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Prevalence and Characteristics of Arthritis Among Caregivers — 17 States, 2017 and 2019

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Caregiving provides numerous benefits to both caregivers and care recipients; however, it can also negatively affect caregivers' mental and physical health (*1–4*), and caregiving tasks often require physical exertion (*1*). Approximately 44% of adults with arthritis report limitations attributable to arthritis, including trouble doing daily activities (*5*). These limitations might affect caregivers' ability to provide care, but little is known about arthritis among caregivers. To assess arthritis among caregivers of a family member or friend, CDC examined data from 17 states that administered both the arthritis and caregiving modules as part of the Behavioral Risk Factor Surveillance System (BRFSS) in either 2017 or 2019. Approximately one in five adults (20.6%) was a caregiver. Prevalence of arthritis was higher among caregivers (35.1%) than noncaregivers (24.5%). Compared with caregivers without arthritis, those with arthritis provided similar types of care and were more likely to have provided care for ≥5 years and for ≥40 hours per week. In addition, higher proportions of caregivers with arthritis reported disabilities compared with those without arthritis, including mobility issues (38.0% versus 7.3%). Arthritis among caregivers might affect their own health as well as the care they can provide. Caregivers can discuss their arthritis and related limitations with a health care professional to identify ways to increase their physical activity and participation in lifestyle management programs.* Such interventions might ease arthritis pain and related limitations and might support them in their ongoing caregiving role. Public health professionals can implement strategies to support caregivers throughout the caregiving process.†

BRFSS is a cross-sectional, random-digit–dialed, annual telephone survey of noninstitutionalized U.S. adults aged ≥18 years. BRFSS is conducted by state and territorial health departments, and data are weighted to make estimates representative of each state. BRFSS data were analyzed among 17 states§ using the most recent year (2017 or 2019) in which respondents were asked both the caregiving and arthritis module questions (including arthritis-related limitation questions) in the same year. Combined (landline and mobile) median response rates for states used in the analysis were 47.3% (2017) and 45.7% (2019).¶

* https://www.cdc.gov/arthritis/healthcare/index.html
† https://www.cdc.gov/aging/healthybrain/issue-maps/supporting-caregivers.html

§ The following states implemented the arthritis and caregiving modules in the same survey year during 2017 or 2019 (most recent year used): Alaska (2017), Hawaii (2019), Kansas (2017), Maine (2019), Maryland (2019), Michigan (2017), New Jersey (2017), New Mexico (2017), New York (2019), Ohio (2019), Oklahoma (2017), Oregon (2019), Rhode Island (2017), Tennessee (2019), Texas (2019), Utah (2019), and Virginia (2019).

¶ https://www.cdc.gov/brfss/annual_data/2017/pdf/2017-response-rates-table-508.pdf; https://www.cdc.gov/brfss/annual_data/2019/pdf/2019-response-rates-table-508.pdf

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Respondents were classified as caregivers of a family member or friend if they responded "yes" when asked whether they provided care to a family member or friend with a health condition or disability during the past 30 days. Respondents were classified as having arthritis if they responded "yes" when asked if they had ever been told by a doctor or other health professional that they have some form of arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia. Data were collected from 106,316 respondents; 15,195 (14.3%) respondents who refused to respond, who responded "don't know/not sure," or were missing responses on either the caregiving or arthritis question were excluded from the analysis. The final sample size included 91,121 respondents.

Prevalence of arthritis was compared between caregivers and noncaregivers overall and by selected demographic subgroups and individual states. Bivariate analyses were conducted among caregivers with and without arthritis to assess distributions of characteristics related to caregiving (length of care,** weekly hours of care,†† and type of care provided[§§]), having a primary care provider, and status of disability types that might be related to arthritis (mobility, self-care, and independent living disabilities).[¶¶] Among caregivers with arthritis, prevalence of arthritis-attributable activity and work limitations*** was determined. Distribution of employment status††† was determined among caregivers providing ≥40 hours of caregiving per week by arthritis status to examine employment status among those who provide care full-time. Analyses were conducted using SUDAAN (version 11.0; RTI International) to account for the complex survey design and weighting. Statistical significance was determined at $\alpha = 0.05$. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[§§§]

** Determined based on the response to the question, "For how long have you provided care for that person? Would you say: less than 30 days, 1 month to less than 6 months, 6 months to less than 2 years, 2 years to less than 5 years, or more than 5 years?"

†† Determined based on the response to the question, "In an average week, how many hours do you provide care or assistance? Would you say: up to 8 hours per week, 9 to 19 hours per week, 20 to 39 hours per week, or 40 hours or more?"

§§ Determined based on the response to two questions regarding personal and household tasks. Personal care was defined as responding "yes" to the question, "In the past 30 days, did you provide care for this person by managing personal care such as giving medications, feeding, dressing, or bathing?" Household care was defined as responding "yes" to the question, "In the past 30 days, did you provide care for this person by managing household tasks such as cleaning, managing money, or preparing meals?"

¶¶ https://www.cdc.gov/brfss/data_documentation/pdf/BRFSS_Data_Users_Guide_on_Disability_Questions_2018-508.pdf

*** Arthritis-attributable activity limitations was defined as responding "yes" to the question, "Are you now limited in any way in any of your usual activities because of arthritis or joint symptoms?" This question was only asked among respondents with arthritis. Arthritis-attributable work limitations was defined as responding "yes" to the question, "Do arthritis or joint symptoms now affect whether you work, the type of work you do or the amount of work you do?" This question was only asked of respondents with arthritis.

††† Determined based on the response to the question, "Are you currently employed for wages, self-employed, out of work for 1 year or more, out of work for less than 1 year, a homemaker, a student, retired, or unable to work?"

§§§ 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.

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In 17 states during 2017 and 2019, one in five adults (20.6%; 95% CI = 20.1%–21.2%) was a caregiver, and more than one in three (35.1%) caregivers had arthritis (Table 1). Prevalence of arthritis was greater among caregivers than among noncaregivers overall (35.1% versus 24.5%), in each state, and across all demographic subgroups by age group, sex, education status, body mass index category, and inactivity status. Prevalence of arthritis was higher among caregivers than among noncaregivers for most employment statuses, races, and ethnicities.

Compared with caregivers without arthritis, those with arthritis provided similar types of personal and household care and were more likely to have provided care for ≥5 years (35.1% versus 28.7%) and for ≥40 hours per week (20.9% versus 17.5%) (Table 2). Among adults with arthritis, 49.1%

TABLE 1. Prevalence of arthritis* among caregivers† and noncaregivers aged ≥18 years, by selected characteristics and state — Behavioral Risk Factor Surveillance System, 17 states,§ 2017 and 2019

Characteristic	Caregivers		Noncaregivers		p-value††
	Unweighted no.¶	Prevalence of arthritis,** % (95% CI)	Unweighted no.¶	Prevalence of arthritis,** % (95% CI)	
Overall	**19,910**	**35.1 (33.8–36.5)**	**71,211**	**24.5 (23.9–29.1)**	**<0.001**
Age group, yrs					
18–44	4,207	17.3 (15.2–19.6)	19,453	7.8 (7.2–8.5)	<0.001
45–64	8,215	39.1 (37.1–41.2)	24,202	31.5 (30.3–32.7)	<0.001
≥65	7,240	55.4 (53.2–57.6)	26,685	49.5 (48.2–50.7)	<0.001
Sex					
Men	7,419	30.6 (28.6–32.7)	32,967	20.9 (20.0–21.7)	<0.001
Women	12,488	38.4 (36.7–40.1)	38,230	28.1 (27.3–29.1)	<0.001
Race and ethnicity					
American Indian or Alaska Native, non-Hispanic	462	34.8 (23.7–47.8)	1,363	26.2 (21.4–31.5)	0.20
Asian, non-Hispanic	495	24.1 (15.5–35.5)	2,692	10.0 (7.5–13.1)	<0.001
Black or African American, non-Hispanic	1,315	29.5 (25.3–34.2)	4,460	26.2 (24.1–28.4)	0.19
White, non-Hispanic	14,802	38.7 (37.2–40.2)	51,328	27.9 (27.2–28.6)	<0.001
Hispanic	1,463	22.1 (18.5–26.2)	6,851	14.8 (13.3–16.4)	<0.001
Other, non-Hispanic§§	789	35.2 (28.7–42.4)	2,450	26.2 (22.7–30.2	0.02
Education level					
High school graduate or less	5,874	37.2 (34.8–39.7)	23,904	26.8 (25.7–27.9)	<0.001
Some college or more	14,002	33.9 (32.4–35.5)	47,050	23.0 (22.3–23.7)	<0.001
Employment status					
Employed or self-employed	9,574	25.9 (24.2–27.6)	35,168	15.5 (14.8–16.2)	<0.001
Unemployed	930	26.9 (21.9–32.6)	2,762	22.3 (19.5–25.3)	0.134
Unable to work	1,491	66.4 (61.2–71.2)	5,153	58.2 (55.3–60.9)	0.005
Retired	6,348	53.5 (51.1–55.9)	22,313	48.3 (47.0–49.7)	<0.001
Homemaker or student	1,435	26.0 (22.4–30.1)	5,320	11.7 (10.5–13.1)	<0.001
Body mass index category¶¶					
Underweight or normal	5,704	27.8 (25.5–30.1)	22,003	17.6 (16.6–18.5)	<0.001
Overweight	6,496	35.0 (32.7–37.4)	23,871	24.3 (23.3–25.5)	<0.001
Obese	6,619	42.4 (40.1–44.8)	20,976	33.4 (32.2–34.7)	<0.001
Physical inactivity* **	4,876	42.2 (39.4–45.1)	20,268	31.5 (30.2–32.8)	<0.001
State					
Alaska	554	33.2 (27.4–39.5)	2,244	22.3 (19.8–25.1)	0.001
Hawaii	1,333	26.0 (23.1–29.0)	5,528	20.4 (19.1–21.8)	<0.001
Kansas	1,874	35.9 (33.3–38.7)	7,198	23.4 (22.3–24.6)	<0.001
Maine	1,056	37.1 (32.9–41.6)	4,169	30.2 (28.2–32.3)	0.005
Maryland	1,213	31.3 (27.8–35.1)	3,787	23.3 (21.6–25.1)	<0.001
Michigan	676	38.6 (34.1–43.3)	2,551	29.0 (26.9–31.1)	<0.001
New Jersey	1,051	31.6 (27.5–35.9)	3,994	23.4 (21.5–25.5)	<0.001
New Mexico	1,232	30.0 (28.6–33.7)	4,404	25.4 (23.7–27.1)	0.02
New York	816	30.9 (26.9–35.3)	2,998	21.9 (20.1–23.9)	<0.001
Ohio	801	44.3 (39.0–49.7)	2,780	28.5 (26.1–30.9)	<0.001
Oklahoma	654	35.4 (31.0–40.1)	2,153	25.5 (23.3–27.8)	<0.001
Oregon	1,082	36.0 (32.6–39.5)	4,170	25.5 (24.0–27.1)	<0.001
Rhode Island	1,090	33.5 (29.9–37.3)	3,801	26.9 (25.1–28.8)	0.002
Tennessee	1,271	39.0 (35.4–42.7)	3,650	30.6 (28.7–32.6)	<0.001
Texas	2,247	33.2 (29.6–36.9)	7,228	21.1 (19.5–22.8)	<0.001
Utah	1,155	33.3 (30.1–36.6)	4,128	20.4 (19.1–21.8)	<0.001
Virginia	1,805	36.7 (33.8–39.7)	6,428	26.2 (24.8–27.6)	<0.001

See table footnotes on the next page.

TABLE 1. (*Continued*) Prevalence of arthritis* among caregivers† and noncaregivers aged ≥18 years, by selected characteristics and state — Behavioral Risk Factor Surveillance System, 17 states,§ 2017 and 2019

Abbreviation: BMI = body mass index.

* Having arthritis was defined as having ever been told by a doctor or other health care professional that the respondent had arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia.

† Caregiving was defined as providing care to a family member or friend with a health condition or disability during the past 30 days.

§ The following states implemented the arthritis and caregiving modules in the same survey year during 2017 or 2019 (most recent year used): Alaska (2017), Hawaii (2019), Kansas (2017), Maine (2019), Maryland (2019), Michigan (2017), New Jersey (2017), New Mexico (2017), New York (2019), Ohio (2019), Oklahoma (2017), Oregon (2019), Rhode Island (2017), Tennessee (2019), Texas (2019), Utah (2019), and Virginia (2019).

¶ Categories might not sum to the sample total because of missing responses.

** Estimates were weighted to each state's adult population.

†† T-tests were used to determine statistically significant differences in arthritis prevalence between caregivers and noncaregivers for each subgroup of selected characteristics.

§§ Includes respondents who reported that they are of some other race group not listed in the survey question responses and are not of Hispanic origin.

¶¶ BMI (kg/m^2) estimates were calculated from self-reported weight and height. BMI was categorized as underweight or healthy weight (BMI <25), overweight (BMI 25 to <30), and having obesity (BMI ≥30).

*** Physical inactivity was defined as responding "no" to the question, "During the past month, other than your regular job, did you participate in any physical activities or exercises such as running, calisthenics, golf, gardening, or walking for exercise?"

TABLE 2. Distribution of selected characteristics among caregivers* aged ≥18 years with and without arthritis† — Behavioral Risk Factor Surveillance System, 17 states§, 2017 and 2019

Characteristic	Caregivers with arthritis		Caregivers without arthritis		p-value††
	Unweighted no.¶	Weighted** % (95% CI)	Unweighted no.¶	Weighted** % (95% CI)	
Length of time of care provided, yrs					
<5	5,256	64.9 (62.7–67.1)	8,121	71.3 (69.5–73.0)	<0.001
≥5	2,636	35.1 (32.9–37.3)	3,401	28.7 (27.0–30.5)	<0.001
No. of hours of care provided weekly					
<20	5,094	67.2 (64.9–69.3)	7,760	71.5 (69.7–73.2)	0.003
20–39	811	12.0 (10.4–13.7)	1,179	11.0 (9.8–12.2)	0.337
≥40	1,443	20.9 (19.1–22.8)	1,929	17.5 (16.1–19.0)	0.005
Type of care provided§§					
Personal care only	417	5.7 (4.8–6.8)	624	5.6 (4.8–6.5)	0.87
Household tasks only	2,621	32.7 (30.6–34.9)	3,910	34.7 (32.8–36.5)	0.17
Both types	3,350	44.8 (42.5–47.0)	5,005	43.8 (42.0–45.7)	0.54
Neither type	1,549	16.8 (15.3–18.4)	2,023	15.9 (14.6–17.2)	0.36
Has a primary care provider¶¶	7,464	91.2 (89.8–92.4)	9,916	80.4 (78.6–82.1)	<0.001
Arthritis-attributable limitations					
Has arthritis-attributable activity limitations***	3,884	49.1 (46.9–51.4)	NA	NA	NA
Has arthritis-attributable work limitations†††	2,802	39.9 (37.7–42.2)	NA	NA	NA
Disability type§§§					
Mobility	2,894	38.0 (35.8–40.2)	888	7.3 (6.4–8.3)	<0.001
Self-care	682	9.8 (8.5–11.3)	165	1.5 (1.1–1.9)	<0.001
Independent living	1,004	14.7 (13.1–16.4)	524	5.0 (4.2–5.8)	<0.001

Abbreviation: NA = not applicable.

* Caregiving was defined as providing care to a family member or friend with a health condition or disability during the past 30 days.

† Having arthritis was defined as having ever been told by a doctor or other health care professional that the respondent had arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia.

§ The following states implemented the arthritis and caregiving modules in the same survey year during 2017 or 2019 (most recent year used): Alaska (2017), Hawaii (2019), Kansas (2017), Maine (2019), Maryland (2019), Michigan (2017), New Jersey (2017), New Mexico (2017), New York (2019), Ohio (2019), Oklahoma (2017), Oregon (2019), Rhode Island (2017), Tennessee (2019), Texas (2019), Utah (2019), and Virginia (2019).

¶ Categories might not sum to the sample total because of missing responses.

** Estimates were weighted to each state's adult population.

†† T-tests were used to determine statistically significant differences in characteristics between respondents with and without arthritis.

§§ Personal care was defined as responding "yes" to the question, "In the past 30 days, did you provide care for this person by managing personal care such as giving medications, feeding, dressing, or bathing?" Household tasks was defined as responding "yes" to the question, "In the past 30 days, did you provide care for this person by managing household tasks such as cleaning, managing money, or preparing meals?"

¶¶ Having a primary care provider was defined as responding "yes," "only one," or "more than one" to the question, "Do you have one person you think of as your personal doctor or health care provider? (If ´No´ ask ´Is there more than one or is there no person who you think of as your personal doctor or health care provider?´)."

*** Arthritis-attributable activity limitation was defined as responding "yes" to the question, "Are you now limited in any way in any of your usual activities because of arthritis or joint symptoms?" This question was only asked among respondents with arthritis.

††† Arthritis-attributable work limitations were defined as responding "yes" to the question, "Do arthritis or joint symptoms now affect whether you work, the type of work you do or the amount of work you do?" This question was only asked among respondents with arthritis.

§§§ Disability types were defined as responding "yes" to the following questions, "Do you have serious difficulty walking or climbing stairs?" (mobility disability), "Do you have difficulty dressing or bathing?" (self-care disability), and "Because of a physical, mental, or emotional condition, do you have difficulty doing errands alone such as visiting a doctor´s office or shopping?" (independent living disability).

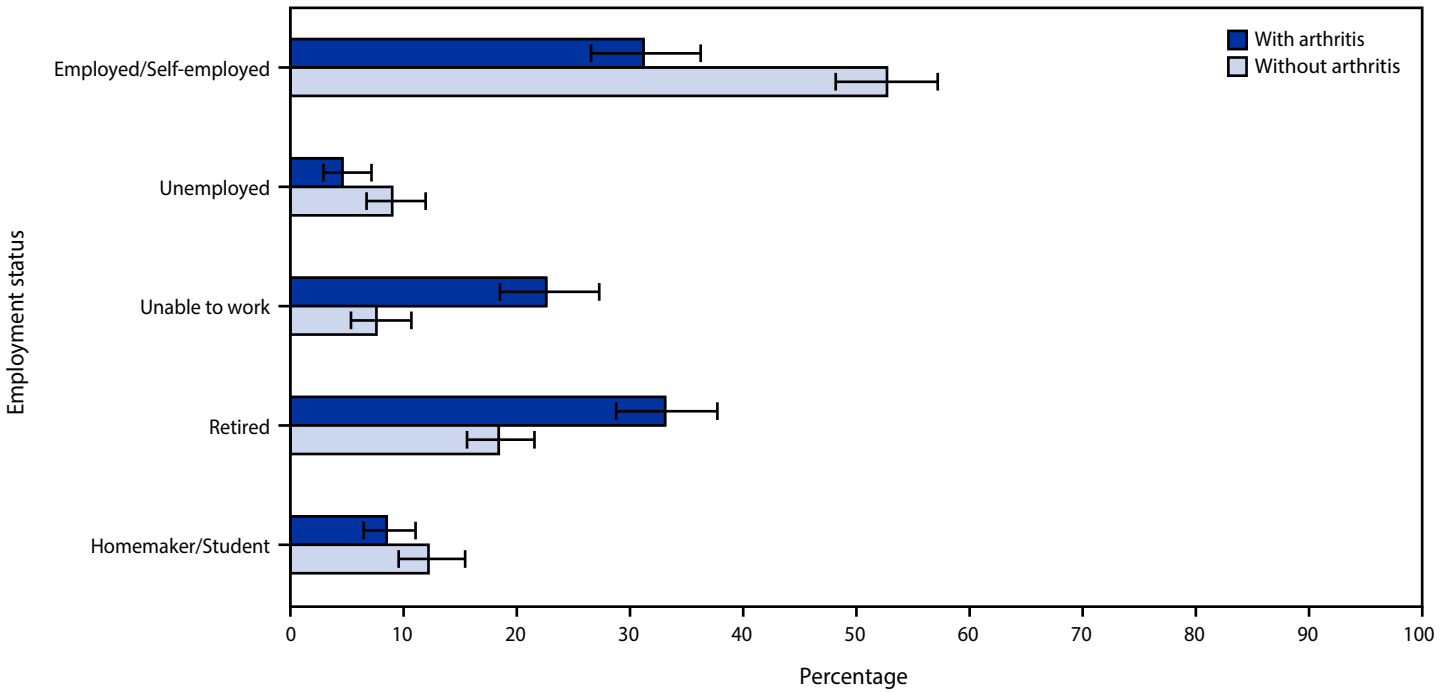
of caregivers reported arthritis-attributable activity limitations, and 39.9% of caregivers reported arthritis-attributable work limitations. Caregivers with arthritis were more likely than were those without arthritis to have the following types of disability: mobility (38.0% versus 7.3%), self-care (9.8% versus 1.5%), and independent living (14.7% versus 5.0%). Among caregivers with arthritis, 91.2% (95% CI = 89.8%–92.4%) reported having a primary care provider. Among caregivers who provided ≥40 hours of care per week, those with arthritis were more likely than those without arthritis to be unable to work (22.6% versus 7.6%) or to be retired (33.1% versus 18.4%) (Figure).

Discussion

Among adults in 17 states, one in five was a caregiver, and one in three caregivers reported arthritis. The prevalence of arthritis was higher among caregivers than among noncaregivers across nearly all demographic subgroups. Caregivers are critical members of the care team. As both the number of persons providing care for friends and family members (*1*) and the number of persons with arthritis increase (*5*), supporting caregivers with arthritis can help promote their own health along with the care they provide.

An estimated 49.1% of caregivers with arthritis reported arthritis-attributable activity limitations. Although not directly comparable, a previous report estimated that 43.9% (95% CI = 42.9%–44.8%) of adults with arthritis reported arthritis-attributable activity limitations during 2016–2018, suggesting that limitations specific to arthritis might be more common among caregivers than among the general population (*5*). In addition, caregivers with arthritis were more likely to have disabilities with mobility, self-care, and independent living than were caregivers without arthritis, and more than one in five caregivers with arthritis who provided ≥40 hours of care per week reported being unable to work. However, the types of personal and household tasks provided to the care recipient

FIGURE: Employment status* of caregivers† aged ≥18 years who provide ≥40 hours of care per week, by arthritis status§ — Behavioral Risk Factor Surveillance System, 17 states,¶ 2017 and 2019**



* Determined based on the response to the question, "Are you currently employed for wages, self-employed, out of work for 1 year or more, out of work for less than 1 year, a homemaker, a student, retired, or unable to work?"
† Caregiving was defined as providing care to a family member or friend with a health condition or disability during the past 30 days.
§ Having arthritis was defined as having ever been told by a doctor or other health care professional that the respondent had arthritis, rheumatoid arthritis, gout, lupus, or fibromyalgia.
¶ The following states implemented the arthritis and caregiving modules in the same survey year during 2017 or 2019 (most recent year used): Alaska (2017), Hawaii (2019), Kansas (2017), Maine (2019), Maryland (2019), Michigan (2017), New Jersey (2017), New Mexico (2017), New York (2019), Ohio (2019), Oklahoma (2017), Oregon (2019), Rhode Island (2017), Tennessee (2019), Texas (2019), Utah (2019), and Virginia (2019).
** Error bars represent 95% CIs.

Summary

What is already known about this topic?

Approximately 44% of adults with arthritis report arthritis-attributable limitations, but little is known about arthritis among caregivers.

What is added by this report?

During 2017 and 2019, one in five adults in 17 states was a caregiver, and one in three caregivers had arthritis. Prevalence of arthritis was higher among caregivers (35.1%) than among noncaregivers (24.5%). Compared with caregivers without arthritis, those with arthritis provided similar types of care and were more likely to have provided care for more hours per week and for more years and report having disabilities.

What are the implications for public health practice?

Arthritis among caregivers might affect the care they provide, which can be physically demanding. Health care professionals can support caregivers with arthritis and their care recipients by promoting arthritis-related health interventions.

did not differ by arthritis status among caregivers, suggesting that such care might be necessary or expected of caregivers. Taken together, these findings suggest that caregivers with arthritis who have related disabilities and activity and work limitations might experience unique challenges to sustaining the care they provide, including financial insecurity because of loss of paid income (*6*).

A higher proportion of caregivers with arthritis also reported providing care for ≥40 hours per week and for ≥5 years than did caregivers without arthritis, suggesting that they might benefit from long-term services and supports. Ensuring that the health and well-being of all caregivers, including those with arthritis, is optimized can help them continue providing quality care. A large proportion of caregivers with arthritis reported having a primary care provider. These caregivers with arthritis can discuss their experiences with their health care provider and seek evidence-based programs for support, such as effective physical activity-based programs and self-management programs to help reduce arthritis symptoms and improve arthritis management and quality of life.[¶¶¶],[****] Caregivers can also learn more about ways to reduce their risk for developing arthritis or managing arthritis if they have it.[††††]

The findings in this report are subject to at least five limitations. First, because of the cross-sectional nature of BRFSS data, causality among caregiving, arthritis, and other conditions such as disability status cannot be determined. Second, self-reported data might be subject to several biases including recall and social desirability. Third, BRFSS data cannot be validated with medical records. Fourth, data were from 17 states and might not represent all jurisdictions. Finally, statistically significant differences in the prevalence of arthritis between caregivers and noncaregivers were not observed in some racial and ethnic groups, even though estimates were consistently higher among caregivers.

Caregiving is common in the United States, and many caregivers have arthritis and related limitations and disabilities. Caregivers with arthritis might benefit from interventions to help them continue providing quality care for their friends and family members. Health care professionals can recommend physical activity and lifestyle management programs for arthritis to help their patients who are caregivers to manage their arthritis symptoms.[§§§§] Public health professionals can support all caregivers and care recipients by strengthening public health infrastructure using the public health strategist approach,[¶¶¶¶] implementing strategies from the Healthy Brain Initiative and Building Our Largest Dementia (BOLD) Infrastructure Act for supporting caregivers,[*****] and accessing resources from the National Public Health Agenda for Osteoarthritis (*7*) and the BOLD Public Health Center of Excellence on Dementia Caregiving[†††††] (*8*).

[¶¶¶] https://oaaction.unc.edu/aaebi/
[****] https://www.cdc.gov/arthritis/interventions/index.htm
[††††] https://www.cdc.gov/arthritis/basics/index.html

[§§§§] https://www.cdc.gov/arthritis/healthcare/index.html
[¶¶¶¶] https://www.cdc.gov/aging/caregiving/caregiver-brief.html
[*****] https://www.cdc.gov/aging/healthybrain/issue-maps/supporting-caregivers.html
[†††††] https://bolddementiacaregiving.org/

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Routine Vaccination Coverage — Worldwide, 2021

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In 2020, the World Health Assembly endorsed the Immunization Agenda 2030, an ambitious global immunization strategy to reduce morbidity and mortality from vaccine-preventable diseases (*1*). This report updates a 2020 report (*2*) with global, regional,* and national vaccination coverage estimates and trends through 2021. Global estimates of coverage with 3 doses of diphtheria-tetanus-pertussis–containing vaccine (DTPcv3) decreased from an average of 86% during 2015–2019 to 83% in 2020 and 81% in 2021. Worldwide in 2021, 25.0 million infants (19% of the target population) were not vaccinated with DTPcv3, 2.1 million more than in 2020 and 5.9 million more than in 2019. In 2021, the number of infants who did not receive any DTPcv dose by age 12 months (18.2 million) was 37% higher than in 2019 (13.3 million). Coverage with the first dose of measles-containing vaccine (MCV1) decreased from an average of 85% during 2015–2019 to 84% in 2020 and 81% in 2021. These are the lowest coverage levels for DTPcv3 and MCV1 since 2008. Global coverage estimates were also lower in 2021 than in 2020 and 2019 for bacillus Calmette-Guérin vaccine (BCG) as well as for the completed series of *Haemophilus influenzae* type b vaccine (Hib), hepatitis B vaccine (HepB), polio vaccine (Pol), and rubella-containing vaccine (RCV). The COVID-19 pandemic has resulted in disruptions to routine immunization services worldwide. Full recovery to immunization programs will require context-specific strategies to address immunization gaps by catching up missed children, prioritizing essential health services, and strengthening immunization programs to prevent outbreaks (*3*).

The World Health Organization (WHO) established the Expanded Programme on Immunization in 1974 to protect infants against six diseases through vaccination (e.g., BCG, DTP, Pol, and MCV) (*4*). Since then, additional vaccines and vaccine doses have been introduced during the first year of life (e.g., HepB, Hib, pneumococcal conjugate vaccine [PCV], RCV, and rotavirus) and at older ages (e.g., human papillomavirus [HPV] vaccine in females) (*4*). WHO and UNICEF produce annual estimates of immunization coverage through review of available country-specific data, including administrative and survey-based coverage[†,§] (*5*). DTPcv3 coverage by age 12 months is an indicator of routine immunization program performance, and DTPcv3, MCV2, 3 doses of PCV (PCV3), and HPV vaccine are indicators for the Sustainable Development Goals.[¶] Children who have not received any doses of DTPcv by age 12 months (zero-dose children) represent those with poor access to immunization and other essential health services. Children who receive the first DTPcv dose (DTPcv1) but do not complete the full series are considered incompletely vaccinated.

WHO and UNICEF global estimates of national immunization coverage for DTPcv1 decreased from 90% in 2019 to 87% in 2020 and 86% in 2021, the lowest level since 2005. In 2021, DTPcv1 coverage ranged from 80% in the WHO African Region to 97% in the European Region (Table 1). DTPcv3 coverage followed similar regional trends. The decline in first and third dose DTPcv coverage during 2019–2021 was largest in the South-East Asia Region (from 94% to 86% for DTPcv1 and from 91% to 82% for DTPcv3). In the Americas, DTPcv1 and DTPcv3 coverage decreased by 3 and 4 percentage points, respectively, during 2019–2021 (Figure). Among the 194 WHO member states, DTPcv1 coverage during 2019–2021 was stable or declined in 170 (88%); DTPcv3 coverage during this period was stable or declined in 167 member states (86%).

In 2021, 25.0 million children worldwide had not completed the 3-dose DTPcv series, 2.1 million more than in 2020 (22.9 million) and 5.9 million more than in 2019 (19.1 million); 18.2 million (73%) had received no doses, and 6.8 million (27%) were incompletely vaccinated with DTPcv. The number of zero-dose children was unevenly

* https://www.who.int/about/who-we-are/regional-offices

† For a given vaccine, administrative coverage is the number of doses administered in a specified target group divided by the estimated target population. Doses administered during routine immunization visits are counted, but doses administered during supplemental immunization activities (mass campaigns) usually are not. Survey-based vaccination coverage is calculated as the proportion of persons in a target age group who had received a vaccine dose. During surveys, a representative sample of households is visited, and caregivers of children in a specified target age group (e.g., 12–23 months) are interviewed. Vaccination dates are transcribed from the child's home-based record or health facility records, and if documented evidence is unavailable, recorded based on caregiver recall.

§ For 18 countries that did not report 2021 immunization coverage data by July 7, 2021, estimated coverage for 2020 was used. https://www.who.int/teams/immunization-vaccines-and-biologicals/immunization-analysis-and-insights/global-monitoring/immunization-coverage/who-unicef-estimates-of-national-immunization-coverage

¶ The 2030 Agenda for Sustainable Development was adopted in 2015 by the 193 countries that make up the United Nations. The agenda lays out 17 Sustainable Development Goals (SDGs) and targets for dignity, peace, and prosperity for the planet and humankind, to be completed by 2030. SDG indicator SDG3.b.1 is the proportion of the target population covered by all vaccines included in their national program. https://sdgs.un.org/goals

TABLE 1. Estimated vaccination coverage, by World Health Organization region and vaccine — worldwide, 2021

Vaccine	Countries with vaccine in schedule,* no. (%)	WHO region coverage,†,§,¶ %						
		Global	African	Americas	Eastern Mediterranean	European	South-East Asia	Western Pacific
BCG	156 (80)	84	78	81	88	92	85	89
DTPcv1	194 (100)	86	80	86	89	97	86	91
DTPcv3	194 (100)	81	71	80	82	94	82	90
HepB BD	111 (57)	42	17	59	33	43	51	78
HepB3	190 (98)	80	71	80	82	91	82	90
Hib3	192 (99)	71	71	79	82	81	82	29
HPV, last**	116 (60)	12	21	38	—	27	2	2
MCV1	194 (100)	81	68	84	82	94	86	91
MCV2	183 (94)	71	41	75	77	91	78	91
PCV3	154 (79)	51	66	74	54	82	29	19
Pol3	194 (100)	80	70	79	83	94	82	90
RCV1	173 (89)	66	35	84	42	94	86	91
Rota, last††	118 (61)	49	52	69	57	34	61	2

Abbreviations: BCG = Bacille Calmette-Guérin vaccine; DTPcv1 = first dose of diphtheria-tetanus-pertussis–containing vaccine; DTPcv3 = third dose of diphtheria-tetanus-pertussis vaccine; HepB BD = birth dose of hepatitis B vaccine; HepB3 = third dose of hepatitis B vaccine; Hib3 = third dose of *Haemophilus influenzae* type b vaccine; HPV, last = final dose of human papillomavirus vaccine; MCV1 = first dose of measles-containing vaccine; MCV2 = second dose of MCV; PCV3 = third dose of pneumococcal conjugate vaccine; Pol3 = third dose of polio vaccine; RCV1 = first dose of rubella-containing vaccine; Rota, last = final dose of rotavirus vaccine series; WHO = World Health Organization.

* Does not include countries recommending vaccines for special groups only.

† Based on WHO regional classifications. https://www.who.int/about/who-we-are/regional-offices

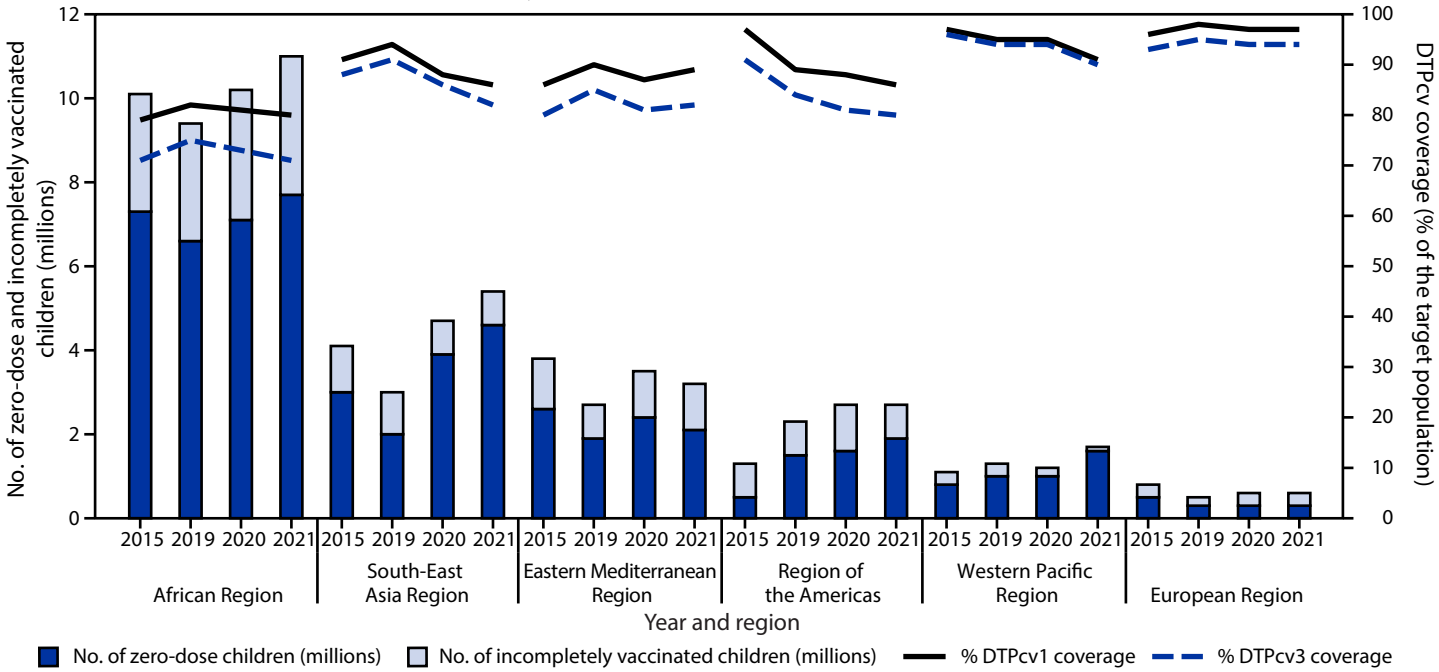
§ https://www.who.int/teams/immunization-vaccines-and-biologicals/policies/who-recommendations-for-routine-immunization---summary-tables

¶ Included countries are 194 WHO member states. BCG coverage is based on 156 countries with BCG in the national schedule, whereas coverage for all other vaccines is based on 194 countries (global) or all countries in the specified region. Administrative coverage is the number of vaccine doses administered to those in a specified target group divided by the estimated target population. During vaccination coverage surveys, a representative sample of households are visited and caregivers of children in a specified target group (e.g., aged 12–23 months) are interviewed. Dates of vaccination are transcribed from the child's home-based record, from health facility records, or recorded based on caregiver recall. Survey-based vaccination coverage is calculated as the proportion of persons in a target age group who received a vaccine dose.

** Estimates based on last dose given among females. Number of doses to complete the HPV series depends on age of recipient.

†† Number of doses to complete the rotavirus vaccine series varies between 2 and 3 depending on vaccine products.

FIGURE. Estimated number of zero-dose and incompletely vaccinated children* and estimated coverage with first and third dose of diphtheria-tetanus-pertussis–containing vaccine, by World Health Organization region — worldwide, 2015 and 2019–2021



Abbreviations: DTPcv1 = first dose of diphtheria-tetanus-pertussis–containing vaccine; DTPcv3 = third dose of diphtheria-tetanus-pertussis–containing vaccine.

* Zero-dose children are surviving infants who lack receipt of any dose of DTPcv by age 12 months. Incompletely vaccinated children are those who received at least 1 dose, but not the third dose needed for basic protection.

distributed by WHO region, economic classification,** and country eligibility for support from Gavi, the Vaccine Alliance (Gavi)†† (Table 2) (Figure). Among 18.2 million zero-dose children in 2021, low-income countries accounted for 5.0 million (27%), whereas middle-income countries had the largest number (12.8 million; 70%). Ten countries (43% of the global birth cohort) accounted for 62% (11.4 million) of zero-dose children: India (2.7 million), Nigeria (2.2 million), Indonesia (1.1 million), Ethiopia (1.1 million), Philippines (1.0 million), Democratic Republic of the Congo (0.73 million), Brazil (0.71 million), Pakistan (0.61 million), Angola (0.55 million), and Burma (0.49 million). Approximately 12 million zero-dose children (69% of the global total) lived in Gavi-eligible countries. DTPcv3 coverage declined sharply in 17 countries that transitioned out of Gavi support,§§ from a weighted average of 82% in 2019 to 70% in 2021, whereas

** Gross national income (GNI) per capita is calculated using the World Bank Atlas method in U.S. dollars (USD). For all years shown, the Cook Islands and Niue are not included because GNI estimates were not available. For 2020 and 2021, data for Venezuela were also temporarily unclassified pending the release of revised national accounts statistics. https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

†† Gavi is a public-private global health partnership that aims to increase access to immunization in poor countries. Based on Gavi 5.0 (2021–2025), eligibility includes 57 low- and middle-income countries eligible to receive financial assistance through grants contingent on a country's GNI per capita. Eligibility is defined as a country's average 3-year GNI per capita in ≤1,630 USD. As GNI increases, a country moves through Gavi's different eligibility phases until reaching the transition phase in which GNI exceeds the eligibility threshold. https://www.gavi.org

§§ Includes Angola, Armenia, Azerbaijan, Bhutan, Bolivia, Cuba, Georgia, Guyana, Honduras, Indonesia, Kiribati, Moldova, Mongolia, Sri Lanka, Timor-Leste, Ukraine, and Vietnam.

TABLE 2. Number and global percentage of zero-dose children,* by World Health Organization region; World Bank economic classification; and Gavi, the Vaccine Alliance eligibility — worldwide, 2015 and 2019–2021

Characteristic, yr	Global	WHO region†						Economic classification¶			Among Gavi-eligible countries§
		Africa	Americas	Eastern Mediterranean	European	South-East Asia	Western Pacific	Low	Middle	High	
2015											
No. of countries	194	47	35	21	53	11	27	31	104	57	57
No. of surviving infants (millions)	138.5	34.7	14.8	18.4	11.5	34.7	24.4	21.5	103.6	12.9	72.8
Global % of surviving infants	—	25	11	13	8	25	18	16	75	9	53
No. of zero-dose children (millions)	14.7	7.3	0.5	2.6	0.5	3.0	0.8	3.9	10.4	0.3	11.7
Global % of zero-dose children	—	50	3	17	3	21	6	27	71	2	80
2019											
No. of countries	194	47	35	21	53	11	27	29	103	60	57
No. of surviving infants (millions)	134.3	37.0	14.0	18.1	10.5	33.3	21.4	23.1	98.9	12.0	74.3
Global % of surviving infants	—	28	10	14	8	25	16	17	74	9	55
No. of zero-dose children (millions)	13.3	6.6	1.5	1.9	0.3	2.0	1.1	3.9	9.0	0.3	9.3
Global % of zero-dose children	—	50	12	14	2	15	8	29	68	2	70
2020											
No. of countries	194	47	35	21	53	11	27	27	108	57	57
No. of surviving infants (millions)	131.6	37.5	13.7	18.2	10.3	32.8	19.0	23.6	95.7	11.8	74.6
Global % of surviving infants	—	29	10	14	8	25	15	18	73	9	57
No. of zero-dose children (millions)	16.5	7.1	1.6	2.4	0.3	3.9	1.0	4.3	11.8	0.3	11.9
Global % of zero-dose children	—	43	10	15	2	24	6	26	72	2	72
2021											
No. of countries	194	47	35	22	53	11	27	28	106	58	57
No. of surviving infants (millions)	130.5	38.1	13.6	18.2	10.2	32.8	17.6	24.0	94.2	11.8	75.2
Global % of surviving infants	—	29	10	14	8	25	13	18	72	9	58
No. of zero-dose children (millions)	18.2	7.7	1.9	2.1	0.3	4.6	1.6	5.0	12.8	0.3	12.5
Global % of zero-dose children	—	42	10	11	2	25	9	27	70	2	69

Abbreviations: DTPcv3 = third dose of diphtheria-tetanus-pertussis–containing vaccine; Gavi = Gavi, the Vaccine Alliance; GNI = gross national income; WHO = World Health Organization.

* Zero-dose children are surviving infants who lack receipt of any dose of DTPcv by age 12 months. The 2021 WHO and UNICEF estimates of national immunization coverage used the 2022 revision of the World Population Prospect from the United Nations Population Division for estimates of national immunization coverage and for calculations of regional and global vaccination coverage figures. Estimates of live births and surviving infants changed for previous years. The changes in target population estimates result in a 1%-point lower global DTPcv3 coverage than if calculations had used data from the 2019 revision and 2%-point lower regional average DTPcv3 coverage for the World Population Prospect.

† Included countries are WHO member states.

¶ GNI per capita is calculated using the World Bank Atlas method in U.S. dollars. For all years shown, Cook Islands and Niue are not included because of lack of available GNI estimates. For 2020 and 2021, data for Venezuela were also temporarily unclassified pending release of revised national accounts statistics. https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

§ Gavi is a public-private global health partnership that aims to increase access to immunization in poor countries. Based on Gavi 5.0 (2021–2025), eligibility includes 57 low- and middle-income countries eligible to receive financial assistance through grants contingent on a country's GNI per capita. Eligibility is defined as a country's average 3-year GNI per capita in ≤1,630 U.S. dollars. As GNI increases, a country moves through Gavi's different eligibility phases until reaching the transition phase in which GNI exceeds the eligibility threshold. https://www.gavi.org

Summary

What is already known about this topic?

High routine childhood vaccination coverage achieved during 2015–2019 declined globally for most vaccines during 2019–2021 because of COVID-19 pandemic disruptions.

What is added by this report?

In 2021, the estimated global coverage with 3 doses of diphtheria-tetanus-pertussis–containing vaccine as well as the first dose of measles-containing vaccine decreased to 81%, the lowest level since 2008. Globally, 25.0 million children were unvaccinated or incompletely vaccinated in 2021, 5.9 million more than in 2019.

What are the implications for public health practice?

Reversing declining vaccination trends and addressing immunity gaps, as well as extending previous gains in vaccination coverage beyond prepandemic levels, requires targeted and context-specific approaches that prioritize routine vaccination as an essential health service and improve access to vaccination across the life span.

those supported by Gavi were less affected (weighted average of 82% in 2019 compared with 77% in 2021).

Global MCV1 coverage remained stable during 2015–2019 (85%–86%) but decreased to 83% in 2020 and to 81% in 2021. The largest declines in MCV1 coverage during 2019–2021 occurred in the South-East Asia Region (from 94% to 86%) and the Western Pacific Region (from 95% to 91%) (Table 1). During 2015–2019, coverage with 2 MCV doses (MCV2) increased from 63% to 71%, reflecting second dose introductions in many countries.[¶¶] However, MCV2 coverage remained stable thereafter (72% in 2020 and 71% in 2021), with only four additional countries introducing MCV2 during 2020–2021.

Global coverage during 2019–2021 decreased for all of the following recommended childhood vaccines: BCG, from 88% to 84%; the completed Hib series, from 73% to 71%; RCV, from 69% to 66%; 3-dose HepB series, from 85% to 80%; HepB birth dose, from 44% to 42%; and the third Pol dose, from 86% to 80%. Global coverage with first dose of HPV vaccine among females declined from 20% in 2019 to 15% in 2021, and with the last dose, from 14% in 2019 to 12% in 2021. Global PCV3 coverage was stagnant (50% in 2019, 51% in 2020, and 51% in 2021), and coverage with the final dose of rotavirus vaccine series increased from 40% in 2019 to 49% in 2021.[***]

[¶¶] During 2010–2019, 42 countries introduced MCV2 into their immunization schedule. In 2020, only one country introduced MCV2 into its immunization schedule. In 2021, four more countries introduced MCV2 into their immunization schedule, leaving 11 WHO member states that have yet to introduce MCV2 into their routine schedule.

[***] During 2019–2021, 10 countries introduced the final dose of rotavirus vaccine into their immunization schedule.

Discussion

Since the start of the COVID-19 pandemic in 2020, a widespread decline in childhood vaccinations has occurred globally, putting millions of additional children at risk for vaccine-preventable diseases. Global DTPcv3 coverage declined by 5 percentage points during 2019–2021, meaning that at least 22.9 million children in 2020 and 25.0 million children in 2021 did not access or fully utilize routine immunization services. Immunization outreach services were particularly affected (*6*), and the most vulnerable populations have experienced the largest impact. Among all WHO regions, the largest declines in DTPcv3 and MCV1 coverage occurred in the South-East Asia Region.

The continued decline in vaccination coverage during 2020–2021 was likely a result of many factors, including strained health systems caused by the COVID-19 pandemic, coupled with delivery of COVID-19 vaccines. These stresses have led to challenges with supply chains, human resources, and financing. Increasing vaccine misinformation, disinformation, and hesitancy also likely contributed to declines in some countries (*6*). The risk of vaccine-preventable disease outbreaks is likely to persist if urgent action is not taken to recover immunization program losses.

Expanding immunization services to reach zero-dose and incompletely vaccinated children and reducing immunization inequities are key objectives of the Immunization Agenda 2030 (*1*). Gavi has provided support for vaccines and vaccination services to low- and lower-middle income countries since 2000, helping to improve access and reduce disparities in immunization coverage with high-income countries (*7*). However, during 2019–2021, vaccination coverage declined more sharply in countries that transitioned out of Gavi support than in those supported by Gavi, underscoring the vulnerability of these systems. As countries develop economically, they potentially become less eligible for external funding and require increased domestic financing for immunization. In times of crisis, such as during the COVID-19 pandemic, middle-income countries, which account for an increasing share of unprotected children, might be unable to allocate sufficient resources to immunization programs to reach every child with available vaccines.

The findings in this report are subject to at least five limitations. First, for 18 countries (6% of the global birth cohort) that did not report immunization coverage data for 2021 by July 7, 2022, estimated coverage for 2020 was used.[†††] Second, because COVID-19 also disrupted survey implementation, estimates for 2021 are less determined by survey data than are estimates for previous years. Third, the estimated numbers of zero-dose and

[†††] Given that these countries represent approximately 6% of the global birth cohort in 2021, missing data likely had a limited impact on reported estimates.

incompletely vaccinated children rely on population estimates that are subject to inaccuracies. Fourth, data quality limitations in some countries might have resulted in inaccurate estimates of administrative coverage, and selection and recall bias could affect survey-based estimates of coverage (*5*). Finally, coverage estimates do not include statistical uncertainty.

Reversing worrisome vaccination trends and extending previous gains in coverage beyond prepandemic levels will require targeted and context-specific approaches to eliminate barriers to vaccination, particularly in communities with large populations of zero-dose children. WHO has published strategies and guiding principles for implementing catch-up vaccination and recovering essential immunization services (*8*–*10*). Countries are urged to recover immunization services while capitalizing on opportunities from the pandemic response and COVID-19 vaccine rollout to strengthen routine immunization services and increase primary health care resiliency. This can be achieved by prioritizing routine immunization as an essential health service, improving access to vaccination across the life span, strengthening data systems, safeguarding sustainable immunization financing, and building vaccine confidence.

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Safety Monitoring of Bivalent COVID-19 mRNA Vaccine Booster Doses Among Persons Aged ≥12 Years — United States, August 31–October 23, 2022

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On August 31, 2022, the Food and Drug Administration (FDA) authorized bivalent formulations of BNT162b2 (Pfizer-BioNTech) and mRNA-1273 (Moderna) COVID-19 vaccines; these vaccines include mRNA encoding the spike protein from the original (ancestral) strain of SARS-CoV-2 (the virus that causes COVID-19) and from the B.1.1.529 (Omicron) variants BA.4 and BA.5 (BA.4/BA.5). These bivalent mRNA vaccines were authorized for use as a single booster dose ≥2 months after completion of primary series or monovalent booster vaccination; Pfizer-BioNTech bivalent booster was authorized for persons aged ≥12 years and Moderna for adults aged ≥18 years.[*,†] On September 1, 2022, the Advisory Committee on Immunization Practices (ACIP) recommended that all persons aged ≥12 years receive an age-appropriate bivalent mRNA booster dose.[§] To characterize the safety of bivalent mRNA booster doses, CDC reviewed adverse events and health impacts reported after receipt of bivalent Pfizer-BioNTech and Moderna booster doses during August 31–October 23, 2022, to v-safe,[¶] a voluntary smartphone-based U.S. safety surveillance system established by CDC to monitor adverse events after COVID-19 vaccination, and the Vaccine Adverse Event Reporting System (VAERS),[**] a U.S. passive vaccine safety surveillance system managed by CDC and FDA (*1*). During August 31–October 23, 2022, approximately 14.4 million persons aged ≥12 years received a bivalent Pfizer-BioNTech booster dose, and 8.2 million adults aged ≥18 years received a bivalent Moderna booster dose.[††] Among the 211,959 registrants aged ≥12 years who reported receiving a bivalent booster dose to v-safe, injection site and systemic reactions were frequently reported in the week after vaccination (60.8% and 54.8%, respectively); fewer than 1% of v-safe registrants reported receiving medical care. VAERS received 5,542 reports of adverse events after bivalent booster vaccination among persons aged ≥12 years; 95.5% of reports were nonserious and 4.5% were serious events. Health care providers and patients can be reassured that adverse events reported after a bivalent booster dose are consistent with those reported after monovalent doses. Health impacts after COVID-19 vaccination are less frequent and less severe than those associated with COVID-19 illness (*2*).

The v-safe system allows existing registrants to report receipt of a COVID-19 booster dose and new registrants to enter information about all doses received; registrants can also indicate whether any other vaccines were administered during the same visit. On September 2, 2022, v-safe was modified to allow participants to enter up to 6 doses of a COVID-19 vaccine. Health surveys sent daily during the first week after administration of each dose include questions about local injection site and systemic reactions and health impacts experienced; registrants can provide additional information about these reactions or health impacts via free text message.[§§] CDC's v-safe call center staff members contact registrants who indicate that medical care was received after vaccination to request more information; registrants are also encouraged to complete a VAERS report, if indicated.

VAERS accepts reports of postvaccination adverse events from health care providers, vaccine manufacturers, and members of the public.[¶¶] Signs and symptoms and diagnostic findings in VAERS reports are assigned Medical Dictionary for Regulatory Activities preferred terms (MedDRA PTs) by VAERS staff members.[***] Reports of serious events to VAERS during August 31–October 23, 2022, were reviewed by CDC physicians to form a consensus clinical impression based on available data.[†††] Death certificates and autopsy reports were requested for any report of death. CDC physicians reviewed

[*] https://www.fda.gov/media/150386/download
[†] https://www.fda.gov/media/144636/download
[§] https://www.cdc.gov/vaccines/covid-19/clinical-considerations/interim-considerations-us.html
[¶] https://vsafe.cdc.gov/en
[**] https://vaers.hhs.gov
[††] https://covid.cdc.gov/covid-data-tracker/#vaccination-demographic (Accessed October 23, 2022).
[§§] Children and adolescents aged ≤15 years must be enrolled by a parent or guardian. Health check-ins are sent via text messages that link to web-based surveys on days 0–7 after vaccination; then weekly through 6 weeks after vaccination; and then 3, 6, and 12 months after vaccination.
[¶¶] Under emergency use authorization regulations, health care providers are required to report certain adverse events after COVID-19 vaccination to VAERS, including death (https://vaers.hhs.gov/faq.html). VAERS forms ask for patient, vaccine, administration, and adverse event information. https://vaers.hhs.gov/docs/VAERS%202.0_Checklist.pdf
[***] Each VAERS report might be assigned more than one MedDRA PT. A MedDRA-coded event does not indicate a medically confirmed diagnosis. https://www.meddra.org/how-to-use/basics/hierarchy
[†††] VAERS reports are classified as serious (based on FDA C.F.R. Title 21) if any of the following are reported: hospitalization, prolongation of hospitalization, life-threatening illness, permanent disability, congenital anomaly or birth defect, or death. https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm?fr

all available information for each decedent to form an impression about the cause of death. Using selected MedDRA PTs, a search was performed to identify possible cases of myocarditis, a rare adverse event that has been associated with mRNA COVID-19 vaccines (*2*).

A bivalent booster dose in v-safe was defined as an age-appropriate mRNA vaccine dose administered on or after August 31, 2022, for registrants who had completed at least a primary series (2 doses of Pfizer-BioNTech, Moderna, or Novavax COVID-19 vaccine or 1 dose of Janssen [Johnson & Johnson] vaccine). Local and systemic reactions and health impacts reported during the week after a bivalent booster dose vaccination were described for v-safe registrants aged ≥12 years who received a bivalent booster dose during August 31–October 23, 2022. VAERS adverse event reports after a bivalent booster dose were described by serious and nonserious classification, demographic characteristics, and MedDRA PTs. All analyses were conducted using SAS software (version 9.4; SAS Institute). These surveillance activities were reviewed by CDC and conducted consistent with applicable federal law and CDC policy.[§§§]

Review of v-safe Data

During August 31–October 23, 2022, a total of 211,959 v-safe registrants aged ≥12 years reported receiving an age-appropriate bivalent booster dose (Table 1); 1,464 (0.7%) were aged 12–17 years, 68,592 (32.4%) were aged 18–49 years, 59,209 (27.9%) were aged 50–64 years, and 82.694 (39.0%) were aged ≥65 years. Most registrants indicated that a bivalent booster dose was their fourth (96,241; 45.4%) or fifth (106,423; 50.2%) COVID-19 vaccine dose; 122,953 (58.0%) received a Pfizer-BioNTech bivalent booster dose and 89,065 (42.0%) received a Moderna bivalent booster dose. More than one third (84,450; 39.8%) of registrants reported receiving at least one other vaccination at the same visit as bivalent booster vaccination; 83,005 (98.3%) received influenza vaccine.

In the week after receipt of the bivalent booster dose, frequency of reporting of local injection site reactions ranged from 49.7% among adults aged ≥65 years to 72.9% among adults aged 18–49 years; the prevalence of reported systemic reactions ranged from 43.5% among adults aged ≥65 years to 67.9% among adults aged 18–49 years (Table 2). The most frequently reported reactions among these age groups after bivalent booster dose vaccination were injection site pain (range = 45.0%–70.5%), fatigue (30.0%–53.1%), headache (19.7%–42.8%), myalgia (20.3%–41.3%), and fever (10.2%–26.3%).

§§§ 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.

TABLE 1. Demographic and vaccination characteristics of persons aged ≥12 years* who reported receipt of a bivalent Pfizer-BioNTech or Moderna COVID-19 vaccine booster dose to v-safe† — United States, August 31–October 23, 2022

Characteristic	Vaccine, no. (%)		
	Pfizer-BioNTech n = 122,953	Moderna n = 89,006	Total N = 211,959
Sex			
Female	77,913 (63.4)	56,651 (63.7)	**134,564 (63.5)**
Male	44,031 (35.8)	31,697 (35.6)	**75,728 (35.7)**
Unknown	1,009 (0.8)	658 (0.7)	**1,667 (0.8)**
Age group, yrs			
12–17	1,464 (1.2)	NA	**1,464 (0.7)**
18–49	41,022 (33.4)	27,570 (31.0)	**68,592 (32.4)**
50–64	34,947 (28.4)	24,262 (27.3)	**59,209 (27.9)**
≥65	45,520 (37.0)	37,174 (41.8)	**82,694 (39.0)**
Ethnicity			
Hispanic	6,967 (5.7)	4,765 (5.4)	**11,732 (5.5)**
Non-Hispanic	112,895 (91.8)	82,009 (92.1)	**194,904 (92.0)**
Unknown	3,091 (2.5)	2,232 (2.5)	**5,323 (2.5)**
Race			
American Indian or Alaska Native	441 (0.4)	328 (0.4)	**769 (0.4)**
Asian	6,884 (5.6)	4,750 (5.3)	**11,634 (5.5)**
Black or African American	6,574 (5.4)	4,583 (5.2)	**11,157 (5.3)**
Native Hawaiian or other Pacific Islander	241 (0.2)	145 (0.2)	**386 (0.2)**
White	102,535 (83.4)	74,984 (84.3)	**177,519 (83.8)**
Multiracial	2,518 (2.1)	1,667 (1.9)	**4,185 (2.0)**
Other	1,873 (1.5)	1,262 (1.4)	**3,135 (1.5)**
Unknown	1,887 (1.5)	1,287 (1.5)	**3,174 (1.5)**
Total no. of COVID-19 vaccine doses received			
2	86 (0.1)	52 (0.1)	**138 (0.1)**
3	4,919 (4.0)	3,186 (3.6)	**8,105 (3.8)**
4	57,603 (46.9)	38,638 (43.4)	**96,241 (45.4)**
5	59,807 (48.6)	46,616 (52.4)	**106,423 (50.2)**
6	538 (0.4)	514 (0.6)	**1,052 (0.5)**
Vaccine co-administration§			
Yes	51,713 (42.1)	32,737 (36.8)	**84,450 (39.8)**
No	71,240 (57.9)	56,269 (63.2)	**127,509 (60.2)**

Abbreviation: NA = not applicable.

* On August 31, 2022, the Food and Drug Administration authorized bivalent formulations of Moderna and Pfizer-BioNTech COVID-19 vaccines for use as a single booster dose ≥2 months after completing primary or booster vaccination, Pfizer-BioNTech for persons aged ≥12 years and Moderna for persons aged ≥18 years. In v-safe, a bivalent booster dose was defined as an age-appropriate mRNA dose administered on or after August 31, 2022, for registrants who completed a primary series (2 doses of Pfizer-BioNTech, Moderna, or Novavax COVID-19 vaccine or 1 dose of Janssen).

† Includes registrants who completed at least one survey during days 0–7 postvaccination.

§ Other vaccines administered during the same visit.

Reported inability to complete normal daily activities ranged from 10.6% among adults aged ≥65 years to 19.8% among adults aged 18–49 years. Receipt of medical care was reported by 0.8% of registrants; most received care via telehealth (0.3%) or clinic (0.3%) appointment. Hospitalization was reported by 55 (0.03%) registrants. Among 45 registrants with information about the hospitalization available from the v-safe call center or free text message response, 29 indicated that the hospitalization

TABLE 2. Adverse reactions and health impacts reported to v-safe for persons aged ≥12 years* who received a bivalent Pfizer-BioNTech or Moderna COVID-19 vaccine booster dose — United States, August 31–October 23, 2022

Event	% Reporting reaction/health impact after vaccination, by age group, yrs†				
	12–17 n = 1,464	18–49 n = 68,592	50–64 n = 59,209	≥65 n = 82,694	Total N = 211,959
Any injection site reaction	**68.7**	**72.9**	**62.0**	**49.7**	**60.8**
Itching	4.6	8.9	7.8	6.9	**7.8**
Pain	66.9	70.5	58.8	45.0	**57.3**
Redness	8.5	10.8	9.1	7.6	**9.1**
Swelling or hardness	13.7	18.4	14.7	9.9	**14.0**
Any systemic reaction	**59.8**	**67.9**	**55.2**	**43.5**	**54.8**
Abdominal pain	6.4	5.5	3.6	2.1	**3.6**
Myalgia	33.6	41.3	29.0	20.3	**29.6**
Chills	19.6	20.6	13.7	9.1	**14.2**
Fatigue	45.2	53.1	40.0	30.0	**40.4**
Fever	26.3	23.7	16.6	10.2	**16.4**
Headache	36.3	42.8	31.5	19.7	**30.6**
Joint pain	14.5	21.7	16.8	11.1	**16.1**
Nausea	12.4	12.9	7.9	4.5	**8.2**
Diarrhea	3.0	6.7	5.4	3.8	**5.2**
Rash	1.4	1.3	1.1	0.9	**1.1**
Vomiting	2.5	1.2	0.6	0.4	**0.7**
Any health impact	**26.8**	**24.2**	**17.3**	**11.6**	**17.3**
Unable to perform normal daily activities	18.4	19.8	14.7	10.6	**14.8**
Unable to attend school or work	15.6	11.3	6.0	1.6	**6.1**
Needed medical care	1.2	0.9	0.7	0.8	**0.8**
Telehealth	0.2	0.3	0.2	0.2	**0.3**
Clinic	0.8	0.4	0.3	0.3	**0.3**
Emergency visit	0.1	0.1	0.1	0.1	**0.1**
Hospitalization	0	0	0	0	**0**

* On August 31, 2022, the Food and Drug Administration authorized bivalent formulations of Moderna and Pfizer-BioNTech COVID-19 vaccines for use as a single booster dose ≥2 months after completing primary or booster vaccination, Pfizer-BioNTech for persons aged ≥12 years and Moderna for adults aged ≥18 years. In v-safe, a bivalent booster was defined as an age-appropriate mRNA dose administered on or after August 31, 2022, for registrants who completed a primary series (2 doses of Pfizer-BioNTech, Moderna, or Novavax COVID-19 vaccine or 1 dose of Janssen).
† Percentage of registrants who reported a reaction or health impact at least once during days 0–7 postvaccination.

was unrelated to vaccination, 13 completed a VAERS report, and three did not wish to complete a VAERS report.

Review of VAERS Data

During August 31–October 23, 2022, VAERS received and processed 5,542 reports of adverse events among persons aged ≥12 years who reported receiving a bivalent booster dose (Table 3).¶¶¶ The median recipient age was 60 years (range = 12–101) and 3,559 (64.2%) were female; 939 (16.9%) reports indicated at least one other vaccine was received at the same visit as booster vaccination, of which influenza vaccine was most commonly co-administered (852; 90.7%).

Events related to vaccination errors (e.g., incorrect product formulation administered, incorrect dose administered, underdose, or wrong product administered) were commonly reported (1,913; 34.5%); among 877 reports of vaccination errors after receipt of Pfizer-BioNTech and 1,037 reports after receipt of Moderna bivalent booster doses, 225 (11.8%) reports indicated that an adverse health event had occurred.

Most VAERS reports (5,291; 95.5%) were classified as nonserious, including 2,762 (94.3%) after Pfizer-BioNTech and 2,530 (96.8%) after Moderna bivalent booster vaccination. The most commonly reported events among nonserious reports were headache (628; 11.9%), fatigue (575; 10.9%), fever (561; 10.6%), pain (524; 9.9%), and chills (459; 8.7%).

Among 251 VAERS reports classified as serious, five were reports of myocarditis, four were reports of pericarditis, and 20 were reports of COVID-19 disease. The age range of those who experienced myocarditis or pericarditis was 12–78 years and 46–78 years, respectively. Thirty-six deaths were reported; median age of decedents was 71 years (range = 46–98 years). For the four reports of death with sufficient information for review at the time of this report, cause of death included cardiac arrest, dementia, metastatic prostate cancer, and myocardial infarction. CDC has requested medical and vital records for the remaining decedents.

¶¶¶ Processed VAERS reports are those that have been coded using MedDRA, deduplicated, and undergone standard quality assurance and quality control review.

TABLE 3. Events* reported to the Vaccine Adverse Event Reporting System for persons aged ≥12 years† after receipt of a bivalent Pfizer-BioNTech or Moderna COVID-19 vaccine booster dose — United States, August 31–October 23, 2022

Adverse events	Vaccine, no. reporting (%)		
	Pfizer-BioNTech	Moderna	Total§
Total	**2,928**	**2,615**	**5,542**
Vaccination errors¶	**877 (30.0)**	**1,037 (39.7)**	**1,913 (34.5)**
Error without adverse health event	717 (81.8)	972 (93.7)	**1,688 (88.2)**
Error with adverse health event**	160 (18.2)	65 (6.3)	**225 (11.8)**
Error with nonserious health event††	157 (17.9)	61 (5.9)	**218 (11.4)**
Error with serious health event	3 (0.3)	4 (0.4)	**7 (0.4)**
Nonserious reports§§,¶¶	**2,762 (94.3)**	**2,530 (96.8)**	**5,291 (95.5)**
Headache	343 (12.4)	285 (11.3)	**628 (11.9)**
Fatigue	318 (11.5)	257 (10.2)	**575 (10.9)**
Fever	299 (10.8)	262 (10.4)	**561 (10.6)**
Pain	293 (10.6)	231 (9.1)	**524 (9.9)**
Chills	254 (9.2)	205 (8.1)	**459 (8.7)**
Pain in extremity	209 (7.8)	167 (6.6)	**376 (7.1)**
Nausea	213 (7.7)	144 (5.7)	**357 (6.8)**
Dizziness	212 (7.7)	135 (5.3)	**347 (6.6)**
Injection site pain	138 (5.0)	121 (4.8)	**259 (4.9)**
COVID-19	169 (6.1)	89 (3.5)	**258 (4.9)**
Serious reports*,†††	**166 (5.7)**	**85 (3.3)**	**251 (4.5)**
Allergic reaction/Anaphylaxis	6	2	**8**
Appendicitis	4	1	**5**
Arrythmia	8	5	**13**
Atrial fibrillation	5	4	**9**
Atrioventricular node block, second or third degree	2	0	**2**
Supraventricular tachycardia	0	1	**1**
Other	1	0	**1**
COVID-19	14	6	**20**
Death§§§	27	9	**36**
Dyspnea	4	1	**5**
Fall	1	6	**7**
Guillain-Barré syndrome	2	0	**2**
Hypertension, acute	7	3	**10**
Pericarditis¶¶¶	1	3	**4**
Pneumonia	6	1	**7**
Seizure	6	0	**6**
Thrombotic event	20	11	**31**
Stroke or transient ischemic attack	12	5	**17**
Pulmonary embolism	5	5	**10**
Other	3	1	**4**
Chest pain, not otherwise specified	9	3	**12**
Myocardial infarction	5	3	**8**
Myocarditis****	3	2	**5**

Abbreviations: MedDRA PT = Medical Dictionary for Regulatory Activities preferred term; VAERS = Vaccine Adverse Event Reporting System.

* Signs and symptoms in VAERS reports are assigned MedDRA PTs by VAERS staff members. Each VAERS report might be assigned more than one MedDRA PT, which can include normal diagnostic findings. A MedDRA PT does not indicate a medically confirmed diagnosis.

† On August 31, 2022, the Food and Drug Administration authorized bivalent formulations of Moderna and Pfizer-BioNTech COVID-19 vaccines for use as a single booster dose ≥2 months after completing primary or booster vaccination, Pfizer-BioNTech for persons aged ≥12 years and Moderna for adults aged ≥18 years.

§ One report was for a person who received both Moderna and Pfizer-BioNTech bivalent booster doses at the same visit and did not experience an adverse health event.

¶ Vaccine administration or handling errors.

** The most common MedDRA PTs among reports of vaccination error included incorrect product formulation administered, incorrect dose administered, underdose, and wrong product administered.

†† Adverse health events coded for reports with nonserious vaccination errors included arthralgia, headache, injection site erythema, injection site swelling, fever, pain, and pain in extremity.

§§ Excluding vaccination error MedDRA PTs.

¶¶ Includes the top 10 most frequently coded MedDRA PTs among nonserious reports.

*** VAERS reports are classified as serious if any of the following are reported: hospitalization, prolongation of hospitalization, life-threatening illness, permanent disability, congenital anomaly or birth defect, or death. Serious reports to VAERS were reviewed by CDC physicians to form preliminary clinical impressions. https://www.meddra.org/how-to-use/basics/hierarchy

††† Because of the small number of serious reports, percentages are not provided for serious report events. Other clinical impressions included acute pancreatitis, acute respiratory failure, aneurysm, arm pain, arthralgia, aseptic meningitis, bilateral pleural effusion, cellulitis, chronic anemia, compression fracture, confusion, contact dermatitis, costochondritis, erythema nodosum, fever, glaucoma, hearing loss, leukocytoplastic vasculitis, lower extremity weakness, lymphadenopathy, migraine, myalgia, pancreatitis, pericardial and pleural effusions, pericardial tamponade, pylephlebitis, rhabdomyolysis, unspecified bradycardia, unspecified tachycardia, transverse myelitis, vertigo, and vision loss.

§§§ For reports of death, cause of death was available for four reports: cardiac arrest, dementia, metastatic prostate cancer, and myocardial infarction.

¶¶¶ All four reports of pericarditis have been verified by medical record review.

**** Three of the five reports of myocarditis have been verified by medical record review.

Summary

What is already known about this topic?

CDC recommended bivalent COVID-19 booster vaccination for persons aged ≥12 years in August 2022; approximately 22.6 million bivalent booster doses were administered during August 31–October 23, 2022.

What is added by this report?

Early safety findings from v-safe and the Vaccine Adverse Event Reporting System for bivalent booster doses administered to persons aged ≥12 years during the first 7 weeks of vaccine availability are similar to those previously described for monovalent vaccine booster vaccines.

What are the implications for public health practice?

Adverse events reported after a bivalent booster dose appear consistent with those reported after a monovalent booster and are less common and less serious than health impacts associated with COVID-19 illness.

Discussion

This report provides findings from v-safe and VAERS data collected during the first 7 weeks of bivalent Pfizer-BioNTech and Moderna mRNA booster dose administration among persons aged ≥12 years, when 22.6 million booster doses were administered in the United States. The findings in this report are generally consistent with those from safety data from preauthorization clinical trials of a BA.1 Omicron bivalent booster vaccination.[****,††††]

Reporting frequencies of reactions and health impacts among the 211,959 v-safe registrants aged ≥12 years who received an age-appropriate bivalent booster vaccination are similar to those described after receipt of first and second booster vaccine doses among adults aged ≥50 years (*3*–*5*). Among adults aged ≥18 years, reporting frequencies of local and systemic reactions after bivalent booster vaccination decreased with increasing age. This reporting pattern was also observed for primary series COVID-19 vaccination; v-safe registrants aged ≥65 years reported reactions less frequently after primary series doses than did younger adults (*6*).

Most reports to VAERS for persons aged ≥12 years after a bivalent booster dose were nonserious (95.5%) and were usually similar to those after first booster vaccination and second booster vaccination among adults aged ≥50 years (*3*–*5*). Vaccination errors were among the most common events reported to VAERS (34.5%); most (88.2%) of which did not list an adverse health event. Continued education of vaccine providers could help reduce administration errors.

Myocarditis and pericarditis are rare adverse events associated with receipt of COVID-19 mRNA vaccines (*2*). To date, five reports of myocarditis and four reports of pericarditis after bivalent booster vaccination were received by VAERS following administration of 22.6 million doses among persons aged ≥12 years in the United States. Reporting rates of myocarditis following COVID-19 mRNA primary series and monovalent booster vaccination were highest among adolescent and young adult males; myocarditis rates after monovalent booster dose in these early data are similar to or lower than those after primary series doses (*2*,*7*). In one study, an increased risk of pericarditis was detected in the first week after the second dose of COVID-19 mRNA vaccines among males aged 12–50 years and females aged 30–50 years (*8*).

Among nonserious reports to VAERS were 258 (4.9%) reports of COVID-19 disease; there were 20 (8.0%) serious reports of COVID-19 disease. Vaccine effectiveness studies have shown that among persons who were diagnosed with COVID-19, previous vaccination with mRNA-based vaccines reduced COVID-19 disease severity, including the risk of hospitalization and death (*9*,*10*).

The findings in this report are subject to at least three limitations. First, v-safe is a voluntary program; therefore, data might not be representative of the vaccinated population. Second, as a passive surveillance system, VAERS is subject to reporting biases and underreporting, especially of nonserious events (*1*). Finally, conclusions drawn from these data are limited by the 7-week surveillance period; safety monitoring will continue during the bivalent booster vaccination program.

As of October 12, 2022, ACIP recommends that all persons aged ≥5 years receive an age-appropriate bivalent mRNA booster dose ≥2 months after completion of a COVID-19 primary series or receipt of a monovalent booster dose (*3*). Preliminary safety findings after bivalent booster vaccination among persons aged ≥12 years are similar to those after monovalent booster vaccination (*3*–*5*). Health care providers and patients can be reassured that adverse events reported after a bivalent booster dose are consistent with those reported after monovalent doses. Health impacts after COVID-19 vaccination are less frequent and less severe than those associated with COVID-19 illness. CDC and FDA will continue to monitor vaccine safety and will provide updates as needed to help guide COVID-19 vaccination recommendations.

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**** https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2022-09-01/07-COVID-Swanson-508.pdf

†††† https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2022-09-01/06-covid-miller-508.pdf

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Epidemiologic and Clinical Features of Children and Adolescents Aged <18 Years with Monkeypox — United States, May 17–September 24, 2022

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Data on monkeypox in children and adolescents aged <18 years are limited (*1*,*2*). During May 17–September 24, 2022, a total of 25,038 monkeypox cases were reported in the United States,† primarily among adult gay, bisexual, and other men who have sex with men (*3*). During this period, CDC and U.S. jurisdictional health departments identified *Monkeypox virus* (MPXV) infections in 83 persons aged <18 years, accounting for 0.3% of reported cases. Among 28 children aged 0–12 years with monkeypox, 64% were boys, and most had direct skin-to-skin contact with an adult with monkeypox who was caring for the child in a household setting. Among 55 adolescents aged 13–17 years, most were male (89%), and male-to-male sexual contact was the most common presumed exposure route (66%). Most children and adolescents with monkeypox were non-Hispanic Black or African American (Black) (47%) or Hispanic or Latino (Hispanic) (35%). Most (89%) were not hospitalized, none received intensive care unit (ICU)–level care, and none died. Monkeypox in children and adolescents remains rare in the United States. Ensuring equitable access to monkeypox vaccination, testing, and treatment is a critical public health priority. Vaccination for adolescents with risk factors and provision of prevention information for persons with monkeypox caring for children might prevent additional infections.

During May 17–September 24, 2022, children and adolescents who received a positive polymerase chain reaction (PCR) test result for MPXV, nonvariola *Orthopoxvirus* (NVO), or generic *Orthopoxvirus* (OPXV) were identified through national surveillance or during CDC clinical consultations. Demographic and exposure characteristics and clinical features of children and adolescents aged <18 years with monkeypox-compatible symptoms§ who received a positive NVO, OPXV, or MPXV PCR test result were analyzed. In cases for which PCR test cycle threshold (Ct) results were available, persons whose specimens had NVO, OPXV, or MPXV PCR Ct values ≥34 (potentially indicating a false positive test result) and who had atypical clinical features or no known epidemiologic risk factors¶ were excluded.

Data collected included age; sex; gender identity (among adolescents); race and ethnicity; exposure setting and risk behaviors; monkeypox symptoms and lesion distribution; receipt of JYNNEOS vaccine postexposure prophylaxis, tecovirimat (Tpoxx; SIGA Technologies), topical trifluridine (Viroptic; Pfizer Inc.), or vaccinia immune globulin intravenous (VIGIV; Cangene Corporation)**; and hospitalization status. Data were stratified by age group (0–4, 5–12, and 13–17 years). This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.††

During May 17–September 24, 2022, 83 MPXV infections were identified among children and adolescents aged <18 years, including 16 (19%) in children aged 0–4 years, 12 (14%) in children aged 5–12 years, and 55 (66%) in adolescents§§ (Table 1). Among 28 children aged 0–12 years, 18 (64%) were boys, and 10 (36%) were girls. Most adolescents were

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† https://www.cdc.gov/poxvirus/monkeypox/response/2022/us-map.html (Accessed October 4, 2022).

§ https://www.cdc.gov/poxvirus/monkeypox/symptoms.html

¶ https://www.cdc.gov/poxvirus/monkeypox/clinicians/case-definition.html

** https://www.fda.gov/news-events/press-announcements/monkeypox-update-fda-authorizes-emergency-use-jynneos-vaccine-increase-vaccine-supply; https://www.cdc.gov/poxvirus/monkeypox/clinicians/Tecovirimat.html; https://www.fda.gov/media/78174/download; https://www.cdc.gov/poxvirus/monkeypox/clinicians/ocular-infection.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.

§§ During the investigation period, CDC received notifications of 109 children and adolescents aged <18 years who received a positive PCR result for MPXV, NVO, or OPXV, among whom 26 cases were ruled out after further investigation based on high Ct values on NVO, OPXV, or MPXV PCR testing, negative repeat testing, or absence of epidemiological risk factors.

TABLE 1. Demographic and epidemiologic features of children and adolescents aged <18 years with monkeypox — United States, May 17–September 24, 2022

Characteristic*	No. (%) by age group, yrs			
	All (N = 83)	0–4 (n = 16)	5–12 (n = 12)	13–17 (n = 55)
Sex†				
Male	66 (80)	12 (75)	6 (50)	48 (89)
Female	16 (20)	4 (25)	6 (50)	6 (11)
Unknown, no.	1	0	0	1
Race or ethnicity				
Black, non-Hispanic or Latino	38 (47)	7 (44)	5 (42)	26 (49)
Hispanic or Latino	28 (35)	5 (31)	5 (42)	18 (34)
White, non-Hispanic or Latino	10 (12)	3 (19)	2 (17)	5 (9)
Asian, non-Hispanic or Latino	2 (2)	0 (—)	0 (—)	2 (4)
American Indian or Alaska Native, non-Hispanic or Latino	1 (1)	0 (—)	0 (—)	1 (2)
Native Hawaiian or other Pacific Islander, non-Hispanic or Latino	1 (1)	1 (6)	0 (—)	0 (—)
Other, non-Hispanic or Latino	1 (1)	0 (—)	0 (—)	1 (2)
Unknown, no.	2	0	0	2
Exposure setting and route				
Sexual contact§	34 (62)	0 (—)	0 (—)	34 (97)
Household contact¶	19 (35)	13 (93)	6 (100)	0 (—)
Other**	2 (4)	1 (7)	0 (—)	1 (3)
Unknown, no.	28	2	6	20

* Percentages were calculated using nonmissing data.

† Reported as sex assigned at birth. Gender identity was known for 25 (45%) adolescents. One adolescent whose assigned sex at birth was female identified as a transgender male.

§ For these persons, all of whom were aged ≥15 years, direct skin-to-skin sexual contact was the presumed mode of spread. Among 48 male adolescents, 23 (48%) reported male-to-male sexual contact, four (8%) reported sexual contact with a female, and five (10%) reported sexual contact with a person whose sex was not specified. One female adolescent reported recent sexual encounters with a male, but further details were unavailable; another adolescent who identified as a transgender person or teen reported recent sexual contact with a male adolescent.

¶ In 17 cases among children aged 0–12 years, direct skin-to-skin contact occurred between the child and an adult with monkeypox who was caring for the child in the setting of routine caregiving activities. In one instance, no direct skin-to-skin contact was noted, but the child shared a living space with the index patient, likely with frequent contact with shared materials (e.g., towels). In the remaining instance, further details about the exposure were unavailable.

** In one instance, direct skin-to-skin contact occurred with an adult with monkeypox who held the child, but the exposure occurred outside the household setting. In another instance, an adolescent shared a bed with another adolescent who had a rash, but further details were unavailable.

male (48; 89%), six (11%) were female, and information on sex was missing for one. Overall, 38 (47%) children and adolescents were Black, 28 (35%) were Hispanic, 10 (12%) were non-Hispanic White, and five (6%) were of another race and ethnicity; data on race and ethnicity were missing for two.

Among 20 (71%) children aged 0–12 years with available exposure data, 19 were exposed in the household setting; for 17 of these children, the reported exposure was direct skin-to-skin contact that routinely occurs between a child and an adult caregiver. In another instance, fomite transmission (e.g., towels shared with a caregiver with monkeypox) was the suspected route of exposure because the index patient and the child had shared a living space without direct skin-to-skin contact. In the remaining instance, further information about the exposure was unavailable. One nonhousehold exposure occurred when an adult with monkeypox held a child outside the household setting. In two instances, adult caregivers contracted monkeypox after caring for children with monkeypox in household settings; the suspected exposure routes were skin-to-skin contact during diapering and other routine child care activities.

Among 35 (64%) adolescents with available exposure data, 32 were males with direct skin-to-skin sexual contact as the presumed mode of spread: 23 (72%) reported male-to-male sexual contact, four (13%) reported male-to-female sexual contact, and five (16%) reported sexual contact with a person whose sex was not specified. One female adolescent reported recent sexual contact with a male adolescent, but further details were unavailable; another adolescent who identified as a transgender male reported recent sexual contact with a male adolescent. One female adolescent had shared a bed with another adolescent who had a rash, but further details were unavailable.

Among the 28 children aged 0–12 years with monkeypox, lesions most commonly occurred on the trunk; no child had anogenital lesions; 10 (36%) received tecovirimat, one (4%) received VIGIV, and three (11%) received topical trifluridine (Table 2). Two children aged 0–4 years were hospitalized with diffuse rash and eyelid involvement; both recovered without complications and were discharged.¶¶ One child aged 5–12 years was hospitalized for periorbital cellulitis and conjunctivitis; this child received oral tecovirimat and topical trifluridine and recovered.

Among the 55 adolescents, lesions most commonly occurred on the trunk (33, 60%) and the genitals or perianal area (33, 60%). Eight (15%) received tecovirimat. Six (11%) adolescent patients were hospitalized. For five adolescent patients, reasons for hospitalization included pain management, treatment of secondary bacterial infections, and systemic symptoms with rash; three of these adolescents received oral tecovirimat, and whether the other two received tecovirimat is unknown; one adolescent received a new diagnosis of HIV infection during hospitalization. Another adolescent was hospitalized to ensure adequate isolation but had mild symptoms and did not receive monkeypox-directed therapies. All adolescents were discharged and recovered.

¶¶ These children were aged <1 year. Both received oral tecovirimat, and both also received topical trifluridine as potential prophylaxis for ocular monkeypox. One received VIGIV because of their very young age (infant), their immature immune system, and certain other factors.

Summary

What is already known about this topic?

Data on epidemiologic and clinical characteristics of monkeypox in persons aged ≤12 years (children) and adolescents during the ongoing 2022 monkeypox outbreak are limited.

What is added by this report?

During May 17–September 24, 2022, *Monkeypox virus* (MPXV) infections in children and adolescents aged <18 years were rare, representing 0.3% of all U.S. cases; none resulted in critical illness or death. Younger children typically acquired MPXV infection after skin-to-skin contact with a household member with monkeypox during caregiving activities; adolescents were most frequently exposed through male-to-male sexual contact.

What are the implications for public health practice?

Additional monkeypox cases in children and adolescents might be prevented through strengthened vaccination efforts and education around preventive measures and sexual health.

Overall, no children or adolescents received ICU-level care or died. No reported case during the investigation timeframe was known to be associated with sexual abuse.

Ten distinct instances were investigated in which a child or adolescent with monkeypox attended a child care facility (two) or school (eight) while symptomatic; no instance of secondary transmission in these settings was identified. JYNNEOS vaccination was offered to close contacts in at least four situations, and in one instance more than 15 other students and staff members received JYNNEOS postexposure prophylaxis.

Discussion

MPXV infections in children and adolescents during May 17–September 24, 2022, constituted a small percentage (0.3%) of total U.S. monkeypox cases, and no children or adolescents with monkeypox received ICU-level care or died. However, consistent with disparities observed during the ongoing monkeypox epidemic (*3*), which are likely related to longstanding inequities in the social determinants of health,*** monkeypox in children and adolescents occurred disproportionately among Black and Hispanic children and adolescents compared with U.S. race and ethnicity percentage distributions of persons aged <18 years.††† This finding underscores the continued need for public health efforts to ensure equitable access to monkeypox vaccination, testing, treatment, and information about prevention measures. Similar to findings reported from Spain (*1*), exposure characteristics differed between younger children and adolescents: younger children most often acquired infection after direct skin-to-skin contact with a caregiver or household member known to have monkeypox, whereas exposure characteristics among adolescents were similar to those most commonly reported among adults (i.e., sexual contact) (*3*). Adults with monkeypox who interact with children in the household setting should follow transmission prevention guidelines, which outline measures to prevent the spread of monkeypox in households (*4*), and caregivers who are symptomatic and believe they might have been exposed should try to limit skin-to-skin contact with children, including by covering lesions. In addition, health care providers caring for sexually active adolescents, particularly males who have male-to-male

*** https://www.cdc.gov/socialdeterminants/about.html
††† https://www.childstats.gov/americaschildren/glance.asp

TABLE 2. Clinical features and treatment of children and adolescents aged <18 years with monkeypox — United States, May 17–September 24, 2022

Characteristic*	No. (%) by age group, yrs			
	All (N = 83)	0–4 (n = 16)	5–12 (n = 12)	13–17 (n = 55)
Condition				
Immunocompromise†	2 (2)	0 (—)	0 (—)	2 (4)
Atopic dermatitis or other exfoliative condition	6 (7)	3 (19)	1 (8)	2 (4)
Symptom				
Rash§	83 (100)	16 (100)	12 (100)	55 (100)
Fever	29 (35)	4 (25)	3 (25)	22 (40)
Malaise	30 (36)	4 (25)	3 (25)	23 (42)
Lymphadenopathy	24 (29)	3 (19)	2 (17)	19 (35)
Location of lesion¶				
Head, face, mouth, or eyes**	34 (41)	7 (44)	3 (25)	24 (44)
Trunk	46 (55)	9 (56)	4 (33)	33 (60)
Extremities	26 (31)	5 (31)	4 (33)	17 (31)
Genitals or perianal area	33 (40)	0 (—)	0 (—)	33 (60)
No. of lesions				
<5	6 (19)	4 (44)	1 (25)	1 (5)
5–10	12 (38)	2 (22)	1 (25)	9 (47)
11–20	9 (28)	2 (22)	2 (50)	5 (26)
>20	5 (16)	1 (11)	0 (—)	4 (21)
Unknown	51	7	8	36
Treatment administered				
Tecovirimat††	18 (22)	8 (50)	2 (17)	8 (15)
Vaccinia immune globulin intravenous	1 (1)	1 (6)	0 (—)	0 (—)
JYNNEOS§§	2 (2)	0 (—)	0 (—)	2 (4)
Outcomes				
Hospitalization	9 (11)	2 (13)	1 (8)	6 (11)
Death	0 (—)	0 (—)	0 (—)	0 (—)

* Percentages calculated using nonmissing data.
† Two adolescents had recently received a diagnosis of HIV infection; one received this diagnosis while hospitalized with monkeypox, and the other received the diagnosis in an outpatient setting.
§ Rash was part of the case definition and is typically required for monkeypox testing.
¶ Lesions could occur on more than one body site.
** Included two children aged 0–4 years who had eyelid involvement and received topical trifluridine as potential prophylaxis for ocular monkeypox and one child aged 5–12 years who received topical trifluridine for conjunctivitis.
†† Eighteen persons received oral tecovirimat, including six of the nine persons who were hospitalized; one hospitalized adolescent aged 13–17 years initially received intravenous tecovirimat before being switched to oral tecovirimat.
§§ One adolescent received JYNNEOS as postexposure prophylaxis 6 days before the onset of monkeypox symptoms; the timing of JYNNEOS receipt was unknown for the other adolescent.

sexual contact, should consider offering vaccination, should provide education on prevention of monkeypox, and should provide testing for HIV and other STIs (*5*).

Limited data, based on infections involving Clade I MPXV rather than the Clade IIb virus causing the current epidemic, suggested that children aged <8 years might be at higher risk for severe disease than are older persons (*6*,*7*). However, the clinical signs and symptoms reported in children and adolescents in this report were broadly similar to findings from Spain and U.S. national surveillance data for cases overall (*1*,*3*), with most children experiencing a mild-to-moderate clinical course. Clinicians caring for children and adolescents should be aware of available clinical guidance for the diagnosis and treatment of monkeypox[§§§] and of the potential for severe disease, particularly in persons with profound immunocompromise (e.g., those with advanced HIV disease or undergoing chemotherapy for cancer) (*8*).

No secondary transmission was identified during instances when children attended school or a child care facility while symptomatic, although incomplete case ascertainment and reporting might have limited detection of such events. The absence of known secondary transmission in schools and child care facilities despite the presence of symptomatic persons in these settings suggests that widespread child-to-child transmission might be unlikely.[¶¶¶] Regardless of age, contacts of persons with monkeypox should be monitored, and JYNNEOS vaccination postexposure prophylaxis should be considered based on an exposure risk assessment and individual risk for severe disease (*7*,*9*).

The findings in this report are subject to at least three limitations. First, data regarding exposure characteristics were missing for one third (34%) of children and adolescents aged <18 years, potentially because of difficulty reaching caregivers or adolescents for interviews or interviewee reluctance to disclose potentially sensitive information because of fear of stigma. Second, exposure misclassification might have occurred because of recall or social desirability bias. Finally, this report could potentially underestimate the number of MPXV infections occurring if children and adolescents aged <18 years with monkeypox did not receive testing. Nonetheless, caution is needed when ordering monkeypox tests and interpreting laboratory results for persons with low pretest probability of infection, because false positive test results can lead to unnecessary or inappropriate medical treatment (*10*).

[§§§] https://www.cdc.gov/poxvirus/monkeypox/clinicians/treatment.html
[¶¶¶] https://www.cdc.gov/poxvirus/monkeypox/community/school-faq.html

This analysis found that monkeypox in children and adolescents aged <18 years has been rare during the current outbreak and most infections were not severe. Public health messaging should emphasize transmission prevention guidelines for persons with monkeypox who interact with newborns, infants, and children in household settings (*4*,*9*). In addition, health care providers caring for sexually active adolescents, particularly male adolescents who have male-to-male sexual contact, should encourage vaccination for eligible persons and should provide testing for HIV and other sexually transmitted diseases.

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Severe Monkeypox in Hospitalized Patients — United States, August 10–October 10, 2022

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As of October 21, 2022, a total of 27,884 monkeypox cases (confirmed and probable) have been reported in the United States.§ Gay, bisexual, and other men who have sex with men have constituted a majority of cases, and persons with HIV infection and those from racial and ethnic minority groups have been disproportionately affected (*1*,*2*). During previous monkeypox outbreaks, severe manifestations of disease and poor outcomes have been reported among persons with HIV infection, particularly those with AIDS (*3*–*5*). This report summarizes findings from CDC clinical consultations provided for 57 patients aged ≥18 years who were hospitalized with severe manifestations of monkeypox¶ during August 10–October 10, 2022, and highlights three clinically representative cases. Overall, 47 (82%) patients had HIV infection, four (9%) of whom were receiving antiretroviral therapy (ART) before monkeypox diagnosis. Most patients were male (95%) and 68% were non-Hispanic Black (Black). Overall, 17 (30%) patients received intensive care unit (ICU)–level care, and 12 (21%) have died. As of this report, monkeypox was a cause of death or contributing factor in five of these deaths; six deaths remain under investigation to determine whether monkeypox was a causal or contributing factor; and in one death, monkeypox was not a cause or contributing factor.** Health care providers and public health professionals should be aware that severe morbidity and mortality associated with monkeypox have been observed during the current outbreak in the United States (*6*,*7*), particularly among highly immunocompromised persons. Providers should test all sexually active patients with suspected monkeypox for HIV at the time of monkeypox testing unless a patient is already known to have HIV infection. Providers should consider early commencement and extended duration of monkeypox-directed therapy†† in highly immunocompromised patients with suspected or laboratory-diagnosed monkeypox.§§ Engaging all persons with HIV in sustained care remains a critical public health priority.

During the ongoing monkeypox outbreak, CDC has provided consultation upon request to jurisdictions and clinicians treating patients with monkeypox.¶¶ This report describes the patients from these consultations who were aged ≥18 years and were hospitalized with probable or confirmed monkeypox during August 10–October 10, 2022; the report includes detailed histories for three patients who experienced severe manifestations of monkeypox. CDC obtained data on patient demographic characteristics, clinical course, and outcomes during consultation with health departments or providers. Patient permission for the use of clinical images was obtained. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.***

During August 10–October 10, 2022, CDC provided consultation for 57 patients aged ≥18 years who were hospitalized with severe manifestations of monkeypox (Table 1). Among 57 patients, 54 (95%) were male, and the median age was

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§ https://www.cdc.gov/poxvirus/monkeypox/response/2022/us-map.html
¶ A list of severe manifestations of monkeypox can be found at https://emergency.cdc.gov/han/2022/han00475.asp.
** During the study period and as of October 21, 2022, CDC was notified by state and local jurisdictions of five decedents whose death certificates included monkeypox as a cause of death or contributing factor, six decedents whose cause of death is still under active investigation, and one decedent in whom the death was not monkeypox-related. Additional monkeypox cases involving severe disease or death might not be included in this report if CDC has not yet been notified about the case or if the case occurred outside of the study period. https://www.cdc.gov/poxvirus/monkeypox/response/2022/index.html
†† https://www.cdc.gov/poxvirus/monkeypox/clinicians/treatment.html
§§ https://www.cdc.gov/poxvirus/monkeypox/clinicians/case-definition.html
¶¶ CDC offers a monkeypox clinical consultation service for the ongoing monkeypox outbreak. Health care providers seeking additional clinical guidance can contact the CDC Emergency Operations by phone (770-488-7100) or by email (eocevent482@cdc.gov).
*** 45 C.F.R. part 46.102(l)(2), 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.

TABLE 1. Characteristics of hospitalized patients with severe manifestations of monkeypox* for whom CDC provided clinical consultation (N = 57) — United States, August 10–October 10, 2022

Characteristic	No. (%)
Median age, yrs (range)	34 (20–61)
Sex	
Male	54 (94.7)
Race and ethnicity	
Black or African American, non-Hispanic	39 (68.4)
White, non-Hispanic	8 (14.0)
Hispanic or Latino	8 (14.0)
Asian, non-Hispanic	1 (1.8)
Multiple races, non-Hispanic	1 (1.8)
Experiencing homelessness†	13 (22.8)
Any immunocompromising condition§	51 (89.5)
HIV infection	47 (82.5)
History of solid organ transplantation	3 (5.3)
Hematologic malignancy (current chemotherapy)	2 (3.5)
Pregnant	3 (5.3)
Clinical manifestation¶	
Dermatologic	57 (100.0)
Mucosal**	39 (68.4)
Pulmonary	12 (21.1)
Ocular	12 (21.1)
Deep tissue (muscle or bone)	5 (8.8)
Neurologic	4 (7.0)
Monkeypox-directed therapy††	
Tecovirimat (oral)	53 (93.0)
Tecovirimat (intravenous)	37 (64.9)
VIGIV	29 (50.9)
Cidofovir††	13 (22.8)
Received ICU-level care	17 (29.8)
STI coinfection§§	16 (28.1)

Abbreviations: ICU = intensive care unit; STI = sexually transmitted infection, VIGIV = vaccinia immune globulin intravenous.

* Severe manifestations of monkeypox include, but are not limited to, the clinical findings listed at https://emergency.cdc.gov/han/2022/han00475.asp.

† Homelessness was defined by the clinician caring for the patient and included the experience of both sheltered and unsheltered homelessness. https://www.cdc.gov/ddid/homelessness/definition.html

§ One patient had HIV infection and was receiving chemotherapy for a hematologic malignancy.

¶ Patients could experience more than one clinical manifestation.

** Mucosal involvement might include oral, urethral, rectal, vaginal, or other lesions.

†† Patients could receive more than one treatment. All patients who received VIGIV or cidofovir also received tecovirimat.

§§ STI coinfection included concurrent diagnosis of syphilis, gonorrhea, chlamydia, herpes simplex virus type 2, or shigellosis.

34 years (range = 20–61 years). Forty-seven (82%) had HIV infection; among these patients, 31 (72%) of 43 with a known CD4 count had <50 CD4 cells/mm^3 (Table 2). Two patients (4%), one of whom had HIV infection, were undergoing chemotherapy for a hematologic malignancy, three (5%) were solid organ transplant recipients, and three (5%) were pregnant. Overall, most patients were Black (68%), and 13 (23%) were experiencing homelessness.†††

††† Homelessness was defined by the clinician caring for the patient and included the experience of both sheltered and unsheltered homelessness. https://www.cdc.gov/ddid/homelessness/definition.html

TABLE 2. Laboratory and treatment characteristics of hospitalized patients with HIV infection and severe monkeypox* for whom CDC provided clinical consultation (N = 47) — United States, August 10–October 10, 2022

Characteristic (no. with information available)	No. (%)
HIV CD4, cells/mm^3 (43)	
<50	31 (72.1)
50–200	9 (20.9)
>200	3 (7.0)
HIV Treatment (47)	
On ART at the time of monkeypox diagnosis	4 (8.5)

Abbreviation: ART = antiretroviral therapy.

* Severe manifestations of monkeypox include, but are not limited to, the clinical findings listed at https://emergency.cdc.gov/han/2022/han00475.asp.

All patients had severe dermatologic manifestations, and 39 (68%) also had severe mucosal lesions (Table 1). Some experienced involvement of other organs, including the lungs (12, 21%), eyes (12, 21%), and brain or spinal cord (four, 7%). Overall, 53 (93%) patients received oral tecovirimat, and 37 (65%) received intravenous tecovirimat; 29 (51%) patients received vaccinia immune globulin intravenous (VIGIV),§§§ and 13 (23%) received intravenous cidofovir. All patients who received cidofovir or VIGIV also received tecovirimat. Seventeen (30%) patients received ICU-level care and 12 (21%) died: monkeypox was a cause of death or contributing factor in five of these cases, six deaths remain under investigation to determine whether monkeypox was a causal or contributing factor, and in one death, monkeypox was not a cause or contributing factor.

Representative Case Descriptions

Patient A. In August 2022, a Hispanic or Latino man in his 20s with no known past medical history was evaluated at an emergency department for back pain and a diffuse rash (location not specified). He was prescribed a course of prednisone for the back pain. Swabs were taken from the lesions to test for *Orthopoxvirus* (OPXV) by PCR, and the results were positive two days later. Over the next week, the patient's rash progressed to involve his entire body. He was admitted to a hospital after being evaluated for dyspnea on exertion, dry cough, persistent back pain, and painful left neck swelling. On admission, he was febrile (102.8°F [39.3°C]), and he had a diffuse rash with central ulcerations as well as eschars on his face, trunk, and extremities; oral lesions; and a left neck mass. Laboratory results

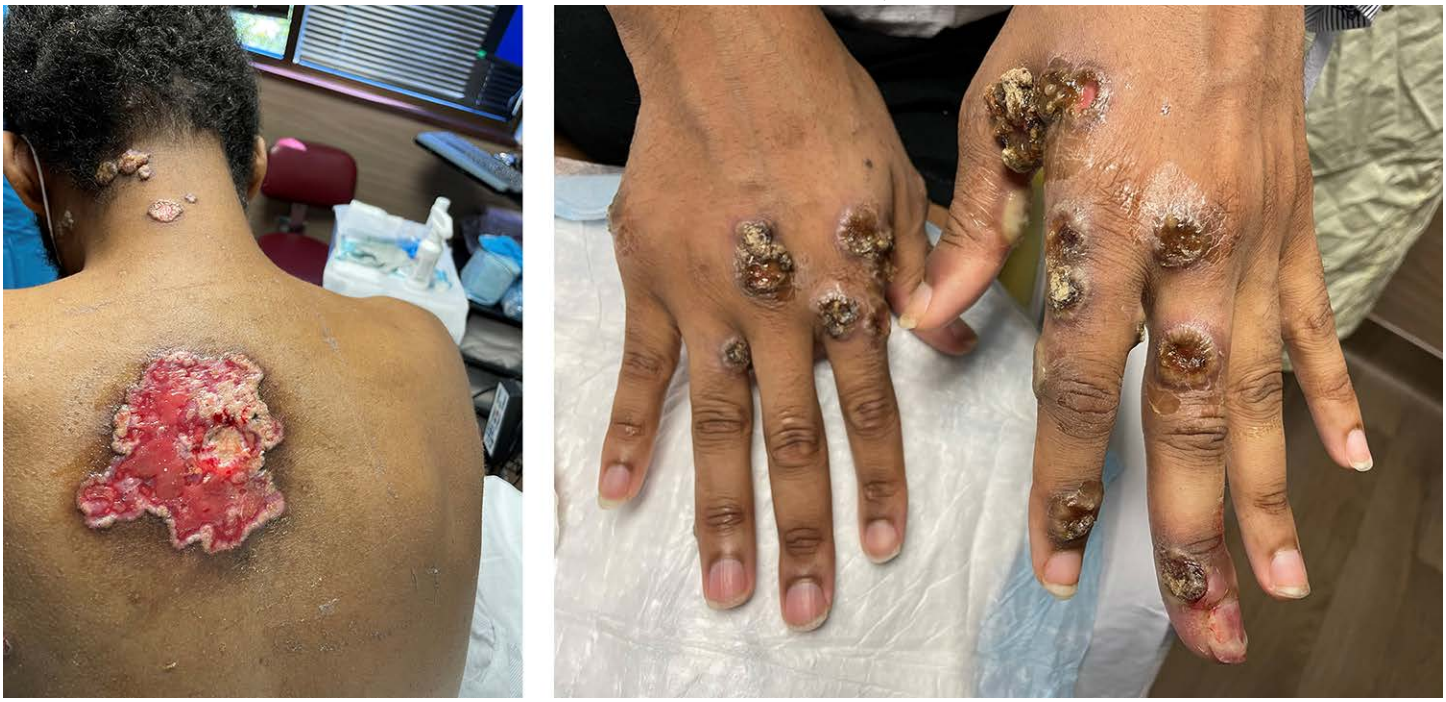
§§§ Tecovirimat, an FDA-approved treatment for smallpox, demonstrated efficacy against monkeypox in animal studies. Interim CDC guidance currently recommends that tecovirimat be considered in patients with severe monkeypox, those at high risk for severe disease, or those whose infection involves anatomic areas where monkeypox virus infection might constitute a special hazard (e.g., the eyes, pharynx, genitals, or anus). VIGIV has been used to treat complications from vaccinia vaccination. CDC holds an expanded access investigative new drug protocol that allows the use of VIGIV for the treatment of orthopoxviruses (including monkeypox) in an outbreak. https://www.fda.gov/media/78174/download

indicated a positive test result for HIV (CD4 = 79 cells/mm^3, CD4 T-lymphocyte percentage 3%). According to state reporting, the patient had received a positive HIV test result in 2020 but was subsequently lost to follow-up. A computed tomography scan of his neck identified a 6.9 x 7.7 x 9.8–cm mass and extensive bilateral cervical lymphadenopathy. On hospital day 2, the patient became somnolent and was transferred to ICU; the next day, he was intubated for airway protection and received intravenous tecovirimat. He developed vasopressor-resistant hypotension, experienced a seizure, and went into kidney failure. During the next several days he was treated with vasopressors, antiepileptics, antibiotics, and antifungals, and required cardiopulmonary resuscitation. An extensive evaluation for infectious agents other than OPXV and HIV was negative. On the second day in ICU, he received 1 dose of VIGIV. Two days later, a brain scan indicated poor perfusion. The family elected to transition the patient to comfort measures. He was terminally extubated. An autopsy was conducted, with pathologic findings of necrosis in multiple tissues consistent with diffuse monkeypox. Immunohistochemistry testing demonstrated extensive orthopoxviral antigen in multiple tissues. Cytomegalovirus antigen was also detected in some tissues.¶¶¶

¶¶¶ Microscopic examination of autopsy tissues at the hospital and CDC showed findings consistent with diffuse monkeypox in specimens from a foot skin lesion, abdomen skin lesion, lip, vocal cord, lung, esophagus, mediastinal lymph nodes, and rectal mass. CDC performed immunohistochemistry testing that demonstrated extensive orthopoxviral antigen in multiple skin and mucosal tissues and in liver, pancreas, testis, adrenal gland, lung, and multiple lymph nodes. Cytomegalovirus antigen was also detected in a subset of skin, mucosal, and lymph node tissues.

Patient B. In July 2022, a Black man in his 30s with AIDS (CD4 <10 cells/mm^3) and not receiving ART developed a rash on his face, head, back, and genitals. At multiple subsequent clinic visits, he was tested and treated for gonorrhea, chlamydia, and syphilis; however, his genital lesions progressed, and he experienced phimosis and urinary retention for which he was admitted to a hospital 4 weeks after his rash began. A lesion swab taken the day of admission tested positive for *Monkeypox virus* (MPXV) DNA by PCR. The patient was discharged with a urinary catheter and 14 days of oral tecovirimat (Supplementary Figure 1; https://stacks.cdc.gov/view/cdc/121838). His skin lesions initially improved, but then spread, coalesced, and developed central necrosis (Figure) (Supplementary Figure 2, https://stacks.cdc.gov/view/cdc/121835). A suprapubic catheter was placed because of continued need for urinary catheterization. Approximately 10 days after discharge, the patient was readmitted with malaise, poor appetite, weight loss, and new hand and penile lesions. During a 15-day hospitalization, the patient was found to have methicillin-resistant *Staphylococcus aureus* bacteremia. He was transferred to ICU because of atrial fibrillation with rapid ventricular response. In ICU he was treated with intravenous tecovirimat, 2 doses of VIGIV, and antimicrobials. Conjunctivitis developed and was treated with trifluridine and antibacterial eye drops. The patient was discharged on oral tecovirimat and ART and with a suprapubic catheter.

FIGURE. Disseminated lesions on the back and hands of a patient* with severe monkeypox — United States, August 10–October 10, 2022



Photos/Alexandra Dretler
* Patient has consented to the publication of these photographs.

Summary

What is already known about this topic?

Severe manifestations of monkeypox in immunocompromised persons have been observed in previous outbreaks.

What is added by this report?

During August–October 2022, CDC provided clinical consultation for 57 hospitalized patients with severe manifestations of monkeypox, most of whom were Black men with AIDS. Delays were observed in initiation of monkeypox-directed therapies. Twelve patients died, and monkeypox was a cause of death or contributing factor in five patients to date, with several other deaths still under investigation.

What are the implications for public health practice?

Clinicians should consider early treatment with available therapeutics for those at risk for severe monkeypox disease, particularly patients with AIDS. Engaging all persons with HIV in care remains a critical public health priority.

During week 7 of oral tecovirimat, he was readmitted because of progressive necrotic lesions with bacterial superinfection on the left hand, left eyelid lesions with periorbital swelling, and a right ear canal lesion associated with drainage and decreased hearing. He was restarted on intravenous tecovirimat and continues this treatment as of this report.

Patient C. In July 2022, a non-Hispanic White man in his 40s with AIDS (CD4 <10 cells/mm^3) and not receiving ART was evaluated for a rash on his face, torso, hands, feet, and perianal area; lesion swabs tested positive for MPXV DNA by PCR. He was admitted to a hospital for pain control and received oral tecovirimat and ART. The patient experienced pain relief and was discharged after 7 days to complete 14 days of tecovirimat. However, his housing and food situations were unstable, and absorption of oral tecovirimat is dependent on concurrent intake of a full, fatty meal. Approximately 3 weeks after discharge, he was readmitted with coalescing, painful, and necrotic lesions on his hands and feet. Despite treatment with oral and intravenous tecovirimat for >4 weeks, 2 doses of cidofovir, 1 dose of VIGIV, and multiple antibiotics, progressive tissue necrosis led to debridement of the soft tissues of the right index finger and amputation of the right fourth toe. Gradually, the monkeypox lesions regressed. He was discharged but was readmitted 1 week later for unresolved lesions and severe pain. He received a second dose of VIGIV and remains hospitalized on oral tecovirimat and ART as of this report.

Discussion

Although most monkeypox cases during the ongoing outbreak have been self-limited (*2*,*8*), this report highlights the occurrence of severe manifestations of monkeypox in the United States, particularly in persons with AIDS. In this cohort of patients hospitalized with monkeypox and for whom clinicians or jurisdictions sought consultations with CDC, nearly one third (30%) received ICU-level care, and 21% of patients died, including several deaths that remain under investigation to determine the cause of death. Most patients eventually received tecovirimat, but some experienced delays of up to 4 weeks between initial care-seeking for monkeypox symptoms and initiation of monkeypox-directed therapy. For patients with suspected or laboratory-diagnosed monkeypox who are at risk for severe disease (particularly those with AIDS and other types of severe immunocompromise), health care providers should consider starting monkeypox-directed therapy early, potentially before receipt of monkeypox testing results or before severe manifestations are observed. In patients with severe disease, or with ongoing disease despite treatment, providers should consider extending tecovirimat treatment beyond 14 days and escalating therapy to include cidofovir or VIGIV if clinically indicated (*9*). For patients with HIV disease who are not on ART, clinicians should initiate ART as soon as possible, regardless of CD4 cell count.**** Health care providers should test all sexually active patients with suspected monkeypox for HIV at the time of testing for monkeypox unless a patient is already known to have HIV infection.

Most patients in this cohort were Black men, and nearly one quarter of cases occurred in persons experiencing homelessness. These findings likely reflect inequities in access to resources for the prevention, early diagnosis, and treatment of HIV infection, as well as missed opportunities to engage groups that have been socially or economically marginalized.†††† Public health outreach should strive to engage all persons with HIV infection in care and to increase access to monkeypox vaccination, diagnosis, and treatment. To accomplish these goals, it is critical to leverage existing HIV and sexually transmitted infection program resources and prioritize communities disproportionately affected by HIV (*1*). Collaboration with homeless services providers can help engage persons who are experiencing homelessness in prevention and treatment services for HIV and monkeypox.

The findings in this report are subject to at least four limitations. First, cases were passively identified by CDC through consultations requested by clinicians or jurisdictions and might not be representative of all patients with severe monkeypox. Second, this report only included outcomes occurring during the study period; therefore, deaths occurring after this period were not included. Third, observed morbidity and mortality might have been related to factors apart from or in addition to monkeypox, including HIV-related opportunistic infections.

**** https://www.cdc.gov/hiv/clinicians/treatment/treatment-clinicians.html

†††† https://www.hiv.gov/hiv-basics/overview/about-hiv-and-aids/who-is-at-risk-for-hiv

Finally, conclusions about the effectiveness of monkeypox treatments cannot be inferred from these observational data.

The occurrence of severe manifestations of monkeypox in patients who were most commonly immunocompromised because of AIDS highlights the importance of engaging all persons with HIV in sustained care and ending the HIV epidemic. Clinicians should consider close clinical monitoring, early treatment with available medical countermeasures, and extension or escalation of therapy as indicated in patients with or at risk for severe monkeypox. Ensuring equitable access to resources for the diagnosis, treatment, and prevention of HIV and monkeypox remains a vital public health priority.

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Wastewater Testing and Detection of Poliovirus Type 2 Genetically Linked to Virus Isolated from a Paralytic Polio Case — New York, March 9–October 11, 2022

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In July 2022, a case of paralytic poliomyelitis resulting from infection with vaccine-derived poliovirus (VDPV) type 2 (VDPV2)[§] was confirmed in an unvaccinated adult resident of Rockland County, New York (*1*). As of August 10, 2022, poliovirus type 2 (PV2)[¶] genetically linked to this VDPV2 had been detected in wastewater[**] in Rockland County and neighboring Orange County (*1*). This report describes the results of additional poliovirus testing of wastewater samples collected during March 9–October 11, 2022, and tested as of October 20, 2022, from 48 sewersheds (the community area served by a wastewater collection system) serving parts of Rockland County and 12 surrounding counties. Among 1,076 wastewater samples collected, 89 (8.3%) from 10 sewersheds tested positive for PV2. As part of a broad epidemiologic investigation, wastewater testing can provide information about where poliovirus might be circulating in a community in which a paralytic case has been identified; however, the most important public health actions for preventing paralytic poliomyelitis in the United States remain ongoing case detection through national acute flaccid myelitis (AFM) surveillance[††] and improving vaccination coverage in undervaccinated communities. Although most persons in the United States are sufficiently immunized, unvaccinated or undervaccinated persons living or working in Kings, Orange, Queens, Rockland, or Sullivan counties, New York should complete the polio vaccination series as soon as possible.

High rates of poliovirus vaccination coverage (*2*) resulted in the elimination of paralytic polio caused by wild-type poliovirus in the United States in 1979.[§§] Only inactivated polio vaccine (IPV) has been used in the United States since 2000; 3 doses of IPV confer 99%–100% protection from paralytic poliomyelitis (*3*). Some countries still use oral poliovirus vaccine (OPV); advantages to this approach include low cost, ease of use, and high efficacy in stopping outbreaks. However, in rare cases, the live attenuated virus in OPV can regain neurovirulence, circulate in underimmunized populations, and cause paralytic disease. A previous report confirmed that paralysis of the Rockland County patient resulted from infection with VDPV2, and that related viruses had been detected in wastewater collected from Orange and Rockland counties (*1*). Since then, the New York State Department of Health (NYSDOH); Nassau, Orange, Putnam, Rockland, Suffolk, Sullivan, Ulster, and Westchester counties' health departments; New York City Department of Health and Mental Hygiene (NYC DOHMH); New York City Department of Environmental Protection; and CDC have expanded poliovirus wastewater testing as part of an emergency response. This report summarizes findings from the more extensive wastewater testing conducted in the New York metropolitan area as part of investigations to understand the extent of poliovirus circulation and to direct polio vaccination efforts.

Wastewater samples, including some originally collected for SARS-CoV-2 surveillance, were collected from a subset of sewersheds during March 9–October 11, 2022. Samples were collected approximately once or twice weekly from each site. Wastewater samples were processed using either

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§ A VDPV is a strain related to the attenuated live poliovirus contained in OPV. VDPV2s are OPV virus strains that are >0.6% divergent (or at least six nucleotide changes) from the OPV2 strain in the complete VP1 genomic region. https://polioeradication.org/wp-content/uploads/2016/09/Reporting-and-Classification-of-VDPVs_Aug2016_EN.pdf

¶ The term PV2, referring to all serotype 2 polioviruses, is used throughout the report to indicate either a confirmed VDPV2 or a type 2 Sabin-like virus that is genetically related to the Rockland County patient. A Sabin-like poliovirus is a poliovirus that is related to one of the Sabin vaccine strains and whose nucleotide sequence in the genome region encoding the VP1 capsid protein differs from the related Sabin strain by 0–5 nucleotides for type 2 or by 0–9 nucleotides, for types 1 and 3.

** Wastewater, also referred to as sewage, includes water from household or building use (e.g., toilets, showers, and sinks) that can contain human fecal waste and water from nonhousehold sources (e.g., rain and industrial use); it does not include open drains or potable water. https://www.cdc.gov/healthywater/surveillance/wastewater-surveillance/wastewater-surveillance.html#how-wastewater-surveillance-works

†† https://www.cdc.gov/acute-flaccid-myelitis/index.html

§§ Since 1979, no cases of polio caused by wild poliovirus have originated in the United States. https://www.cdc.gov/polio/what-is-polio/polio-us.html

ultracentrifugation or polyethylene glycol precipitation followed by nucleic acid extraction. The extracts were forwarded to the Wadsworth Center (part of NYSDOH) or the New York City Public Health Laboratory (part of NYC DOHMH) where they were packaged and shipped to CDC. At CDC, total nucleic acids were screened for the presence of PV2 using the pan-poliovirus real-time reverse transcription–polymerase chain reaction (RT-PCR) assay, and positive samples were sequenced (*4*,*5*).

To investigate the number of indeterminate[¶¶] results from some of the New York City samples from large sewersheds (those servicing more than 700,000 residents), NYC DOHMH collected additional larger volume (500 mL) wastewater samples from two sewersheds on August 11, one receiving wastewater from parts of New York County, and another with combined wastewater from parts of Kings, New York, and Queens counties (two distinct upstream sub-sewersheds[***] were sampled, one feeding only from the New York County area and another feeding from Kings and Queens counties combined). CDC then concentrated virus from the samples using the filtration and elution method, followed by inoculation of concentrates onto susceptible cell lines to isolate polioviruses (*6*). Cultures exhibiting viral cytopathic effect were screened by real-time RT-PCR to identify polioviruses (*4*) and sequenced as described. Data presented are from samples collected during March 9–October 11, 2022, and testing conducted through October 20, 2022.

The 48 sewersheds tested serve parts of 13 counties in New York, with a total population of approximately 11,413,000 persons (*7*). A total of 1,076 wastewater samples were collected during March 9–October 11, 2022. Among these, 89 (8.3%) samples from 10 sewersheds tested positive for PV2. Of the 82 PV2-positive samples in the state of New York (outside of New York City), 81 (98.8%) sequences from six sewersheds in Nassau, Orange, Rockland, and Sullivan counties were linked to the virus isolated from the Rockland County patient, and the sequencing results for one sample were not adequate to determine whether it was linked to the virus isolated from the patient (Table) (Figure 1) (Figure 2). Of the seven PV2-positive samples in New York City, only one, from a sub-sewershed receiving wastewater from parts of Kings and Queens counties, was linked

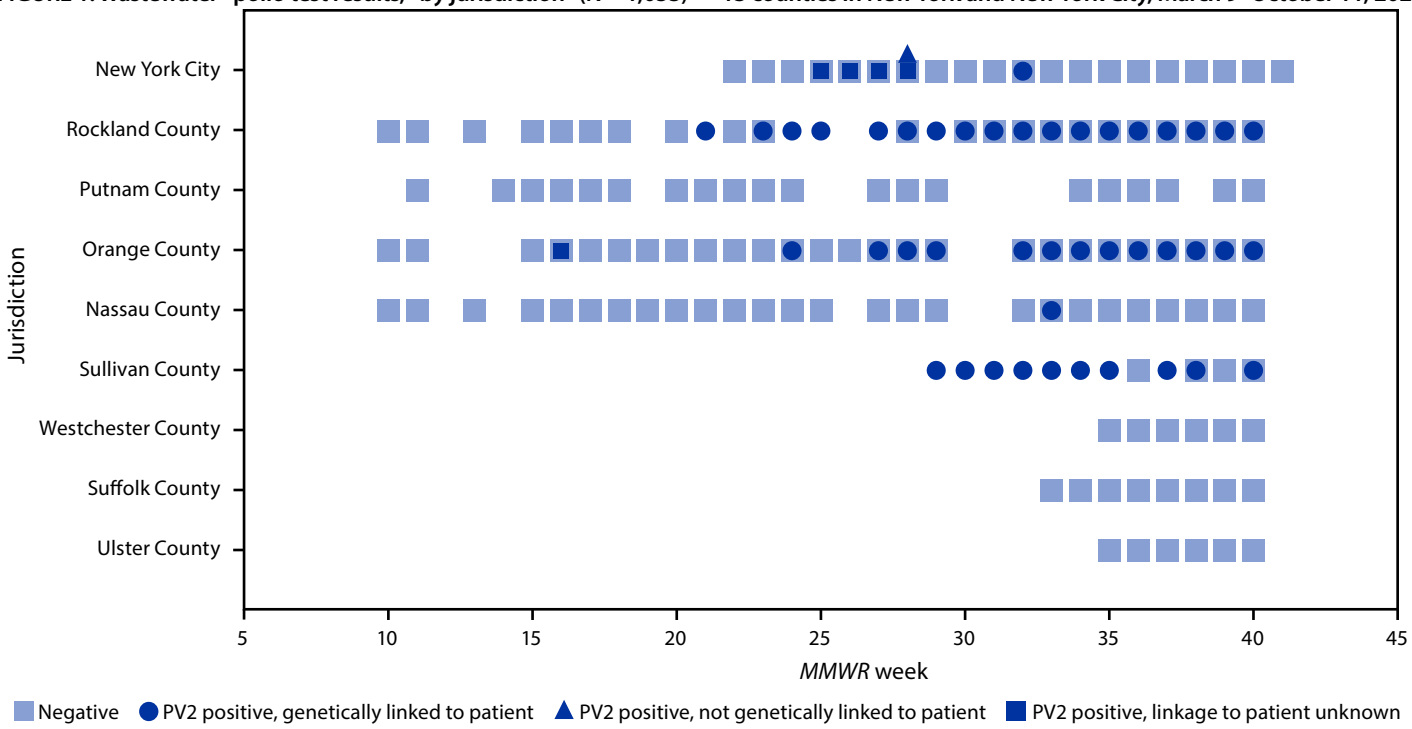
[¶¶] Indeterminate results include those from samples that tested positive using real-time RT-PCR, but not enough viral material was available to complete sequencing.
[***] Sub-sewersheds are upstream sampling locations within a larger sewershed.

TABLE. Wastewater test results for poliovirus, by county — 13 counties, New York and New York City, March 9–October 11, 2022

County	No. of sampling sites*	Estimated % of county population covered by sewershed	Dates samples collected	No. of sites with any PV2-positive sample	Total no. of samples tested	No. of indeterminate samples†	No. of PV2-positive samples				No. of negative samples
							Total	Genetic linkage to Rockland County patient§			
								Unknown¶	No	Yes	
Nassau	4	84.6	Mar 9–Oct 6	1	**87**	2	**1**	0	0	1	84
NYC–Bronx	1	52.2	Jul 5–Oct 11	0	**26**	1	**0**	0	0	0	25
NYC–Kings	4	76.1	May 31–Oct 11	2	**129****	4	**2**	1	1	0	121
NYC–New York	1	38.7	Jul 5–Oct 11	0	**26**	0	**0**	0	0	0	26
NYC–Queens	4	91.4	May 31–Oct 11	0	**112**	0	**0**	0	0	0	112
NYC–Bronx and New York††	1	46.2, 28.9	July 5–Oct 11	0	**26**	0	**0**	0	0	0	26
NYC–Kings, New York, and Queens§§	1	22.4, 31.9, 5.9	May 31–Oct 11	1	**36**	8	**4**	3	0	1¶¶	24
NYC–Richmond	2	96.2	May 31–Oct 11	1	**68**	0	**1**	1	0	0	67
Orange	8	45.9	Mar 9–Oct 6	1	**284**	4	**25**	1	0	24	255
Putnam	1	4.6	Mar 16–Oct 5	0	**20**	0	**0**	0	0	0	20
Rockland	6	96.1	Mar 9–Oct 6	2	**126**	2	**43**	0	0	43	81
Suffolk	3	19.1	Aug 15–Oct 4	0	**14**	0	**0**	0	0	0	14
Sullivan	3	20.5	Jul 21–Oct 6	2	**21**	0	**13**	0	0	13	8
Ulster	2	20.4	Aug 31–Oct 6	0	**18**	0	**0**	0	0	0	18
Westchester	7	83.6	Aug 28–Oct 6	0	**83**	0	**0**	0	0	0	83
Total	**48**	**82.9**	**Mar 9–Oct 11**	**10**	**1,076****	**21**	**89**	**6**	**1**	**82**	**964**

Abbreviations: NYC = New York City; PV2 = poliovirus type 2.
* Sampling sites are sewersheds defined as the community area served by a wastewater collection system.
† Indeterminate results include those from samples that tested positive using real-time reverse transcription polymerase chain reaction, but not enough viral material was available to complete sequencing.
§ In July 2022, paralytic poliomyelitis resulting from infection with vaccine-derived PV2 was confirmed in an unvaccinated adult resident of Rockland County, New York.
¶ Sequencing insufficient to determine relation to Rockland County patient.
** Totals include two samples from Kings County that were pending sequencing results as of October 20, 2022.
†† Sewershed includes portions of Bronx and New York counties.
§§ Sewershed includes portions of Kings, New York, and Queens counties.
¶¶ Large-volume sample collected from the sub-sewershed serving parts of Kings and Queens counties tested positive, but the sub-sewershed serving New York County tested negative.

FIGURE 1. Wastewater* polio test results,† by jurisdiction§ (N = 1,053) — 13 counties in New York and New York City, March 9–October 11, 2022



Abbreviation: PV2 = poliovirus type 2.

* Sampling sites are sewersheds defined as the community area served by a wastewater collection system.

† Testing was conducted to determine if a sample was negative or positive for PV2, and if positive for PV2, whether the PV2 was genetically linked to an unvaccinated paralytic poliomyelitis patient from Rockland County, New York identified in July 2022. Some samples had sequencing insufficient to determine relation to the Rockland County patient (i.e., linkage to patient unknown). Indeterminate results are excluded from this figure. Indeterminate results include those from samples that tested positive using real-time reverse transcription polymerase chain reaction, but not enough viral material was available to complete sequencing. Specimens pending sequencing results are also excluded.

§ Number of samples in each jurisdiction include New York City (408) and the following New York counties: Rockland (124), Putnam (20), Orange (280), Nassau (85), Sullivan (21), Westchester (83), Suffolk (14), and Ulster (18).

to the virus isolated from the patient; this sample was from one of the larger-volume samples. The other six PV2-positive New York City samples included one from Kings County that was not genetically linked to the virus isolated from the patient, and five from three different sewersheds serving parts of Kings, New York, and Richmond counties that were inadequate for sequencing. PV2-positive samples genetically linked to the virus isolated from the patient were collected on more than one occasion in Orange (June 13–October 6), Rockland (May 23–October 4), and Sullivan (July 21–October 5) counties. Only a single sample each from Nassau County on August 18 and the sub-sewershed serving parts of Kings and Queens counties on August 11 tested positive for a PV2 linked to virus isolated from the patient.

In addition to wastewater testing for poliovirus in New York, a multifaceted public health response is underway that includes efforts to enhance case detection and increase vaccination access and demand. Efforts to improve case detection include testing of persons with nonparalytic, nonspecific viral symptoms consistent with poliovirus infection[†††] and review of syndromic surveillance databases. Strategies to increase vaccination include communication campaigns, community engagement, vaccination clinics, and outreach to providers and patients, focused on communities with the lowest IPV coverage. On August 12, NYSDOH and NYC DOHMH issued a press release and health alert to guide the public and the health care community about the importance of polio vaccination, emphasizing the imperative to protect unvaccinated and undervaccinated children through vaccination.[§§§] On September 9, New York declared a state of emergency,[¶¶¶] which allowed additional health professionals (including certain emergency medical service providers, midwives, and pharmacists) to administer poliovirus vaccine in the state.

Discussion

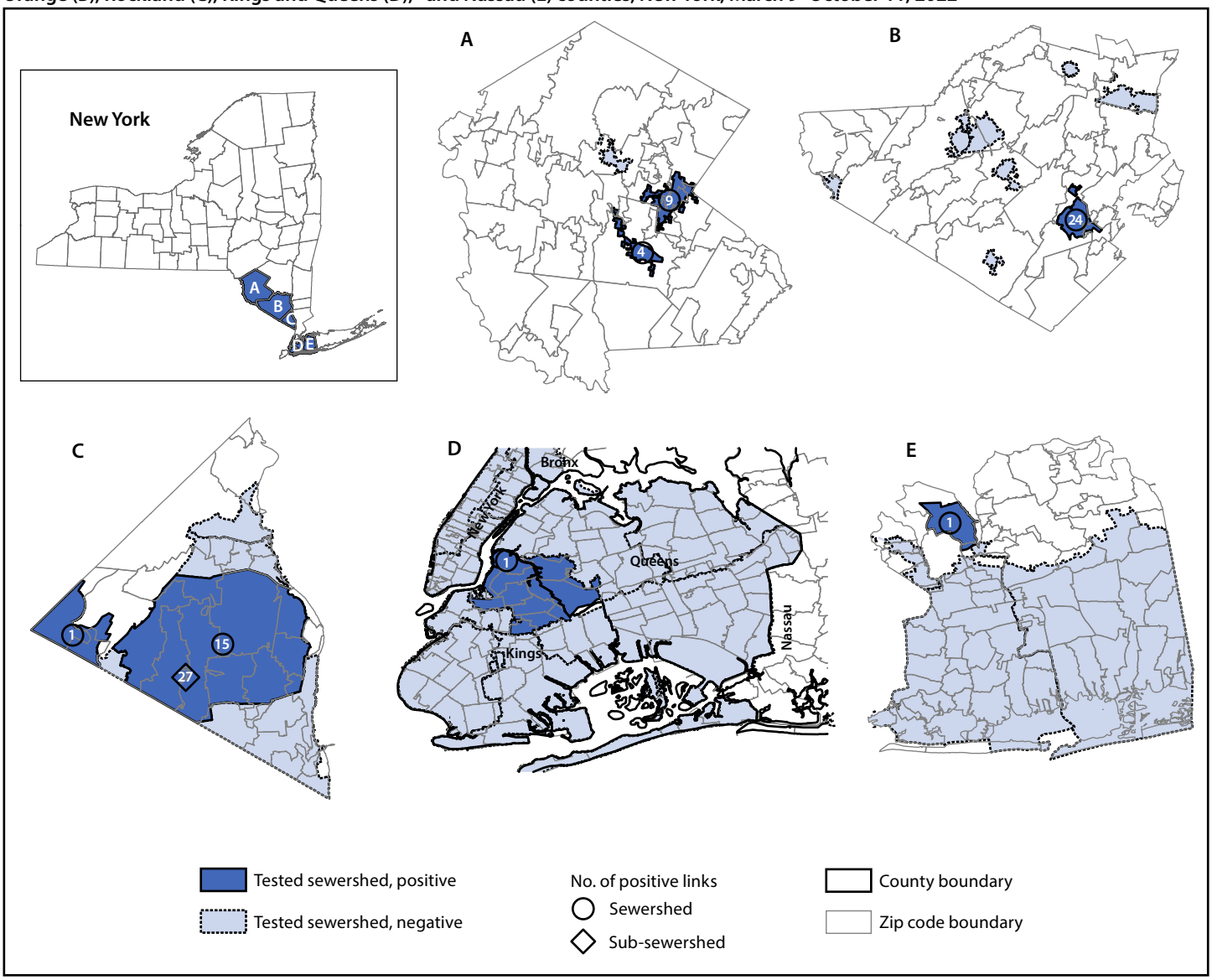
Wastewater testing during March 9–October 11 has detected PV2 genetically linked to the virus isolated from the Rockland County patient in six of 13 New York counties where

[†††] https://health.ny.gov/diseases/communicable/polio/docs/2022-09-28_health_advisory.pdf

[§§§] https://www1.nyc.gov/site/doh/about/press/pr2022/nysdoh-and-nycdohm-wastewater-monitoring-finds-polio-urge-to-get-vaccinated.page

[¶¶¶] https://health.ny.gov/press/releases/2022/2022-09-09_polio_immunization.htm

FIGURE 2. Sewersheds* with detections of poliovirus type 2 genetically linked to the virus isolated from a paralytic polio patient† — Sullivan (A), Orange (B), Rockland (C), Kings and Queens (D),§ and Nassau (E) counties, New York, March 9–October 11, 2022



Abbreviation: PV2 = poliovirus type 2.

* Sampling sites are sewersheds defined as the community area served by a wastewater collection system. Sub-sewersheds are upstream sampling locations within a larger sewershed.

† In July 2022, paralytic poliomyelitis resulting from infection with vaccine-derived PV2 was confirmed in an unvaccinated adult resident of Rockland County, New York.

§ A single large-volume sample from a sub-sewershed serving parts of Kings and Queens counties tested positive for the PV2 genetically linked to the virus isolated from the patient.

wastewater was tested. One county (Nassau) had only a single detection, and therefore was not considered to have evidence of a transmission event. Three counties (Orange, Rockland, and Sullivan) had repeated detections over the course of months in one or more sewersheds, suggesting some level of community transmission in these areas. Only a single large-volume wastewater sample collected on August 11 from Kings and Queens counties in New York City tested positive for a PV2 genetically linked to virus isolated from the patient. However, this finding, coupled with the repeated PV2-positive results from the lower volume samples collected from the broader sewershed catchment areas serving parts of Kings, New York, and Queens counties during June 5–September 6 for which sequencing was not possible, suggests that PV2 could be circulating in Kings and Queens counties as well.

Wastewater testing in conjunction with high-quality AFM surveillance, has helped clarify the scope of the polio outbreak in New York, which indicates community transmission in a five-county area near the only identified symptomatic patient. Some researchers and public health agencies have had interest

Summary

What is already known about this topic?

In July 2022, a case of paralytic poliomyelitis was confirmed in an unvaccinated adult Rockland County, New York resident; environmental sampling found evidence of poliovirus transmission.

What is added by this report?

Wastewater testing has identified circulating polioviruses genetically related to virus isolated from the Rockland County patient in at least five New York counties.

What are the implications for public health practice?

Public health efforts to prevent polio should focus on improving coverage with inactivated polio vaccine. Although most persons in the United States are sufficiently immunized, unvaccinated or undervaccinated persons living or working in Kings, Orange, Queens, Rockland, or Sullivan counties, New York should complete the polio vaccination series to prevent additional paralytic cases and curtail transmission.

in expanding wastewater testing for poliovirus beyond the current outbreak area; however, additional effort is needed to understand the limitations and implications of wastewater testing for poliovirus outside the context of a localized emergency response and epidemiologic investigation of a confirmed polio case. The impact of sewershed system design and size on result interpretation needs further characterization. According to the World Health Organization's guidelines for environmental surveillance of poliovirus circulation,**** sampling sites chosen for testing should represent selected populations at high risk with a source population of 300,000 or fewer persons. Many sewersheds in the United States, including many in New York and New York City have catchments that exceed this number by a factor of five, which could affect reliability or interpretability of results and limit the ability to effectively target interventions. Although sampling upstream sub-sewersheds can sometimes be possible, this activity might not always be feasible to do regularly because of resource and logistical constraints. In addition, monitoring the progress of polio eradication in a population with high IPV coverage is complicated by use of OPV for routine vaccination and outbreak response in other international settings. The live OPV strain can persist in stool for several weeks after vaccination, and detection of these viruses in wastewater does not have the same public health implication as does detection of a VDPV. In addition, standardized methods of testing and virus characterization need to be established if wastewater testing is to become more widespread, because reliable sequencing and careful interpretation are needed to characterize a finding in wastewater as either an OPV strain or a VDPV. Lastly, and most importantly, the public health objectives for wastewater testing for poliovirus should be defined before its application and before the public health response is scaled up beyond the currently implicated communities at risk in New York. Identifying geographies with connections to the patient's community and persistently low polio vaccination coverage can, even in the absence of wastewater testing, help target vaccination efforts. However, these areas at risk for paralytic polio and poliovirus circulation might be considered for wastewater testing to prioritize or enhance vaccination efforts in the event of poliovirus detections.

The findings in this report are subject to at least five limitations. First, even if only a small number of persons are excreting poliovirus into a given sewershed, virus mixtures in a sample can be difficult to resolve. High-quality sequences are needed to characterize the virus and confirm linkages between viruses. Because the total number of nucleotide differences is small, a single nucleotide change can be critical in confirming a linkage between viruses. Second, defecation by infected persons in counties other than their home county in New York (e.g., where they work or visit, or through which they travel) could result in wastewater detection; hence, isolated detections do not confirm community circulation. Third, wastewater testing does not provide information about communities and facilities that are not served by municipal sewer systems; neither was every sewershed in each county sampled. Fourth, test results indicate detection or nondetection of poliovirus but cannot provide quantitative estimates of the number of persons infected. Finally, negative test results cannot guarantee that a community is free from poliovirus but can be assessed in conjunction with other surveillance approaches.

At least five New York counties had evidence of a sustained period of community transmission of poliovirus in 2022. Unvaccinated and undervaccinated persons in these areas are at risk for infection and paralytic disease. A robust national AFM surveillance system must be maintained with reporting of any suspected case of AFM to the appropriate public health authorities and collection of stool samples from any person with a suspected case. All U.S. children should receive IPV in accordance with the routine childhood immunization schedule (*8*). Most adults in the United States were vaccinated as children and are therefore likely to be protected from paralytic polio; however, any unvaccinated or undervaccinated adult or child living or working in Kings, Orange, Queens, Rockland, or Sullivan counties, New York should complete the IPV series now (*9*).

Acknowledgment

New York State Wastewater Surveillance Network.

**** https://polioeradication.org/wp-content/uploads/2016/07/WHO_V-B_03.03_eng.pdf

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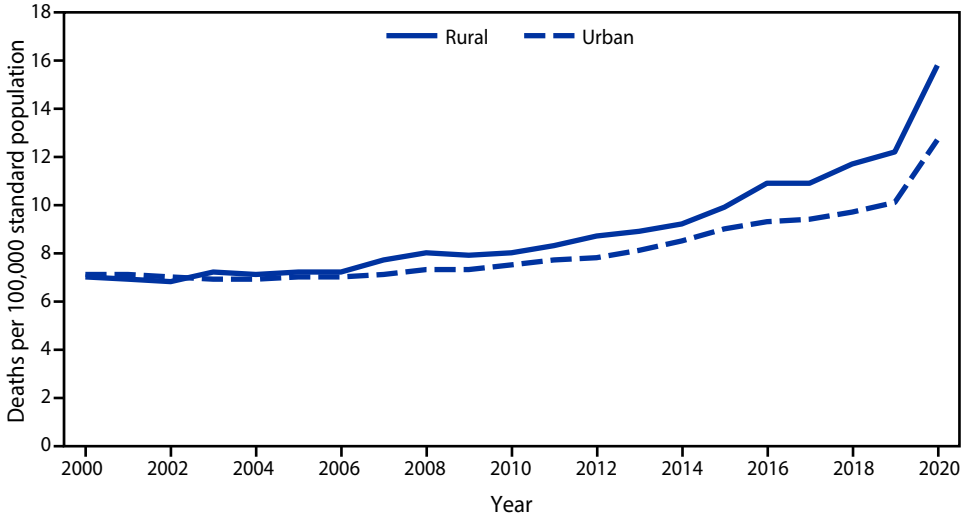
QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Age-Adjusted Rates* of Alcohol-Induced Deaths,† by Urban-Rural Status§ — United States, 2000–2020



* Alcohol-induced deaths per 100,000 standard population. In 2020, the age-adjusted rate of alcohol-induced deaths was 13.1 per 100,000 standard population.

† Alcohol-induced deaths were defined as any *International Classification of Diseases, Tenth Revision* (ICD–10) underlying cause-of-death codes E24.4, F10, G31.2, G62.1, G72.1, I42.6, K29.2, K70, K85.2, K86.0, R78.0, X45, X65, and Y15. Alcohol-induced causes exclude unintentional injuries, homicides, and other causes of death from conditions either indirectly or partially related to alcohol use, as well as newborn deaths associated with maternal alcohol use.

§ Urban-rural status is based on county of residence using the National Center for Health Statistics Urban-Rural Classification Scheme for Counties. https://www.cdc.gov/nchs/data/series/sr_02/sr02_166.pdf

The age-adjusted rate for alcohol-induced deaths in 2020 was 13.1 per 100,000 standard population. From 2000 to 2020, the rate increased in both urban and rural counties: from 7.1 to 12.7 in urban counties and from 7.0 to 15.8 in rural counties. From 2019 to 2020, the rate increased by 26% in urban counties and 30% in rural counties, which was the largest increase for both urban and rural counties during the 2000–2020 period. Rates were similar between rural and urban counties from 2000 to 2004, but from 2005 to 2020 rates were higher in rural counties than in urban counties. During 2005–2020, rural rates increased at a greater pace than did urban rates. By 2020, the rate in rural counties was 24% higher than in urban counties.

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

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