pregnant women, if needed, to ensure that ≥70% of infants are protected at birth; 3) promoting ≥60% clean deliveries through increased access to a skilled birth attendant ; and 4) maintaining strong neonatal tetanus surveillance (*6*). After validation, WHO recommends that countries conduct annual neonatal tetanus risk analyses as part of an immunization desk review and complete postvalidation

**** Antenatal care coverage is the percentage of females aged 15–49 years with a live birth who received antenatal care provided by skilled health personnel (doctor, nurse, or midwife) at least once during pregnancy.

†††† https://www.who.int/immunization/documents/MNTE_Validation_survey_WHO_IVB_18.15.pdf

§§§§ https://www.who.int/initiatives/maternal-and-neonatal-tetanus-elimination-(mnte)/the-partnership

FIGURE 1. Number of women of reproductive age protected by tetanus toxoid–containing vaccine* received during supplementary immunization activities, number targeted but not yet vaccinated, number not yet targeted, and number of priority countries achieving maternal and neonatal tetanus elimination — worldwide, 2000–2020



Source: WHO/UNICEF Maternal and Neonatal Tetanus Elimination Database, as of January 2022.
Abbreviations: SIA = supplementary immunization activities; WHO = World Health Organization.
* Protected with 2 doses of tetanus toxoid or 2 doses of tetanus and diphtheria toxoids.

assessments every 5 years to identify whether elimination status is maintained and take corrective actions as needed (*6*). In 2020, 14 (30%) of the 47 priority countries validated for MNTE achieved ≥90%[¶¶¶¶] coverage with 3 doses of DTP; TTCV booster doses[*****] were provided to children aged 12–23 months in 11 (23%) of those countries, to children aged 4–7 years in 12 (26%) countries, and to children aged 9–15 years in nine (19%) countries. In 45 (96%) countries, ≥70% of infants were protected at birth against tetanus; and in 34 (72%), ≥60% of births were assisted by a skilled birth attendant.

Five countries (Algeria, Cameroon, Djibouti, Indonesia, and Timor-Leste) implemented postvalidation assessments for corrective actions and have met the sustainability indicators for infants protected at birth and the percentage of births with access to a skilled birth attendant. In addition, Cameroon conducted annual neonatal tetanus risk analyses and used assessment outcomes for corrective action by targeting women of reproductive age in high-risk districts with two rounds of TTCV SIAs to sustain MNTE.

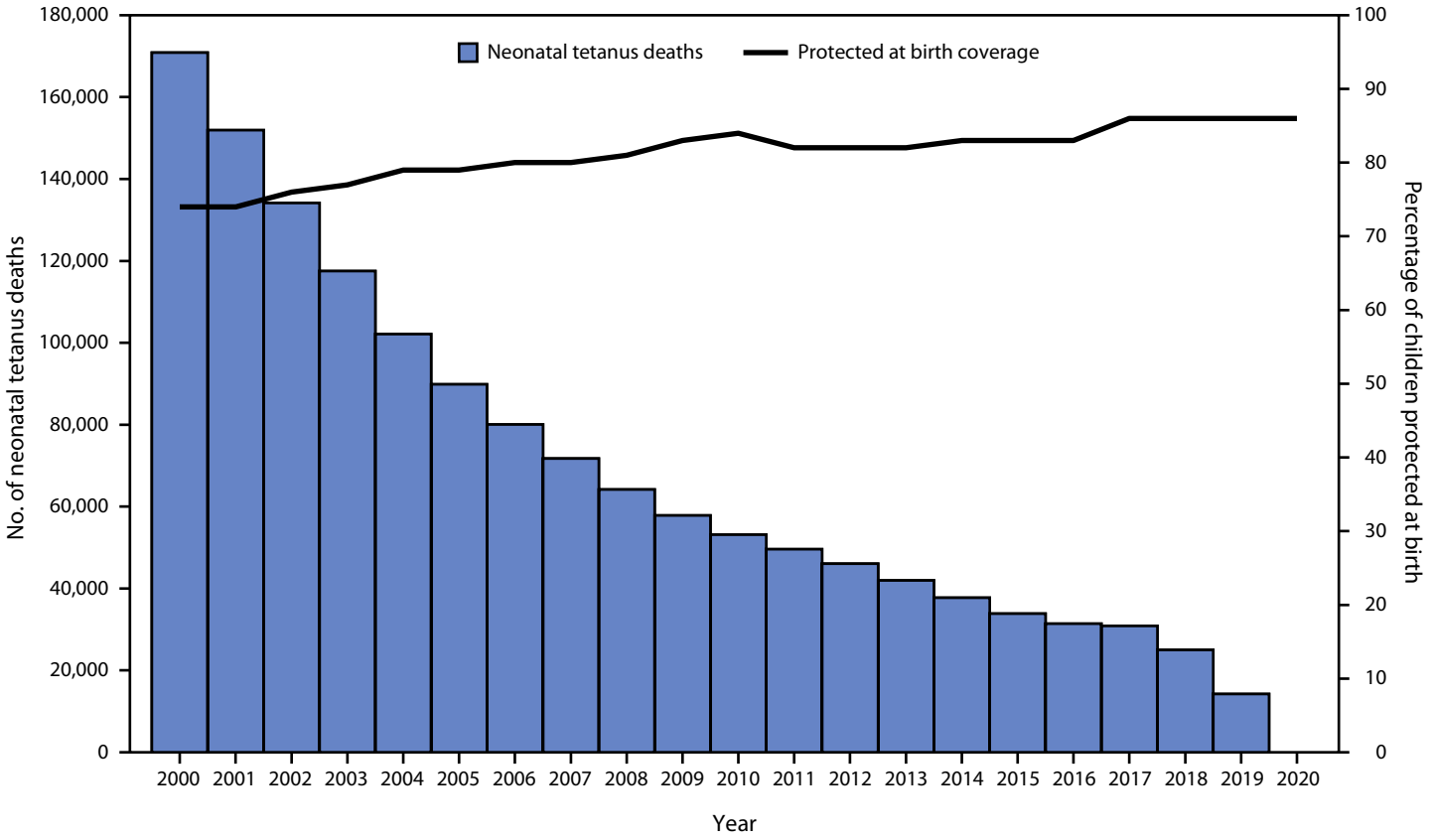
Discussion

Substantial progress has been made toward global MNTE; 80% of the 59 priority countries were validated to have achieved MNTE by the end of 2020. Progress can be attributed to increases in TTCV2+ coverage among women of reproductive age in 34 (58%) of 59 priority countries, implementation of intensive SIAs in high-risk districts, and a 30% increase in deliveries with a skilled birth attendant. These efforts contributed to a 16% increase in infants protected against tetanus at birth and a 92% decline in estimated neonatal tetanus mortality since 2000.

Although progress has been made, countries that have not achieved MNTE still face several challenges. First, suboptimal health systems, evidenced by low vaccination coverage and low

[¶¶¶¶] https://www.who.int/data/gho/data/indicators/indicator-details/GHO/diphtheria-tetanus-toxoid-and-pertussis-(dtp3)-immunization-coverage-among-1-year-olds-(-)
[*****] https://immunizationdata.who.int/pages/schedule-by-disease/tetanus.html?TARGETPOP_GENERAL = GENERAL

FIGURE 2. Estimated number of neonatal tetanus deaths* and estimated proportion of children protected at birth† against tetanus — worldwide, 2000–2020§



Sources: Neonatal tetanus data: WHO Global Health Observatory Data Repository (2000–2018) and the Global Health Data Exchange (2019), Protected at birth data: WHO/UNICEF Joint Reporting Form on Immunization (2000–2020).
Abbreviations: TTCV = tetanus toxoid–containing vaccine; WHO = World Health Organization.
* The number of deaths is estimated from mathematical models that compute the yearly incidence and mortality for each country using the baseline rate of neonatal tetanus before introduction of TTCVs and promotion of clean deliveries, with adjustment for the estimated proportion of women vaccinated with TTCV and deliveries assisted by trained personnel.
† The status of an infant born to a mother who received 2 doses of TTCV during the last birth, ≥2 doses with the last dose received ≤3 years before the last delivery, ≥3 doses with the last dose received ≤5 years earlier, ≥4 doses with the last dose received ≤10 years earlier, or receipt of ≥5 previous doses.
§ Data on deaths for 2020 were not available.

proportions of safe and clean deliveries assisted by a skilled birth attendant, make it difficult to adequately implement MNTE strategies. Second, conflict and political instability in some countries contribute to districts remaining inaccessible and at high risk for the incidence of maternal and neonatal tetanus. Lastly, country immunization programs might have competing priorities in addressing the overall incidence of vaccine preventable diseases (e.g., measles and polio) or responding to outbreaks (e.g., Ebola and COVID-19) that hinder their ability to achieve MNTE. During 2020, the COVID-19 pandemic affected TTCV SIAs planned in five countries.

Complete eradication of tetanus is not possible because tetanus spores are ubiquitous in the environment. Therefore, countries need to implement strategies to sustain MNTE. Only five of 47 countries validated for MNTE have conducted the recommended postvalidation assessments, and only 12 have introduced ≥1 TTCV booster doses in their routine immunization schedule. This low uptake could be attributed to competing priorities and the deprioritizing of MNTE once countries are validated, which put countries at risk for reemergence of MNT (*6*). Combining MNTE postvalidation assessments with review of immunization programs and integrating childhood and adolescent tetanus vaccination with other immunization activities (e.g., measles vaccination during second year of life, school vaccination programs, or human papillomavirus vaccination) promote better efficiency and use of resources and help sustain MNTE. Neonatal tetanus case-based surveillance could also be integrated into polio and measles case-based surveillance; community engagement might help raise awareness of neonatal tetanus and serve to strengthen community-based vaccine preventable disease surveillance systems (*8*).

Summary

What is already known about this topic?

In 1999, the maternal and neonatal tetanus (MNT) initiative was relaunched to focus on 59 priority countries still at risk for maternal and neonatal tetanus.

What is added by this report?

During 2000–2020, 47 countries achieved elimination of MNT, reported neonatal tetanus cases decreased 88%, and estimated deaths declined 92%. Despite progress, 12 countries have not achieved elimination and are challenged by conflict, insecurity, and competing priorities. Other countries are struggling to maintain elimination.

What are the implications for public health practice?

To achieve MNT elimination in remaining priority countries and to maintain it globally, efforts are needed to enhance routine vaccination, integrate tetanus activities with other health activities, and promote a life-course vaccination approach for tetanus protection.

The findings in this report are subject to at least three limitations. First, TTCV coverage among pregnant women can underestimate true tetanus protection because it excludes women who were unvaccinated during current pregnancy but protected through previous vaccination or those missing documentation of previous doses (*6*). Second, the percentage of infants protected at birth could be underestimated because of doses provided outside routine services (*6*). Finally, <10% of neonatal tetanus cases and deaths are estimated to be reported (*2*); although neonatal deaths are projected using mathematical models, cases and deaths might still be underestimated, especially in communities with suboptimal health systems.

The Immunization Agenda 2030,[†††††] the global immunization strategy for the next decade, includes MNTE as an endorsed vaccine-preventable disease elimination target. To achieve and sustain MNTE, strong national commitment and integration are needed, including integrating MNTE activities with polio, measles, cholera, yellow fever, or other vaccine-preventable disease SIAs, using MNTE to promote equitable access to health services, such as clean deliveries, and promoting a life course approach to tetanus vaccination by integrating TTCV booster doses in school health programs and other life course immunization platforms (*10*).

[†††††] https://www.who.int/publications/m/item/implementing-the-immunization-agenda-2030

Acknowledgments

UNICEF country offices in Central African Republic, Nigeria, South Sudan; Jose Chivale; Mohammed Farid; Quamrul Hasan; Javid Iqbal; Julien Hyacinte Kabore; Mouctar Kande; Emmaculate Lebo; Richard Luce; Osama Mere; Terna Nomhwange; Constance Razaiarimanga; Abdoul Karim Sidibe; Maleghemi Sylvester; Patricia Tanifum.

Corresponding author: Florence A. Kanu, fkanu@cdc.gov.

[1]Global Immunization Division, Center for Global Health, CDC; [2]Immunization, Vaccines and Biologicals, World Health Organization, Geneva, Switzerland; [3]Maternal, Newborn, and Adolescent Health Program Division, UNICEF, New York, New York.

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflicts of interest were disclosed.

References

1. World Health Organization. Tetanus vaccines: WHO position paper–February 2017. Wkly Epidemiol Rec 2017;92:53–76. PMID:28185446
2. World Health Organization. Maternal and neonatal tetanus elimination: the strategies. Geneva, Switzerland: World Health Organization; 2021. https://www.who.int/initiatives/maternal-and-neonatal-tetanus-elimination-(mnte)/the-strategies
3. Njuguna HN, Yusuf N, Raza AA, Ahmed B, Tohme RA. Progress toward maternal and neonatal tetanus elimination—worldwide, 2000–2018. MMWR Morb Mortal Wkly Rep 2020;69:515–20. PMID:32352953 https://doi.org/10.15585/mmwr.mm6917a2
4. World Health Organization. Protection at birth (PAB) against neonatal tetanus and tetanus toxoid-containing vaccine (TT2+/Td2+) vaccination coverage. Geneva, Switzerland: World Health Organization; 2021. https://immunizationdata.who.int/pages/coverage/tt2plus.html?CODE=Global&ANTIGEN=PAB+TT2PLUS&YEAR=
5. World Health Organization. Maternal and neonatal tetanus elimination: programmatic update. Geneva, Switzerland: World Health Organization; 2021. https://www.who.int/initiatives/maternal-and-neonatal-tetanus-elimination-(mnte)/programmatic-update
6. World Health Organization. Protecting all against tetanus: guide to sustaining maternal and neonatal tetanus elimination (MNTE) and broadening tetanus protection for all populations. Geneva, Switzerland: World Health Organization; 2019. https://www.who.int/publications/i/item/protecting-all-against-tetanus
7. UNICEF; World Health Organization. UNICEF/WHO joint database: delivery at care. New York, NY: UNICEF; 2019. https://data.unicef.org/topic/maternal-health/delivery-care/
8. World Health Organization. Surveillance standards for vaccine-preventable diseases. Geneva, Switzerland: World Health Organization; 2018. https://www.who.int/publications/i/item/surveillance-standards-for-vaccine-preventable-diseases-2nd-edition
9. Yen LM, Thwaites CL. Tetanus. Lancet 2019;393:1657–68. PMID:30935736 https://doi.org/10.1016/S0140-6736(18)33131-3
10. Yusuf N, Raza AA, Chang-Blanc D, et al. Progress and barriers towards maternal and neonatal tetanus elimination in the remaining 12 countries: a systematic review. Lancet Glob Health 2021;9:e1610–7. PMID:34678200 https://doi.org/10.1016/S2214-109X(21)00338-7

Reported Cases of End-Stage Kidney Disease — United States, 2000–2019

Nilka Ríos Burrows, MPH[1]; Alain Koyama, ScD[1]; Meda E. Pavkov, MD, PhD[1]

End-stage kidney disease (ESKD) (kidney failure requiring dialysis or transplantation) is a costly and disabling condition that often results in premature death (*1*). During 2019, Medicare fee-for-service expenditures for ESKD were $37.3 billion, accounting for approximately 7% of Medicare paid claims costs (*1*). Diabetes and hypertension remain the leading causes of ESKD, accounting for 47% and 29%, respectively, of patients who began ESKD treatment in 2019 (*1*). Compared with White persons, Black, Hispanic, and American Indian or Alaska Native persons are more likely to develop ESKD (*1*,*2*) and to have diagnosed diabetes (*3*). After declining for more than a decade, the incidence rate of ESKD with diabetes reported as the primary cause (ESKD from diabetes) has leveled off since 2010 (*1*,*4*). Further, after increasing for many years, the prevalence of diagnosed diabetes has also leveled off (*4*). Although these flattening trends in rates are important from a population perspective, the trend in the number of ESKD cases is important from a health systems resources perspective. Using United States Renal Data System (USRDS) 2000–2019 data, CDC examined trends in the number of incident and prevalent ESKD cases by demographic characteristics and by primary cause of ESKD. During 2000–2019, the number of incident ESKD cases increased by 41.8%, and the number of prevalent ESKD cases increased by 118.7%. Higher percentage changes in both incident and prevalent ESKD cases were among Asian, Hispanic, and Native Hawaiian or other Pacific Islander persons and among cases with hypertension or diabetes as the primary cause. Interventions to improve care and better manage ESKD risk factors among persons with diabetes and hypertension, along with increased use of therapeutic agents such as angiotensin-converting enzyme (ACE) inhibitors, angiotensin-receptor blockers (ARB), and sodium-glucose cotransporter 2 (SGLT2) inhibitors shown to have kidney-protective benefits (*5*,*6*) might slow the increase and eventually reverse the trend in incident ESKD cases.

USRDS collects, analyzes, and distributes ESKD clinical and claims data from the Centers for Medicare & Medicaid Services (CMS) Medical Evidence Report form (CMS 2728), which includes sociodemographic characteristics, the date patients were first treated for ESKD, and the primary cause of ESKD. The Medicare program covers 80% of the cost of ESKD treatment for beneficiaries in the United States regardless of age (*1*). Kidney care providers are required to complete the CMS 2728 form for each new patient with ESKD, regardless of Medicare eligibility status. Using USRDS 2000–2019 data, CDC examined the number of incident and prevalent ESKD cases in the United States each year during 2000–2019 by demographic characteristics (i.e., age, sex, and race/ethnicity) and by primary cause (i.e., diabetes, hypertension, or other cause). This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.*

During 2000 and 2019, for both incident and prevalent ESKD cases, 34.9%–42.3% occurred among persons aged 45–64 years, 53.4%–-58.3% occurred among males, and 44.7%–55.2% occurred among White persons (Table). During 2000–2019, the number of incident ESKD cases increased 41.8%, from 92,660 to 131,422 (Table) (Figure 1), and the number of prevalent cases increased 118.7%, from 358,247 to 783,594 (Table) (Figure 2). Larger increases among incident cases occurred among Asian (149.5%), Native Hawaiian or other Pacific Islander (96.5%), and Hispanic (84.0%) persons (Table). Similarly, larger increases among prevalent cases were also observed among these populations. Smaller percentage increases in both incident and prevalent cases were observed among persons aged <45 years and among American Indian or Alaska Native persons. Although diabetes was the primary cause for a larger percentage of incident and prevalent ESKD cases, the largest increase in incident and prevalent cases was among patients with hypertension reported as the primary cause.

Discussion

During 2000–2019, in the general U.S. population, the number of reported incident ESKD cases increased 41.8%, and the number of prevalent cases approximately doubled. Although persons aged 45–64 years, males, White persons, and persons with ESKD from diabetes accounted for the larger percentage of cases, Asian, Native Hawaiian or other Pacific Islander, Hispanic persons, and persons with ESKD from hypertension experienced the larger increase in cases. Compared with White persons, these racial/ethnic populations together with American Indian or Alaska Native and Black persons are disproportionately affected by ESKD (*1*). The continued increase in the number of ESKD cases will increase strain on the health care system and lead to higher costs. Effective management of diabetes and hypertension can help prevent ESKD and decrease the number of incident

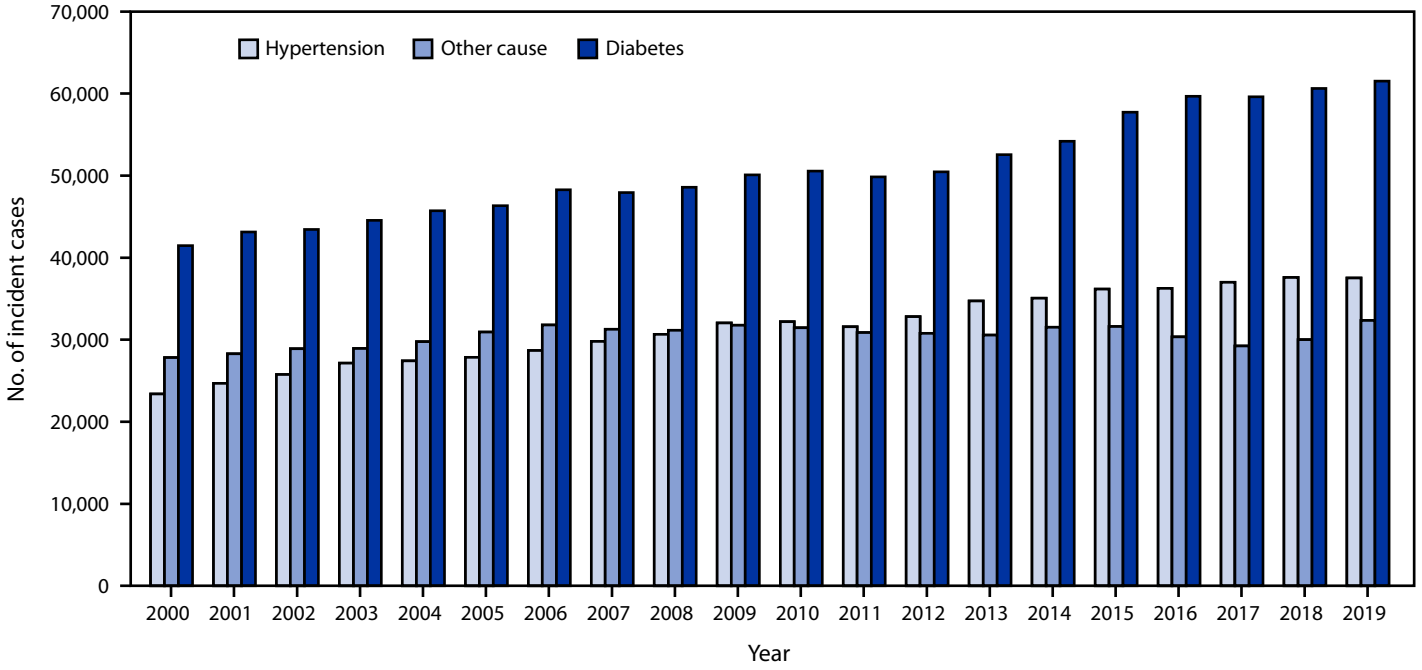
* 45 C.F.R. part 46.102(l)(2); 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.

TABLE. Number of reported incident and prevalent cases of end-stage kidney disease, by selected characteristics — United States, 2000 and 2019*

Characteristic	Incident cases			Prevalent cases		
	2000 No. (%)†	2019 No. (%)†	Percentage change	2000 No. (%)†	2019 No. (%)†	Percentage change
Total	**92,660 (100.0)**	**131,422 (100.0)**	**41.8**	**358,247 (100.0)**	**783,594 (100.0)**	**118.7**
Age group, yrs						
<45	14,194 (15.3)	16,230 (12.3)	14.3	87,769 (24.5)	118,208 (15.1)	34.7
45–64	32,370 (34.9)	48,874 (37.2)	51.0	144,703 (40.4)	331,220 (42.3)	128.9
65–74	23,494 (25.4)	35,744 (27.2)	52.1	71,825 (20.0)	199,005 (25.4)	177.1
≥75	22,602 (24.4)	30,574 (23.3)	35.3	53,950 (15.1)	135,161 (17.2)	150.5
Sex						
Men	49,500 (53.4)	76,631 (58.3)	54.8	195,216 (54.5)	456,821 (58.3)	134.0
Women	43,160 (46.6)	54,791 (41.7)	26.9	163,031 (45.5)	326,773 (41.7)	100.4
Race and Ethnicity						
White	51,156 (55.2)	67,919 (51.7)	32.8	180,636 (50.4)	349,596 (44.7)	93.5
Black	25,917 (28.0)	33,700 (25.6)	30.0	116,376 (32.5)	234,399 (29.9)	101.4
Hispanic	11,297 (12.2)	20,790 (15.8)	84.0	42,129 (11.8)	140,961 (18.0)	234.6
Asian	2,507 (2.7)	6,256 (4.8)	149.5	11,839 (3.3)	41,393 (5.3)	249.6
American Indian or Alaska Native	1,041 (1.1)	1,299 (1.0)	24.8	4,538 (1.3)	7,949 (1.0)	75.2
Native Hawaiian or other Pacific Islander	742 (0.8)	1,458 (1.1)	96.5	2,729 (0.8)	9,296 (1.2)	240.6
Primary cause						
Diabetes	41,458 (44.7)	61,522 (46.8)	48.4	129,699 (36.2)	307,385 (39.2)	137.0
Hypertension	23,384 (25.2)	37,539 (28.6)	60.5	83,553 (23.3)	209,437 (26.7)	150.7
Other cause	27,818 (30.0)	32,361 (24.6)	16.3	144,995 (40.5)	266,772 (34.0)	84.0

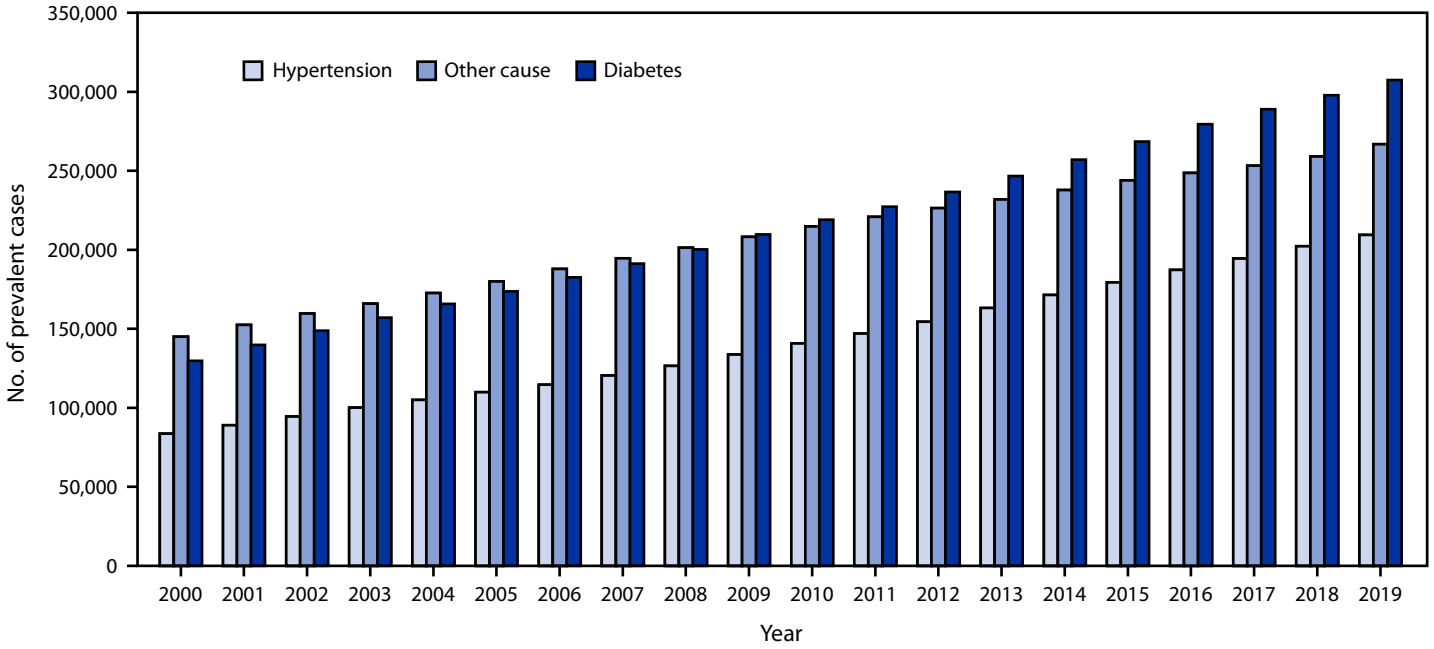
* Data from United States Renal Data System, 2021 Annual Data Report, Reference Tables. https://adr.usrds.org/2021/reference-tables
† Percentages might not sum to 100% because of rounding.

FIGURE 1. Number of reported incident cases of end-stage kidney disease, by primary cause — United States, 2000–2019*



* Data from United States Renal Data System, 2021 Annual Data Report, Reference Tables. https://adr.usrds.org/2021/reference-tables

FIGURE 2. Number of reported prevalent cases of end-stage kidney disease, by primary cause — United States, 2000–2019*



* Data from United States Renal Data System, 2021 Annual Data Report, Reference Tables. https://adr.usrds.org/2021/reference-tables

cases, thus alleviating the burden on the health care system and reducing costs.

Managing risk factors such as diabetes and high blood pressure and treatment with ACE inhibitors or ARBs have been shown to help prevent or delay the onset of ESKD from diabetes (*5*,*7*). In persons with diabetes, ACE inhibitors and ARBs lower blood pressure, reduce albuminuria, and slow the decline in kidney function (*5*). Other agents such as SGLT2 inhibitors have been shown to reduce the risks for cardiovascular disease and progression of chronic kidney disease in patients with type 2 diabetes, in addition to lowering blood glucose (*6*). However, the number of patients with newly treated ESKD from diabetes is likely to continue to increase with the increasing number of persons with diagnosed diabetes (*4*).

Compared with White persons, Black, Hispanic, and American Indian or Alaska Native persons are approximately two to three times as likely to develop ESKD (*1*,*2*). However, growth in incident and prevalent cases in the American Indian or Alaska Native population was slower than that in other populations. Population health and team-based approaches to diabetes care, including kidney disease testing and case management, implemented by the Indian Health Service, tribal and urban Indian health facilities, and supported by the Special Diabetes Program for Indians were associated with an estimated Medicare savings as high as $520.4 million in ESKD cases averted (*8*). This program might explain the lower percentage change in ESKD cases during 2000–2019. Expansion of these programs to other populations could reduce morbidity and save costs. In addition, interventions to promote and increase use of ACE inhibitors, ARBs, and SGLT2 inhibitors, along with improving care and better managing ESKD risk factors among persons with diabetes, might slow the increase and eventually reverse the trend in incident ESKD cases.

ESKD will continue to have a large impact on the U.S. health care system with population growth, aging, high prevalence of ESKD risk factors such as diabetes, better survival of the ESKD population, and improved transplant outcomes (*1*,*3*,*4*). Although the mortality rate in kidney transplant patients is three times lower compared with patients on dialysis (*1*), transplant recipients accounted for 3.0% of the incident and 29.6% of the prevalent ESKD cases in 2019. Further, annual transplant rates in this population declined somewhat during 2000–2019 (*1*). Several government agencies and nongovernmental organizations have implemented initiatives to increase access to kidney transplants and promote transplantation (*9*). In addition, CMS extended Medicare coverage of immunosuppressive drugs from 36 months to the lifetime of the kidney transplant recipient, preventing the return of transplant patients to dialysis. This extension of coverage is expected to save Medicare $400 million over 10 years (*10*). Whereas these factors collectively might result in the continued growth of the ESKD population, with better management of ESKD, patients can live a healthier life at a reduced cost to the health care system.

Summary

What is already known about this topic?

End-stage kidney disease (ESKD) (kidney failure requiring dialysis or transplantation) is a disabling condition that often results in premature death. ESKD is costly, accounting for $37.3 billion of Medicare expenditures during 2019.

What is added by this report?

During 2000–2019, the number of ESKD cases reported in the United States increased 41.8%; the number of prevalent cases approximately doubled. Higher percentage changes in incident and prevalent ESKD cases were attributable to primary causes related to diabetes and hypertension.

What are the implications for public health practice?

Effective management of diabetes and hypertension can help prevent ESKD and decrease the number of incident cases, thus reducing costs and alleviating the impact on the health care system.

The findings in this report are subject to at least three limitations. First, data on ESKD treatment were based on reports to CMS; patients whose treatment was not reported to CMS (e.g., persons who refused treatment or died from ESKD before receiving treatment) were not included. Second, the primary cause of ESKD was obtained from the CMS Medical Evidence Report and was based on a physician's assessment of the patient, which could be influenced by the physician's awareness of a diabetes or hypertension diagnosis and not reflect the true cause of ESKD. Finally, differential classification of race or ethnicity in the CMS Medical Evidence Form could result in overcount or undercount of the actual number of ESKD cases in racial- or ethnic-specific groups.

One of the goals of the Advancing American Kidney Health Initiative of the U.S. Department of Health and Human Services is to reduce the number of Americans developing ESKD by 25% by 2030 (*9*). Effective management of diabetes and hypertension, including kidney disease testing and management as part of diabetes care in at-risk populations, can help prevent ESKD. Monitoring trends and racial or ethnic disparity gaps in ESKD, and tracking other factors such as kidney disease awareness, pre-ESKD care, and risk factor (e.g., diabetes or hypertension) control and prevention, will be very important to evaluate the success of these interventions. Continued efforts to address ESKD risk factors to prevent or delay ESKD onset could stabilize or reverse the increase in the number of persons living with ESKD.

Corresponding author: Nilka Ríos Burrows, nrios@cdc.gov, 770-488-1057.

[1]Division of Diabetes Translation, National Center for Chronic Disease Prevention and Health Promotion, CDC.

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflicts of interest were disclosed.

References

1. United States Renal Data System. 2021 USRDS annual data report: epidemiology of kidney disease in the United States. Bethesda, MD: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases; 2021. Accessed March 7, 2022. https://adr.usrds.org/2021
2. Burrows NR, Zhang Y, Hora I, et al. Sustained lower incidence of diabetes-related end-stage kidney disease among American Indians and Alaska Natives, Blacks, and Hispanics in the US, 2000–2016. Diabetes Care 2020;43:2090–7. PMID:32616609 https://doi.org/10.2337/dc20-0495
3. CDC. National diabetes statistics report. Atlanta, GA: US Department of Health and Human Services, CDC; 2022. Accessed March 7, 2022. https://www.cdc.gov/diabetes/data/statistics-report/index.html
4. CDC. US Diabetes Surveillance System. Atlanta, GA: US Department of Health and Human Services; CDC. Accessed February 2, 2022. https://gis.cdc.gov/grasp/diabetes/DiabetesAtlas.html
5. Kunz R, Friedrich C, Wolbers M, Mann JFE. Meta-analysis: effect of monotherapy and combination therapy with inhibitors of the renin angiotensin system on proteinuria in renal disease. Ann Intern Med 2008;148:30–48. PMID:17984482 https://doi.org/10.7326/0003-4819-148-1-200801010-00190
6. Jardine M, Zhou Z, Lambers Heerspink HJ, et al. Kidney, cardiovascular, and safety outcomes of canagliflozin according to baseline albuminuria: a CREDENCE secondary analysis. Clin J Am Soc Nephrol 2021;16:384–95. PMID:33619120 https://doi.org/10.2215/CJN.15260920
7. Stratton IM, Adler AI, Neil HA, et al. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. BMJ 2000;321:405–12. PMID:10938048 https://doi.org/10.1136/bmj.321.7258.405
8. US Department of Health and Human Services. The special diabetes program for Indians: estimates of Medicare savings. Washington, DC: US Department of Health and Human Services; 2019. https://aspe.hhs.gov/reports/special-diabetes-program-indians-estimates-medicare-savings
9. US Department of Health and Human Services. Advancing American kidney health. Washington, DC: US Department of Health and Human Services; 2019. https://aspe.hhs.gov/sites/default/files/private/pdf/262046/AdvancingAmericanKidneyHealth.pdf
10. News Medical. Congress extends Medicare coverage of immunosuppressive drugs for kidney transplant. Manchester, UK: News Medical; 2020. https://www.news-medical.net/news/20201223/Congress-extends-Medicare-coverage-of-immunosuppressive-drugs-for-kidney-transplant.aspx

The Advisory Committee on Immunization Practices' Recommendation for Use of Moderna COVID-19 Vaccine in Adults Aged ≥18 Years and Considerations for Extended Intervals for Administration of Primary Series Doses of mRNA COVID-19 Vaccines — United States, February 2022

Megan Wallace, DrPH[1]; Danielle Moulia, MPH[1]; Amy E. Blain, MPH[1]; Erin K. Ricketts, MD[1,2]; Faisal S. Minhaj, PharmD[1,2]; Ruth Link-Gelles, PhD[1]; Kathryn G. Curran, PhD[1]; Stephen C. Hadler, MD[1]; Amimah Asif, MPH[1]; Monica Godfrey, MPH[1]; Elisha Hall, PhD[1]; Anthony Fiore, MD[1]; Sarah Meyer, MD[1]; John R. Su, MD, PhD[1]; Eric Weintraub, MPH[1]; Matthew E. Oster, MD[1]; Tom T. Shimabukuro, MD[1]; Doug Campos-Outcalt, MD[3]; Rebecca L. Morgan, PhD[4]; Beth P. Bell, MD[5]; Oliver Brooks, MD[6]; H. Keipp Talbot, MD[7]; Grace M. Lee, MD[8]; Matthew F. Daley, MD[9]; Sara E. Oliver, MD[1]

The mRNA-1273 (Moderna) COVID-19 vaccine is a lipid nanoparticle-encapsulated, nucleoside-modified mRNA vaccine encoding the stabilized prefusion spike glycoprotein of SARS-CoV-2, the virus that causes COVID-19. During December 2020, the vaccine was granted Emergency Use Authorization (EUA) by the Food and Drug Administration (FDA), and the Advisory Committee on Immunization Practices (ACIP) issued an interim recommendation for use among persons aged ≥18 years (*1*), which was adopted by CDC. During December 19, 2020–January 30, 2022, approximately 204 million doses of Moderna COVID-19 vaccine were administered in the United States (*2*) as a primary series of 2 intramuscular doses (100 μg [0.5 mL] each) 4 weeks apart. On January 31, 2022, FDA approved a Biologics License Application (BLA) for use of the Moderna COVID-19 vaccine (Spikevax, ModernaTX, Inc.) in persons aged ≥18 years (*3*). On February 4, 2022, the ACIP COVID-19 Vaccines Work Group conclusions regarding recommendations for the use of the Moderna COVID-19 vaccine were presented to ACIP at a public meeting. The Work Group's deliberations were based on the Evidence to Recommendation (EtR) Framework,* which incorporates the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) approach† to rank evidence quality. In addition to initial clinical trial data, ACIP considered new information gathered in the 12 months since issuance of the interim recommendations, including additional follow-up time in the clinical trial, real-world vaccine effectiveness studies, and postauthorization vaccine safety monitoring. ACIP also considered comparisons of mRNA vaccine effectiveness and safety in real-world settings when first doses were administered 8 weeks apart instead of the original intervals used in clinical trials (3 weeks for BNT162b2 [Pfizer-BioNTech] COVID-19 vaccine and 4 weeks for Moderna COVID-19 vaccine). Based on this evidence, CDC has provided guidance that an 8-week interval might be optimal for some adolescents and adults. The additional information gathered since the issuance of the interim recommendations increased certainty that the benefits of preventing symptomatic and asymptomatic SARS-CoV-2 infection, hospitalization, and death outweigh vaccine-associated risks of the Moderna COVID-19 vaccine. On February 4, 2022, ACIP modified its interim recommendation to a standard recommendation§ for use of the fully licensed Moderna COVID-19 vaccine in persons aged ≥18 years.

Recommendations for Use of Moderna COVID-19 Vaccine

During June 2020–February 2022, ACIP convened 23 public meetings to review data on the epidemiology of COVID-19 and considerations for use of all COVID-19 vaccines, including the Moderna COVID-19 vaccine (*4*). The ACIP COVID-19 Vaccines Work Group, which includes experts in infectious diseases, vaccinology, vaccine safety, public health, and ethics, held meetings each week to review COVID-19 epidemiologic and surveillance data on vaccine efficacy, effectiveness, and safety and implementation considerations. After a systematic review of published and unpublished scientific evidence for benefits and harms¶ of Moderna COVID-19 vaccination, the Work Group used a modified GRADE approach to assess the certainty of evidence for outcomes related to the vaccine, rated on a scale of type 1 to type 4 (type 1 = high certainty, type 2 = moderate certainty, type 3 = low certainty, and type 4 = very low certainty). Within the EtR Framework, ACIP considered the importance of COVID-19 as a public health problem, benefits and harms (as informed by the GRADE evidence assessment), patients' values and preferences, issues of

* https://www.cdc.gov/vaccines/acip/recs/grade/downloads/acip-evidence-recs-framework.pdf

† https://www.cdc.gov/vaccines/acip/recs/grade/about-grade.html

§ On February 4, 2022, ACIP voted unanimously in favor of the recommendation for use of Moderna COVID-19 vaccine for persons aged ≥18 years under the FDA BLA.

¶ Evaluated benefits were prevention of symptomatic, laboratory-confirmed COVID-19 and associated hospitalization or death, and asymptomatic SARS-CoV-2 infection. Harms evaluated were serious adverse events and reactogenicity (grade 3 or higher).

resource use, acceptability to stakeholders, feasibility of implementation, and anticipated impact on health equity. Work Group conclusions regarding the evidence for the Moderna COVID-19 vaccine were presented to ACIP at a public meeting on February 4, 2022.**

The body of scientific evidence for potential benefits and harms of the Moderna COVID-19 vaccine was guided by one large randomized, double-blind, placebo-controlled Phase III clinical trial (*5*,*6*), one Phase II clinical trial (*7*), one small Phase I clinical trial (*8*,*9*), 26 observational vaccine effectiveness studies, and two postauthorization vaccine safety monitoring systems: the Vaccine Adverse Events Reporting System (VAERS) and the Vaccine Safety Datalink (VSD). VAERS is a national passive surveillance vaccine safety monitoring system managed by CDC and FDA. VSD covers nine participating integrated health care organizations serving approximately 12 million persons and identifies possible adverse events after vaccination, using detailed clinical and demographic data available in near real time from electronic medical records. Updated findings from the ongoing Phase III clinical trial were based on 30,420 enrolled participants contributing approximately 11,000 person-years of data, with a median follow-up of 5 months during September 4, 2020–March 26, 2021 (ending with the date placebo recipients were offered crossover to receive study vaccine). Pooled effectiveness estimates were calculated when multiple observational studies reported data on a specific outcome; the study periods for the observational studies included in the pooled estimates ranged from 1 to 10 months (median = 5 months).

The estimated efficacy of the Moderna COVID-19 vaccine in the Phase III clinical trial was based on outcomes that occurred ≥14 days after receipt of the second dose. The demographic characteristics of participants, including age and race (*5*), have remained consistent since initial enrollment. Efficacy in preventing symptomatic, laboratory-confirmed COVID-19 in persons aged ≥18 years without evidence of previous SARS-CoV-2 infection was 92.7% (Table 1). One hospitalization occurred among the vaccinated group and 24 hospitalizations among the placebo group, yielding an estimated vaccine efficacy of 95.9% against COVID-19–associated hospitalization. No COVID-19–associated deaths occurred among study participants in the vaccinated group, and three occurred in the placebo group resulting in a vaccine efficacy of 100% against COVID-19–associated deaths. Efficacy in preventing asymptomatic SARS-CoV-2 infection was 57.4%. Observational data were available for all beneficial outcomes assessed: the pooled vaccine effectiveness estimates were 89.2% for prevention of symptomatic, laboratory-confirmed COVID-19 (11 studies); 94.8% against COVID-19–associated hospitalizations (15 studies), 93.8% against COVID-19–associated death (five studies), and 69.8% against asymptomatic SARS-CoV-2 infection (three studies). Most of the follow-up time occurred before B.1.1.529 (Omicron) became the predominant circulating SARS-CoV-2 variant. From the GRADE evidence assessment, the level of certainty for the benefits of Moderna COVID-19 vaccination among persons aged ≥18 years was type 1 (high certainty) for the prevention of symptomatic SARS-CoV-2 infection, type 1 (high certainty) for the prevention of asymptomatic SARS-CoV-2 infection, type 2 (moderate certainty) for prevention of COVID-19–associated hospitalization, and type 2 (moderate certainty) for the prevention of COVID-19–associated death.

In the Phase III clinical trial, severe local and systemic adverse reactions (i.e., reactogenicity) in the 7 days after vaccination (grade 3 or higher,†† defined as adverse reactions interfering with daily activity) were more likely to occur among vaccine recipients (21.3%) than placebo recipients (4.5%) (relative risk = 5.03; 95% CI = 4.65–5.45) (Table 2). Among vaccine recipients, the most common grade 3 symptoms were fatigue, headache, joint pain, muscle pain, and injection-site pain. Overall, reactions categorized as grade 3 or higher were more likely to be reported after the second dose than after the first dose. The frequency of serious adverse events§§ was 1.7% among vaccine recipients and 1.9% among placebo recipients. Based on data from VAERS and VSD, two rare but clinically serious adverse events after vaccination were detected: anaphylaxis and myocarditis or myopericarditis.¶¶ Based on VSD data, 5.1 cases of anaphylaxis per 1 million doses of Moderna COVID-19 vaccine administered among persons aged ≥18 years were observed (*10*). Myocarditis or pericarditis were more common among vaccine recipients who were younger and male, and occurred more frequently after the second vaccine dose; 65.7 cases per 1 million doses of Moderna COVID-19 vaccine administered were observed from analysis of VSD chart-reviewed myocarditis and myopericarditis cases that met

** https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2022-02-04/07-COVID-Oliver-508.pdf

†† Grade 1 (mild): does not interfere with activity; grade 2 (moderate): some interference with activity; Grade 3 (severe): prevents daily activity; and grade 4: emergency department visit or hospitalization. Some reactogenicity grade categories are symptom specific. https://www.cdc.gov/vaccines/covid-19/info-by-product/moderna/reactogenicity.html

§§ Serious adverse events are defined as any untoward medical occurrence that results in death, is life-threatening, requires inpatient hospitalization or prolongation of existing hospitalization, or results in persistent disability or incapacity; suspected transmission of any infectious agent via a medicinal product; and a medically important event.

¶¶ Myocarditis is an adverse event defined as inflammation of the heart muscle and is called myopericarditis when accompanied by pericarditis, an inflammation of the thin tissue surrounding the heart (the pericardium).

TABLE 1. Summary of the certainty of evidence of potential benefits of Moderna COVID-19 vaccination — United States, February 2022

Potential benefit	Clinical trial evidence		Observational evidence		GRADE evidence certainty†
	No. of studies	Vaccine efficacy (95% CI)	No. of studies	Pooled vaccine effectiveness* (95% CI)	
Prevention of symptomatic, laboratory-confirmed COVID-19§	1	92.7 (90.4–94.4)	11	89.2 (82.0–93.6)	1
Prevention of COVID-19–associated hospitalization§	1	95.9 (69.5–99.4)	15	94.8 (93.1–96.1)	2
Prevention of COVID-19–associated death	1	100 (NE–100)	5	93.8 (91.5–95.4)	2
Prevention of asymptomatic SARS-CoV-2 infection	1	57.4 (50.1–63.6)	3	69.8 (60.9–76.7)	1

Abbreviations: GRADE = Grading of Recommendations, Assessment, Development and Evaluation; NE = not evaluable.
* Vaccine effectiveness estimates were pooled to provide an overall estimate across studies for the purposes of GRADE review.
† GRADE evidence certainty: 1 = high certainty, 2 = moderate certainty, 3 = low certainty, 4 = very low certainty.
§ Considered a critical outcome in GRADE. https://www.cdc.gov/vaccines/acip/recs/grade/about-grade.html

TABLE 2. Summary of the certainty of evidence of potential harms of Moderna COVID-19 vaccination — United States, February 2022

Characteristic	Clinical trial evidence		Observational evidence		GRADE evidence certainty*
	No. of studies	Relative risk (95% CI)	No. of studies	No. of cases per 1 million doses	
Potential harms, pooled data					
Reactogenicity	2	5.03 (4.65–5.45)	0	—†	1
Serious adverse events§	2	0.92 (0.78–1.08)	0	—¶	2
Potential harms by data source					
VSD					
Anaphylaxis, persons ≥18 yrs	NA	NA	1	5.1**	3
Myocarditis, sex and age group, yrs					
Men, 18–39	NA	NA	1	65.7††	3
Women, 18–39	NA	NA	1	6.2††	3
VAERS					
Myocarditis, sex and age group, yrs					
Men, 18–24	NA	NA	1	40.0§§	3
Women, 18–24	NA	NA	1	5.5§§	
Men, 25–29	NA	NA	1	18.3¶¶	
Women, 25–29	NA	NA	1	5.8¶¶	
Men, 30–39	NA	NA	1	8.4***	
Women, 30–39	NA	NA	1	0.6***	

Abbreviations: GRADE = Grading of Recommendations, Assessment, Development and Evaluation; NA = not applicable; RR = relative risk; VAERS = Vaccine Adverse Event Reporting System; VSD = Vaccine Safety Datalink.
* GRADE evidence certainty is ranked as follows: 1 = high certainty, 2 = moderate certainty, 3 = low certainty, 4 = very low certainty.
† Observational evidence did not include a measure of reactogenicity.
§ Considered a critical outcome in GRADE. https://www.cdc.gov/vaccines/acip/recs/grade/about-grade.html
¶ Observational evidence did not include an aggregate measure of serious adverse events. Data on specific serious adverse events identified through postauthorization safety surveillance were reviewed. Increased risk for myocarditis and anaphylaxis were observed in VAERS and VSD.
** Based on VSD chart reviewed cases of anaphylaxis, in persons aged ≥18 years, occurring in a 0–1-day risk interval after vaccination (RR = 5.1; 95% CI = 3.3–7.6).
†† Based on VSD chart-reviewed cases of myocarditis and pericarditis that met CDC case definitions among persons aged 18–39 years after dose 2, occurring in a 0–7-day risk interval after vaccination.
§§ Based on VAERS chart-reviewed cases of myocarditis that met CDC case definitions among men and women aged 18–24 years, days 0–7 after dose 2.
¶¶ Based on VAERS chart-reviewed cases of myocarditis that met CDC case definitions among men and women aged 25–29 years, days 0–7 after dose 2.
*** Based on VAERS chart-reviewed cases of myocarditis that met CDC case definitions among men and women aged 30–39 years, days 0–7 after dose 2.

CDC case definitions (*11*) among men aged 18–39 years after dose 2 and occurring within a 0–7-day risk interval after vaccination. Although VAERS data are subject to the limitations of a passive surveillance system,*** the elevated number of observed versus expected myocarditis and myopericarditis cases during the 0–7-day risk interval after receipt of the second Moderna vaccine dose is generally consistent with the findings from VSD. The level of certainty from the GRADE evidence assessment regarding potential harms after vaccination was type 2 (moderate certainty) for serious adverse events and type 1 (high certainty) for reactogenicity. GRADE was last completed for Moderna COVID-19 primary vaccination in December 2020 (*1*); since that time, additional data became available on all prespecified outcomes of interest, resulting in a higher level of certainty in the estimates for the benefit of vaccination in prevention of asymptomatic infection and death (the GRADE

*** Limitations of VAERS are that, as a passive reporting system, there might be bias in reporting, inconsistent data quality and completeness of information, and lack of a direct comparison group. The VAERS system was not designed to assess causality, and therefore VAERS data generally cannot determine if a causal association between an adverse event and a vaccine exists.

evidence profile is available at https://www.cdc.gov/vaccines/acip/recs/grade/bla-covid-19-moderna-vaccine.html). Overall, the benefits for the Moderna COVID-19 vaccine outweigh any observed vaccine-associated risks (Table 1) (Table 2).

Data reviewed within the EtR Framework support the use of the Moderna COVID-19 vaccine. The Work Group concluded that COVID-19 remains an important public health problem and that the desirable effects of disease prevention through vaccination with Moderna COVID-19 vaccine in persons aged ≥18 years are large and outweigh the potential harms. With 204 million doses of Moderna COVID-19 vaccine administered to date (*2*), the Work Group determined that the vaccine is acceptable to vaccine providers and that implementation of vaccination is feasible. The Work Group also acknowledged that vaccine-eligible persons aged ≥18 years probably considered the desirable effects of vaccination to be favorable compared with the undesirable effects; however, there is likely important variability in vaccine acceptance within this age group, especially among those who are currently unvaccinated. Despite having recommendations for the Moderna COVID-19 vaccine for >1 year, data indicate vaccine coverage varies by geography, race/ethnicity, sexual orientation, and gender identity (*12*–*14*). Because these disparities remained even after the Pfizer COVID-19 vaccine had received standard authorization, the Work Group concluded that changing from an interim to a standard ACIP recommendation alone for the Moderna COVID-19 vaccine would probably have minimal impact on health equity (the evidence used to inform the EtR is available at https://www.cdc.gov/vaccines/acip/recs/grade/bla-covid-19-moderna-etr.html).

Interval Between Primary mRNA COVID-19 Vaccination Series Doses

In addition to data presented to guide the recommendation for use of the Moderna COVID-19 vaccine, data were also presented to ACIP regarding the optimal interval between the first and second dose of a Moderna or Pfizer-BioNTech mRNA primary vaccination series. mRNA COVID-19 vaccines are safe and effective at the authorized interval between the first and second doses (4 weeks for Moderna vaccine; 3 weeks for Pfizer-BioNTech vaccine), but an extended interval might be considered for some populations. An elevated risk for myocarditis and myopericarditis among mRNA COVID-19 vaccine recipients has been observed, particularly in adolescent and young adult males (*11*,*15*). Several studies in adolescents and adults have indicated the small risk for myocarditis associated with mRNA COVID-19 vaccines might be reduced (*16*) and peak antibody responses and vaccine effectiveness might be increased (*17*–*20*) with an interval longer than 4 weeks between the 2 primary series doses. In a population-based cohort study in Ontario, Canada, rates of myocarditis among persons aged ≥18 years were lower with an extended interval (>4 to <8 weeks and ≥8 weeks) compared with the shorter interval (3–4 weeks) between the first and second doses of a primary series for both Moderna and Pfizer-BioNTech vaccines (*16*). In several studies, neutralizing antibody titers were higher after an extended interval between doses in a primary mRNA vaccine series (range = 6–14 weeks), compared with a standard interval of 3–4 weeks (*17*–*20*). Vaccine effectiveness against infection and hospitalization was higher with an extended (6–8-week) interval than with a standard (3–4-week) interval (*19*).[†††] Based on this evidence presented to ACIP, CDC has provided guidance that an 8-week interval might be optimal for some adolescents and adults, especially for males aged 12–39 years. Additional primary series interval considerations are available at https://www.cdc.gov/vaccines/covid-19/clinical-considerations/covid-19-vaccines-us.html.

After a year of use under an FDA-issued EUA and ACIP interim recommendation, the Moderna COVID-19 vaccine received full FDA approval and is recommended by ACIP for use in persons aged ≥18 years in the United States. Spikevax, the trade name of the Moderna COVID-19 vaccine, has the same formulation and can be used interchangeably with the Moderna COVID-19 vaccine used under EUA without presenting any safety or effectiveness concerns. ACIP considered new information beyond what was available at the time of the interim recommendation, including an additional 3 months of follow-up of the Phase III clinical trial participants, 26 observational vaccine effectiveness studies involving large populations of vaccinated persons, and two postauthorization safety monitoring systems with data from millions of vaccinated persons in the United States. The additional information increased certainty that the benefits of Moderna COVID-19 vaccine outweigh vaccine-associated risks. The Moderna COVID-19 vaccine continues to have FDA authorization and interim ACIP recommendations for a booster dose (*21*), as well as an additional dose in persons aged ≥18 years with moderate to severe immunocompromise (*22*). For an mRNA primary series, an 8-week interval between first and second doses might be optimal for some persons aged ≥12 years, especially males aged 12–39 years.

Before vaccination, a fact sheet (*23*) or vaccine information sheet should be provided to recipients. Providers should counsel Moderna COVID-19 vaccine recipients about expected systemic and local reactogenicity. Additional clinical considerations for COVID-19 vaccine administration are available at https://www.cdc.gov/vaccines/covid-19/clinical-considerations/covid-19-vaccines-us.html.

[†††] https://www.medrxiv.org/content/10.1101/2021.10.26.21265397v1

Summary

What is already known about this topic?

On January 31, 2022, the Food and Drug Administration (FDA) granted full approval to the Moderna COVID-19 vaccine for persons aged ≥18 years.

What is added by this report?

On February 4, 2022, after a systematic review of the evidence, the Advisory Committee on Immunization Practices issued a standard recommendation for use of the Moderna COVID-19 vaccine in persons aged ≥18 years. CDC provided guidance that an 8-week interval between primary series doses of mRNA vaccines might be optimal for some persons.

What are the implications for public health practice?

Use of the FDA-approved Moderna COVID-19 vaccine is recommended for persons aged ≥18 years; benefits of the prevention of infection and associated hospitalization or death outweigh vaccine-associated risks.

Reporting of Vaccine Adverse Events

Providers are required to report adverse events that occur after receipt of any COVID-19 vaccine to VAERS (*23*) (https://vaers.hhs.gov/index.html or 1–800–822–7967). Any person who administers or receives a COVID-19 vaccine is encouraged to report any clinically significant adverse event, regardless of whether it is clear that a vaccine caused the adverse event. In addition, all COVID-19 vaccine recipients are encouraged to enroll in v-safe, a CDC voluntary smartphone-based online tool that uses text messaging and online surveys to conduct periodic health check-ins after vaccination. CDC's v-safe (https://www.cdc.gov/vsafe) call center follows up on reports to v-safe that include possible medically significant health events to collect additional information for completion of a VAERS report.

Acknowledgments

Voting members of the Advisory Committee on Immunization Practices (in addition to listed authors): Kevin A. Ault, University of Kansas Medical Center; Lynn Bahta, Minnesota Department of Health; Wilbur Chen, University of Maryland School of Medicine; Sybil Cineas, Warren Alpert Medical School of Brown University; James Loehr, Cayuga Family Medicine; Sarah Long, Drexel University College of Medicine; Katherine A. Poehling, Wake Forest School of Medicine; Pablo J. Sánchez, The Research Institute at Nationwide Children's Hospital. Members of the Advisory Committee on Immunization Practices COVID-19 Vaccines Work Group (in addition to listed authors): Edward Belongia, Center for Clinical Epidemiology & Population Health, Marshfield Clinic Research Institute; Henry Bernstein, Cohen Children's Medical Center, Zucker School of Medicine at Hofstra/Northwell; Dayna Bowen Matthew, George Washington University Law School; Uzo Chukwuma, Indian Health Service; Marci Drees, Society for Healthcare Epidemiology of America; Jeffrey Duchin, Infectious Diseases Society of America; Kathy Kinlaw, Center for Ethics, Emory University; Doran Fink, Food and Drug Administration; Sandra Fryhofer, American Medical Association; Jason M. Goldman, American College of Physicians; Michael Hogue, American Pharmacists Association; Denise Jamieson, American College of Obstetricians and Gynecologists; Jeffrey Kelman, Centers for Medicare & Medicaid Services; David Kim, U.S. Department of Health and Human Services; Susan Lett, Council of State and Territorial Epidemiologists; Lauri Markowitz, CDC; Kendra McMillan, American Nurses Association; Kathleen Neuzil, Center for Vaccine Development and Global Health, University of Maryland School of Medicine; Sean O'Leary, American Academy of Pediatrics; Christine Oshansky, Biomedical Advanced Research and Development Authority; Stanley Perlman, Department of Microbiology and Immunology, University of Iowa; Marcus Plescia, Association of State and Territorial Health Officials; Chris Roberts, National Institutes of Health; José R. Romero, Arkansas Department of Health; William Schaffner, National Foundation for Infectious Diseases; Rob Schechter, Association of Immunization Managers; Kenneth Schmader, American Geriatrics Society; Bryan Schumacher, U.S. Department of Defense; Peter Szilagyi, University of California, Los Angeles; Jonathan Temte, American Academy of Family Physicians; Matthew Tunis, National Advisory Committee on Immunization Secretariat, Public Health Agency of Canada; Melinda Wharton, CDC; Matthew Zahn, National Association of County and City Health Officials; Rachel Zhang, Food and Drug Administration.

Corresponding author: Sara E. Oliver, yxo4@cdc.gov.

[1]CDC COVID-19 Emergency Response Team; [2]Epidemic Intelligence Service, CDC; [3]College of Medicine, University of Arizona, Phoenix, Arizona; [4]Department of Health Research Methods, Evidence, and Impact, McMaster University, Hamilton, Ontario; [5]University of Washington, Seattle, Washington; [6]Watts Healthcare Corporation, Los Angeles, California; [7]Vanderbilt University School of Medicine, Nashville, Tennessee; [8]Stanford University School of Medicine, Stanford, California; [9]Institute for Health Research, Kaiser Permanente Colorado, Denver, Colorado.

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflicts of interest were disclosed.

References

1. Oliver SE, Gargano JW, Marin M, et al. The Advisory Committee on Immunization Practices' interim recommendation for use of Moderna COVID-19 vaccine—United States, December 2020. MMWR Morb Mortal Wkly Rep 2021;69:1653–6. PMID:33382675 https://doi.org/10.15585/mmwr.mm695152e1
2. CDC. COVID data tracker. COVID-19 vaccinations in the United States. Atlanta, GA: US Department of Health and Human Services, CDC; 2022. Accessed March 10, 2022. https://covid.cdc.gov/covid-data-tracker/#vaccinations_vacc-total-admin-rate-total
3. Food and Drug Administration. Spikevax. Silver Spring, MD: US Department of Health and Human Services, Food and Drug Administration; 2022. https://www.fda.gov/vaccines-blood-biologics/spikevax
4. Advisory Committee on Immunization Practices. ACIP meeting information. Atlanta, GA: US Department of Health and Human Services, CDC; 2022. https://www.cdc.gov/vaccines/acip/meetings/index.html
5. Baden LR, El Sahly HM, Essink B, et al.; COVE Study Group. Efficacy and safety of the mRNA-1273 SARS-CoV-2 vaccine. N Engl J Med 2021;384:403–16. PMID:33378609 https://doi.org/10.1056/NEJMoa2035389
6. El Sahly HM, Baden LR, Essink B, et al.; COVE Study Group. Efficacy of the mRNA-1273 SARS-CoV-2 vaccine at completion of blinded phase. N Engl J Med 2021;385:1774–85. PMID:34551225 https://doi.org/10.1056/NEJMoa2113017
7. Chu L, McPhee R, Huang W, et al.; mRNA-1273 Study Group. A preliminary report of a randomized controlled phase 2 trial of the safety and immunogenicity of mRNA-1273 SARS-CoV-2 vaccine. Vaccine 2021;39:2791–9. PMID:33707061 https://doi.org/10.1016/j.vaccine.2021.02.007
8. Anderson EJ, Rouphael NG, Widge AT, et al.; mRNA-1273 Study Group. Safety and Immunogenicity of SARS-CoV-2 mRNA-1273 vaccine in older adults. N Engl J Med 2020;383:2427–38. PMID:32991794 https://doi.org/10.1056/NEJMoa2028436
9. Jackson LA, Anderson EJ, Rouphael NG, et al.; mRNA-1273 Study Group. An mRNA vaccine against SARS-CoV-2—preliminary report. N Engl J Med 2020;383:1920–31. PMID:32663912 https://doi.org/10.1056/NEJMoa2022483
10. Klein NP, Lewis N, Goddard K, et al. Surveillance for adverse events after COVID-19 mRNA vaccination. JAMA 2021;326:1390–9. PMID:34477808 https://doi.org/10.1001/jama.2021.15072
11. Gargano JW, Wallace M, Hadler SC, et al. Use of mRNA COVID-19 vaccine after reports of myocarditis among vaccine recipients: update from the Advisory Committee on Immunization Practices—United States, June 2021. MMWR Morb Mortal Wkly Rep 2021;70:977–82. PMID:34237049 https://doi.org/10.15585/mmwr.mm7027e2
12. CDC. COVID data tracker: demographic trends of people receiving COVID-19 vaccinations in the United States. Atlanta, GA: US Department of Health and Human Services, CDC; 2022. Accessed March 10, 2022. https://covid.cdc.gov/covid-data-tracker/#vaccination-demographics-trends
13. Kaiser Family Foundation. KFF COVID-19 vaccine monitor: differences in vaccine attitudes between rural, suburban, and urban areas. San Francisco, CA: Kaiser Family Foundation; 2021. Accessed January 18, 2022. https://www.kff.org/report-section/kff-covid-19-vaccine-monitor-differences-in-vaccine-attitudes-between-rural-suburban-and-urban-areas-methodology/
14. McNaghten AD, Brewer NT, Hung MC, et al. COVID-19 vaccination coverage and vaccine confidence by sexual orientation and gender identity—United States, August 29–October 30, 2021. MMWR Morb Mortal Wkly Rep 2022;71:171–6. PMID:35113846 https://doi.org/10.15585/mmwr.mm7105a3
15. Oster ME, Shay DK, Su JR, et al. Myocarditis cases reported after mRNA-based COVID-19 vaccination in the US from December 2020 to August 2021. JAMA 2022;327:331–40. PMID:35076665 https://doi.org/10.1001/jama.2021.24110
16 Buchan SA, Seo CY, Johnson C, et al. Epidemiology of myocarditis and pericarditis following mRNA vaccines in Ontario, Canada: by vaccine product, schedule and interval. medRxiv [preprint posted online December 5, 2021]. https://www.medrxiv.org/content/10.1101/2021.12.02.21267156v1
17. Payne RP, Longet S, Austin JA, et al.; PITCH Consortium. Immunogenicity of standard and extended dosing intervals of BNT162b2 mRNA vaccine. Cell 2021;184:5699–5714.e11. PMID:34735795 https://doi.org/10.1016/j.cell.2021.10.011
18. Grunau B, Asamoah-Boaheng M, Lavoie PM, et al. A higher antibody response is generated with a 6-to7-week (vs standard) severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) vaccine dosing interval. Clin Infect Dis 2021. Epub November 30, 2021. PMID:34849655 https://doi.org/10.1093/cid/ciab938
19. Amirthalingam G, Bernal JL, Andrews NJ, et al. Serological responses and vaccine effectiveness for extended COVID-19 vaccine schedules in England. Nat Commun 2021;12:7217. PMID:34893611 https://doi.org/10.1038/s41467-021-27410-5
20. Parry H, Bruton R, Stephens C, et al. Extended interval BNT162b2 vaccination enhances peak antibody generation. NPJ Vaccines 2022;7:14. PMID:35087066 https://doi.org/10.1038/s41541-022-00432-w
21. Food and Drug Administration. Coronavirus (COVID-19) update: FDA shortens interval for booster dose of Moderna COVID-19 vaccine to five months. Silver Spring, MD: US Department of Health and Human Services, Food and Drug Administration; 2022. https://www.fda.gov/news-events/press-announcements/coronavirus-covid-19-update-fda-shortens-interval-booster-dose-moderna-covid-19-vaccine-five-months
22. Food and Drug Administration. Coronavirus (COVID-19) update: FDA authorizes additional vaccine dose for certain immunocompromised individuals. Silver Spring, MD: US Department of Health and Human Services, Food and Drug Administration; 2021. https://www.fda.gov/news-events/press-announcements/coronavirus-covid-19-update-fda-authorizes-additional-vaccine-dose-certain-immunocompromised
23. Food and Drug Administration. Spikevax and Moderna COVID-19 vaccine. Silver Spring, MD: US Department of Health and Human Services, Food and Drug Administration; 2022. https://www.fda.gov/emergency-preparedness-and-response/coronavirus-disease-2019-covid-19/spikevax-and-moderna-covid-19-vaccine#additional

Effectiveness of 2-Dose BNT162b2 (Pfizer BioNTech) mRNA Vaccine in Preventing SARS-CoV-2 Infection Among Children Aged 5–11 Years and Adolescents Aged 12–15 Years — PROTECT Cohort, July 2021–February 2022

Ashley L. Fowlkes, ScD[1]; Sarang K. Yoon, DO[2]; Karen Lutrick, PhD[3]; Lisa Gwynn, DO[4]; Joy Burns, PhD[5]; Lauren Grant, MS[1]; Andrew L. Phillips, MD[2]; Katherine Ellingson, PhD[6]; Maria V. Ferraris, MEd, MSPM[4]; Lindsay B. LeClair, MS, MPH[5]; Clare Mathenge[7]; Young M. Yoo, MSPH[1]; Matthew S. Thiese, PhD[2]; Lynn B. Gerald, PhD[6]; Natasha Schaefer Solle, PhD[4]; Zuha Jeddy, MPH[5]; Leah Odame-Bamfo, MPH[7]; Josephine Mak, MPH[1]; Kurt T. Hegmann, MD[2]; Joe K. Gerald, MD[6]; Jezahel S. Ochoa[4]; Mark Berry, PhD[5]; Spencer Rose[7]; Julie Mayo Lamberte, MSPH[1]; Purnima Madhivanan, MBBS[6]; Felipe A. Pubillones, DO[4]; Ramona P. Rai, MPH[5]; Kayan Dunnigan, MPH[7]; John T. Jones, MSPH[1]; Karl Krupp, PhD[6]; Laura J. Edwards, MPH[5]; Edward J. Bedrick, PhD[6]; Brian E. Sokol, MSPA[5]; Ashley Lowe, PhD[6]; Hilary McLeland-Wieser, MPH[5]; Krystal S. Jovel, MA[6]; Deanna E. Fleary, MSc[5]; Sana M. Khan, MPH[6]; Brandon Poe, MPA[5]; James Hollister[6]; Joanna Lopez, MSPH[5]; Patrick Rivers, MPP[3]; Shawn Beitel, MSc[6]; Harmony L. Tyner, MD[8]; Allison L. Naleway, PhD[9]; Lauren E.W. Olsho, PhD[5]; Alberto J. Caban-Martinez, DO, PhD[4]; Jefferey L. Burgess, MD[6]; Mark G. Thompson, PhD[1]; Manjusha Gaglani, MBBS[7,10]

On March 11, 2022, this report was posted as an MMWR *Early Release on the* MMWR *website (https://www.cdc.gov/mmwr).*

The BNT162b2 (Pfizer-BioNTech) mRNA COVID-19 vaccine was recommended by CDC's Advisory Committee on Immunization Practices for persons aged 12–15 years (referred to as adolescents in this report) on May 12, 2021, and for children aged 5–11 years on November 2, 2021 (*1–4*). Real-world data on vaccine effectiveness (VE) in these age groups are needed, especially because when the B.1.1.529 (Omicron) variant became predominant in the United States in December 2021, early investigations of VE demonstrated a decline in protection against symptomatic infection for adolescents aged 12–15 years and adults* (*5*). The PROTECT† prospective cohort of 1,364 children and adolescents aged 5–15 years was tested weekly for SARS-CoV-2, irrespective of symptoms, and upon COVID-19–associated illness during July 25, 2021–February 12, 2022. Among unvaccinated participants (i.e., those who had received no COVID-19 vaccine doses) with any laboratory-confirmed SARS-CoV-2 infection, those with B.1.617.2 (Delta) variant infections were more likely to report COVID-19 symptoms (66%) than were those with Omicron infections (49%). Among fully vaccinated children aged 5–11 years, VE against any symptomatic and asymptomatic Omicron infection 14–82 days (the longest interval after dose 2 in this age group) after receipt of dose 2 of the Pfizer-BioNTech vaccine was 31% (95% CI = 9%–48%), adjusted for sociodemographic characteristics, health information, frequency of social contact, mask use, location, and local virus circulation. Among adolescents aged 12–15 years, adjusted VE 14–149 days after dose 2 was 87% (95% CI = 49%–97%) against symptomatic and asymptomatic Delta infection and 59% (95% CI = 22%–79%) against Omicron infection. Fully vaccinated participants with Omicron infection spent an average of one half day less sick in bed than did unvaccinated participants with Omicron infection. All eligible children and adolescents should remain up to date with recommended COVID-19 vaccinations.

PROTECT is a prospective cohort study monitoring SARS-CoV-2 infections among participants aged 6 months–17 years in jurisdictions in four states (Arizona, Florida, Texas, and Utah), initiated in July 2021 (*6*). Upon enrollment, parents or legal guardians provided the participants' demographic, health, vaccination history, and prior SARS-CoV-2 infection information; the number of hours and percentage of time participants wore masks in school and in the community were reported monthly.§ Vaccination was verified by vaccine cards, electronic medical records, and state immunization registries. Active surveillance for SARS-CoV-2 infection and any COVID-19–associated symptoms¶ within the preceding 7 days occurred through weekly submission of a survey and nasal swab for reverse transcription–polymerase chain reaction testing and viral whole genome sequencing.** Specific symptoms and duration, hours of school missed

* https://www.medrxiv.org/content/10.1101/2021.12.10.21267408v3

† PROTECT (Pediatric Research Observing Trends and Exposures in COVID-19 Timelines) is conducted in Phoenix and Tucson, Arizona; Miami, Florida; Temple, Texas; and Salt Lake City, Utah.

§ Parents or legal guardians were asked, "In the past 7 days, how many hours did [participant] spend in the community, meaning outside the home and NOT at school, daycare, or before-/after-school care? (For example: in stores, at parks, at work, playing sports, or at summer camp)" followed by, "In the past 7 days when [participant] was in the community, for what % of time did they wear a face mask?"

¶ COVID-19–associated illness signs and symptom included fever >100°F (37.8°C), chills, cough, shortness of breath, sore throat, diarrhea, muscle or body aches, change in smell or taste, runny nose, fatigue or being run-down, decreased activity, and irritability or crankiness were also included for nonverbal children. A short survey submitted with the specimen asked the parent or guardian if the child had any COVID-19 symptoms in the previous 7 days.

** Specimens not eligible (cycle threshold [Ct] value >30) for sequencing were assumed to contain the Delta variant from July 25, 2021, to the date when the Omicron variant accounted for >50% of sequenced viruses at each study site. During weeks of Omicron and Delta cocirculation, 62% (38 of 61) of SARS-CoV-2 samples were sequenced. Point estimates of VE changed <5% when unsequenced samples were removed; however, 95% CIs were wider because of decreased sample size and precision.

because of illness, and receipt of medical care were documented through the electronic surveys.

For the calculation of VE, person-time for adolescents aged 12–15 years began at the start of active surveillance on July 25, 2021, and ended February 12, 2022, or, for adolescents eligible for a third (booster) dose (≥5 months after second mRNA vaccine dose receipt), person-time ended when a booster dose was authorized on January 3, 2022.[††] For children aged 5–11 years, person-time for Omicron models began 6 weeks after the Pfizer-BioNTech vaccine was recommended on November 2, 2021, and ended February 12, 2022. COVID-19 characteristics and comparisons between Delta and Omicron infections were assessed. Cox proportional hazards models with time-varying vaccination status were used to calculate hazard ratios of unvaccinated to vaccinated participants with no prior SARS-CoV-2 infection (≥14 days after receipt of a second Pfizer-BioNTech vaccine dose), weighted for inverse probability of vaccination using sociodemographic characteristics, health information, frequency of social contact, mask use, location, and local virus circulation. Characteristics of Omicron infections among vaccinated and unvaccinated participants were also compared.[§§] All analyses were conducted using SAS software (version 9.4; SAS Institute) or R software (version 4.1.2; R Foundation). This study was reviewed by CDC and approved by the institutional review boards at participating sites or under a reliance agreement with Abt Associates institutional review board and was conducted consistent with applicable federal law and CDC policy.[¶¶]

The study sample comprised 1,364 participants, including 1,052 (77%) children aged 5–11 years and 312 (23%) adolescents aged 12–15 years (Table 1).[***] Overall, 76% of participants lived in Arizona, 52% were female, 76% were White, 34% were Hispanic, and 10% had at least one chronic medical condition. Of 381 SARS-CoV-2 infections among children aged 5–11 years, and 127 infections among adolescents aged 12–15 years, 352 (93%) and 97 (76%), respectively, were Omicron infections.

Participants who received ≥1 doses of vaccine were reported to have worn a mask during 84% of school hours and 70% of hours in the community, whereas unvaccinated children were masked during 60% of school hours and 48% of hours in the community (p <0.001 for both). Lower percentages of masked time in school (71%) and in the community (58%) were reported for participants with SARS-CoV-2 infection, compared with those of participants who had no infection (82% and 68%, respectively) (p <0.001).

Among 252 unvaccinated participants with SARS-CoV-2 infections throughout the study period, 112 (44%) were asymptomatic; unvaccinated participants with Omicron infections were less likely to report COVID-19 symptoms (49%) than were those with Delta infections (66%) (crude odds ratio = 0.5; 95% CI = 0.3–0.8) (Table 2). Overall, unvaccinated participants with COVID-19 symptoms experienced an average of 6.9 days with illness symptoms, spent an average of 1.9 days sick in bed, and missed an average of 24.0 hours of school because of illness. Omicron-associated COVID-19 symptoms lasted an average of 5.3 days and resulted in an average of 18.8 hours of missed school, which was 3.4 fewer days of symptoms (95% CI = –5.7 to –1.0) and 10.6 fewer hours of school missed (95% CI = –18.6 to –2.7) than Delta-associated COVID-19.

Among the 1,052 participants aged 5–11 years, 682 (65%) received 2 vaccine doses, 69 (7%) received 1 dose, and 301 (29%) were unvaccinated. Adjusted VE against symptomatic and asymptomatic Omicron infection 14–82 days after receipt of dose 2 (the longest interval after dose 2 in this age group) was 31% (95% CI = 9%–48%) (Table 3).

Among 312 adolescents aged 12–15 years, 212 (68%) received 2 vaccine doses, 15 (5%) received 1 dose, and

[††] The Food and Drug Administration (FDA) amended the Emergency Use Authorization (EUA) for the Pfizer-BioNTech vaccine to include adolescents aged 12–15 years on May 10, 2021 (https://www.fda.gov/news-events/press-announcements/coronavirus-covid-19-update-fda-authorizes-pfizer-biontech-covid-19-vaccine-emergency-use), and CDC recommended the Pfizer-BioNTech vaccine for this age group on May 12, 2021 (https://www.cdc.gov/media/releases/2021/s0512-advisory-committee-signing.html). FDA amended EUA for the Pfizer-BioNTech COVID-19 vaccine to expand the use of a single booster dose to include use in persons aged 12–15 years, 5 months after receipt of the second primary series mRNA COVID-19 vaccine dose on January 3, 2022, and CDC recommended a third dose for this age group on January 5, 2022 (https://www.cdc.gov/media/releases/2022/s0105-Booster-Shot.html). FDA authorized EUA for the Pfizer-BioNTech vaccine for children aged 5–11 years on October 29, 2021 (https://www.fda.gov/news-events/press-announcements/fda-authorizes-pfizer-biontech-covid-19-vaccine-emergency-use-children-5-through-11-years-age), and CDC recommended the Pfizer-BioNTech vaccine for this age group on November 2, 2021 (https://www.cdc.gov/media/releases/2021/s1102-PediatricCOVID-19Vaccine.html).

[§§] Severity of infection was assessed by variant type among unvaccinated children and by vaccination status among Omicron infections because of limited number of Delta infections among vaccinated persons. Logistic and linear regression models were used for dichotomous and continuous outcome measures, respectively, weighted for inverse probability of vaccination by site, sociodemographic characteristics, health information, including number of chronic medical conditions, number of daily prescription medications, and influenza vaccination history, and SARS-CoV-2 infection and vaccine knowledge, attitudes, and practices. For VE and severity of infection models, any variable that was unbalanced (standardized mean difference ≥0.2) after weighting and that modified the model outcome point estimate ≥5%, was added to the model as a covariate. Participants with partial vaccination or <14 days after second dose were excluded from VE and attenuation analyses.

[¶¶] 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.

[***] The study excluded 167 children and adolescents aged 5–15 years with documented SARS-CoV-2 infection before enrollment or start of follow-up, 90 who failed to complete weekly nasal swabs or were not in surveillance during the variant-specific follow-up period, and 17 who received a vaccine product other than Pfizer-BioNTech or had incomplete vaccination information.

TABLE 1. Characteristics of children and adolescents aged 5–15 years in the PROTECT* Pfizer-BioNTech COVID-19 vaccine effectiveness cohort — four states, July 2021–February 2022

Characteristic	All participants, no. (column %)	COVID-19 vaccination status, no. (row %)			All SARS-CoV-2 infections, no. (row %)		
		Unvaccinated	≥1 dose†	P-value§	Yes¶	No	P-value§
All participants	**1,364**	**386 (28.3)**	**978 (71.7)**	—	**508 (37.2)**	**856 (62.8)**	—
Geographic location							
Phoenix, Arizona	232 (17.0)	53 (22.8)	179 (77.2)	<0.001	87 (37.5)	145 (62.5)	<0.001
Tucson, Arizona	682 (50.0)	127 (18.6)	555 (81.4)		214 (31.4)	468 (68.6)	
Other areas in Arizona	121 (8.9)	50 (41.3)	71 (58.7)		55 (45.5)	66 (54.5)	
Miami, Florida	114 (8.4)	59 (51.8)	55 (48.2)		50 (43.9)	64 (56.1)	
Temple, Texas	84 (6.2)	41 (48.8)	43 (51.2)		47 (56.0)	37 (44.0)	
Salt Lake City, Utah	131 (9.6)	56 (42.7)	75 (57.3)		55 (42.0)	76 (58.0)	
Age group, yrs							
5–11	1,052 (77.1)	301 (28.6)	751 (71.4)	0.637	381 (36.2)	671 (63.8)	0.150
12–15	312 (22.9)	85 (27.2)	227 (72.8)		127 (40.7)	185 (59.3)	
Sex							
Female	713 (52.3)	203 (28.5)	510 (71.5)	0.883	254 (35.6)	459 (64.4)	0.196
Male	651 (47.7)	183 (28.1)	468 (71.9)		254 (39.0)	397 (61.0)	
Ethnicity (all races)							
Hispanic	469 (34.4)	158 (33.7)	311 (66.3)	0.264	163 (34.8)	306 (65.2)	0.312
Non-Hispanic	895 (65.6)	228 (25.5)	667 (74.5)		345 (38.5)	550 (61.5)	
Race (all ethnicities)**							
White	1,032 (75.7)	284 (27.5)	748 (72.5)	0.260	392 (38.0)	640 (62.0)	0.318
Other races	332 (24.3)	102 (30.7)	230 (69.3)		116 (34.9)	216 (65.1)	
No. of children in household							
1	204 (15.0)	52 (25.5)	152 (74.5)	0.334	66 (32.4)	138 (67.6)	0.117
≥2	1160 (85.0)	334 (28.8)	826 (71.2)		442 (38.1)	718 (61.9)	
Chronic condition††							
One or more	139 (10.2)	39 (28.1)	100 (71.9)	0.835	57 (41.0)	82 (59.0)	0.718
None	1,225 (89.8)	347 (28.3)	878 (71.7)		451 (36.8)	774 (63.2)	
Daily medication§§							
None	823 (60.3)	194 (50.3)	629 (64.3)	0.121	287 (56.5)	536 (62.6)	0.626
1	116 (8.5)	21 (5.4)	95 (9.7)		40 (7.9)	76 (8.9)	
2	52 (3.8)	5 (1.3)	47 (4.8)		21 (4.1)	31 (3.6)	
3	24 (1.8)	4 (1.0)	20 (2.0)		9 (1.8)	15 (1.8)	
≥4	16 (1.2)	4 (1.0)	12 (1.2)		3 (0.6)	13 (1.5	
Insurance							
Private	1,052 (77.1)	247 (23.5)	805 (76.5)	<0.001	385 (36.6)	667 (63.4)	0.203
Public	197 (14.4)	78 (39.6)	119 (60.4)		84 (42.6)	113 (57.4)	
None or did not respond	115 (8.4)	61 (53.0)	54 (47.0)		39 (33.9)	76 (66.1)	
Average weekly social contact and mask use¶¶							
Hours attending school, mean (SE)	37.9 (0.2)	36.1 (0.4)	38.5 (0.2)	<0.001	36.8 (0.3)	38.6 (0.2)	0.230
Percentage of school time masked, mean (SE)	78.0 (0.2)	59.9 (0.5)	83.8 (0.2)	<0.001	71.3 (0.4)	81.8 (0.2)	<0.001
Hours in community, mean (SE)	10.7 (0.1)	11.6 (0.2)	10.4 (0.1)	0.157	11.6 (0.1)	10.1 (0.1)	0.041
Percentage of community time masked, mean (SE)	64.3 (0.2)	47.6 (0.5)	69.6 (0.2)	<0.001	57.5 (0.4)	68.1 (0.3)	<0.001
Hours of COVID-19 exposure, mean (SE)	2.1 (0.1)	2.8 (0.2)	1.8 (0.1)	0.389	2.7 (0.1)	1.7 (0.1)	<0.001

* PROTECT (Pediatric Research Observing Trends and Exposures in COVID-19 Timelines) is conducted in Phoenix and Tucson, Arizona; Miami, Florida; Temple, Texas; and Salt Lake City, Utah.

† COVID-19 vaccination status excludes participants with reverse transcription–polymerase chain reaction–confirmed SARS-CoV-2 infection during the first 13 days after receiving their first vaccine dose (n = 36).

§ P-values comparing the percentage of persons vaccinated with those not vaccinated and those with SARS-CoV-2 infections with those not infected by sociodemographic and health categories were calculated using Pearson's chi-square test. P-values for continuous variables were calculated using the Kruskal-Wallis test.

¶ SARS-CoV-2 infections were detected by reverse transcription–polymerase chain reaction testing.

** Among 332 children of other races, 111 (33.4%) identified as multiracial, 43 (13.0%) as Asian, 28 (8%) as Black or African American, eight (2%) as American Indian or Alaskan Native, three (1%) as Native Hawaiian or other Pacific Islander, and 14 (4%) as other; race was missing, or respondent declined to answer for 125 (38%).

†† Chronic conditions included asthma or chronic lung disease, cancer, diabetes, heart disease, hypertension, immunosuppression or autoimmune disorder, kidney disease, liver disease, neurologic or neuromuscular disorder, or other chronic conditions.

§§ Number of daily medications prescribed by a physician were reported by participant parent or legal guardian at study enrollment.

¶¶ Participants were asked to respond to monthly survey questions about COVID-19 exposure, social contact, and mask use during the previous 7 days. The average of monthly responses is calculated for each person. Average values across persons were compared according to their vaccination and SARS-CoV-2 infection status at the time of this analysis. School hours represent in-person school, child care, or before- or after-school care attendance.

TABLE 2. Comparison of SARS-CoV-2 Delta and Omicron variant infection characteristics among unvaccinated children and adolescents aged 5–15 years and by Pfizer-BioNTech vaccination status among Omicron infections — PROTECT* cohort study, four states, July 2021–February 2022

	Participant vaccination status at time of infection							
	Unvaccinated					2 COVID-19 vaccine doses received 14–149 days before infection		
	Infections, no. (%)							
Characteristic	Total†	Delta	Omicron	OR or mean difference, Omicron versus Delta (95% CI)§	P-value§	Omicron No. (%)¶	Adjusted OR or mean difference, vaccinated versus unvaccinated (95% CI)**	P-value**
Total participants, no. (%)	**252 (100)**	102 (100)	150 (100.0)	—	—	186 (100.0)	—	—
COVID-19–associated symptoms, no. (%)††	**140 (55.6)**	67 (65.7)	73 (48.7)	2.0 (1.20 to 3.45)	0.008	116 (62.4)	0.91 (0.48 to 1.59)	0.669
Febrile symptoms, no. (%)§§	**88 (62.9)**	38 (56.7)	50 (68.5)	1.7 (0.83 to 3.31)	0.151	66 (56.9)	0.48 (0.23 to 1.03)	0.062
Received medical care, no. (%)	**23 (16.4)**	11 (16.4)	12 (16.4)	1.0 (0.41 to 2.45)	0.997	18 (15.5)	1.0 (0.43 to 2.48)	0.949
Total days of symptoms, mean (SE)	**6.9 (6.7)**	8.6 (8.0)	5.3 (5.4)	−3.4 (−5.7 to −1.0)	0.006	6.3 (3.9)	0.8 (−1.8 to 2.7)	0.426
Days spent sick in bed, mean (SE)	**1.9 (2.4)**	1.7 (2.7)	2.1 (2.1)	0.4 (−0.4 to 1.2)	0.322	1.4 (1.6)	−0.6 (−1.1 to −0.1)	0.016
Hours of missed school, mean (SE)	**24.0 (23.5)**	29.5 (24.1)	18.8 (21.8)	−10.6 (−18.6 to −2.7)	0.010	26.2 (17.5)	11.1 (4.6 to 17.6)	0.010

Abbreviation: OR = odds ratio.

* PROTECT (Pediatric Research Observing Trends and Exposures in COVID-19 Timelines) is conducted in Phoenix and Tucson, Arizona; Miami, Florida; Temple, Texas; and Salt Lake City, Utah.

† Includes all participants aged 5-15 years, and infections that occurred at any time during the cohort study (July 25, 2021–February 12, 2022). However, of 275 total infections among unvaccinated participants, only 252 completed a post-illness survey capturing symptoms.

§ Severity of infection, comparing Delta infections as the referent group with Omicron infections, was assessed by variant type among unvaccinated children and adolescents. Logistic and linear regression models were used for dichotomous and continuous outcome measures, respectively. P-values <0.05 were considered statistically significant.

¶ Of 198 total infections in persons that occurred 14–149 days after dose 2 receipt, 186 completed a post-illness survey to report symptoms. This excludes four Omicron infections in persons aged 12–15 years with infection ≥150 days after receipt of dose 2.

** Severity of infection was assessed by vaccination status, comparing unvaccinated children as the referent group with children vaccinated 14–149 days earlier, among Omicron infections. Comparison of vaccinated and unvaccinated participants with Delta infections was not included because of the limited number of vaccinated children with Delta infections. Logistic and linear regression models were used for dichotomous and continuous outcome measures, respectively, weighted for inverse probability of vaccination by site, sociodemographic characteristics, health information, and knowledge, attitudes, and practices regarding SARS-CoV-2 infection and vaccine.

†† COVID-19–associated illness signs and symptoms included fever >100°F (37.8°C), chills, cough, shortness of breath, sore throat, diarrhea, muscle or body aches, change in smell or taste; runny nose, fatigue or being run-down, decreased activity, and irritability or crankiness were also included for nonverbal children.

§§ Febrile symptoms were defined as symptoms of feverishness or chills, or a measured temperature >100.4°F (38°C).

85 (27%) were unvaccinated. The adjusted VE at 14–149 days after receipt of dose 2 was 87% (95% CI = 49%–97%) against Delta infection and 59% (95% CI = 22%–79%) against Omicron infection. Adjusted VE ≥150 days after dose 2 was 60% against Delta infection and 62% against Omicron, with wide CIs that included zero.

Among 186 vaccinated participants with Omicron infections (174 [93%] in children aged 5–11 years and 13 [7%] in adolescents aged 12–15 years), 37.6% were asymptomatic; those reporting COVID-19 symptoms spent 1.4 days in bed, which was 0.6 days fewer than reported for unvaccinated participants (95% CI = −1.1 to −0.1) (Table 2), after adjusting for the propensity to be vaccinated. Conversely, vaccinated participants with Omicron infections stayed home from school 26.2 hours, an adjusted mean of 11 hours more than that reported for unvaccinated participants (95% CI = 4.6–17.6). Overall, medical care–seeking was reported for 16.4% of unvaccinated participants with Omicron infections and 15.5% of vaccinated participants, which was not significantly different.

Discussion

In this prospective cohort study of children and adolescents aged 5–15 years that included routine weekly SARS-CoV-2 testing, irrespective of symptoms, 2 doses of Pfizer-BioNTech vaccines were effective in preventing symptomatic and asymptomatic SARS-CoV-2 infections, although effectiveness varied by variant. VE point estimates were highest against Delta variant infections among adolescents aged 12–15 years and lowest against Omicron variant infections among children aged 5–11 years.

The SARS-CoV-2 infections prevented by vaccination differed by variant. Approximately one half (51%) of all Omicron infections were asymptomatic compared with approximately one third (34%) of Delta infections. However, when children or adolescents experienced symptomatic COVID-19, the illnesses disrupted life at home and school; on average COVID-19 lasted 7 days, two of which were spent sick in bed, and resulted in 24 hours of missed school.

Two doses of Pfizer-BioNTech vaccine received <5 months earlier were moderately effective (31%) in preventing symptomatic and asymptomatic Omicron infection among children

TABLE 3. COVID-19 Pfizer-BioNTech vaccine effectiveness against asymptomatic or symptomatic SARS-CoV-2 infection among children and adolescents aged 5–15 years, by time since receipt of second vaccine dose and variant — PROTECT* cohort study, four states, July 2021–February 2022

Age group and COVID-19 vaccination status (no. of days since receipt of most recent dose)	No. of contributing participants†	Total person-days	Median no. of days (IQR)	No. of SARS-CoV-2 infections§	VE, % (95% CI)	
					Unadjusted	Adjusted¶
Children aged 5–11 yrs						
Omicron variant infections						
Unvaccinated (referent)	336	13,801	41 (28 to 62)	137	—	—
2 doses (14–82 days)	640	29,996	53 (34 to 61)	184	47 (32 to 59)	31 (9 to 48)
Adolescents aged 12–15 yrs						
Delta variant infections						
Unvaccinated (referent)	139	9,786	65 (25 to 107)	23	—	—
2 doses (≥14 days)	193	23,575	142 (91 to 156)	7	87 (70 to 95)	81 (51 to 93)
2 doses (14–149 days)	188	16,517	97 (75 to 105)	3	93 (76 to 98)	87 (49 to 97)
2 doses (≥150 days)	138	7,058	57 (49 to 63)	4	67 (0 to 89)	60 (−35 to 88)
Omicron variant infections						
Unvaccinated (referent)	76	3,001	37 (24 to 62)	38	—	—
2 doses (≥14 days)	192	5,432	22 (22 to 31)	18	64 (37 to 80)	59 (24 to 78)
2 doses (14–149 days)	65	2,623	42 (28 to 56)	14	62 (30 to 79)	59 (22 to 79)
2 doses (≥150 days)	134	2,809	22 (22 to 22)	4	74 (16 to 92)	62 (−28 to 89)

Abbreviations: SMD = standard mean difference; VE = vaccine effectiveness.

* PROTECT (Pediatric Research Observing Trends and Exposures in COVID-19 Timelines) is conducted in Phoenix and Tucson, Arizona; Miami, Florida; Temple, Texas; and Salt Lake City, Utah.

† Vaccination status varied with time, therefore, contributing participants in vaccination categories do not equal the number of participants in the study because participants could contribute to more than one vaccination category.

§ Of 275 SARS-CoV-2 infections among unvaccinated participants, 98 occurred among children aged 5–11 years either before vaccine availability (n = 60) or were Delta infections (n = 17) for whom VE was not calculated. Among vaccinated participants, 61 occurred after receipt of dose 1 and <14 days after dose 2; two children aged 5–11 years were vaccinated before authorization, and two had Delta infections among children aged 5–11 years for whom VE was not calculated.

¶ Adjusted VE is inversely weighted for propensity to be vaccinated. Among children aged 5–11 years, all covariates met balance criteria of SMD <0.2 after weighting for the Delta variant model. For the Omicron variant model, all covariates met balance criteria of SMD <0.2 after weighting, except local virus circulation and social (school or community) mask use, which both changed the VE estimate by ≥5% when added to the model, and thus remained in the final model as covariates. Among adolescents aged 12–15 years, all covariates met balance criteria of SMD <0.2 after weighting except social mask use, which also changed the VE estimate by ≥5% when added to the Delta variant model, and thus remained in the final model as a covariate. For the Omicron variant model, all covariates met balance criteria of SMD <0.2 after weighting, except local virus circulation, social (school or community) mask use, and number of medications. Only local virus circulation changed the VE estimate by ≥5% when added to the model, and thus remained in the final model as a covariate.

aged 5–11 years and 59% effective among adolescents aged 12–15 years. The wide and overlapping CIs indicate that these age-specific VE point estimates might not be significantly different and are similar to a recent report of VE of 45%–51% for 2 doses, received within 150 days, against Omicron COVID-19–associated emergency department and urgent care visits among children and adolescents aged 5–15 years (*7*). Participants who were infected with Omicron despite receipt of 2 vaccine doses spent an average of one half day less sick in bed than did unvaccinated participants with Omicron infections. Also, similar to studies of children (*7*) and adults (*6*), among adolescents aged 12–15 years, point estimates for VE of 2 doses received within the previous 150 days were lower against Omicron than Delta infections, although these differences were not statistically significant.

The findings in this report are subject to at least five limitations. First, despite the use of robust adjusted models previously applied in other cohort studies (*8*), VE estimates might have been biased by residual confounding due to other differences between vaccinated and unvaccinated participants. For example, vaccinated participants reported wearing face masks significantly more often at school and in the community than did unvaccinated participants. Second, although PROTECT is among the largest studies with routine weekly SARS-CoV-2 testing, the relatively small number of infections within vaccination categories among certain age groups reduced precision of VE estimates. Estimates of VE at ≥150 days after dose 2 had very wide CIs, and thus it is unclear whether VE wanes with increased time since vaccination. Third, data were not available to assess possible reasons that vaccinated participants with COVID-19 might have missed more school than did unvaccinated participants despite unvaccinated participants reporting more days sick in bed. Fourth, these interim estimates do not include separate analyses of VE against asymptomatic infection and symptomatic infection at this time. Finally, although this study was conducted in multiple sites and included more than 1,300 participants, findings from the study sample might not be generalizable to all populations.

This study provides evidence that receipt of 2 doses of Pfizer-BioNTech vaccine is effective in preventing both asymptomatic

and symptomatic SARS-CoV-2 infection with the Omicron variant among children and adolescents aged 5–15 years. All eligible children and adolescents should remain up to date with recommended COVID-19 vaccinations.

Acknowledgments

Eduardo Azziz-Baumgartner, Stephanie Bialek, Monica Dickerson, Alicia M. Fry, Ruth Link-Gelles, Aaron Hall, Adam MacNeil, Tamara Pilishvili, CDC; Claire Douglas, Edward Hock, Keya Jacoby, Utsav Kattel, Ryan Klein, Khaila Prather, Rajbansi Raorane, Alfredo Rodriguez-Nogues, John Thacker, Joseph Thomas, Molly Vaughan, Abt Associates, Inc.; Alexander Arroliga, Madhava Beeram, Nicole Calhoun, Jason Ettlinger, Ashley Graves, Eric Hoffman, Muralidhar Jatla, Amanda McKillop, Kempapura Murthy, Elisa Priest, Natalie Settele, Michael Smith, Jennifer Thomas, Martha Zayed, Baylor Scott & White Health; Ariyah Armstrong, Nora Baccam, Zoe Baccam, Maiya Block Ngaybe, Tatum Butcher, Dimaye Calvo, Shelby Capell, Andrea Carmona, Alissa Coleman, Hannah Cowling, Carly Deal, Kiara Earley, Sophie Evans, Erika Goebert, Taylor Graham, Sofia Grijalva, Hanna Hanson, Chloe Hendrix, Katherine Herder, Adrianna Hernandez, Raven Hilyard, Rezwana Islam, Caroline Klinck, Karla Ledezma, Sally Littau, Amelia Lobos, Jeremy Makar, Natalya Mayhew, Kristisha Mevises, Flavia Nakayima Miiro, Janko Nikolich-Zugich, Assumpta Nsengiyunva, Kennedy Obrien, Mya Pena, Cynthia Porter, James K. Romine, Priyanka Sharma, Alison Slocum, Saskia Smidt, Jayla Soowell, Danielle Stea, Nicholas Tang, Gianna Taylor, Heena Timsina, Italia Trejo, Mel and Enid Zuckerman College of Public Health, University of Arizona; Brandon Astor, Cynthia Beaver, Olga Carrera, Alexandra Cruz, Meghal Desai, Paola Louzado Feliciano, Damena Gallimore-Wilson, Johanna Garibaldi, Eugenia Victoria Gomez, Catalina Gonzalez, Aimee Green, John M. Jones, Hannah Kling, Ian Lee, Brigitte Madan, Daniela Maizel, Erin Morgan, Roger Noriega, Kemi Ogunsina, Annabel Reyes, Rachel Reyes, Christian Rojas, Carlos Silvera, Cole Southworth, Alex Steward, Nathaly Suarez, Addison Testoff, Leonard M. Miller School of Medicine, University of Miami; Arlyne Arteaga, Rachel Brown, Matthew M. Bruner, Brianna Cottam, Amanda Flanagan, Adriele Fugal, Tiffany Ho, Adrianna F. Hunsaker, Taryn Hunt-Smith, Iman M. Ibrahim, Michael Langston, Jacob McKell, Christy Porucznik, Jenna Praggastis, Lillian C. Prentice, Madeleine Smith, Joseph B. Stanford, Rocky Mountain Center for Occupational and Environmental Health, University of Utah Health.

Corresponding author: Ashley L. Fowlkes, ahl4@cdc.gov.

Summary

What is already known about this topic?

Receipt of 2 doses of Pfizer-BioNTech COVID-19 vaccine has been shown to be effective in preventing infection with the SARS-CoV-2 B.1.617.2 (Delta) variant in persons aged ≥12 years.

What is added by this report?

Children and adolescents aged 5–15 years were tested for SARS-CoV-2 weekly, irrespective of symptoms, during July 2021–February 2022. Approximately one half of Omicron infections in unvaccinated children and adolescents were asymptomatic. Two doses of Pfizer-BioNTech COVID-19 vaccine reduced the risk of Omicron infection by 31% among children aged 5–11 years and by 59% among persons aged 12–15 years.

What are the implications for public health practice?

All eligible children and adolescents should remain up to date with recommended COVID-19 vaccinations.

[1]CDC COVID-19 Emergency Response Team; [2]Rocky Mountain Center for Occupational and Environmental Health, Department of Family and Preventive Medicine, University of Utah Health, Salt Lake City, Utah; [3]College of Medicine - Tucson, University of Arizona, Tucson, Arizona; [4]Leonard M. Miller School of Medicine, University of Miami, Miami, Florida; [5]Abt Associates, Rockville, Maryland; [6]Mel and Enid Zuckerman College of Public Health, University of Arizona, Tucson, Arizona; [7]Baylor Scott & White Health, Texas, Temple, Texas; [8]St. Luke's Regional Health Care System, Duluth, Minnesota; [9]Kaiser Permanente Northwest Center for Health Research, Portland, Oregon; [10]Texas A&M University College of Medicine, Temple, Texas.

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. Allison L. Naleway reports institutional support from Pfizer for an unrelated study of meningococcal B vaccine safety during pregnancy. Matthew S. Thiese reports grants and personal fees from Reed Group and the American College of Occupational and Environmental Medicine, outside the submitted work. No other potential conflicts of interest were disclosed.

References

1. Frenck RW Jr, Klein NP, Kitchin N, et al.; C4591001 Clinical Trial Group. Safety, immunogenicity, and efficacy of the BNT162b2 Covid-19 vaccine in adolescents. N Engl J Med 2021;385:239–50. PMID:34043894 https://doi.org/10.1056/NEJMoa2107456
2. Walter EB, Talaat KR, Sabharwal C, et al.; C4591007 Clinical Trial Group. Evaluation of the BNT162b2 Covid-19 vaccine in children 5 to 11 years of age. N Engl J Med 2022;386:35–46. PMID:34752019 https://doi.org/10.1056/NEJMoa2116298
3. Wallace M, Woodworth KR, Gargano JW, et al. The Advisory Committee on Immunization Practices' interim recommendation for use of Pfizer-BioNTech COVID-19 vaccine in adolescents aged 12–15 years—United States, May 2021. MMWR Morb Mortal Wkly Rep 2021;70:749–52. PMID:34014913 https://doi.org/10.15585/mmwr.mm7020e1
4. Woodworth KR, Moulia D, Collins JP, et al. The Advisory Committee on Immunization Practices' interim recommendation for use of Pfizer-BioNTech COVID-19 vaccine in children aged 5–11 years—United States, November 2021. MMWR Morb Mortal Wkly Rep 2021;70:1579–83. PMID:34758012 https://doi.org/10.15585/mmwr.mm7045e1
5. Ferdinands JM, Rao S, Dixon BE, et al. Waning 2-dose and 3-dose effectiveness of mRNA vaccines against COVID-19–associated emergency department and urgent care encounters and hospitalizations among adults during periods of Delta and Omicron variant predominance—VISION Network, 10 states, August 2021–January 2022. MMWR Morb Mortal Wkly Rep 2022;71:255–63. PMID:35176007 https://doi.org/10.15585/mmwr.mm7107e2
6. Lutrick K, Rivers P, Yoo YM, et al. Interim estimate of vaccine effectiveness of BNT162b2 (Pfizer-BioNTech) vaccine in preventing SARS-CoV-2 infection among adolescents aged 12–17 years—Arizona, July–December 2021. MMWR Morb Mortal Wkly Rep 2021;70:1761–5. PMID:34968373 https://doi.org/10.15585/mmwr.mm705152a2
7. Klein NP, Stockwell MS, Demarco M, et al. Effectiveness of COVID-19 Pfizer-BioNTech BNT162b2 mRNA vaccination in preventing COVID-19–associated emergency department and urgent care encounters and hospitalizations among nonimmunocompromised children and adolescents aged 5–17 years—VISION Network, ten states, April 2021–January 2022. MMWR Morb Mortal Wkly Rep 2022;71:352–8. PMID:35239634 https://doi.org/10.15585/mmwr.mm7109e3
8. Thompson MG, Burgess JL, Naleway AL, et al. Interim estimates of vaccine effectiveness of BNT162b2 and mRNA-1273 COVID-19 vaccines in preventing SARS-CoV-2 infection among health care personnel, first responders, and other essential and frontline workers—eight U.S. locations, December 2020–March 2021. MMWR Morb Mortal Wkly Rep 2021;70:495–500. PMID:33793460 https://doi.org/10.15585/mmwr.mm7013e3

Hospitalization of Infants and Children Aged 0–4 Years with Laboratory-Confirmed COVID-19 — COVID-NET, 14 States, March 2020–February 2022

Kristin J. Marks, PhD[1,2]; Michael Whitaker, MPH[1]; Nickolas T. Agathis, MD[1,2]; Onika Anglin, MPH[1,3]; Jennifer Milucky, MSPH[1]; Kadam Patel, MPH[1,3]; Huong Pham, MPH[1]; Pam Daily Kirley, MPH[4]; Breanna Kawasaki, MPH[5]; James Meek, MPH[6]; Evan J. Anderson, MD[7,8,9]; Andy Weigel, MSW[10]; Sue Kim, MPH[11]; Ruth Lynfield, MD[12]; Susan L. Ropp, PhD[13]; Nancy L. Spina, MPH[14]; Nancy M. Bennett, MD[15]; Eli Shiltz, MPH[16]; Melissa Sutton, MD[17]; H. Keipp Talbot, MD[18]; Andrea Price[19]; Christopher A. Taylor, PhD[1]; Fiona P. Havers, MD[1]; COVID-NET Surveillance Team

On March 15, 2022, this report was posted as an MMWR *Early Release on the* MMWR *website (https://www.cdc.gov/mmwr).*

The B.1.1.529 (Omicron) variant of SARS-CoV-2, the virus that causes COVID-19, has been the predominant circulating variant in the United States since late December 2021.* Coinciding with increased Omicron circulation, COVID-19–associated hospitalization rates increased rapidly among infants and children aged 0–4 years, a group not yet eligible for vaccination (*1*). Coronavirus Disease 19–Associated Hospitalization Surveillance Network (COVID-NET)† data were analyzed to describe COVID-19–associated hospitalizations among U.S. infants and children aged 0–4 years since March 2020. During the period of Omicron predominance (December 19, 2021–February 19, 2022), weekly COVID-19–associated hospitalization rates per 100,000 infants and children aged 0–4 years peaked at 14.5 (week ending January 8, 2022); this Omicron-predominant period peak was approximately five times that during the period of SARS-CoV-2 B.1.617.2 (Delta) predominance (June 27–December 18, 2021, which peaked the week ending September 11, 2021).§ During Omicron predominance, 63% of hospitalized infants and children had no underlying medical conditions; infants aged <6 months accounted for 44% of hospitalizations, although no differences were observed in indicators of severity by age. Strategies to prevent COVID-19 among infants and young children are important and include vaccination among currently eligible populations (*2*) such as pregnant women (*3*), family members, and caregivers of infants and young children (*4*).

COVID-NET conducts population-based surveillance for laboratory-confirmed COVID-19–associated hospitalizations in 99 counties across 14 U.S. states.¶ Among residents of a predefined surveillance catchment area, COVID-19–associated hospitalizations are defined as receipt of a positive SARS-CoV-2 real-time reverse transcription–polymerase chain reaction or rapid antigen detection test result during hospitalization or during the 14 days preceding admission. This analysis describes weekly hospitalization rates among infants and children aged 0–4 years during March 1, 2020–February 19, 2022, which includes the pre-Delta–, Delta- and Omicron-predominant periods; detailed clinical data were available through January 31, 2022. Unadjusted weekly COVID-19–associated hospitalization rates were calculated by dividing the total number of hospitalized patients by the population estimates within each age group for the counties included in the surveillance catchment area.** All rates are estimated per 100,000 infants and children aged 0–4 years. Rate ratios (RR) comparing Omicron- and Delta-predominant periods and 95% CIs were calculated. Three-week moving averages are presented for visualization purposes.

Trained surveillance staff conducted medical chart abstractions for all pediatric COVID-NET patients using a standardized case report form during March 2020 through November 2021. Because of the large surge in hospitalizations during December 2021 and January 2022, some sites examined clinical data on a representative sample of hospitalized infants and children.†† Data regarding primary reason for hospital admission,§§ symptoms at admission,¶¶

* Delta became the predominant variant (>50% of sequenced isolates) circulating in the United States during the week ending July 3, 2021 (https://covid.cdc.gov/covid-data-tracker/#variant-proportions). By the week ending December 18, 2021, Omicron accounted for 38% of circulating variants; Omicron became the predominant variant during the week ending December 25 at 74%.

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

§ COVID-NET hospitalization data are preliminary and subject to change as more data become available. Specifically, case counts and rates for recent hospital admissions are subject to reporting lag, and some data might be incomplete or unavailable for children with prolonged hospitalizations who might still be hospitalized at the time of publication.

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

** Rates are calculated using the National Center for Health Statistics' vintage 2020 bridged race postcensal population estimates for the counties included in surveillance (https://www.cdc.gov/nchs/nvss/bridged_race.htm).

†† During December 2021–January 2022, sites sampled pediatric patients at 12%–100%. Random numbers (1–100) are automatically generated and assigned to each patient on entry into the surveillance database to produce random samples of hospitalized patients for medical record abstraction. Percentages are weighted to account for the probability of selection for sampled patients.

§§ Among sampled cases, COVID-NET collects data on the primary reason for admission to differentiate hospitalizations of patients with laboratory-confirmed SARS-CoV-2 infection who are likely admitted primarily for COVID-19 illness versus other reasons, including inpatient surgery or trauma. Infants with diagnosed COVID-19 during their birth hospitalization were not categorized as likely COVID-19–related unless they exhibited COVID-19–related signs or symptoms.

¶¶ COVID-19–related symptoms included respiratory symptoms (congestion/runny nose, cough, hemoptysis/bloody sputum, shortness of breath/respiratory distress, sore throat, upper respiratory infection, influenza-like illness, and wheezing) and nonrespiratory 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, and seizures, and among infants and children aged <2 years: apnea, cyanosis, decreased vocalization/stridor, dehydration, hypothermia, inability to eat/poor feeding, and lethargy). Symptoms were abstracted from medical charts and might be incomplete.

underlying medical conditions, and indicators of severe disease (i.e., hospital length of stay, intensive care unit [ICU] admission, need for respiratory support,*** and in-hospital death) were collected (*5*). Data on viral codetections (respiratory syncytial virus [RSV], influenza, rhinovirus/enterovirus, and other viruses)††† were collected for infants and children who received additional testing. Monthly ICU admission rates were calculated. Proportions were compared between periods of pre-Delta predominance (March 1, 2020–June 26, 2021), Delta predominance (June 27–December 18, 2021), and Omicron predominance (December 19, 2021–January 31, 2022); a variant that accounted for >50% of sequenced isolates was considered predominant. For the period of Omicron predominance, proportions were compared by age (<6 months, 6–23 months, and 2–4 years). Wilcoxon rank-sum tests and chi-square tests were used to compare medians and proportions, respectively; p-values <0.05 were considered statistically significant. Percentages were weighted to account for the probability of selection for sampled cases and adjusted to account for nonresponse. Data were analyzed using SAS (version 9.4; SAS Institute). This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.§§§

During March 1, 2020–February 19, 2022, weekly hospitalization rates (hospitalized patients per 100,000 infants and children aged 0–4 years) peaked during Omicron predominance, in the week ending January 8, 2022, at 14.5. This peak hospitalization rate during Omicron predominance was approximately five times the peak during Delta predominance (2.9) (week ending September 11, 2021) (RR = 5.0; 95% CI = 3.8–6.8). Hospitalization rates among infants aged <6 months were approximately six times as high during the peak week of Omicron predominance (68.1) as during Delta predominance (11.1) (RR = 6.1; 95% CI = 3.9–10.0); Omicron-predominant versus Delta-predominant hospitalization RRs were also elevated among infants and children aged 6–23 months (16.9 versus 3.3; RR = 5.1; 95% CI = 3.1–8.5) and 2–4 years (4.7 versus 1.4; RR = 3.5; 95% CI = 2.0–6.3) (Figure). Monthly ICU admission rates were approximately 3.5 times as high during the Omicron predominance peak in January 2022 (10.6) as during the Delta predominance peak in September 2021 (3.0). Hospitalization rates among infants and children aged 0–4 years decreased by the week ending February 19, 2022 (3.9).

Complete clinical data were available for 97% (2,562 of 2,637) of hospitalized infants and children aged 0–4 years, including 99% (1,200 of 1,209), 94% (790 of 841), and 97% (572 of 587) hospitalized during the pre-Delta–, Delta- and Omicron-predominant periods, respectively (Table 1). Although there was some variation across periods, most patients had COVID-19–related symptoms recorded at admission (87%) and COVID-19 as the primary reason for admission (85%). During Omicron predominance, 37% of hospitalized infants and children had one or more underlying medical condition.¶¶¶ Among 62% (1,582 of 2,562) of infants and children with testing for additional viral pathogens,**** the proportion hospitalized with RSV codetections was significantly higher during Delta predominance (20%) than during Omicron predominance (7%) (p<0.001). Compared with Delta predominance, hospital length of stay during Omicron predominance was shorter (2 versus 1.5 days, p = 0.002) and the proportion of hospitalized infants and children requiring ICU admission (27% versus 21%, p = 0.02) was lower.

During Omicron predominance, 44% of hospitalized infants and children aged 0–4 years were infants aged <6 months, similar to proportions during the Delta- (43%) and pre-Delta–predominant (46%) periods. Among 252 hospitalized infants aged <6 months, 146 (58%) were aged <2 months, 30 (21%) of whom received a diagnosis of COVID-19 during their birth hospitalization. A smaller proportion of infants and children aged <6 months was hospitalized with COVID-19–related symptoms at admission (82%) than the proportion aged 6–23 months (92%) or 2–4 years (89%) (Table 2), although no difference was observed when birth hospitalizations (91% of which were asymptomatic infections) were excluded. Approximately one half (51%) of hospitalized infants aged <6 months were febrile at the time of admission, including 44% of those aged <2 months and 61% of those aged 2–5 months. A higher proportion of infants aged <6 months (13%) were hospitalized with RSV codetections than were older infants and children (6–23 months = 4%; 2–4 years = 2%). Length of stay, ICU admission, and need for respiratory support did not significantly differ by age group.

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

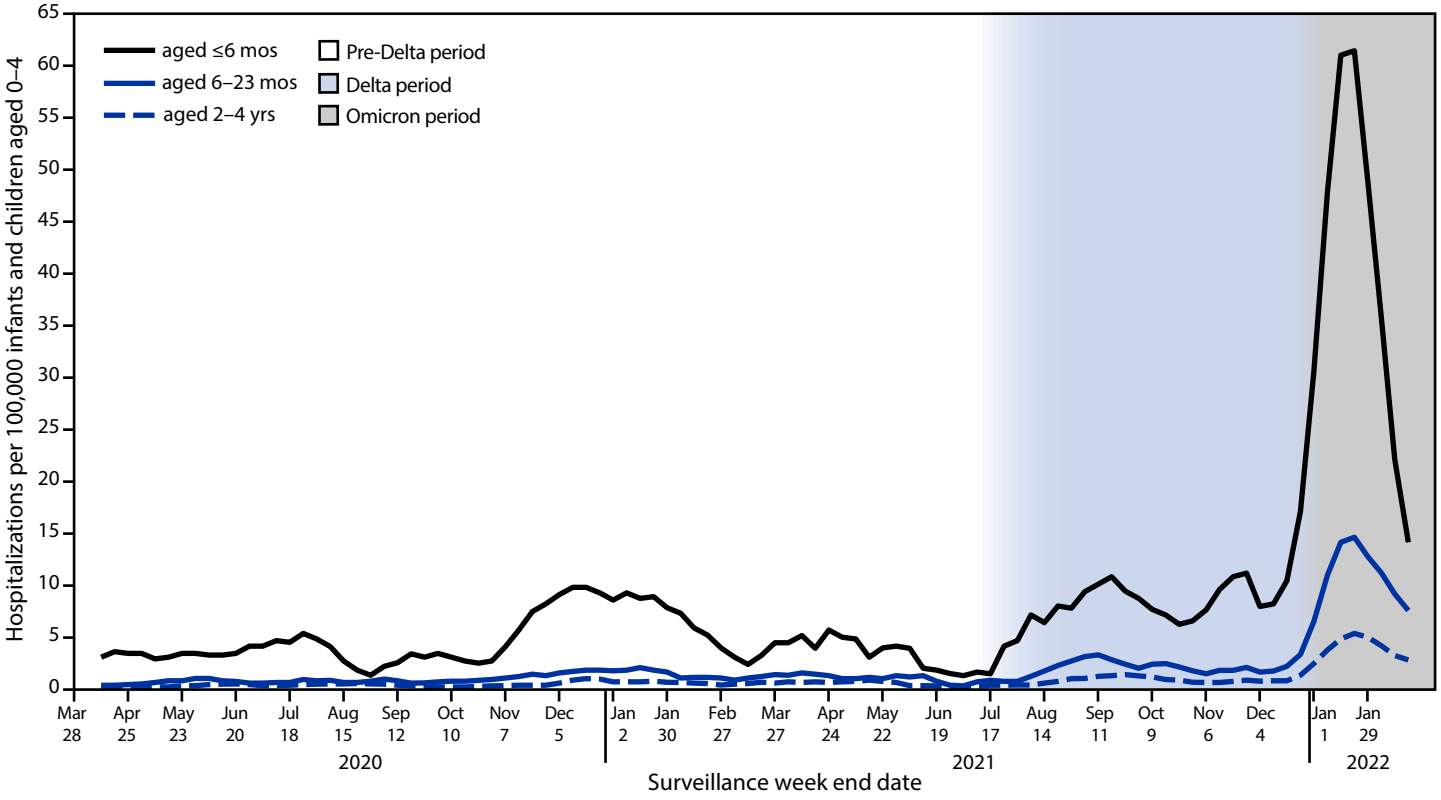
††† Testing is clinician-driven and proportions with codetections include infants and children who received a test in the denominator (as opposed to all hospitalized infants and children). Influenza includes influenza A, influenza B, and flu (not subtyped). Other viruses include adenovirus, parainfluenza 1, parainfluenza 2, parainfluenza 3, parainfluenza 4, and human metapneumovirus.

§§§ 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.

¶¶¶ Defined as one or more 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, or wheelchair dependency.

**** Forty-eight percent (581 of 1,200) of infants and children received RSV testing during pre-Delta predominance (March 1, 2020–June 26, 2021), 73% (577 of 790) during Delta predominance (June 27–December 18, 2021), and 74% (424 of 572) during Omicron predominance (December 19, 2021–January 31, 2022).

FIGURE. COVID-19–associated hospitalization rates* among infants and children aged 0–4 years, by age group (3-week moving average) — Coronavirus Disease 2019–Associated Hospitalization Surveillance Network, 14 states,† March 2020–February 2022§



Abbreviation: COVID-NET = Coronavirus Disease 2019–Associated Hospitalization Surveillance Network.

* Number of patients with laboratory-confirmed COVID-19–associated hospitalizations per 100,000 population; rates are subject to change as additional data are reported.

† 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. Starting the week ending December 4, 2021, Maryland data are removed from weekly rate calculations.

§ Periods of predominance are defined as follows: pre-Delta = March 1, 2020–June 26, 2021; Delta = June 27–December 18, 2021; Omicron = December 19, 2021–February 19, 2022.

Discussion

Weekly COVID-19–associated hospitalization rates among U.S. infants and children aged 0–4 years have declined since the peak of January 8, 2022; however, peak rates during Omicron predominance were approximately five times those of the peak during Delta predominance. Similarly, ICU admission rates during Omicron predominance peaked at approximately 3.5 times the peak rate during Delta predominance. The proportion of hospitalized infants and children with severe illness during all variant periods of predominance, coupled with the potential for longer-term sequelae including multisystem inflammatory syndrome (*6,7*), highlight the importance of preventing COVID-19 among infants and children aged 0–4 years. Strategies to prevent COVID-19 among infants and young children are important and include vaccination of currently eligible populations (*2*) such as pregnant women (*3*), family members, and caregivers of infants and young children (*4*).

The proportion of patients with codetections of RSV was higher during Delta predominance than Omicron predominance. RSV circulation was low during the first year of the pandemic (pre-Delta predominance). The pattern of RSV codetections during 2021–2022 correlated with trends in RSV circulation observed in other surveillance systems: RSV circulation increased during the summer and fall of 2021 (Delta predominance) and declined during Omicron predominance (*8*).†††† These limited data suggest that the surge in hospitalizations during Omicron predominance was not driven by coinfections. The highest proportion of hospitalized infants and children requiring ICU admission occurred during Delta predominance, and the lowest occurred during Omicron predominance. Although the proportion of hospitalized infants and children admitted to an ICU was higher during Delta predominance, the rate of pediatric ICU admissions during Omicron predominance was approximately 3.5 times as high as

†††† https://www.cdc.gov/surveillance/nrevss/rsv/natl-trend.html

TABLE 1. Demographic and clinical characteristics and outcomes among infants and children aged 0–4 years hospitalized with laboratory-confirmed COVID-19,* by variant predominance period — Coronavirus Disease 2019–Associated Hospitalization Surveillance Network, 14 states,† March 1, 2020–January 31, 2022

Characteristic	Total	Variant predominant period, no. (%) of hospitalizations			P-value§ (Omicron versus pre-Delta)	P-value§ (Omicron versus Delta)
		Pre-Delta Mar 1, 2020–Jun 26, 2021	Delta Jun 27–Dec 18, 2021	Omicron Dec 19, 2021–Jan 31, 2022		
Total no. of hospitalized infants and children	**2,562¶**	**1,200¶**	**790¶**	**572¶**	**NA**	**NA**
Age group, yrs, median (IQR)	**0.6 (0.1–1.0)**	0.6 (0.1–1.1)	0.7 (0.1–1.1)	0.6 (0.1–1.0)	0.41	0.69
<6 months	**1,137 (44.3)**	547 (45.6)	338 (42.8)	252 (43.9)	0.46	0.76
6–23 months	**772 (30.4)**	345 (28.8)	247 (31.2)	180 (32.0)		
2–4 years	**653 (25.3)**	308 (25.6)	205 (26.0)	140 (24.1)		
Sex						
Male	**1,433 (56.1)**	651 (54.4)	443 (56.3)	339 (58.2)	0.18	0.54
Female	**1,129 (43.9)**	549 (45.6)	347 (43.7)	233 (41.8)		
Race/Ethnicity**						
Hispanic	**710 (28.8)**	397 (32.9)	184 (24.2)	129 (27.5)	0.001	0.40
Black, non-Hispanic	**719 (26.7)**	347 (28.8)	219 (27.5)	153 (23.1)		
White, non-Hispanic	**767 (29.9)**	283 (23.5)	278 (34.6)	206 (34.1)		
Asian or other Pacific Islander, non-Hispanic	**154 (6.0)**	76 (6.5)	45 (5.6)	33 (5.7)		
Persons of all other races††	**65 (2.8)**	32 (2.7)	16 (2.2)	17 (3.4)		
Unknown race/ethnicity	**147 (5.8)**	65 (5.5)	48 (5.9)	34 (6.1)		
Primary reason for admission§§						
Likely COVID-19–related	**2,068 (84.7)**	874 (80.5)	709 (90.0)	485 (84.8)	0.06	0.009
COVID-19–related symptoms at admission¶¶						
Yes	**2,217 (86.6)**	1,000 (83.6)	715 (90.8)	502 (86.9)	0.13	0.04
Underlying medical conditions						
One or more underlying medical condition***	**923 (35.8)**	412 (34.6)	291 (36.8)	220 (36.6)	0.45	0.95
Prematurity†††	**294 (15.5)**	120 (13.3)	100 (17.0)	74 (17.1)	0.10	0.95
Neurologic disorders	**270 (10.3)**	134 (11.0)	76 (9.5)	60 (10.0)	0.56	0.78
Chronic lung disease, including asthma	**202 (7.7)**	93 (7.9)	74 (9.4)	35 (5.8)	0.13	0.02
Congenital heart disease	**152 (6.3)**	62 (5.2)	41 (5.2)	49 (8.6)	0.01	0.02
Immunocompromised condition	**81 (3.2)**	40 (3.3)	23 (2.9)	18 (3.2)	0.92	0.83
Chronic lung disease of prematurity/BPD	**64 (2.5)**	27 (2.3)	19 (2.5)	18 (2.6)	0.67	0.86
Abnormality of airway	**63 (2.3)**	40 (3.4)	12 (1.5)	11 (1.4)	0.01	0.91
Chronic metabolic disease	**61 (2.3)**	31 (2.5)	15 (1.8)	15 (2.5)	0.95	0.39
Viral codetection§§§						
RSV	**154 (9.5)**	9 (1.6)	115 (19.7)	30 (7.3)	<0.001	<0.001
Influenza	**11 (0.7)**	1 (0.2)	3 (0.5)	7 (1.3)	0.02	0.16
Rhinovirus/Enterovirus	**203 (17.0)**	66 (15.1)	103 (25.8)	34 (10.7)	0.10	<0.001
Other viral infection	**103 (8.8)**	30 (6.5)	45 (11.2)	28 (9.0)	0.23	0.35

See table footnotes on the next page.

that during Delta predominance, driven by the overall higher disease incidence.

Throughout the pandemic, infants aged <6 months have been hospitalized with laboratory-confirmed COVID-19 at higher rates than have infants and children aged 6 months–4 years. Infants aged <6 months were hospitalized with RSV codetections in higher proportions but required ICU admission and respiratory support in similar proportions to other age groups. Future studies are needed to understand the possible long-term consequences of COVID-19 infection among infants. Although infants aged <6 months are not currently eligible for vaccination, evidence suggests that this age group can receive protection through passive transplacental transfer of maternal antibodies acquired through vaccination (*9*). CDC recommends that women who are pregnant, breastfeeding, trying to become pregnant, or might become pregnant get vaccinated and stay up to date with COVID-19 vaccination.

The findings in this report are subject to at least four limitations. First, COVID-19–associated hospitalizations and viral coinfections might have been missed because of testing practice differences and test availability; this analysis could not account for changes in viral testing practices over time. Second, periods of variant predominance are not exclusive to a given variant; other variants might be circulating while one predominates. Third, it was not possible to account for seasonality or changes in public health policies and treatment practices over time; for example, the proportion of ICU admissions might reflect changing hospital capacity during the period of variant predominance rather than disease severity. Finally, the COVID-NET catchment areas include approximately 10% of the U.S. population; thus, these findings might not be nationally generalizable.

TABLE 1. (*Continued*) Demographic and clinical characteristics and outcomes among infants and children aged 0–4 years hospitalized with laboratory-confirmed COVID-19,* by variant predominance period — Coronavirus Disease 2019–Associated Hospitalization Surveillance Network, 14 states,† March 1, 2020–January 31, 2022

Characteristic	Variant predominant period, no. (%) of hospitalizations				P-value§ (Omicron versus pre-Delta)	P-value§ (Omicron versus Delta)
	Total	Pre-Delta Mar 1, 2020–Jun 26, 2021	Delta Jun 27–Dec 18, 2021	Omicron Dec 19, 2021–Jan 31, 2022		
Hospitalization outcome¶¶¶						
Length of hospital stay, days, median (IQR)	**1.5 (1–3.0)**	1.5 (1–3.5)	2 (1–3.5)	1.5 (0.5–2.5)	0.001	0.002
ICU admission	**624 (23.9)**	290 (24.0)	210 (26.7)	124 (21.0)	0.19	0.02
BiPAP/CPAP	**172 (6.5)**	69 (5.9)	72 (9.1)	31 (5.1)	0.53	0.008
High flow nasal cannula	**341(13.3)**	98 (8.3)	159 (20.4)	84 (13.4)	0.002	0.002
Invasive mechanical ventilation	**146 (5.7)**	77 (6.4)	40 (5.2)	29 (5.2)	0.39	0.96
In-hospital death	**16 (0.6)**	10 (0.8)	4 (0.5)	2 (0.5)	0.51	0.99

Abbreviations: BiPAP/CPAP = bilevel positive airway pressure/continuous positive airway pressure; BPD = bronchopulmonary dysplasia; COVID-NET = Coronavirus Disease 2019–Associated Hospitalization Surveillance Network; ICU = intensive care unit; NA = not applicable; RSV = respiratory syncytial virus.

* Data are from a weighted sample of hospitalized infants and children with completed medical record abstractions. Sample sizes presented are unweighted with weighted percentages.

† Includes persons admitted to a hospital with an admission date during March 1, 2020–January 31, 2022. Maryland contributed data through November 26, 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).

§ Proportions between the Omicron and Delta and Omicron and pre-Delta predominance periods were compared using chi-square tests, and medians were compared using Wilcoxon rank-sum tests; p-values <0.05 were considered statistically significant.

¶ Data are missing for <6% of observations for all variables, except for viral codetections.

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

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

§§ Primary reason for admission was collected beginning June 1, 2020; hospitalizations before June 1, 2020, are excluded. Among sampled patients, COVID-NET collects data on the primary reason for admission to differentiate hospitalizations of patients with laboratory-confirmed SARS-CoV-2 infection who are likely admitted primarily for COVID-19 illness versus other reasons. During chart review, if the surveillance officer finds that the chief complaint or history of present illness mentions fever/respiratory illness, COVID-19–like illness, or a suspicion for COVID-19, then the case is categorized as COVID-19–related illness as the primary reason for admission. Reasons for admission that are likely primarily not COVID-19–related include categories such as inpatient surgery or trauma. Infants diagnosed with COVID-19 during their birth hospitalization were not categorized as likely COVID-19–related unless they exhibited COVID-19–related symptoms.

¶¶ 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, and 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, and seizures, and among those aged <2 years: apnea, cyanosis, decreased vocalization/stridor, dehydration, hypothermia, inability to eat/poor feeding, and lethargy). Symptoms are abstracted from the medical chart and might be incomplete.

*** Defined as one or more 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, or wheelchair dependency.

††† Prematurity as an underlying medical condition is only reported for infants and children aged <2 years.

§§§ Results reported among infants and children who had testing performed (as opposed to all hospitalized infants and children). Because of testing practices, denominators differed among the viral respiratory pathogens: 1,582 infants and children were tested for RSV, 1,644 for influenza (influenza A, influenza B, flu [not subtyped]), 1,109 for rhino/enterovirus, and 1,120 for other viruses (adenovirus, parainfluenza 1, parainfluenza 2, parainfluenza 3, parainfluenza 4, human metapneumovirus).

¶¶¶ Hospitalization outcomes are not mutually exclusive; patients could be included in more than one category.

Coinciding with Omicron predominance, COVID-19–associated hospitalization rates among infants and children aged 0–4 years reached the current highest level of the pandemic during early January 2022. All persons who are eligible for vaccination (*2*), including pregnant women (*3*), should receive and stay up to date with COVID-19 vaccination to reduce the risk for severe disease for themselves and others with whom they come into contact (*10*), including infants and children aged 0–4 years who are currently not eligible for vaccination (*4*).

Acknowledgments

Joelle Nadle, Monica Napoles, Sherry Quach, Gretchen Rothrock, California Emerging Infections Program, Oakland, California; Nisha Alden, Isaac Armistead, Madelyn Lensing, Sarah McLafferty, Millen Tsegaye, Colorado Department of Public Health and Environment; Ann Basting, Tessa Carter, Maria Correa, Daewi Kim, Amber Maslar, Julie Plano, Kimberly Yousey-Hindes, Connecticut Emerging Infections Program, Yale School of Public Health, New Haven, Connecticut; Marina Bruck, Rayna Ceaser, Taylor Eisenstein, Emily Fawcett, Sabrina Hendrick, Johanna Hernandez, Asmith

TABLE 2. Clinical characteristics and outcomes among infants and children aged 0–4 years hospitalized with laboratory-confirmed COVID-19 (N = 572),* by age group, during Omicron predominance — COVID-NET, 14 states,† December 19, 2021–January 31, 2022

Characteristic	No. (%) of hospitalizations, by age group				P-value§
	Total	<6 mos	6–23 mos	2–4 yrs	
Total no. of hospitalized infants and children	**572 (100)¶**	**252 (44)¶**	**180 (32)¶**	**140 (24)¶**	**NA**
Primary reason for admission**					
Likely COVID-19–related	**485 (84.8)**	210 (83.3)	159 (89.2)	116 (81.8)	0.23
COVID-19–related symptoms at admission††					
Yes	**502 (86.9)**	211 (82.0)§§	163 (91.9)	128 (89.2)	0.04
Symptoms at admission					
Fever/Chills	**340 (60.3)**	128 (51.0)	123 (70.8)	89 (63.2)	0.001
Cough	**317 (55.6)**	119 (45.6)	120 (70.8)	78 (53.7)	<0.001
Congested/Runny nose	**290 (52.1)**	135 (51.3)	98 (61.1)	57 (41.6)	0.01
Shortness of breath/Respiratory distress	**201 (34.7)**	85 (31.0)	74 (43.8)	42 (29.3)	0.02
Inability to eat/Poor feeding	**139 (29.2)**	75 (26.6)	64 (32.6)	—¶¶	0.21
Nausea/Vomiting	**148 (26.6)**	40 (18.1)	59 (31.8)	49 (35.4)	0.003
Fatigue	**83 (13.4)**	21 (6.6)	25 (13.7)	37 (25.2)	<0.001
Decreased vocalization/Stridor	**49 (11.6)**	15 (5.8)	34 (19.7)	—¶¶	<0.001
Seizures	**27 (3.9)**	4 (1.5)	9 (5.0)	14 (6.9)	0.02
Underlying medical condition					
One or more underlying medical condition***	**220 (36.6)**	66 (26.3)	80 (40.3)	74 (50.4)	<0.001
Prematurity	**74 (17.1)**	39 (16.7)	35 (17.7)	—¶¶	0.83
Neurologic disorders	**60 (10.0)**	10 (3.6)	17 (8.9)	33 (23.0)	<0.001
Congenital heart disease	**49 (8.6)**	18 (7.1)	19 (9.2)	12 (10.5)	0.62
Chronic lung disease, including asthma	**35 (5.8)**	5 (2.5)	12 (5.3)	18 (12.6)	<0.001
Immunocompromised condition	**18 (3.2)**	1 (0.5)	5 (1.9)	12 (9.7)	<0.001
Chronic lung disease of prematurity/BPD	**18 (2.6)**	4 (1.8)	7 (2.6)	7 (4.3)	0.32
Chronic metabolic disease	**15 (2.5)**	2 (0.7)	5 (2.8)	8 (5.3)	0.02
Abnormality of airway	**11 (1.4)**	4 (1.2)	5 (1.8)	2 (1.3)	0.85
Viral codetection†††					
RSV	**30 (7.3)**	22 (12.7)	6 (4.3)	2 (2.0)	0.003
Influenza	**7 (1.3)**	4 (1.3)	1 (0.8)	2 (2.1)	0.62
Rhinovirus/Enterovirus	**34 (10.7)**	13 (10.6)	10 (8.4)	11 (13.5)	0.59
Other viral infections	**28 (9.0)**	4 (3.2)	14 (13.4)	10 (12.2)	0.03

See table footnotes on the next page.

Summary

What is already known about this topic?

COVID-19 can cause severe illness in infants and children, including those aged 0–4 years who are not yet eligible for COVID-19 vaccination.

What is added by this report?

During Omicron variant predominance beginning in late December 2021, U.S. infants and children aged 0–4 years were hospitalized at approximately five times the rate of the previous peak during Delta variant predominance. Infants aged <6 months had the highest rates of hospitalization, but indicators of severity (e.g., respiratory support) did not differ by age group.

What are the implications for public health practice?

Important strategies to prevent COVID-19 among infants and young children include vaccination of currently eligible populations such as pregnant women, family members, and caregivers of infants and young children.

Joseph, Grayson Kallas, Stephanie Lehman, Jana Manning, Annabel Patterson, Allison Roebling, Suzanne Segler, Chandler Surell, Katelyn Ward, Hope Wilson, School of Medicine, Emory University, Georgia Emerging Infections Program, Georgia Department of Public Health, Veterans Affairs Medical Center, Foundation for Atlanta Veterans Education and Research, Atlanta, Georgia; Chloe Brown, Jim Collins, Justin Henderson, Shannon Johnson, Sierra Peguies-Khan, Alexander Kohrman, Lauren Leegwater, Val Tellez Nunez, Libby Reeg, Michigan Department of Health and Human Services; Alison Babb, Richard Danila, Kristen Ehresmann, Jake Garfin, Jennifer Gilbertson, Grace Hernandez, Melissa McMahon, Kieu My Phi, Jill Reaney, Sara Vetter, Xiong Wang, Minnesota Department of Health; Melissa Judson, Sunshine Martinez, Mark Montoya, Florent Nkouaga, Jasmyn Sanchez, Chad Smelser, Daniel Sosin, New Mexico Department of Health; Kathy M. Angeles, Molly Bleecker, Sarah Shrum Davis, Nancy Eisenberg, Emily B. Hancock, Sarah A. Khanlian, Sarah Lathrop, Wickliffe Omondi, Mayvilynne Poblete, Francesca Pacheco, Dominic Rudin, Yadira Salazar-Sanchez, New Mexico Emerging Infections Program; Jennifer Akpo, Celina Chavez, Murtada Khalifa, Alesia Reed, Yassir Talha, CDC Foundation, Atlanta, Georgia; New Mexico Department of Health; Grant Barney, Kerianne Engesser, Suzanne McGuire, Adam Rowe, New York State Department of Health; Sophrena Bushey, Christina Felsen, Maria Gaitan, Christine Long, Thomas Peer, Kevin Popham, University of Rochester School of Medicine and Dentistry, Rochester, New York; Julie Freshwater, Denise Ingabire-Smith, Ann Salvator,

TABLE 2. (*Continued*) Clinical characteristics and outcomes among infants and children aged 0–4 years hospitalized with laboratory-confirmed COVID-19 (N = 572),* by age group, during Omicron predominance — COVID-NET, 14 states,† December 19, 2021–January 31, 2022

Characteristic	No. (%) of hospitalizations, by age group				P-value§
	Total	<6 mos	6–23 mos	2–4 yrs	
Hospitalization outcome§§§					
Length of hospital stay, days, median (IQR)	**1.5 (0.5–2.5)**	1.5 (1–2.5)	1.5 (0.5–3)	1.5 (0.5–3)	0.70
ICU admission	**124 (21.0)**	57 (21.6)	39 (21.9)	28 (18.9)	0.81
BiPAP/CPAP	**31 (5.1)**	12 (4.5)	12 (6.1)	7 (4.8)	0.76
High flow nasal cannula	**84 (13.4)**	43 (14.1)	28 (16.1)	13 (8.7)	0.20
Invasive mechanical ventilation	**29 (5.2)**	10 (4.6)	11 (5.9)	8 (5.6)	0.84
In-hospital death	**2 (0.5)**	2 (1.1)	0 (—)	0 (—)	0.70

Abbreviations: BiPAP/CPAP = bilevel positive airway pressure/continuous positive airway pressure; BPD = bronchopulmonary dysplasia; COVID-NET = Coronavirus Disease 2019–Associated Hospitalization Surveillance Network; ICU = intensive care unit; NA = not applicable; RSV = Respiratory syncytial virus.

* Data are from a weighted sample of hospitalized infants and children with completed medical record abstractions. Sample sizes presented are unweighted with weighted percentages.

† Includes persons admitted to a hospital with an admission date during December 19, 2021–January 31, 2022. Counties included in COVID-NET surveillance during this period: 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); 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).

§ Proportions of infants and children aged <6 months, 6–23 months, and 2–4 years were compared using chi-square tests, and medians were compared using the Wilcoxon rank-sum test; p-values <0.05 were considered statistically significant.

¶ Data are missing for <6% of observations for all variables, except for viral codetections.

** Among sampled patients, COVID-NET collects data on the primary reason for admission to differentiate hospitalizations of patients with laboratory-confirmed SARS-CoV-2 infection who are likely admitted primarily for COVID-19 illness versus other reasons. During chart review, if the surveillance officer found that the chief complaint or history of present illness mentions fever/respiratory illness, COVID-19–like illness, or a suspicion for COVID-19, then the case was categorized as COVID-19–related illness as the primary reason for admission. Reasons for admission that are likely primarily not COVID-19–related include categories such as inpatient surgery or trauma. Infants with COVID-19 diagnosed during their birth hospitalization were not categorized as likely COVID-19–related unless they exhibited COVID-19–related symptoms.

†† 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, and 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, and seizures, and among those aged <2 years: apnea, cyanosis, decreased vocalization/stridor, dehydration, hypothermia, inability to eat/poor feeding, and lethargy). Symptoms are abstracted from the medical chart and might be incomplete.

§§ Among the 250 hospitalizations among infants aged <6 months with complete data on birth hospitalization, 14% (31 of 250) were birth hospitalizations. Of these birth hospitalizations, 91% (28 of 31) had no symptoms recorded. If birth hospitalizations are excluded, 94% (208 of 219) infants aged <6 months had symptoms recorded.

¶¶ Cyanosis, decreased vocalization/stridor, inability to eat/poor feeding, and lethargy are symptoms that are only recorded for infants and children aged <2 years. Prematurity is an underlying medical condition only reported for infants and children aged <2 years.

*** Defined as one or more 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, or wheelchair dependency.

††† Results reported among infants and children who had testing performed (as opposed to all hospitalized infants and children). Because of differing testing practices, denominators differed among the viral respiratory pathogens: 424 infants and children were tested for RSV, 440 for influenza (influenza A, influenza B, flu [not subtyped]), 260 for rhino/enterovirus, and 261 for other viruses (adenovirus, parainfluenza 1, parainfluenza 2, parainfluenza 3, parainfluenza 4, and human metapneumovirus).

§§§ Hospitalization outcomes are not mutually exclusive; patients could be included in more than one category.

Rebekah Sutter, Ohio Department of Health; Sam Hawkins, Public Health Division, Oregon Health Authority; Kathy Billings, Katie Dyer, Anise Elie, Gail Hughett, Karen Leib, Tiffanie Markus, Terri McMinn, Danielle Ndi, Manideepthi Pemmaraju, Emmanuel Sackey, Vanderbilt University Medical Center, Nashville, Tennessee; Ian Buchta, Amanda Carter, Ryan Chatelain, Melanie Crossland, Andrea George, Andrew Haraghey, Mary Hill, Laine McCullough, Jake Ortega, Tyler Riedesel, Caitlin Shaw, Ashley Swain, Salt Lake County Health Department, Salt Lake City, Utah; Rainy Henry, Sonja Mali Nti-Berko, Robert W. Pinner, Alvin Shultz, CDC; Epidemiology Task Force, CDC COVID-19 Emergency Response Team; Elizabeth Daly, Council of State and Territorial Epidemiologists.

COVID-NET Surveillance Team

Jeremy Roland, California Emerging Infections Program; Jordan Surgnier, Colorado Department of Public Health and Environment; Carol Lyons, Connecticut Emerging Infections Program, Yale School of Public Health; Kyle Openo, Georgia Emerging Infections Program, Georgia Department of Health, Division of Infectious Diseases, Emory University School of Medicine; Kenzie Teno, Iowa Department of Health; Alexander Kohrman, Michigan Department of Health and Human Services; Erica Bye, Minnesota Department of Health; Cory Cline, New Mexico Department of Health; Alison Muse, New York State Department of Health; Virginia Cafferky, University of Rochester School of Medicine and Dentistry; Laurie Billing, Ohio Department

of Health; Nasreen Abdullah, Public Health Division, Oregon Health Authority; William Schaffner, Vanderbilt University Medical Center; Keegan McCaffrey, Utah Department of Health.

Corresponding author: Kristin J. Marks, KJMarks@cdc.gov.

[1]CDC COVID-19 Emergency Response Team; [2]Epidemic Intelligence Service, CDC; [3]General Dynamics Information Technology, Atlanta, Georgia; [4]California Emerging Infections Program, Oakland, California; [5]Colorado Department of Public Health and Environment; [6]Connecticut Emerging Infections Program, Yale School of Public Health, New Haven, Connecticut; [7]Emory University School of Medicine, Atlanta, Georgia; [8]Georgia Emerging Infections Program, Georgia Department of Public Health; [9]Atlanta Veterans Affairs Medical Center, Atlanta, Georgia; [10]Iowa Department of Public Health; [11]Michigan Department of Health and Human Services; [12]Minnesota Department of Health; [13]New Mexico Department of Health; [14]New York State Department of Health; [15]University of Rochester School of Medicine and Dentistry, Rochester, New York; [16]Ohio Department of Health; [17]Public Health Division, Oregon Health Authority; [18]Vanderbilt University Medical Center, Nashville, Tennessee; [19]Salt Lake County Health Department, Salt Lake City, Utah.

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. Evan J. Anderson reports grants from Pfizer, Merck, PaxVax, Micron, Sanofi-Pasteur, Janssen, MedImmune, and GlaxoSmithKline; personal fees from Pfizer, Medscape, Kentucky Bioprocessing, Inc., Sanofi-Pasteur, and Janssen, outside the submitted work; and institutional funding from the National Institutes of Health to conduct clinical trials of Moderna and Janssen COVID-19 vaccines. Eli Shiltz, Andy Weigel, Sue Kim, and Andrea Price report grants from the Council of State and Territorial Epidemiologists during the conduct of the study. Sue Kim reports grants from the Michigan Department of Health and Human Services during the conduct of the study. Ruth Lynfield reports editorial payments from the American Academy of Pediatrics Red Book (Committee on Infectious Diseases), which were donated to the Minnesota Department of Health. No other potential conflicts of interest were disclosed.

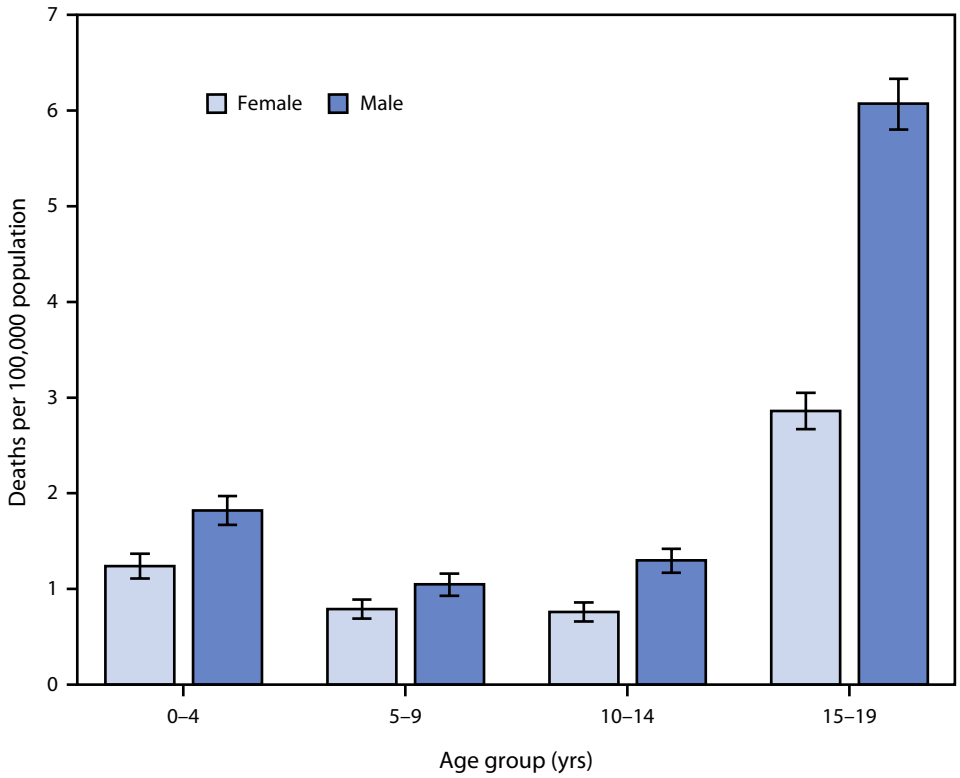
References

1. Marks KJ, Whitaker M, Anglin O, et al.; COVID-NET Surveillance Team. Hospitalizations of children and adolescents with laboratory-confirmed COVID-19—COVID-NET, 14 states, July 2021–January 2022. MMWR Morb Mortal Wkly Rep 2022;71:271–8. PMID:35176003 https://doi.org/10.15585/mmwr.mm7107e4
2. CDC. Stay up to date with your COVID-19 vaccines. Atlanta, GA: US Department of Health and Human Services, CDC; 2022. https://www.cdc.gov/coronavirus/2019-ncov/vaccines/stay-up-to-date.html
3. CDC. COVID-19 vaccines while pregnant or breastfeeding. Atlanta, GA: US Department of Health and Human Services, CDC; 2022. https://www.cdc.gov/coronavirus/2019-ncov/vaccines/recommendations/pregnancy.html
4. CDC. 10 things to know about the COVID-19 vaccine for children. Atlanta, GA: US Department of Health and Human Services, CDC; 2021. https://www.cdc.gov/vaccines/covid-19/planning/children/10-things-to-know.html
5. Woodruff RC, Campbell AP, Taylor CA, et al. Risk factors for severe COVID-19 in children. Pediatrics 2021;e2021053418. PMID:34935038 https://doi.org/10.1542/peds.2021-053418
6. Feldstein LR, Rose EB, Horwitz SM, et al.; Overcoming COVID-19 Investigators; CDC COVID-19 Response Team. Multisystem inflammatory syndrome in U.S. children and adolescents. N Engl J Med 2020;383:334–46. PMID:32598831 https://doi.org/10.1056/NEJMoa2021680
7. Barrett CE, Koyama AK, Alvarez P, et al. Risk for newly diagnosed diabetes >30 days after SARS-CoV-2 infection among persons aged <18 years—United States, March 1, 2020–June 28, 2021. MMWR Morb Mortal Wkly Rep 2022;71:59–65. PMID:35025851 https://doi.org/10.15585/mmwr.mm7102e2
8. Olsen SJ, Winn AK, Budd AP, et al. Changes in influenza and other respiratory virus activity during the COVID-19 pandemic—United States, 2020–2021. MMWR Morb Mortal Wkly Rep 2021;70:1013–9. PMID:34292924 https://doi.org/10.15585/mmwr.mm7029a1
9. Halasa NB, Olson SM, Staat MA, et al.; Overcoming COVID-19 Investigators; Overcoming COVID-19 Network. Effectiveness of maternal vaccination with mRNA COVID-19 vaccine during pregnancy against COVID-19–associated hospitalization in infants aged <6 months—17 states, July 2021–January 2022. MMWR Morb Mortal Wkly Rep 2022;71:264–70. PMID:35176002 https://doi.org/10.15585/mmwr.mm7107e3
10. Harris RJ, Hall JA, Zaidi A, Andrews NJ, Dunbar JK, Dabrera G. Effect of vaccination on household transmission of SARS-CoV-2 in England. N Engl J Med 2021;385:759–60. PMID:34161702 https://doi.org/10.1056/NEJMc2107717

QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Rate* of Unintentional Traumatic Brain Injury–Related Deaths† Among Persons Aged ≤19 Years, by Age Group and Sex — National Vital Statistics System, United States, 2018–2020



* Deaths per 100,000 population in each age group reported as the average annual rate for 2018–2020, with 95% CIs indicated by error bars.

† Based on *International Classification of Diseases, Tenth Revision* underlying cause-of-death codes V01–X59 or Y85–Y86, and one or more of the following multiple cause-of-death codes: S01.0–S01.9 (open wound of head); S02.0, S02.1, S02.3, and S02.7–S02.9 (fracture of the skull and facial bones); S04.0 (injury to optic nerve and pathways); S06.0–S06.9 (intracranial injury); S07.0, S07.1, S07.8, and S07.9 (crushing injury of head); S09.7–S09.9 (other unspecified injuries of head); T01.0 (open wounds involving head with neck); T02.0 (fractures involving head with neck); T04.0 (crushing injuries involving head with neck); T06.0 (injuries of brain and cranial nerves with injuries of nerves and spinal cord at neck level); and T90.1, T90.2, T90.4, T90.5, T90.8, and T90.9 (sequelae of injuries of head).

During 2018–2020, death rates for unintentional traumatic brain injury among persons aged ≤19 years were higher for males than for females in each age group. Rates were highest for males (6.1 per 100,000) and females (2.9) among persons aged 15–19 years. Rates were lowest for males and females aged 5–9 years (1.1 and 0.8, respectively) and for males and females aged 10–14 years (1.3 and 0.8, respectively).

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

Reported by: Merianne Rose Spencer, MPH, MSpencer@cdc.gov, 301-458-4377; Matthew F. Garnett, MPH; Holly Hedegaard, MD.

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

The *Morbidity and Mortality Weekly Report (MMWR)* Series is prepared by the Centers for Disease Control and Prevention (CDC) and is available free of charge in electronic format. To receive an electronic copy each week, visit *MMWR* at https://www.cdc.gov/mmwr/index.html.

Readers who have difficulty accessing this PDF file may access the HTML file at https://www.cdc.gov/mmwr/index2022.html. Address all inquiries about the *MMWR* Series to Editor-in-Chief, *MMWR* Series, Mailstop V25-5, CDC, 1600 Clifton Rd., N.E., Atlanta, GA 30329-4027 or to mmwrq@cdc.gov.

ISSN: 0149-2195 (Print)