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Outbreak of Locally Acquired Mosquito-Transmitted (Autochthonous) Malaria — Florida and Texas, May–July 2023

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Abstract

Eight cases of locally acquired, mosquito-transmitted (i.e., autochthonous) *Plasmodium vivax* malaria, which has not been reported in the United States since 2003, were reported to CDC from state health departments in Florida and Texas during May 18–July 17, 2023. As of August 4, 2023, case surveillance, mosquito surveillance and control activities, and public outreach and education activities continue in both states. U.S. clinicians need to consider a malaria diagnosis in patients with unexplained fever, especially in areas where autochthonous malaria has been recently reported, although the risk for autochthonous malaria in the United States remains very low. Prompt diagnosis and treatment of malaria can prevent severe disease or death and limit ongoing transmission to local *Anopheles* mosquitoes and other persons. Preventing mosquito bites and controlling mosquitoes at home can prevent mosquitoborne diseases, including malaria. Before traveling internationally to areas with endemic malaria, travelers should consult with a health care provider regarding recommended malaria prevention measures, including potentially taking malaria prophylaxis. Malaria is a nationally notifiable disease; continued reporting of malaria cases to jurisdictional health departments and CDC will also help ensure robust surveillance to detect and prevent autochthonous malaria in the United States.

Investigation and Results

On May 18, 2023, the Florida Department of Health (FDOH) requested telediagnosis assistance from DPDx, CDC's interactive parasitic diseases website (https://www.cdc.gov/dpdx/index.html), to confirm *Plasmodium* species in a patient with suspected malaria who had no known risk factors (i.e., history of international travel, intravenous drug use,

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blood transfusion, or organ transplantation). CDC confirmed *Plasmodium vivax* (Figure 1), triggering an investigation into the first mosquito-transmitted (i.e., autochthonous) malaria case in the United States since 2003, when eight cases of autochthonous *P. vivax* malaria were identified in Palm Beach County, Florida (*1*).

On June 7, 2023, a hospital in Texas requested CDC DPDx telediagnosis assistance to confirm malaria in a patient who also did not report any known risk factors. CDC similarly confirmed *P. vivax* and notified the Texas Department of State Health Services (TDSHS). The most recent documented autochthonous malaria cases in Texas occurred in 1994 (*2*).

During June 19–July 17, 2023, six additional cases of autochthonous *P. vivax* malaria were reported to CDC by FDOH. None of the eight patients had received a previous malaria diagnosis. CDC is supporting both state health departments in the ongoing investigations of and response to these cases.[†] This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[§]

All seven reported Florida cases occurred in persons who lived within a 4-mile (6.4-km) radius in Sarasota County. An imported case of *P. vivax* malaria (symptom onset of April 20) was previously reported in the same immediate area. In Texas, an imported case of *P. vivax* malaria (symptom onset of May 2) was previously reported in the same area in Cameron County where the patient with autochthonous infection was likely exposed. Whether the imported cases in Florida and Texas are related to these autochthonous malaria cases is currently not known. No evidence links the outbreaks in the two states (Figure 2).

Patients with autochthonous malaria sought health care for a range of clinical signs and symptoms, and cases were diagnosed using a combination of rapid diagnostic tests (RDTs), blood smears, or polymerase chain reaction (PCR) testing (Table). *P. vivax* was identified on blood smears of all eight patients. All patients reported fever, six reported chills, five reported abdominal pain, and five reported vomiting. Thrombocytopenia was reported for all eight patients, and six were anemic. Seven of the eight patients were hospitalized, none developed severe malaria,[¶] and no deaths were reported. Seven of the eight patients did not report any of the known risk factors for malaria. One patient reported intravenous drug use 1 week before symptom onset but did not report unsafe injection practices; drug use was not determined to be a risk factor for this patient's malaria diagnosis. Three of the patients in Florida reported experiencing homelessness.

Patients with confirmed *P. vivax* malaria require immediate treatment for the acute blood-stage infection followed by

[†] This outbreak report does not include the recent locally acquired case of *P. falciparum* malaria that was diagnosed in the National Capital Region, Maryland, in August 2023.

[§] 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.

[¶] https://www.cdc.gov/malaria/about/disease.html

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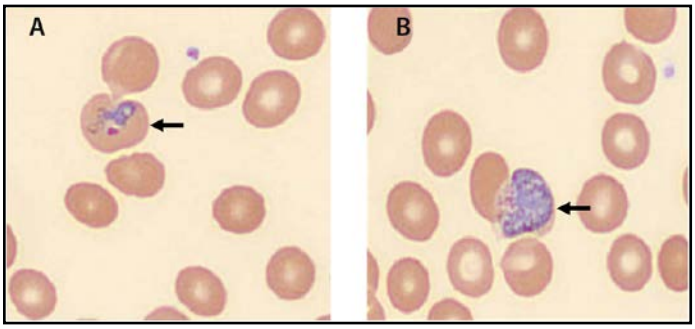
FIGURE 1. Thin blood smear from patient showing *Plasmodium vivax* ring-form trophozoite (A) and gametocyte (B) — Florida, May 2023



antirelapse treatment of liver-stage infection to prevent recurring parasitemia months or years later. As of August 4, 2023, five patients had been treated with artemether-lumefantrine and three with atovaquone-proguanil. All patients were prescribed primaquine for antirelapse treatment. Because primaquine cannot be used in patients with glucose-6-phosphate dehydrogenase (G6PD) deficiency, quantitative G6PD activity assays confirmed that all patients had normal enzyme activity. All patients have recovered.

Florida Public Health Response

Active Case Surveillance

On May 17, 2023, enhanced case finding through syndromic surveillance was initiated, including a retrospective review of data during the preceding 4 weeks. On May 26, Florida began active surveillance for additional cases, to be continued until ≥8 weeks pass without identification of additional cases. Local hospitals in Sarasota and Manatee counties were requested to begin performing malaria tests for persons meeting specific clinical criteria.** All seven cases were reported by the providers to the county health department; providers were the first reporting source for six of the cases, and one case was detected first through syndromic surveillance. CDC is providing ongoing laboratory support by performing PCR confirmatory testing; genotyping of parasite DNA from each case is underway. As of August 4, a total of 30 patients identified through syndromic surveillance received negative malaria PCR test results.††

Mosquito Surveillance and Control Activities

After immediate notification of the first suspected case to mosquito control programs in Sarasota and neighboring Manatee County, enhanced mosquito surveillance commenced in the affected area, including use of CDC light traps and CDC UpDraft Blacklight (ultraviolet) traps in known *Anopheles* breeding areas within 0.9 miles (1.5 km) of the first identified case. Trapped mosquitoes morphologically identified as *Anopheles* were assayed for evidence of *Plasmodium* infection by CDC's Division of Parasitic Diseases and Malaria Entomology Branch.§§ As of August 4, a total of 407 *Anopheles* mosquitoes have been tested. No sporozoite-positive mosquitoes have been detected, but three *Anopheles crucians* abdomens were positive for *P. vivax* DNA, suggesting that these mosquitoes had recently fed on a *P. vivax*–infected person.¶¶

On May 24, 2023, Florida began enhanced mosquito control activities in the affected area, including aerial and ground spraying for adult mosquitoes. Because the area of public health concern crossed county boundaries, interagency communication and coordination were increased, including aerial larvicide application to treat large areas of wetland habitat not easily accessible by other means. Products containing spinosad (a natural substance toxic to some insects), monomolecular films (which reduce the surface tension of water preventing mosquito larvae from attaching to the surface), methoprene (an insect growth regulator), and *Bacillus thuringiensis israelensis* (*Bti*) dunks (a common larvicide), were used to treat standing water for mosquito larvae.

Public Outreach

After confirmation of the first case, FDOH in Sarasota and Manatee County issued a mosquitoborne illness advisory on May 26. On June 19, after confirmation of the second autochthonous case, both county health departments upgraded the advisory to a mosquitoborne illness alert. On June 26, FDOH issued a statewide mosquitoborne illness advisory and a health care provider notification after confirmation of the third and fourth cases.

FDOH collaborated with organizations serving unhoused persons in the area and provided insect repellent, bed nets, and education on mosquito bite prevention. FDOH recommended

** The original syndromic surveillance query included review of hospital and urgent care chief complaint and discharge diagnoses mentioning 1) malaria, 2) homelessness with fever or chills, and 3) subjective or objective fever or chills with thrombocytopenia or anemia, and medical records and malaria PCR testing were requested as indicated. Independent additional malaria testing at hospitals also occurred on the basis of these criteria. The original syndromic surveillance query was updated on the basis of syndromic surveillance data for the first four cases, adding 1) splenomegaly and 2) abdominal pain with one of the original clinical criteria search terms.

†† BinaxNOW Malaria RDTs were also offered to the hospitals as a malaria screening tool. Because of operational challenges, there was limited use of RDTs.

§§ Specific tests include screening for *Plasmodium* circumsporozoite proteins in heads and thoraces (referred to as "sporozoite-positive") via bead immunoassay and DNA extractions from abdomens to detect *Plasmodium* cytochrome c oxidase subunit I via PCR.

¶¶ These three mosquitoes were collected from two trapping locations in close proximity during three separate collection nights in early June. The presence of DNA in the mosquito abdomens suggested that these mosquitoes had recently fed on a person infected with *P. vivax*, but the lack of parasites in their heads and thoraces meant they were not considered infectious to humans.

FIGURE 2. Intervals between symptom onset date and health care date resulting in malaria diagnosis among patients with autochthonous malaria (N = 8) — Florida and Texas, May–July 2023

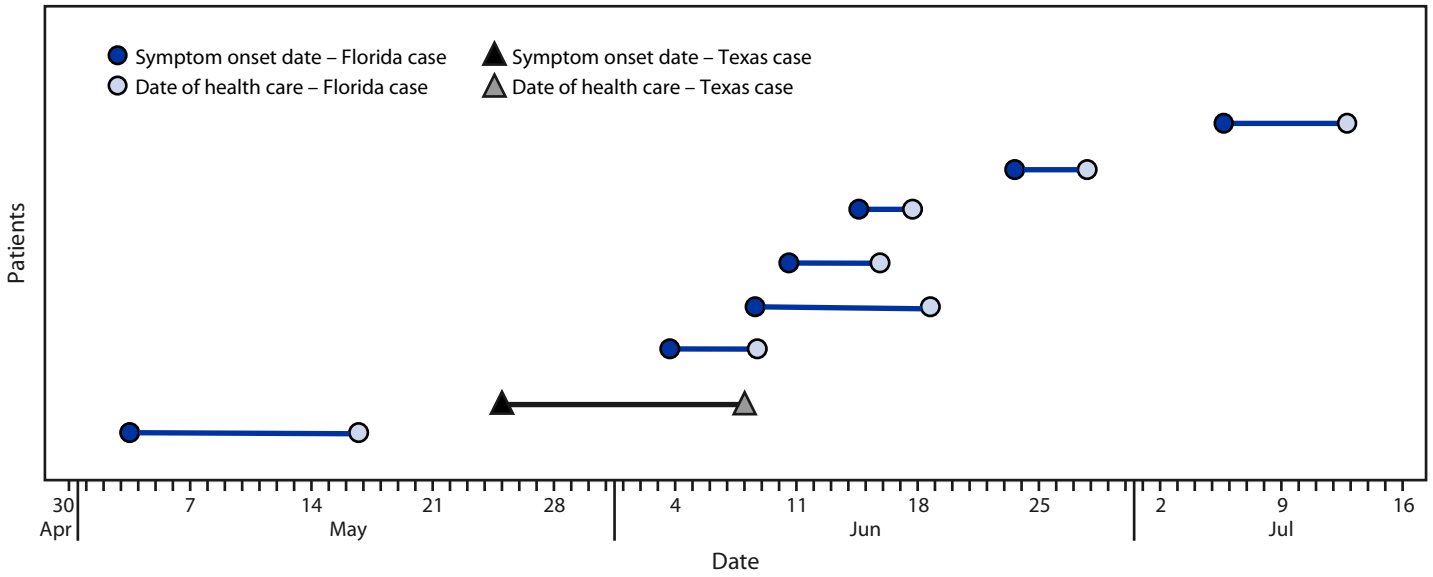


TABLE. Epidemiologic and clinical characteristics of locally acquired mosquito-transmitted malaria cases (N = 8) — Florida and Texas, May–July 2023

Characteristic	No. of cases (%)
Age group, yrs	
20–39	4 (50)
40–59	3 (38)
60–79	1 (13)
Sex	
Men	6 (75)
Women	2 (25)
Signs and symptoms at time of seeking medical attention	
Fever	8 (100)
Chills	6 (75)
Abdominal pain	5 (63)
Vomiting	5 (63)
Nausea	4 (50)
Sweats	3 (38)
Diarrhea	3 (38)
Fatigue or weakness	3 (38)
Anorexia	2 (25)
Myalgia	2 (25)
Body ache	1 (13)
Headache	1 (13)
Back pain	1 (13)
Cough	1 (13)
Melena	1 (13)
Shortness of breath	1 (13)
Diagnostic test	
Positive rapid diagnostic test result	5 (63)
Positive blood smear test result	8 (100)
Positive PCR test result*	8 (100)

Abbreviation: PCR = polymerase chain reaction.
* *Plasmodium vivax* was confirmed by CDC through PCR targeting 18S rRNA.

that any persons experiencing homelessness seek care if they developed symptoms. FDOH also repeatedly distributed information on the diagnosis and treatment of malaria to clinicians in the area.

Texas Public Health Response

Active Case Surveillance

In May, four persons who worked outdoors at the same time and location as the first identified Texas patient self-reported an illness consistent with malaria to their supervisors. TDSHS successfully contacted three of the four persons to ascertain clinical details and recommend malaria testing; one person was lost to follow-up. One person received a negative whole blood PCR malaria test result at the TDSHS laboratory. One of the contacted persons lives outside of Texas; TDSHS coordinated with the state health department in that person's state of residence to recommend malaria testing, but the individual chose not to pursue malaria testing. The third contacted person also chose not to pursue malaria testing.

Mosquito Surveillance and Control Activities

On June 13, 2023, mosquito control agencies in the area began enhanced mosquito surveillance and control activities at three target sites in Cameron County: 1) the worksite where the patient with an autochthonous case spent time outside at night, 2) his temporary residence, and 3) the temporary residence of the patient with imported malaria. Mosquito surveillance and control activities were also conducted around the patient's residence (outside of Cameron County). Mosquitoes

Summary

What is already known about this topic?

Locally acquired mosquito-transmitted (autochthonous) *Plasmodium vivax* malaria was most recently reported in the United States in 2003.

What is added by this report?

Eight cases of autochthonous malaria were reported to CDC by state health departments in Florida (seven) and Texas (one) during May 18–July 17, 2023. Case surveillance, mosquito surveillance and control activities, and public outreach are ongoing.

What are the implications for public health practice?

The risk for autochthonous malaria in the United States remains very low. Prompt diagnosis and treatment of persons with malaria and reporting of cases to health departments and CDC is important to ensuring favorable clinical outcomes and a timely public health response. Malaria and other mosquito-borne diseases can be prevented by preventing mosquito bites.

were collected using CDC light traps; those morphologically identified as *Anopheles* were assayed for evidence of *Plasmodium* infection by CDC's Division of Parasitic Diseases and Malaria Entomology Branch. As of August 4, a total of 71 *Anopheles* mosquitoes collected from the target sites and the patient's residence were sent to CDC for *Plasmodium* testing; all test results were negative.

On June 16, five adulticidal treatments were conducted with an ultralow volume fogger. *Bti* dunks were used to treat standing water for mosquito larvae. Adulticidal treatments were also conducted in May in response to high mosquito activity near the work site of the patient with autochthonous malaria.

Public Outreach

On June 23, TDSHS issued a statewide health advisory regarding an autochthonous malaria case in Texas. Cameron County Public Health issued a similar public health advisory the same day. Information on malaria was also shared with Cameron County infection control practitioners and emergency response partners. In addition, Cameron County Public Health initiated education and outreach measures with local health care providers and residents; the CDC Health Alert Network (HAN) Health Advisory (*3*) was forwarded to other local health departments and health care providers in the region.

CDC Response

On June 26, 2023, CDC issued a HAN Health Advisory to notify clinicians, public health authorities, and the public about the autochthonous malaria cases in Florida and Texas (*3*). On July 20, CDC convened a Clinician Outreach and Communication Activity webinar to provide information to clinicians on the diagnosis and treatment of malaria. CDC continues to provide technical assistance in laboratory diagnostics, treatment options, active case detection strategies, epidemiology, and entomology and continues to ensure timely communication with other state and federal agencies regarding response activities.

Discussion

Malaria was eliminated as a public health threat in the United States in the mid-1950s, and the World Health Organization certified the United States malaria-free in 1970. Currently, approximately 2,000 cases of malaria are diagnosed in the United States annually, although most cases are imported from countries where malaria remains endemic (*4*,*5*).

As of August 4, no additional autochthonous *P. vivax* cases have been detected in Florida or Texas since early July, and there has been no evidence of infected *Anopheles* mosquitoes since early June.*** The autochthonous malaria cases during this investigation highlight the importance of controlling cases globally to prevent future autochthonous cases in the United States. Species of *Anopheles* mosquitoes that are biologically capable of transmitting malaria are found throughout many regions of the United States.†††

Although the risk for autochthonous malaria in the United States remains very low,§§§ U.S. clinicians need to consider a malaria diagnosis in patients with an unexplained fever, especially in areas where autochthonous malaria has been recently reported. The occurrence of the current autochthonous cases underscores the potential for imported malaria cases in areas with competent vectors to produce local mosquito transmission of malaria parasites. Targeted mosquito surveillance based on the location of human cases is important in predicting human risk and preventing disease in humans. Prompt diagnosis and treatment¶¶¶ of persons with malaria can prevent severe disease or death and limit ongoing transmission to local *Anopheles* mosquitoes and other persons. Continued reporting of malaria

*** The heightened period of public health vigilance will extend at least through mid-September 2023 as long as no additional human cases or infected *Anopheles* vectors are detected. At that point, this outbreak of autochthonous malaria would be considered over. This takes into consideration the incubation period of *P. vivax* in humans, duration of parasite development in the mosquito preceding transmission potential to humans, mosquito survival probabilities, and potential delays in health care–seeking behavior among persons with new cases.

††† The risk might be higher in areas where local climatic conditions allow *Anopheles* populations to survive during most of the year and where travelers from areas with endemic malaria are found.

§§§ Clinicians practicing in areas of the United States where autochthonous malaria cases have occurred need to follow guidance from their state and local health departments.

¶¶¶ https://www.cdc.gov/malaria/diagnosis_treatment/index.html

cases to jurisdictional health departments and CDC will help ensure robust surveillance to prevent, detect, and respond to autochthonous malaria in the United States. Before traveling internationally to areas where malaria is endemic, travelers should consult with their health care provider regarding recommended malaria prevention measures, including potentially taking malaria prophylaxis. In addition, preventing mosquito bites and controlling mosquitoes at home can prevent malaria, and other mosquitoborne diseases.[****]

[****]Recommendations to prevent mosquito bites and control mosquitoes at home include using Environmental Protection Agency (EPA)–registered insect repellents, wearing loose-fitting, long-sleeved shirts and pants, using 0.5% permethrin to treat clothing and gear, keeping windows and doors closed or covered with screens to keep mosquitoes out of the house, and emptying standing water at least once a week to prevent mosquitoes from laying eggs.

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Health Care Provider Knowledge and Attitudes Regarding Adult Pneumococcal Conjugate Vaccine Recommendations — United States, September 28–October 10, 2022

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Abstract

Despite the availability of effective vaccines against pneumococcal disease, pneumococcus is a common bacterial cause of pneumonia, causing approximately 100,000 hospitalizations among U.S. adults per year. In addition, approximately 30,000 invasive pneumococcal disease (IPD) cases and 3,000 IPD deaths occur among U.S. adults each year. Previous health care provider surveys identified gaps in provider knowledge about and understanding of the adult pneumococcal vaccine recommendations, and pneumococcal vaccine coverage remains suboptimal. To assess the feasibility and acceptability domains of the Advisory Committee on Immunization Practices (ACIP) Evidence to Recommendations (EtR) framework, a health care provider knowledge and attitudes survey was conducted during September 28–October 10, 2022, by the Healthcare and Public Perceptions of Immunizations Survey Collaborative before the October 2022 ACIP meeting. Among 751 provider respondents, two thirds agreed or strongly agreed with the policy option under consideration to expand the recommendations for the new 20-valent pneumococcal conjugate vaccine (PCV20) to adults who had only received the previously recommended 13-valent pneumococcal conjugate vaccine (PCV13). Gaps in providers' knowledge and perceived challenges to implementing recommendations were identified and were included in ACIP's EtR framework discussions in late October 2022 when ACIP updated the recommendations for PCV20 use in adults. Currently, use of PCV20 is recommended for certain adults who have previously received PCV13, in addition to those who have never received a pneumococcal conjugate vaccine. The survey findings indicate a need to increase provider awareness and implementation of pneumococcal vaccination recommendations and to provide tools to assist with patient-specific vaccination guidance. Resources available to address the challenges to implementing pneumococcal vaccination recommendations include the PneumoRecs VaxAdvisor mobile app and other CDC-developed tools, including summary documents and overviews of vaccination schedules and CDC's strategic framework to increase confidence in vaccines and reduce vaccine-preventable diseases, Vaccinate with Confidence.

Introduction

Effective vaccines against pneumococcal disease have been available in the United States for decades. Beginning in 2012, adults at high risk for pneumococcal disease or for experiencing its associated complications (i.e., adults with immunocompromising conditions and, beginning in 2014, all adults aged ≥65 years) were recommended to receive a single dose of 13-valent pneumococcal conjugate vaccine (PCV13) (Wyeth Pharmaceuticals LLC, a subsidiary of Pfizer Inc.) in series with an indication-specific number of doses of 23-valent pneumococcal polysaccharide vaccine (PPSV23) (Merck Sharp and Dohme Corp.). However, pneumococcus continued to be a common bacterial cause of pneumonia, bacteremia, and meningitis, resulting in significant morbidity and mortality in the United States. Before the COVID-19 pandemic, approximately 100,000 hospitalized pneumococcal pneumonia cases occurred among U.S. adults per year (*1*), with high all-cause mortality in older adults (*2*). In addition, there were approximately 30,000 invasive pneumococcal disease (IPD) cases (e.g., meningitis or bacteremia) and 3,000 IPD deaths annually among U.S. adults (*1*).

In October 2021, after licensure of two new pneumococcal conjugate vaccines (PCVs), 15-valent PCV (PCV15) (Merck Sharp and Dohme Corp.) and 20-valent PCV (PCV20) (Wyeth Pharmaceuticals LLC, a subsidiary of Pfizer Inc.) for use in U.S. adults, the Advisory Committee on Immunization Practices (ACIP) recommended PCV15 followed by 1 dose of PPSV23 or PCV20 alone for PCV-naïve adults aged ≥65 years or aged 19–64 years with certain health conditions or risk factors (*2*);

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neither PCV15 nor PCV20 was recommended for adults who had previously received PCV13.[§] PCVs are considered more immunogenic than PPSV23, and PCV20 provides the broadest pneumococcal serotype coverage among currently available PCVs, whereas PPSV23[¶] contains additional serotypes that are not included in PCV20[**] (*3*,*4*).

Previous surveys of health care providers identified gaps in their knowledge about and understanding of the adult pneumococcal vaccination recommendations (*5*,*6*). In addition, coverage with either PCV15 or PCV20 remains low, particularly among adults aged 19–64 years who are at high risk for acquisition of or complications from pneumococcal disease (Immunization Services Division, National Center for Immunization and Respiratory Diseases, CDC, unpublished data, 2023). The ACIP Evidence to Recommendations (EtR) framework, which includes seven domains, was used to guide discussions on expanding recommendations to include the new PCV20 as an option for any adult at high risk who had received PCV13, regardless of whether they had completed their previously recommended vaccination series. To assess the feasibility and acceptability domains of the EtR framework in anticipation of these updates to the pneumococcal recommendations to include PCV20 as an option for adults at high risk who received PCV13, the Healthcare and Public Perceptions of Immunizations (HaPPI) Survey Collaborative conducted a knowledge and attitudes survey of family physicians, general internists, and pharmacists[††] during September 28–October 10, 2022. The survey aimed to assess 1) behaviors and attitudes regarding pneumococcal vaccination recommendations, 2) knowledge about pneumococcal vaccination recommendations, and 3) attitudes toward expanding recommendations for use of PCV20 among adults who had previously received PCV13.

Methods

The HaPPI Survey Collaborative's partnership among CDC, the University of Iowa, and the RAND Corporation uses a Qualtrics panel, a web-based survey tool, of 2 million U.S. health care providers. Eligibility criteria for this survey included spending ≥50% of practice time in outpatient primary care and administration of vaccines at the provider's worksite. In this opt-in survey, provider attitudes toward the current pneumococcal vaccination recommendations and potential updates were assessed through open-ended responses and 5-point Likert scales, ranging from "strongly disagree" to "strongly agree." The survey also assessed knowledge about pneumococcal vaccination recommendations via multiple choice and true or false questions. Knowledge questions were the same for all providers regardless of the types of pneumococcal vaccines that they indicated were available in their clinics. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[§§]

Results

Among 829 family physician, general internist, and pharmacist respondents who consented and were eligible to participate, 757 (91%) completed the survey (Table), although the number of respondents to each question varied. Among 751 respondents, 283 (38%) disagreed or strongly disagreed with the statement, "the current adult pneumococcal vaccine recommendations are easy to follow." In the open-ended responses, 98 (13%) of the providers described the recommendations as "confusing," and 61 (8%) felt that the recommendations included "too many choices." Twenty-eight (4%) respondents reported that it is "hard to keep track of the recommended sequence." Fourteen (2%) reported lack of knowledge of patients' vaccination history as a challenge, and five (0.6%) noted challenges with supply of certain vaccines in clinics. Vaccine hesitancy among patients was reported as a reason for not recommending PCVs to patients by 63 (25%) family physicians, 56 (22%) general internists, and 40 (16%) pharmacists.

Responses to the knowledge questions indicated that approximately one half of respondents were not familiar with the 2021 ACIP pneumococcal vaccination recommendations regarding PCV15 and PCV20. For example, 372 (50%) of 750 respondents incorrectly answered that adults aged ≥65 years who had previously received PCV13 should later receive PCV20. Approximately ne third of 751 respondents (264, 35%) correctly answered that PCV-naïve adults aged ≥65 years should receive PCV15 followed by PPSV23, and 319 (43%) correctly selected PCV20 alone (Figure 1). CDC developed the PneumoRecs VaxAdvisor mobile app[¶¶] to provide patient-specific pneumococcal vaccination guidance; however,

[§] These adults were recommended to receive PPSV23 according to earlier recommendations. In 2012, ACIP recommended PCV13 use in series with PPSV23 for adults with an immunocompromising condition, cerebrospinal fluid leak, or cochlear implant. In 2014, all adults aged ≥65 years were recommended to receive PCV13 in series with PPSV23. In 2019, the recommendation was updated and shared clinical decision-making was recommended regarding PCV13 use for adults aged ≥65 years without an immunocompromising condition, cerebrospinal leak, or cochlear implant.

[¶] Serotypes included in PPSV23: 1, 2, 3, 4, 5, 6B, 7F, 8, 9N, 9V, 10A, 11A, 12F, 14, 15B, 17F, 18C, 19F, 19A, 20, 22F, 23F, and 33F.

[**] Serotypes included in PCV20: 1, 3, 4, 5, 6A, 6B, 7F, 8, 9V, 10A, 11A, 12F, 14, 15B, 18C, 19A, 19F, 22F, 23F, and 33F.

[††] Pediatricians were also surveyed, but their responses were not analyzed.

[§§] 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. 3501et seq.

[¶¶] https://www.cdc.gov/vaccines/vpd/pneumo/hcp/pneumoapp.html

TABLE. Characteristics of respondents to adult pneumococcal vaccine knowledge and attitudes survey, by provider type (N = 757) — United States, September–October 2022*

Characteristic	Provider type, no. (%)		
	Family medicine (n = 255)	Internal medicine (n = 251)	Pharmacy (n = 251)
Gender			
Female	83 (32.5)	60 (23.9)	114 (45.4)
Male	166 (65.1)	187 (74.5)	133 (53.0)
Transgender	0 (—)	0 (—)	0 (—)
Other gender identity	6 (2.4)	4 (1.6)	4 (1.6)
Race and ethnicity			
Black or African American, non-Hispanic	6 (2.4)	13 (5.2)	11 (4.4)
White, non-Hispanic	176 (69.0)	140 (55.8)	185 (73.7)
Hispanic or Latino	13 (5.1)	13 (5.2)	14 (5.6)
Other	60 (23.5)	85 (33.9)	41 (16.3)
No. of yrs in practice			
0–5	22 (8.6)	25 (10.0)	12 (4.8)
6–10	48 (18.8)	47 (18.7)	42 (16.7)
11–15	26 (10.2)	34 (13.6)	67 (26.7)
16–20	55 (21.6)	37 (14.7)	32 (12.8)
≥21	104 (40.8)	108 (43.0)	98 (39.0)
U.S. Census Bureau region†			
Northeast	58 (22.7)	77 (30.7)	53 (21.1)
Midwest	73 (28.6)	54 (21.5)	66 (26.3)
South	70 (27.5)	76 (30.3)	95 (37.9)
West	54 (21.2)	44 (17.5)	37 (14.7)
Metropolitan statistical area status			
Metropolitan	230 (90.2)	233 (92.8)	226 (90.0)
Nonmetropolitan	25 (9.8)	18 (7.2)	25 (10.0)
No. of patients treated in practice per mo			
1–499	59 (23.1)	78 (31.1)	39 (15.5)
500–1,999	127 (49.8)	108 (43.0)	108 (43.0)
≥2,000	69 (27.1)	65 (25.9)	104 (41.4)

* Responses from pediatricians (251) were not analyzed.
† https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf

among all 757 surveyed providers, 403 (53%) reported never having used the app.

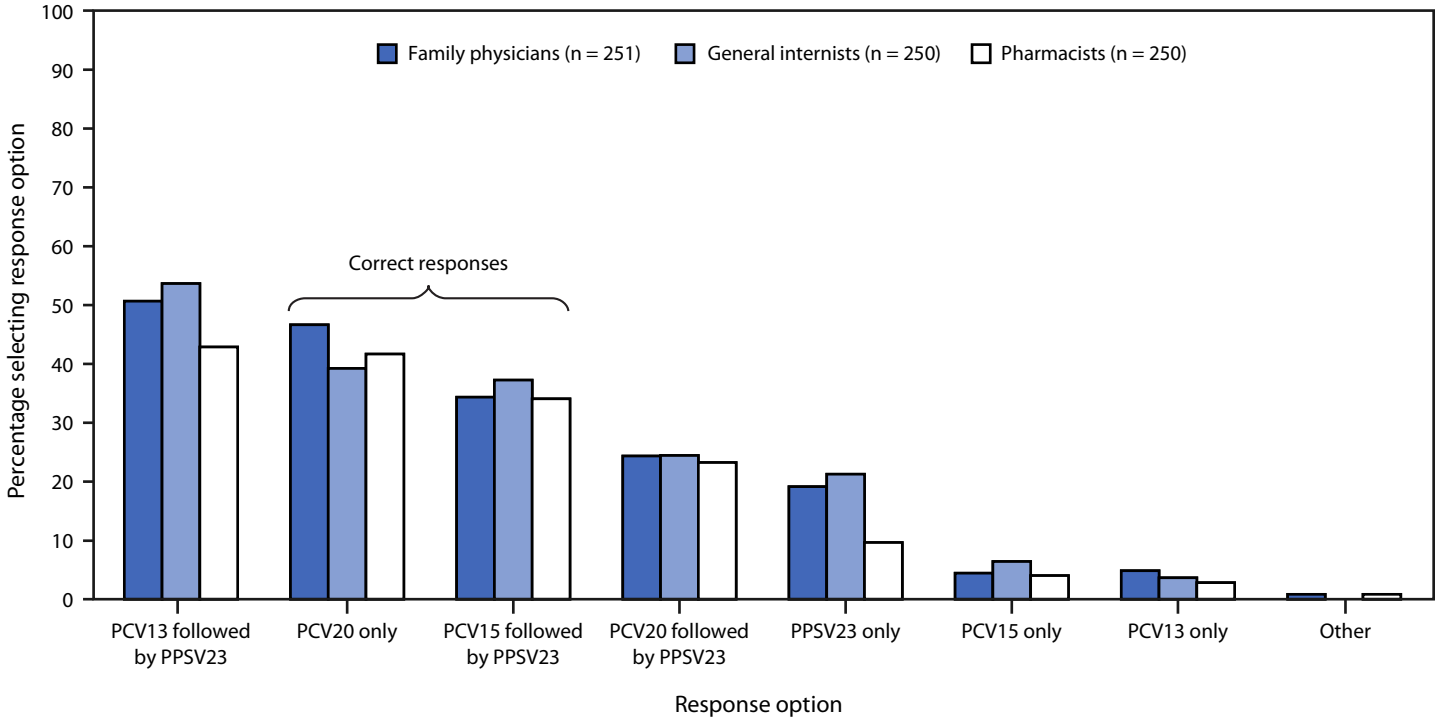
Regarding attitudes toward expanding use of PCV20 among adults at high risk who previously received PCV13, two thirds of respondents agreed or strongly agreed with the policy option under consideration to expand the recommendations for PCV20 to adults who had received PCV13 only, including 531 (71%) who agreed with the recommendation for adults aged 19–64 years with an immunocompromising condition, and 478 (64%) who agreed with the recommendation for all adults aged ≥65 years (Figure 2). However, fewer than one half of respondents agreed or strongly agreed with the policy option under consideration to expand the recommendations for PCV20 to adults who had received both PCV13 and PPSV23, including 353 (47%) who agreed with the recommendation for adults with an immunocompromising condition and 286 (38%) who agreed with the recommendation for all adults aged ≥65 years.

Discussion

In addition to the scientific evidence presented at the October 2022 ACIP meeting, findings from a survey among U.S. family physicians, general internists, and pharmacists conducted before the meeting were included in discussions related to ACIP's EtR feasibility and acceptability domains (*7*). At this meeting, ACIP updated its recommendations to allow adults at high risk who received PCV13 but have not completed the recommended number of PPSV23 doses the option to receive a dose of PCV20 instead (*8*). ACIP also recommended the use of shared clinical decision-making regarding PCV20 use for adults aged ≥65 years who had completed recommended vaccination with both PCV13 and PPSV23.

The survey found that whereas providers recognize the value of pneumococcal vaccines, a substantial proportion found that the nuances of the recommendations, which varied based on patients' vaccination history and underlying medical conditions, posed challenges to interpretation and implementation. This uncertainty might contribute to the low rates of administration of PCV15 and PCV20 among adults aged ≥65 years. As

FIGURE 1. Responses* by family physicians, general internists, and pharmacists to questions about the 2021 Advisory Committee on Immunization Practices' pneumococcal vaccine recommendations† regarding which vaccines were recommended for adults aged ≥65 years who had not received any pneumococcal vaccine (N = 751) — United States, September–October 2022



Abbreviations: PCV13 = 13-valent pneumococcal conjugate vaccine; PCV15 = 15-valent pneumococcal conjugate vaccine; PCV20 = 20-valent pneumococcal conjugate vaccine; PPSV23 = 23-valent pneumococcal polysaccharide vaccine.
* Multiple responses permitted.
† https://doi.org/10.15585/mmwr.mm7104a1

of December 2022, only 4.4% of Medicare beneficiaries aged ≥65 years had received PCV15 or PCV20; coverage was 7.1% among those aged 65–69 years, who are the least likely to have previously received PCV13 (Immunization Services Division, National Center for Immunization and Respiratory Diseases, CDC, unpublished data, 2023). Pneumococcal vaccination coverage also remains low among adults with underlying health conditions that increase their risk for pneumococcal disease and its complications, with coverage varying by race and ethnicity and geography (*9*,*10*). Limited awareness of the new vaccination recommendations and obstacles to ascertaining patients' vaccination history might continue to hinder broader use of the new PCVs.

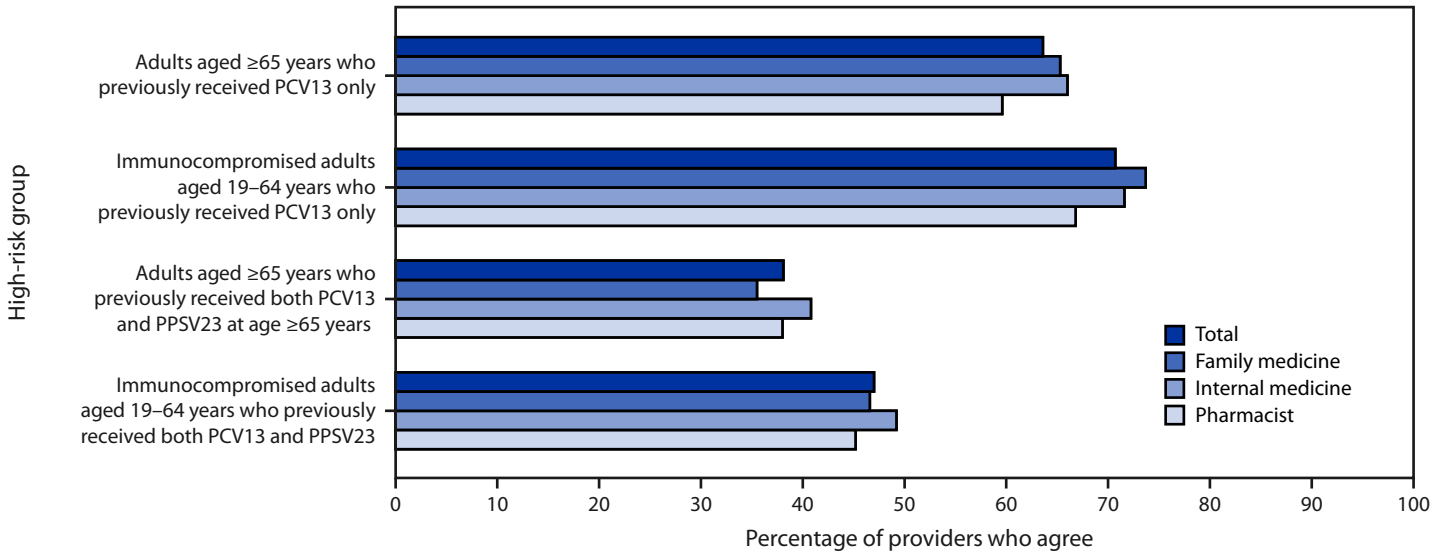
Limitations

The findings in this report are subject to at least two limitations. First, a convenience sample was used, which limits generalizability and could introduce bias. However, respondents were evenly distributed among the different provider categories and geographically diverse. Second, although the survey asked if pneumococcal vaccines were offered at a provider's clinic, the knowledge questions did not consider which pneumococcal vaccine types were offered in their clinics in the answer to these questions. Provider knowledge might have been limited to the vaccines available at their sites, and, therefore, might have skewed the knowledge responses of those whose clinics did not carry PCV20.

Implications for Public Health Practice

Increasing vaccination coverage is critical to preventing pneumococcal disease. Gaps in knowledge and challenges to implementing recommendations for use of pneumococcal vaccines indicate a need to increase provider awareness and implementation of the most recent (October 2022) updated pneumococcal vaccination recommendations (*8*) and to provide tools to assist with patient-specific vaccination guidance. Resources available to address the challenges to implementing pneumococcal vaccination recommendations include the PneumoRecs VaxAdvisor mobile app and other CDC-developed tools, including summary documents and overviews of vaccination schedules and CDC's strategic framework to increase confidence in vaccines and reduce

FIGURE 2. Agreement with administering 20-valent pneumococcal conjugate vaccine to different high-risk groups, by provider type (N = 751) — United States, September–October 2022



Abbreviations: PCV13 = 13-valent pneumococcal conjugate vaccine; PCV15 = 15-valent pneumococcal conjugate vaccine; PCV20 = 20-valent pneumococcal conjugate vaccine; PPSV23 = 23-valent pneumococcal polysaccharide vaccine.

vaccine-preventable diseases, Vaccinate with Confidence.*** This framework focuses on protecting communities, empowering families, and stopping misinformation from eroding public trust in vaccines. Educational interventions in the form of point-of-care decision tools, continuing medical education modules, and educational sessions at conferences might also be beneficial. Addition of more vaccines to the adult immunization schedule highlights the need for a harmonized approach to communicating new vaccine recommendations to providers from CDC and for better understanding of potential barriers to implementation of these recommendations.

*** https://www.cdc.gov/vaccines/partners/vaccinate-with-confidence.html

Acknowledgments

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Summary

What is already known about this topic?

Despite the availability of effective vaccines, pneumococcal disease continues to be a significant cause of morbidity among U.S. adults. The Advisory Committee on Immunization Practices (ACIP) considers feasibility and acceptability of new policy options in its Evidence to Recommendations framework.

What is added by this report?

A survey of vaccine providers before the October 2022 ACIP meeting identified knowledge gaps and implementation challenges in existing recommendations. Respondents agreed with expanding the recommendations for 20-valent pneumococcal conjugate vaccine to adults at high risk who had received the 13-valent vaccine alone.

What are the implications for public health practice?

Interventions to facilitate implementation of the updated pneumococcal vaccine recommendations are needed. Available resources include the PneumoRecs VaxAdvisor mobile app and other CDC-developed tools, such as overviews of vaccination schedules and CDC's strategic framework, Vaccinate with Confidence.

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Progress Toward Measles Elimination — African Region, 2017–2021

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Abstract

Worldwide, measles remains a major cause of disease and death; the highest incidence is in the World Health Organization African Region (AFR). In 2011, the 46 AFR member states established a goal of regional measles elimination by 2020; this report describes progress during 2017–2021. Regional coverage with a first dose of measles-containing vaccine (MCV) decreased from 70% in 2017 to 68% in 2021, and the number of countries with ≥95% coverage decreased from six (13%) to two (4%). The number of countries providing a second MCV dose increased from 27 (57%) to 38 (81%), and second-dose coverage increased from 25% to 41%. Approximately 341 million persons were vaccinated in supplementary immunization activities, and an estimated 4.5 million deaths were averted by vaccination. However, the number of countries meeting measles surveillance performance indicators declined from 26 (62%) to nine (22%). Measles incidence increased from 69.2 per 1 million population in 2017 to 81.9 in 2021. The number of estimated annual measles cases and deaths increased 22% and 8%, respectively. By December 2021, no country in AFR had received verification of measles elimination. To achieve a renewed regional goal of measles elimination in at least 80% of countries by 2030, intensified efforts are needed to recover and surpass levels of surveillance performance and coverage with 2 MCV doses achieved before the COVID-19 pandemic.

Introduction

Measles remains a major cause of disease and death worldwide, with the highest numbers of cases and deaths occurring in the World Health Organization (WHO) African Region (AFR) (*1*). In 2011, the 46 member states* in AFR established a goal of measles elimination† by 2020, using a regional strategy to achieve 1) ≥95% coverage with 2 doses of measles-containing vaccine (MCV) at national and district levels through routine or supplementary immunization activities (SIAs)§; 2) confirmed measles incidence of <1 case per 1 million population in all countries; and 3) case-based surveillance systems that meet performance indicator targets¶ (*2*). This report describes progress toward the regional measles elimination goal during 2017–2021 and updates the previous report (*3*).

Methods

WHO and UNICEF estimate coverage with the first and second MCV doses (MCV1 and MCV2, respectively) delivered through routine immunization services** for all countries, using annual administrative coverage data (number of doses administered divided by the estimated target population), national coverage estimates, and vaccination coverage surveys (*4*). AFR countries conduct case-based measles surveillance,†† with suspected cases identified using a case investigation form. Suspected cases are laboratory-confirmed based on serologic testing, epidemiologic linkage to a confirmed case, or clinical criteria (*5*). Serologic testing is performed within the regional

* Before 2013, the WHO African Region included 46 member states: Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Côte d'Ivoire, Democratic Republic of the Congo, Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Republic of the Congo, Rwanda, São Tomé and Príncipe, Senegal, Seychelles, Sierra Leone, South Africa, Tanzania, Togo, Uganda, Zambia, and Zimbabwe. South Sudan obtained WHO membership in 2013 and is included in all analyses since that time; South Sudan was not included in the modeling estimates.

† Measles elimination is defined as the absence of endemic measles virus transmission in a region or other defined geographic area for ≥12 months in the presence of a high-quality surveillance system that meets the targets of key performance indicators. Regional verification of measles elimination takes place after 36 months of interrupted endemic measles virus transmission.

§ Measles SIAs are generally conducted using two target age ranges. An initial, nationwide catch-up SIA targets all persons aged 9 months–14 years, with the aim of eliminating susceptibility to measles in the general population. Follow-up SIAs are conducted nationwide every 2–4 years and target children aged 9–59 months to eliminate any measles susceptibility that has accumulated in recent birth cohorts and to protect the estimated 2%–5% of children who do not respond to MCV1.

¶ These indicators are 1) discard rate of two or more suspected measles cases determined to be nonmeasles febrile rash illness per 100,000 population per year, and 2) collection of a blood specimen from one or more suspected measles case in ≥80% of districts per year.

** Calculated for MCV1, among children aged 1 year or, if MCV1 is given at age ≥1 year, among children aged 24 months. Calculated for MCV2 among children at the recommended age for the administration of MCV2, per the national immunization schedule. https://www.who.int/teams/immunization-vaccines-and-biologicals/immunization-analysis-and-insights/global-monitoring/immunization-coverage/who-unicef-estimates-of-national-immunization-coverage (Accessed May 1, 2023).

†† Case-based surveillance is the collection of epidemiologic information about each individual measles case; effective case-based measles surveillance includes confirmatory laboratory testing or epidemiologic linkage to a previous, laboratory-confirmed case.

laboratory network, which consists of 52 laboratories in 43 countries, supported by the WHO Global Measles and Rubella Laboratory Network.[§§] Two principal surveillance performance indicators used to monitor surveillance performance are 1) identification of two or more discarded cases of nonmeasles febrile rash illness per 100,000 population annually, and 2) collection of a blood specimen from at least one suspected measles case in at least 80% of districts annually (*5*). A previously described model for estimating measles cases and deaths was updated with measles case data and United Nations population estimates data during 2000–2021[¶¶] (*6*), and regional estimates were calculated. This activity was reviewed by CDC and was conducted consistent with applicable federal laws and CDC policy.[***]

Results

Immunization Activities

During 2017–2019, estimated regional MCV1 coverage remained stable at 70% but decreased to 68% in 2021 (Figure 1). Six countries reported ≥95% MCV1 coverage in 2017 (Botswana, Cabo Verde, Ghana, Rwanda, Seychelles, and Zambia) and in 2019 (Botswana, Cabo Verde, Mauritius, Rwanda, São Tomé and Príncipe, and Seychelles); however, only two countries (Botswana and Cabo Verde) reported ≥95% MCV1 coverage in 2021 (Table). The number and percentage of countries providing MCV2 increased from 27 (57%) to 38 (81%) and estimated regional MCV2 coverage increased from 25% to 41%. Three countries (Mauritius, Rwanda, and Seychelles) reported ≥95% MCV2 coverage in 2017; this decreased to two countries (Mauritius and Seychelles) in 2019, and none in 2021. Approximately 341 million persons received MCV during 69 SIAs conducted in 41 countries (Supplementary Table, https://stacks.cdc.gov/view/cdc/132420). Reported administrative coverage was ≥95% in 42 (61%) SIAs. Only two of 29 post-SIA coverage surveys reported ≥95% coverage.

Surveillance Activities

During 2017–2021, 42 (88%) countries reported weekly case-based measles surveillance data to the WHO African Regional Office. The number and percentage of countries that met both surveillance indicators decreased from 26 (62%) in 2017 to 19 (45%) in 2019 and to nine (22%) in 2021 (Figure 2).

Reported Measles Incidence and Measles Virus Genotypes

From 2017 to 2019, the number of reported measles cases[†††] increased more than sevenfold, from 72,603 to 618,595, then declined to 88,789 in 2021 (Figure 1). During 2017–2021, three countries accounted for 87% (885,934) of confirmed cases reported: the Democratic Republic of Congo (DRC) (584,578; 57%), Madagascar (235,483; 23%), and Nigeria (65,873; 6%). Confirmed annual measles incidence[§§§] increased from 69.2 cases per 1 million population in 2017 to 559.8 in 2019 and decreased to 81.9 in 2021 (Table).

The regional laboratory network processed blood specimens from 46,501 suspected measles cases in 2017, 61,636 in 2019, and 41,291 in 2021. Measles genotypes were obtained from confirmed measles cases in 16 (34%) countries; genotypes B3 (180; 64%) and D8 (103; 36%)[¶¶¶] were detected.

Measles Case and Mortality Estimates

Using the previously described model, the estimated number of measles cases in AFR increased 22% from 3,623,869 in 2017 to 4,430,595 in 2021, peaking at 6,377,451 in 2019. The estimated number of annual measles deaths increased from 61,166 in 2017 to 104,543 in 2019 before decreasing to 66,230 in 2021. During 2017–2021, an estimated 4.5 million measles deaths were prevented by measles vaccination.

Regional Verification of Measles Elimination

The African Regional Commission for the Verification of Measles Elimination (RVC) was established in 2017. During 2017–2021, 10 countries established national verification committees to support documentation of progress toward measles

[§§] The WHO Global Measles and Rubella Laboratory Network supports standardized methods and quality assurance measures in national laboratories across countries, as well as in three regional reference laboratories (Abidjan, Côte d'Ivoire; Entebbe, Uganda; and Johannesburg, South Africa).

[¶¶] State-space model of unobserved measles incidence generated using inputs from all AFR countries except South Sudan: total annual reported measles cases; annual MCV1 coverage from WHO and UNICEF estimates of national immunization coverage (WUENIC); annual MCV2 coverage from WUENIC; annual SIAs, with coverage and age targets (subnational SIAs are discounted by the proportion of the total population targeted); total annual population size; total annual births; list of all AFR countries and years for which reporting was enhanced.

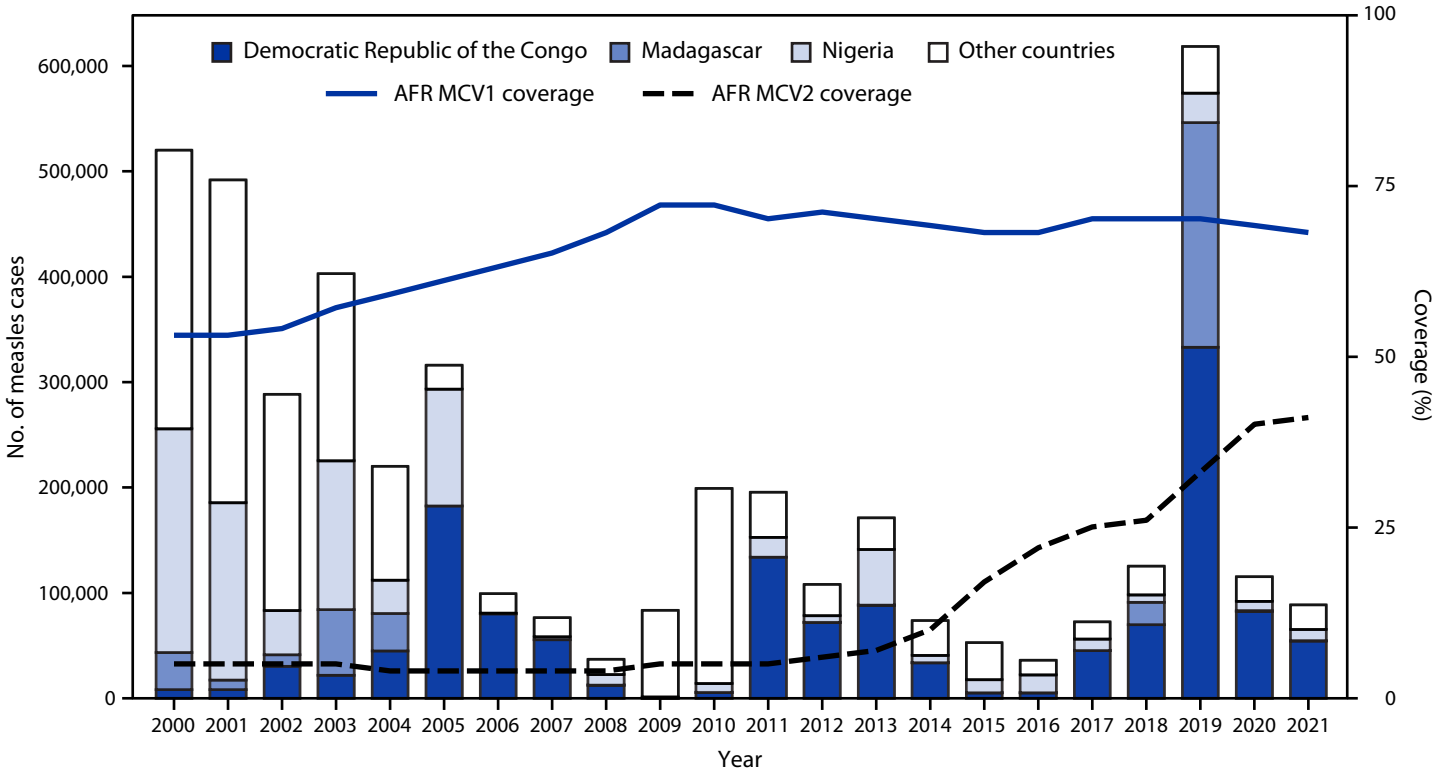
[***] 45 C.F.R. part 46, 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C. Sect. 552a; 44 U.S.C. Sect. 3501 et seq.

[†††] Data from the Joint Reporting Form submitted to WHO and UNICEF by member states with the official number of measles cases in the country for the year. https://immunizationdata.who.int/pages/incidence/measles.html (Accessed May 1, 2023).

[§§§] To calculate incidence, only countries that reported data are in the numerator and denominator. The countries that did not report measles cases by year are Mauritius and Seychelles (2018); Algeria, Cabo Verde, The Gambia, Mauritius, and São Tomé and Príncipe (2020); and Algeria, Burkina Faso, Guinea-Bissau, and South Sudan (2021). Countries do not provide WHO with their reasons for not reporting measles cases.

[¶¶¶] The WHO Global Measles and Rubella Laboratory Network sequences the 450 nucleotides coding for the carboxy-terminal 150 amino acids of the nucleoprotein to characterize circulating genotypes of measles viruses.

FIGURE 1. Estimated coverage with the first and second doses of measles-containing vaccine* and the number of confirmed measles cases† — World Health Organization African Region, 2000–2021



Abbreviations: AFR = African Region; MCV1 = first dose of measles-containing vaccine; MCV2 = second dose of measles-containing vaccine; WHO = World Health Organization.

* Data from WHO and UNICEF estimates, 2021 revision (as of May 2023). http://immunizationdata.who.int (Accessed May 1, 2023).

† The number of measles cases reported via the Joint Reporting Form submitted to WHO and UNICEF by member states (as of May 2023). https://immunizationdata.who.int/pages/incidence/measles.html (Accessed May 1, 2023).

elimination. The African RVC met during 2018–2019**** but not during 2020–2021 because many national immunization programs were fully engaged in the COVID-19 pandemic response. By December 2021, no country in AFR had received verification of measles elimination.

Discussion

The WHO AFR has made substantial progress in reducing measles cases and deaths since 2000 (*1*). However, the 2020 measles elimination goal was not attained, and the COVID-19 pandemic further exacerbated challenges associated with implementing the regional strategy (*7*). After a review in 2021, the Regional Strategic Plan for Immunization 2021–2030 reset the goal to achieve measles elimination in at least 80% of countries by 2030 (*8*).

During 2017–2021, regional MCV1 coverage remained stable at 68%–70%, but below the level of ≥95% necessary to achieve and sustain measles elimination; regional coverage was largely driven by low coverage in populous countries like DRC, Ethiopia, and Nigeria, which account for nearly 40% of the region's population. Eleven countries introduced MCV2, but no AFR country reached 95% MCV2 coverage. Worldwide, among all children who did not receive MCV1 in 2021, approximately 50% (12.3 million) lived in AFR countries.†††† An additional 21.1 million children in the region missed MCV2, leaving a large population at increased risk for measles disease and outbreaks. Tailored efforts must be made to monitor this risk and reach unvaccinated and undervaccinated children through intensified immunization activities, increased vaccine demand, and improved delivery of MCV at both fixed and outreach sites. Periodic, preventive SIAs remain a critical tool for reaching unvaccinated and undervaccinated children, particularly in settings where MCV coverage is <95%, and immunization data quality is unreliable (*9*).

**** The second meeting of the African RVC occurred during May 21–23, 2019 in Addis Ababa, Ethiopia.

†††† Data from WHO and UNICEF estimates, 2021 revision (as of June 2023). http://immunizationdata.who.int (Accessed June 21, 2023).

TABLE. Measles-containing vaccine administration schedule,* estimated coverage† with the first and second doses of measles-containing vaccine, number of reported measles cases,§ and measles incidence,¶ by country — World Health Organization African Region, 2017, 2019, and 2021

			2017				2019				2021			
	MCV schedule and vaccine dose		Estimated coverage,† %		No. of reported measles cases§	Measles incidence¶	Estimated coverage,† %		No. of reported measles cases§	Measles incidence¶	Estimated coverage,† %		No. of reported measles cases§	Measles incidence¶
Country	MCV1	MCV2	MCV1	MCV2			MCV1	MCV2			MCV1	MCV2		
Algeria	11 mos	18 mos	88	92	112	2.7	80	77	2,585	60.5	80	77	NR**	NA
Angola	9 mos	15 mos	42	30	29	1.0	51	45	2,987	92.3	36	32	300	8.7
Benin	9 mos	—††	68	—††	97	8.4	68	—††	437	35.6	68	—††	35	2.7
Botswana	9 mos	18 mos	97	74	0	0	97	76	0	0	97	70	0	0
Burkina Faso	9 mos	15 mos	88	65	49	2.5	88	71	672	32.1	88	71	NR**	NA
Burundi	9 mos	18 mos	90	75	18	1.6	92	80	112	9.4	90	85	369	29.4
Cabo Verde	9 mos	15 mos	96	85	0	0	98	91	0	0	95	86	0	0
Cameroon	9 mos	15 mos	65	—††	712	29.2	60	NR**	2,809	109.0	62	35	771	28.3
Central African Republic	9 mos	—††	41	—††	801	160.3	41	—††	3,390	650.8	41	—††	286	52.4
Chad	9 mos	—††	37	—††	9	0.6	41	—††	1,882	116.7	55	—††	2,577	150
Comoros	9 mos	18 mos	90	—††	0	0	90	—††	65	82.2	82	19	0	0
Côte d'Ivoire	9 mos	15 mos	70	—††	163	6.6	73	—††	372	14.2	68	1	1,837	66.9
Democratic Republic of the Congo	9 mos	—††	65	—††	45,107	535.2	65	—††	333,017	3,704.0	55	—††	54,471	568.0
Equatorial Guinea	9 mos	18 mos	53	—††	1	0.7	53	—††	0	0	53	17	43	26.3
Eritrea	9 mos	18 mos	93	88	1,199	353.0	93	85	6	1.7	93	85	25	6.9
Eswatini	9 mos	18 mos	89	70	0	0	81	75	0	0	80	69	29	24.3
Ethiopia	9 mos	15 mos	59	—††	1,921	17.8	58	41	3,998	35.0	54	46	1,953	16.2
Gabon	9 mos	—††	63	—††	1,075	502.3	62	—††	2	0.9	64	—††	134	57.2
The Gambia	9 mos	18 mos	90	68	1	0.4	85	61	1	0.4	79	67	0	0
Ghana	9 mos	18 mos	95	83	19	0.6	92	83	1,274	40.4	94	83	52	1.6
Guinea	9 mos	—††	47	—††	2,036	166.3	47	—††	4,555	353.7	47	—††	505	37.3
Guinea-Bissau	9 mos	—††	66	—††	11	5.9	79	—††	60	30.4	63	—††	NR**	NA
Kenya	9 mos	18 mos	89	35	63	1.3	89	49	439	8.6	89	57	266	5.0
Lesotho	9 mos	18 mos	90	82	0	0	90	82	464	208.5	90	82	368	161.3
Liberia	9 mos	15 mos	75	—††	960	200.1	68	13	1,203	241.3	58	35	250	48.1
Madagascar	9 mos	15–18 mos	55	—††	11	0.4	55	—††	213,231	7,744.5	39	24	44	1.5
Malawi	9 mos	15 mos	83	67	4	0.2	92	75	17	0.9	90	74	5	0.3

See table footnotes on the next page.

Surveillance quality improved in 2017, with 26 countries attaining both indicator targets compared with 19 countries in 2016 (*3*). However, only 19 countries met both targets in 2019, and performance further declined during the COVID-19 pandemic (*7*), with only nine countries meeting both targets in 2021 and significant reductions in reported cases and specimens processed by the regional laboratory network. These declines might be further compounded by the forecasted reduction in resources from the Global Polio Eradication Initiative for vaccine-preventable disease surveillance infrastructure as part of the Polio Endgame Strategy 2019–2023.§§§§

Measles incidence continued to increase during 2017–2021, reaching a peak in 2019 amid a global resurgence (*10*). In 2021, reported cases were still 22% higher than in 2017, with DRC and Nigeria accounting for nearly three quarters (73%) of the 88,789 reported cases. The number of cases estimated by modeling in 2021 was 4.4 million, indicating underperforming surveillance systems. Lessons learned from explosive outbreaks in 2019 in DRC and Madagascar highlight the need to conduct timely preventive SIAs, implement high-quality surveillance, and ensure outbreak preparedness, including availability of resources for rapid response. Beginning in 2020, the WHO African Regional Office has supported priority countries in building capacity and developing and implementing measles outbreak preparedness and response plans.

Limitations

The findings in this report are subject to at least three limitations. First, immunization coverage estimates are based primarily on administrative data, which might

§§§§ https://polioeradication.org/wp-content/uploads/2019/06/english-polio-endgame-strategy.pdf

TABLE. (*Continued*) Measles-containing vaccine administration schedule,* estimated coverage† with the first and second doses of measles-containing vaccine, number of reported measles cases,§ and measles incidence,¶ by country — World Health Organization African Region, 2017, 2019, and 2021

Country	MCV schedule and vaccine dose		2017				2019				2021			
			Estimated coverage,† %		No. of reported measles cases§	Measles incidence¶	Estimated coverage,† %		No. of reported measles cases§	Measles incidence¶	Estimated coverage,† %		No. of reported measles cases§	Measles incidence¶
	MCV1	MCV2	MCV1	MCV2			MCV1	MCV2			MCV1	MCV2		
Mali	9 mos	12–23 mos	70	—††	26	1.3	70	4	454	22.1	70	33	2,074	94.7
Mauritania	9 mos	—††	75	—††	63	15.1	75	—††	196	44.7	63	—††	249	54.0
Mauritius	9 mos	17 mos	89	95	0	0	99	99	98	75.6	77	64	0	0
Mozambique	9 mos	18 mos	87	45	122	4.3	87	64	63	2.1	84	70	619	19.3
Namibia	9 mos	15 mos	80	32	16	6.8	80	56	12	4.9	90	63	4	1.6
Niger	9 mos	16 mos	82	46	1,171	53.9	79	58	10,321	440.3	80	66	9,271	367.1
Nigeria	9 mos	15 mos	54	—††	11,190	57.8	57	9	28,094	138.2	59	36	10,649	49.9
Republic of the Congo	9 mos	15 mos	70	—††	958	180.3	73	9	66	11.8	68	31	160	27.4
Rwanda	9 mos	15 mos	97	95	145	11.9	96	92	818	63.7	87	85	40	3.0
São Tomé and Príncipe	9 mos	18 mos	90	76	0	0	95	81	0	0	77	69	0	0
Senegal	9 mos	15 mos	90	59	11	0.7	89	68	267	16.7	87	75	187	11.1
Seychelles	15 mos	6 yrs	99	99	0	0	99	99	0	0	94	86	0	0
Sierra Leone	9 mos	15 mos	80	55	1,873	244.0	93	72	40	5.0	87	67	170	20.2
South Africa	6 mos	12 mos	81	78	210	3.7	83	79	59	1.0	87	82	21	0.4
South Sudan	9 mos	—††	50	—††	487	45.7	49	—††	3,401	325.5	49	—††	NR**	NA
Tanzania	9 mos	18 mos	90	67	852	15.1	88	72	120	2.0	76	62	0	0
Togo	9 mos	15 mos	77	—††	46	5.9	75	53	69	8.4	70	50	82	9.5
Uganda	9 mos	—††	83	—††	1,021	25.4	87	—††	920	21.4	90	—††	606	13.2
Zambia	9 mos	18 mos	96	64	13	0.8	93	66	15	0.8	90	81	55	2.8
Zimbabwe	9 mos	18 mos	90	78	1	0.1	85	75	4	0.3	85	74	282	17.6
Region overall	**NA**	**NA**	**70**	**25**	**72,603**	**69.2**	**70**	**33**	**618,595**	**559.8**	**68**	**41**	**88,789**	**81.9**

Abbreviations: JRF = Joint Reporting Form; MCV = measles-containing vaccine; MCV1 = first dose of MCV in routine immunization; MCV2 = second dose of MCV in routine immunization; NA = not applicable; NR = not reported; WHO = World Health Organization.

* As reported to WHO and UNICEF via the JRF by member states for the year.

† Data from WHO and UNICEF estimates, 2021 revision (as of May 2023). http://immunizationdata.who.int (Accessed May 1, 2023).

§ The JRF was submitted to WHO and UNICEF by member states with the official immunization data and the number of measles cases in the country for the year (as of May 2023). https://immunizationdata.who.int/pages/incidence/measles.html (Accessed May 1, 2023).

¶ Cases per 1 million population.

** Cases were not reported to the JRF.

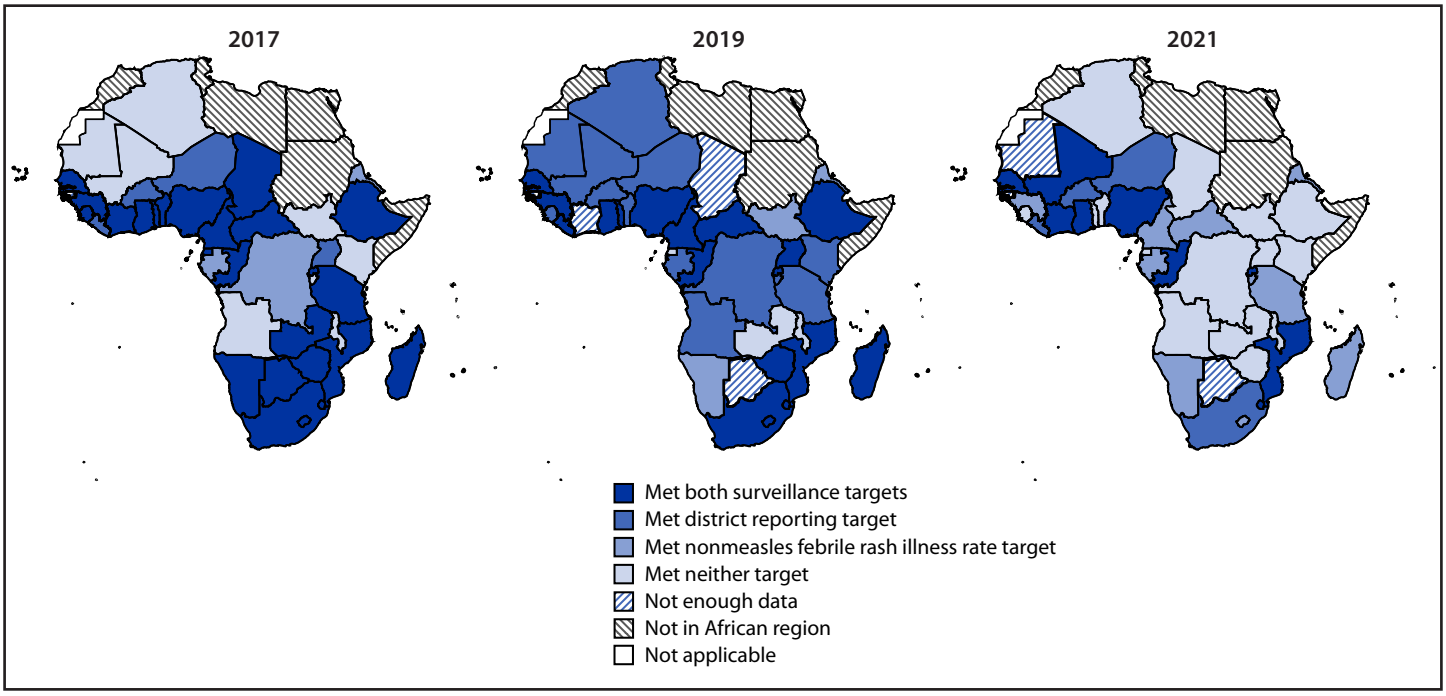
†† MCV2 was not introduced into routine immunization.

contain inaccuracies resulting from errors in recording doses administered or in population estimates. Second, cases and incidence might be underestimated because of inaccuracies in population estimates, variation in measles surveillance performance and data quality among countries, and because not all persons with suspected measles seek care and thus are not identified by the health system. Finally, the measles case and mortality estimates might contain inaccuracies resulting from errors in the data inputs and are subject to the inherent uncertainty of modeling estimates.

Implications for Public Health Practice

Despite not reaching the 2020 elimination goal, implementation of measles elimination strategies substantially reduced measles morbidity and mortality in AFR, with measles vaccination averting approximately 19.5 million deaths during 2000–2021 (*1*). However, an estimated 33.4 million children in the region still did not receive 1 or both MCV doses in 2021, highlighting the urgent need to accelerate recovery of immunization systems and prevention of outbreaks after the COVID-19 pandemic. Country progress toward measles elimination is an impact indicator within the Immunization Agenda 2021–2030 and represents an opportunity to garner political commitment and mobilize resources. Achieving measles elimination in 80% of countries in AFR by 2030 will require intensified action to attain ≥95% coverage with 2 MCV doses at national and district levels, to strengthen and rebuild high-quality surveillance systems, and to mitigate the risk for outbreaks.

FIGURE 2. Measles case-based surveillance performance,* by country — World Health Organization African Region, 2017, 2019, and 2021



* Two surveillance performance indicator targets were 1) investigation of two or more cases of nonmeasles febrile rash illness per 100,000 population annually (nonmeasles febrile rash illness rate target), and 2) collection of a blood specimen from one or more suspected measles case in ≥80% of districts annually (district reporting target).

Summary

What is already known about this topic?

The World Health Organization African Region established a 2020 measles elimination goal. In 2016, regional coverage with 1 dose of measles-containing vaccine (MCV) was 68%, and 40% of countries met surveillance performance indicators.

What is added by this report?

The 2020 elimination goal was not met, and in 2021, coverage with a first MCV dose remained <95% in all but two countries. After a 2019 global measles resurgence, incidence in 2021 exceeded that in 2017. Surveillance quality declined during 2017–2021, with 62% of countries achieving surveillance performance indicators in 2017 compared with 22% in 2021.

What are the implications for public health practice?

Reaching all children with 2 MCV doses and improving surveillance is critical to achieving the renewed 2030 regional measles elimination goal in at least 80% of African countries.

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Reduced Odds of Mpox-Associated Hospitalization Among Persons Who Received JYNNEOS Vaccine — California, May 2022–May 2023

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Abstract

The effectiveness of 1 dose of JYNNEOS vaccine (modified vaccinia Ankara vaccine, Bavarian Nordic) against hospitalization for mpox (caused by *Monkeypox virus*), has been demonstrated; however, the impact of 2 doses on hospitalization risk, especially among persons infected with HIV, who are at higher risk for severe disease, is an important factor in evaluating vaccine effectiveness against mpox disease severity and *Monkeypox virus* infection. Surveillance data collected by the California Department of Public Health were used to evaluate whether receipt of 2 doses of JYNNEOS vaccine reduced the odds of hospitalization among persons with mpox. The odds of hospitalization among persons with mpox who had received 1 or 2 JYNNEOS doses were 0.27 (95% CI = 0.08–0.65) and 0.20 (95% CI = 0.01–0.90), respectively, compared with unvaccinated mpox patients. In mpox patients with HIV infection, the odds of hospitalization among those who had received 1 JYNNEOS vaccine dose was 0.28 (95% CI = 0.05–0.91) times that of those who were unvaccinated. No mpox-associated hospitalizations were identified among persons infected with HIV who had received 2 JYNNEOS vaccine doses. To optimize durable immunity, all eligible persons at risk for mpox, especially those infected with HIV, should complete the 2-dose JYNNEOS series.

Introduction

During May 12, 2022–May 18, 2023, a total of 5,765 persons with mpox and 250 (4.3%) mpox-associated hospitalizations were reported among California residents (*1*). At the end of May 2022, California began to distribute JYNNEOS smallpox and mpox vaccine, licensed in the United States as a 2-dose series, with doses administered 28 days apart, for protection against mpox (*2–4*). Observational studies of JYNNEOS vaccine effectiveness against mpox have ranged from 66% to 89% for 2 doses and 36% to 75% for 1 dose (*5–7*). A 2022 study in 29 jurisdictions found that persons with mpox who had received 1 JYNNEOS dose were less likely to be hospitalized and reported fewer lesions compared with unvaccinated persons with mpox (*8*). The effect of 2 JYNNEOS doses on hospitalization risk, especially among persons with HIV infection, who are at higher risk for severe mpox disease, has not been evaluated (*1*). This study analyzed reported California mpox cases and immunization registry data to determine the risk for mpox-associated hospitalization by JYNNEOS vaccination status.

Methods

California residents with laboratory-confirmed *Monkeypox virus* infections were interviewed to obtain data on demographic, epidemiologic, and clinical characteristics. Case reports with missing information on hospitalization status were excluded. JYNNEOS vaccination status was based on data reported to the California Immunization Registry.* Mpox patients were categorized by vaccination status and HIV status. One-dose recipients were defined as patients who had 1) received 1 preexposure JYNNEOS dose ≥14 days before their episode date,† or 2) received 2 doses, with the second dose administered <14 days before the episode date, or 3) received 2 doses <24 days apart. Two-dose recipients were defined as patients who had received 2 doses ≥24 days apart with the second dose administered ≥14 days before the episode date. Postexposure prophylaxis (PEP) vaccination was defined as receipt of the first JYNNEOS dose after a known or suspected exposure and <14 days before the episode date. Mpox patients who had received zero doses of JYNNEOS vaccine reported to the California Immunization Registry were considered unvaccinated.

Mpox patients with a previous HIV case report in the California Department of Public Health's Office of AIDS were considered to have HIV infection. Mpox hospitalization was defined as inpatient hospitalization for mpox disease; emergency department visits were not included.

Demographic characteristics of unvaccinated mpox patients were compared with those of 1-dose, 2-dose, and PEP recipients. Odds ratios comparing hospitalization by vaccination status were calculated using binomial logistic regression, and 95% CIs were estimated. Analyses were then stratified by HIV status. To determine whether and how missing hospitalization

* Although a 28-day interval is recommended between the 2 JYNNEOS doses, a 4-day grace period allows for a minimum interval of 24 days between doses.
† The symptom onset date, specimen collection date, date of specimen receipt by the laboratory, or date of receipt of the laboratory report by the mpox surveillance registry, whichever occurred earlier.

data might have biased the analysis, mpox patients included in the analysis were compared with those who were excluded because of missing or unknown hospitalization status using Pearson's chi-square tests. All analyses were conducted using R statistical software (version 4.0.2; R Foundation). This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[§]

Results

Among the 5,765 California residents who had received a diagnosis of mpox, 1,154 (20.0%) were excluded because hospitalization status was not reported. Among the remaining 4,611 included persons, 4,353 (94.4%) were male, 2,083 (45.2%) were Hispanic or Latino, and 3,188 (69.1%) identified as gay, lesbian, or same-gender loving (Table 1). Comparison of patients included in the study and those excluded because of missing hospitalization status identified substantial differences in race and ethnicity, sexual orientation, prevalence of HIV infection, age, and prevalence of missing data on gender identity, race and ethnicity, and sexual orientation (Table 1).

Overall, 233 (5.0%) *Monkeypox virus* infections occurred in persons who received 1 JYNNEOS dose, 79 (1.7%) in those who received 2 doses, 457 (9.9%) in persons who received PEP,[¶] and 3,845 (83.4%) in unvaccinated persons. A total of 250 (5.4%) mpox patients were hospitalized, including four (1.6%) who received 1 JYNNEOS dose, one (0.4%) who received 2 doses, 12 (4.8%) who received PEP, and 233 (93.2%) who were unvaccinated. Compared with unvaccinated mpox patients, the odds of hospitalization among persons with mpox who received 1 dose, 2 doses, and PEP were 0.27, 0.20, and 0.42, respectively (Table 2).

Persons with HIV accounted for 1,878 (40.7%) of the 4,611 mpox patients included in the study and 140 (56.0%) of the 250 mpox hospitalizations (Table 3). Among hospitalized HIV-positive mpox patients, two of 81 (2.5%) had received 1 JYNNEOS dose, zero of 19 had received 2 doses, and seven of 193 (3.6%) had received PEP; 131 of 1,585 (8.3%) were unvaccinated. The odds of hospitalization among HIV-positive mpox patients who had received 1 dose of JYNNEOS or PEP were 0.28 and 0.42 times, respectively, the odds among unvaccinated HIV-positive mpox patients; no hospitalizations occurred among HIV-positive mpox patients who had received 2 JYNNEOS doses. Among HIV-negative mpox patients, the odds of hospitalization among 1-dose, 2-dose, and PEP recipients were 0.29, 0.36, and 0.41, respectively, times those among unvaccinated patients.

[§] 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.

[¶] Median interval before episode date = 4 days; IQR = 1–7 days.

Summary

What is already known about this topic?

One JYNNEOS vaccine dose decreases mpox lesion severity and hospitalization prevalence.

What is added by this report?

Among persons with and without HIV infection, mpox-associated hospitalization rates were lower among those who had received ≥1 dose of JYNNEOS vaccine compared with those who were unvaccinated.

What are the implications for public health practice?

Receiving ≥1 dose of JYNNEOS vaccine reduced the odds of hospitalization among California residents. To maximize enduring immunity against *Monkeypox virus* infection, all eligible persons should complete the 2-dose JYNNEOS vaccine series.

Discussion

During May 12, 2022–May 18, 2023, persons with mpox who had received 1 or 2 preexposure doses of JYNNEOS vaccine or had received JYNNEOS as PEP had lower odds of being hospitalized than did unvaccinated mpox patients. These findings suggest that receipt of both pre- and postexposure JYNNEOS vaccination reduces the odds of hospitalization among persons with mpox. In addition, among HIV-positive persons with mpox, who are at increased risk for severe mpox disease (*9*), those who were vaccinated had lower odds of hospitalization than did those who were unvaccinated. Zero hospitalizations were reported among persons infected with HIV who had received 2 doses of JYNNEOS vaccine. These findings underscore the benefit to persons with HIV infection of completing the 2-dose JYNNEOS vaccination series (*1*,*9*).

Approximately 300,000 doses of the JYNNEOS vaccine have been administered to California residents since May 26, 2022.[**] During this time, an estimated 64% of California's at-risk population[††] received 1 dose and 40% received 2 doses (*10*). Messaging to persons at higher risk for *Monkeypox virus* infection and persons with HIV infection should encourage completion of the 2-dose JYNNEOS vaccination series to limit virus transmission and mitigate disease severity.

Because JYNNEOS vaccine is not 100% effective, as more persons are vaccinated, the number of infections occurring in vaccinated persons will likely increase. It is important to

[**] Certain California residents received JYNNEOS vaccine before this date. May 26, 2022, was used for this analysis because this was the date that the California Department of Public Health had doses recorded among lots received by the Administration for Strategic Preparedness and Response for use as part of the state's ongoing response to mpox.

[††] Defined as the population recommended to receive the vaccine, which was estimated by CDC using 2021 data for men who have sex with men (MSM) with HIV preexposure prophylaxis indications and 2020 data for HIV prevalence among MSM from CDC AtlasPlus.

TABLE 1. Characteristics of mpox cases, by vaccination status — California, May 12, 2022–May 18, 2023

Characteristic	JYNNEOS vaccination status, no. (%)						
	Received 1 dose n = 230	Received 2 doses n = 79	Received PEP* n = 457	Unvaccinated n = 3,845	Total included N = 4,611	Total excluded† n = 1,154	p-value§
Gender identity							
Female	0 (—)	1 (1.3)	4 (0.9)	118 (3.1)	**123 (2.7)**	**21 (1.8)**	0.122
Genderqueer or non-binary	4 (1.7)	0 (—)	7 (1.5)	23 (0.6)	**34 (0.7)**	**3 (0.3)**	0.107
Male	223 (97.0)	77 (97.5)	443 (96.9)	3,610 (93.9)	**4,353 (94.4)**	**1,068 (92.5)**	0.021
Transgender female	3 (1.3)	0 (—)	2 (0.4)	51 (1.3)	**56 (1.2)**	**23 (2.0)**	0.058
Transgender male	0 (—)	0 (—)	0 (—)	15 (0.4)	**15 (0.3)**	**4 (0.3)**	1.000
Declined to answer	0 (—)	1 (1.3)	0 (—)	17 (0.4)	**18 (0.4)**	**17 (1.5)**	<0.001
Unknown	0 (—)	0 (—)	1 (0.2)	11 (0.3)	**12 (0.3)**	**18 (1.6)**	<0.001
Age, yrs, median (IQR)	35 (22–48)	36 (24.5–47.5)	38 (24–52)	35 (21–49)	**35 (25–48)**	**37 (23–51)**	<0.001
Race and ethnicity¶							
AI/AN	1 (0.4)	0 (—)	2 (0.4)	18 (0.5)	**21 (0.5)**	**2 (0.2)**	0.272
Asian	17 (7.4)	3 (3.8)	30 (6.6)	200 (5.2)	**250 (5.4)**	**58 (5.0)**	0.644
Black or African American	16 (7.0)	5 (6.3)	32 (7.0)	537 (14.0)	**590 (12.8)**	**108 (9.4)**	0.002
NH/OPI	3 (1.3)	0 (—)	5 (1.1)	14 (0.4)	**22 (0.5)**	**3 (0.3)**	0.451
White	97 (42.2)	31 (39.2)	178 (38.9)	1,023 (26.6)	**1,329 (28.8)**	**333 (28.9)**	1.000
Hispanic or Latino	83 (36.1)	32 (40.5)	175 (38.3)	1,793 (46.6)	**2,083 (45.2)**	**323 (28.0)**	<0.001
Multiple races	3 (1.3)	2 (2.5)	8 (1.8)	61 (1.6)	**74 (1.6)**	**5 (0.4)**	0.003
Unknown	10 (4.3)	6 (7.6)	27 (5.9)	199 (5.2)	**242 (5.2)**	**322 (27.9)**	<0.001
Sexual orientation							
Bisexual	9 (3.9)	2 (2.5)	28 (6.1)	424 (11.0)	**463 (10.0)**	**26 (2.3)**	<0.001
Gay, lesbian, or same-gender loving	189 (82.2)	69 (87.3)	375 (82.1)	2,555 (66.4)	**3,188 (69.1)**	**333 (28.9)**	<0.001
Heterosexual or straight	7 (3.0)	2 (2.5)	9 (2.0)	402 (10.5)	**420 (9.1)**	**42 (3.6)**	<0.001
Declined to answer	7 (3.0)	3 (3.8)	10 (2.2)	135 (3.5)	**155 (3.4)**	**21 (1.8)**	0.009
Orientation not listed	6 (2.6)	1 (1.3)	5 (1.1)	63 (1.6)	**75 (1.6)**	**29 (2.5)**	0.057
Unknown	12 (5.2)	2 (2.5)	30 (6.6)	266 (6.9)	**310 (6.7)**	**703 (60.9)**	<0.001
HIV status							
Positive	81 (35.4)	19 (24.1)	193 (42.2)	1,585 (41.2)	**1,878 (40.7)**	**402 (34.8)**	<0.001
Negative	148 (64.6)	60 (75.9)	264 (57.8)	2,261 (58.8)	**2,733 (59.3)**	**752 (65.2)**	<0.001

Abbreviations: AI/AN = American Indian or Alaska Native; NH/OPI = Native Hawaiian or other Pacific Islander; PEP = postexposure prophylaxis.
* Mpox patients who reported symptom onset <14 days after their first JYNNEOS dose were presumed to have received PEP.
† Mpox cases with missing or unknown hospitalization status were excluded from this analysis.
§ Pairwise chi-square testing was conducted between the included and excluded groups.
¶ Persons of Hispanic or Latino (Hispanic) origin might be of any race but are categorized as Hispanic; all racial groups are non-Hispanic.

TABLE 2. Mpox hospitalizations, by JYNNEOS vaccination status (N = 4,611) — California, May 12, 2022–May 18, 2023

JYNNEOS vaccination status	Hospitalization status, no. (%)		Total, no.	OR (95% CI)
	Hospitalized n = 250	Not hospitalized n = 4,361		
Received 1 dose*	4 (1.7)	226 (98.3)	**230**	0.27 (0.08–0.65)
Received 2 doses†	1 (1.3)	78 (98.7)	**79**	0.20 (0.01–0.90)
Received PEP§	12 (2.6)	445 (97.4)	**457**	0.42 (0.22–0.72)
Unvaccinated¶	233 (6.1)	3,612 (93.9)	**3,845**	Ref

Abbreviations: OR = odds ratio; PEP = postexposure prophylaxis; Ref = referent group.
* Receipt of 1 JYNNEOS vaccine dose ≥14 days before their episode date (symptom onset date, specimen collection date, date of specimen receipt by the laboratory, or date laboratory report was received by the mpox surveillance registry, whichever was earlier), receipt of 2 doses with the second dose administered <14 days before the episode date, or receipt of 2 doses <24 days apart.
† Receipt of 2 JYNNEOS vaccine doses ≥24 days apart with the second dose administered ≥14 days before the episode date.
§ Receipt of the first JYNNEOS vaccine dose after a known or suspected exposure and <14 days before the episode date.
¶ Receipt of no JYNNEOS vaccine doses.

prioritize further efforts to quantify the impact of JYNNEOS vaccination on disease severity (e.g., number of lesions, lesion spread, fever, and other prodromal signs and symptoms) to build upon current evidence. These efforts should be coupled with efforts to better understand the relationship between HIV and *Monkeypox virus*, including how viral suppression and CD4 counts might affect the immune response to mpox in response to vaccination; this could not be determined in the current study because of the limited number of infections that occurred among vaccinated persons with HIV infection.

TABLE 3. Mpox hospitalizations, by vaccination status and HIV status* (N = 4,611) — California, May 12, 2022–May 18, 2023

HIV status/JYNNEOS vaccination status	Hospitalization status, no. (%)		Total, no.	OR (95% CI)
	Hospitalized n = 250	Not hospitalized n = 4,361		
HIV positive (1,878)				
1 dose†	2 (2.5)	79 (97.5)	**81**	0.28 (0.05–0.91)
2 doses§	0 (—)	19 (100.0)	**19**	0 (—)
PEP¶	7 (3.6)	186 (96.4)	**193**	0.42 (0.17–0.84)
Unvaccinated**	131 (8.3)	1,454 (91.7)	**1,585**	Ref
HIV negative (2,733)				
1 dose†	2 (1.4)	146 (98.6)	**148**	0.29 (0.05–0.93)
2 doses§	1 (1.7)	59 (98.3)	**60**	0.36 (0.02–1.65)
PEP¶	5 (1.9)	259 (98.1)	**264**	0.41 (0.14–0.91)
Unvaccinated**	102 (4.5)	2,159 (95.5)	**2,261**	Ref

Abbreviations: OR = odds ratio; PEP = post-exposure prophylaxis; Ref = referent group.

* HIV status was determined based on the presence or absence of a previous HIV case report submitted to the California Department of Public Health Office of AIDS.

† Receipt of 1 JYNNEOS vaccine dose ≥14 days before episode date (symptom onset date, specimen collection date, date of specimen receipt by the laboratory, or date laboratory report was received by the mpox surveillance registry, whichever was earlier), receipt of 2 doses with the second dose administered <14 days before the episode date, or receipt of 2 doses <24 days apart.

§ Receipt of 2 JYNNEOS vaccine doses ≥24 days apart with the second dose administered ≥14 days before the episode date.

¶ Receipt of the first JYNNEOS vaccine dose after a known or suspected exposure and <14 days before the episode date.

** Receipt of no JYNNEOS vaccine doses.

Limitations

The findings in this report are subject to at least six limitations. First, persons with mpox with symptom onset <14 days after receipt of the first JYNNEOS dose were presumed to have received PEP, but whether exposure preceded vaccination could not be confirmed. Second, differential misclassification of vaccination and hospitalization status, uncontrolled confounding, and selection bias might have affected this association. For example, these biases could manifest because the study did not determine whether persons in poorer health (and presumably higher a priori risk for hospitalization) were less likely to be vaccinated. If these persons were less likely to be vaccinated, the protective effect of vaccination might be overestimated, because it was not possible to control for baseline health status, especially among persons with HIV infection. Third, persons with diagnosed mpox, especially those who were vaccinated, might represent a population with better access to health care compared with persons with unreported mpox who were unvaccinated, leading to underestimation of the impact of JYNNEOS vaccination on prevention of mpox-associated hospitalization. Fourth, differential absence in hospitalization status with respect to vaccination status might have occurred, because the excluded population was less likely to report race and ethnicity, sexual orientation, or gender identity. If vaccinated persons were more likely to be misclassified as missing or not hospitalized, the protective effect would be overestimated. Fifth, because of the limited numbers of mpox cases and associated hospitalizations in persons who had received 2 JYNNEOS doses, the superiority of 2 doses versus 1 dose in preventing hospitalization among persons with mpox could not be demonstrated. Finally, associations by HIV status were limited by the low number of infections in vaccinated persons and resulted in wide CIs, perhaps because of the effectiveness of JYNNEOS at preventing *Monkeypox virus* infection.

Implications for Public Health Practice

These findings provide evidence that JYNNEOS vaccination reduces the odds of hospitalization among persons with mpox. The protective effect of JYNNEOS was consistent among persons with mpox irrespective of HIV infection status. Although small case counts precluded determining whether 2 doses were superior to 1 dose in the total population, there were fewer hospitalizations among HIV-positive persons with mpox who had received 2 JYNNEOS doses compared with those who had received 1 dose, and in both groups, the odds of hospitalization were lower compared with those among unvaccinated persons. Persons at risk for mpox should receive the complete 2-dose JYNNEOS vaccine series to protect against infection and to reduce the odds of hospitalization if infection does occur.

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All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. Philip Peters reports co-leadership of the immunization panel for the U.S. Guidelines for the Prevention and Treatment of Opportunistic Infections in Adults and Adolescents with HIV. Marisa Ramos reports unpaid membership on the Board of Directors for the National Alliance of State and Territorial AIDS Directors. No other potential conflicts of interest were disclosed.

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Notes from the Field

Gastrointestinal Illness Among Hikers on the Pacific Crest Trail — Washington, August–October 2022

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On August 26, 2022, the Washington State Department of Health received informal reports of numerous Pacific Crest Trail hikers with acute gastroenteritis (AGE). The Pacific Crest Trail stretches 2,650 miles from California to Washington, attracting hikers from around the world (*1*). An investigation of social media postings on September 5 found 27 reports of AGE by Washington Pacific Crest Trail hikers during the previous month, 26 of whom provided information about symptom onset date (Figure). Numerous additional reports without a specific date were found, suggesting that that AGE was occurring during the 2022 hiking season.

Investigation and Outcomes

During September 13–18, a REDCap survey was posted on a Facebook group popular with Washington Pacific Crest Trail hikers and displayed (with a quick response code) at trailhead locations where illness had been reported. Survey responses were collected from 27 ill Pacific Crest Trail hikers regarding symptoms, locations, and contact details; 22 respondents reported onset dates. Two respondents (the only two with symptoms during the preceding 14 days who were still in Washington), agreed to provide stool samples; both samples tested positive for norovirus by real-time reverse transcription–polymerase chain reaction (RT-PCR) (*2*) at the Washington State Public Health Laboratory. The samples were sent to CaliciNET Laboratory (California Department of Public Health) for sequencing; both were identified as GII.10[P16]. Twenty (74%) survey respondents reported an illness of short duration (median = 2.5 days; 95% CI = 1–15.7 days); among 22 (81%) who reported signs and symptoms, those most commonly reported were fatigue (21; 95%) and vomiting and diarrhea (17; 77%). Twenty-one (95%) survey respondents who reported an onset date noted that they became ill within a 73-mile stretch of the Washington Pacific Crest Trail; this suggested the potential for environmental exposure.

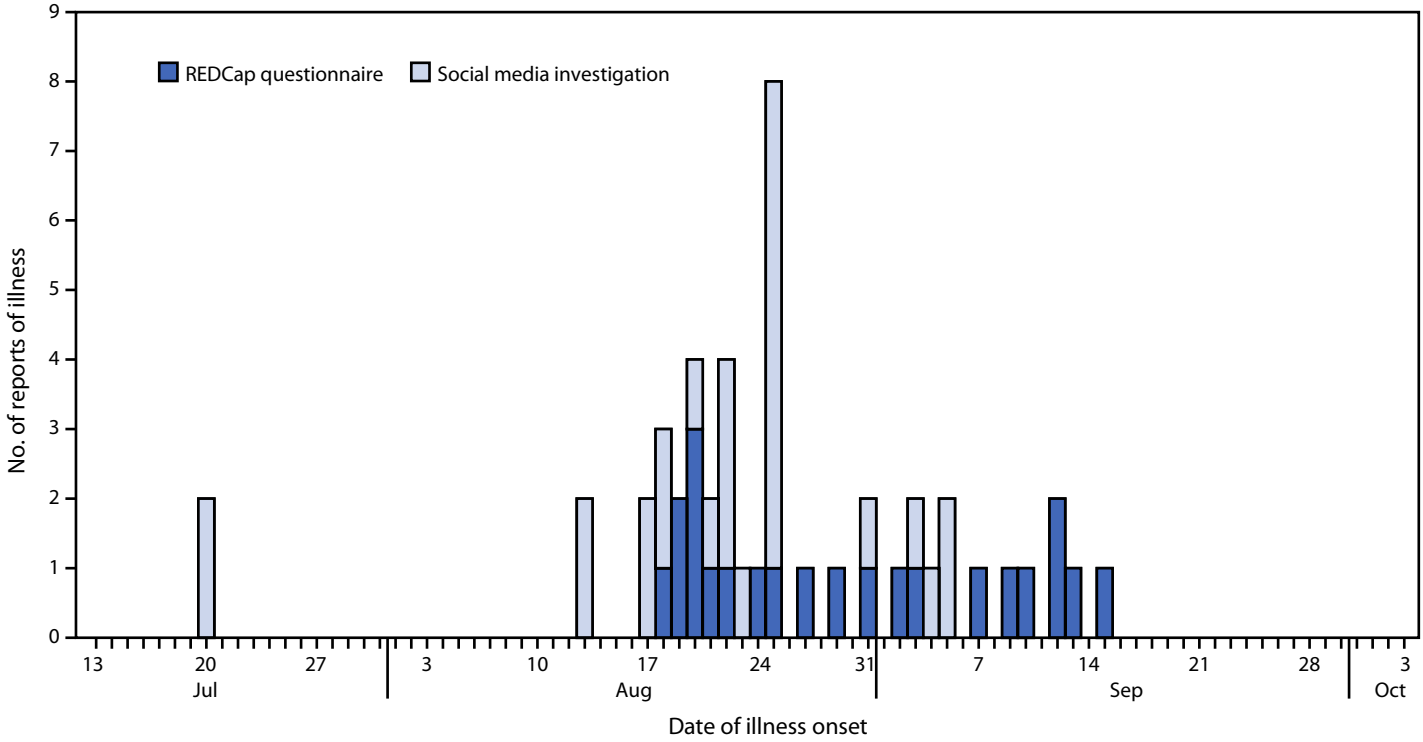
The probable distance an infected hiker could have walked during the norovirus incubation period was subtracted from onset locations to estimate a probable geographic exposure area. Cross-referencing the estimated exposure area with facilities on the trail guided identification of two sets of ventilated improved pit (VIP) latrines, a cabin available as a rest stop, and a stream with drinking water as potential sampling sites. During October 3–4, 2022, samples were collected from drinking water sources used by hikers and high-touch surfaces in the cabin and VIP latrines to test for norovirus and fecal contamination using real time RT-PCR and quantitative PCR testing (*3*,*4*). Norovirus was not detected in any samples. No culture-based fecal indicators, *E. coli*, or human-specific fecal contamination were detected in any water source. All surface swabs inside the cabin and pit latrines tested positive for human-specific fecal contamination. Despite absence of detection of norovirus from environmental sampling, symptom profiles, respondent and environmental laboratory results, and epidemiologic links all supported the conclusion that the outbreak was primarily caused by norovirus, and that exposure to contaminated surfaces within the cabin and VIP latrines likely amplified transmission. Improved sanitation protocols, messaging on handwashing, and guidance on reporting outbreaks were shared with jurisdictional authorities. This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.*

Preliminary Conclusions and Actions

Although the REDCap survey identified only 27 ill hikers, social media reports indicated that the true size of the outbreak was likely substantially larger, with 27 reports with a date of onset, and numerous others without further chronologic information apart from the year (2022). Norovirus prevention in remote areas is difficult because of a lack of easily available clean water and soap for handwashing, and inability to routinely disinfect shared surfaces (e.g., cabins and restrooms). Moreover, alcohol-based hand sanitizers, commonly used in hiking, are not effective against norovirus (*5*). Preventing future outbreaks will require fostering increased awareness of the importance of handwashing and lack of effectiveness of alcohol-based hand sanitizers against norovirus, and more frequent cleaning of public facilities; early outbreak detection might be facilitated by social media surveillance.

* 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.

FIGURE. Number of hikers with gastrointestinal symptoms by illness onset date* based on social media investigation (N = 26) and REDCap Survey (N = 22) — Pacific Crest Trail, Washington, July 20–October 4, 2022



* Among a total of 27 social media postings and 27 REDCap survey responses, 26 and 22 persons, respectively, reported the date of symptom onset and are included in this figure.

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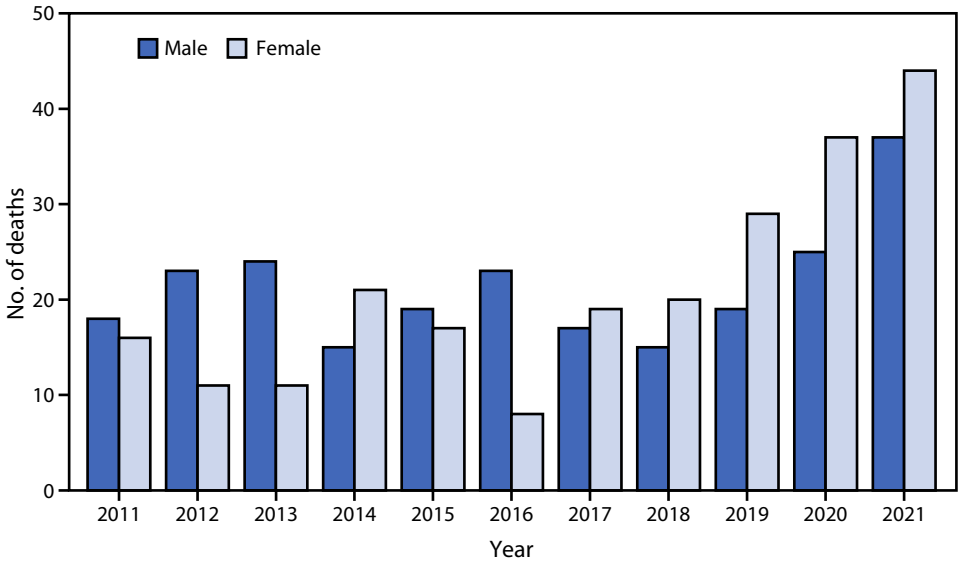
QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Number of Deaths Resulting from Being Bitten or Struck by a Dog,* by Sex — National Vital Statistics System, United States, 2011–2021



* Deaths from being bitten or struck by a dog as underlying cause of death were coded as W54, according to the *International Classification of Diseases, Tenth Revision,* and exclude deaths from rabies resulting from a dog bite.

During 2011–2021, a total of 468 deaths from being bitten or struck by a dog occurred (average = 43 deaths per year). The annual number of deaths ranged from 31 (2016) to 81 (2021). During 2011–2016, more deaths occurred among males than among females during most years; however, during 2017–2021, more deaths occurred among females than among males. From 2018 to 2021, deaths more than doubled for both males (from 15 to 37) and females (from 20 to 44).

Source: National Center for Health Statistics, National Vital Statistics System, Mortality Data, 2011–2021. https://wonder.cdc.gov/Deaths-by-Underlying-Cause.html

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