

## Measles Outbreak Associated with a Migrant Shelter — Chicago, Illinois, February–May 2024

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### Abstract

Measles, a highly contagious respiratory virus with the potential to cause severe complications, hospitalization, and death, was declared eliminated from the United States in 2000; however, with ongoing global transmission, infections in the United States still occur. On March 7, 2024, the Chicago Department of Public Health (CDPH) confirmed a case of measles in a male aged 1 year residing in a temporary shelter for migrants in Chicago. Given the congregate nature of the setting, high transmissibility of measles, and low measles vaccination coverage among shelter residents, measles virus had the potential to spread rapidly among approximately 2,100 presumed exposed shelter residents. CDPH immediately instituted outbreak investigation and response activities in collaboration with state and local health departments, health care facilities, city agencies, and shelters. On March 8, CDPH implemented active case-finding and coordinated a mass vaccination campaign at the affected shelter (shelter A), including vaccinating 882 residents and verifying previous vaccination for 784 residents over 3 days. These activities resulted in 93% measles vaccination coverage (defined as receipt of  $\geq 1$  recorded measles vaccine dose) by March 11. By May 13, a total of 57 confirmed measles cases associated with residing in or having contact with persons from shelter A had been reported. Most cases (41; 72%) were among persons who did not have documentation of measles vaccination and were considered unvaccinated. In addition, 16 cases of measles occurred among

persons who had received  $\geq 1$  measles vaccine dose  $\geq 21$  days before first known exposure. This outbreak underscores the need to ensure high vaccination coverage among communities residing in congregate settings.

### Investigation and Results

Measles is a highly contagious respiratory virus with the potential to cause severe complications, hospitalization, and death (*I*). Although measles was declared eliminated from the United States in 2000, global transmission is ongoing (*2*). Receipt of 1 and 2 doses of measles vaccine is 93% and 97% effective, respectively, in preventing measles (*1*).

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Since August 2022, approximately 41,000 migrants have arrived in Chicago, Illinois from the U.S. southern border (3); most (88%) are from Venezuela, a country with a recent decline in routine childhood immunization coverage, including with measles vaccine (4). On February 22, 2024, approximately 12,000 persons were residing in 27 temporary migrant shelters operated by the city of Chicago. The largest shelter (shelter A) is a congregate setting with shared sleeping areas, dining area, and bathrooms. On February 22, 2024, approximately 2,100 persons resided in shelter A, with some rooms housing 500 or more persons.

### Index Patient

A male shelter A resident aged 1 year developed a rash on February 26, 2024, and was hospitalized on February 27 with suspected measles. On March 4, when the Chicago Department of Public Health (CDPH) was first notified of the suspected case, confirmatory measles testing with real-time reverse transcription–polymerase chain reaction (RT-PCR) was requested by CDPH. The child had arrived in the United States >5 months earlier and had received 1 dose of measles, mumps, and rubella (MMR) vaccine 5 weeks before rash onset<sup>†</sup>; he had no recent travel or known exposure to measles.

<sup>†</sup> Up to 5% of persons who receive MMR vaccine will develop a vaccine reaction with rash, which is clinically indistinguishable from a rash resulting from wild-type measles infection.

Upon confirmation of wild-type measles infection by measles vaccine assay (MeVA)<sup>§</sup> on March 7, CDPH alerted residents and staff members the same evening and arranged a vaccination event for the next morning. Given the highly congregate nature of shelter A, CDPH considered anyone who had been inside the shelter during February 22–27, the index patient's infectious period at shelter A, to be exposed.

### Case Identification

A shelter A–associated case was defined as an RT-PCR–confirmed, wild-type measles infection in a person with a shelter A measles exposure, either by virtue of residing in, working at, or having a known epidemiologic link to persons from shelter A with a confirmed measles infection, during February 26–May 13. Laboratory confirmation included measles RT-PCR testing at the Illinois Department of Public Health Laboratory. To distinguish measles vaccine reaction from wild-type measles infection, laboratory confirmation required MeVA testing be performed by the Minnesota Department of Health Public Health Laboratory for persons who had received measles vaccine 5–21 days before rash onset. Among exposed persons who did not have a rash (but who had measles signs and symptoms,

<sup>§</sup> After measles vaccination, vaccine strain measles virus can be detected with conventional measles RT-PCR, and MeVA is used to differentiate between vaccine strain and wild-type measles virus. The MeVA test is a real-time RT-PCR assay that detects only measles vaccine strains.

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such as fever, cough, coryza, or conjunctivitis), RT-PCR collection date was used to determine the need for MeVA testing. For all cases, standard genotyping was attempted for available specimens. This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.<sup>‡</sup>

**Additional Cases**

During February 26–May 13, CDPH confirmed 57 shelter A–associated measles cases, including 52 among residents, three among staff members, and two among community members (Figure) (Table). The median age of persons with confirmed infections was 3 years (range = 0–52 years); most were originally from Venezuela (43; 84%) and arrived in the United States a median of 124 days (range = 56–202 days) before rash onset. Most persons (41; 72%) did not have documentation of measles vaccination and were considered unvaccinated. Among all cases, 16 (28%) occurred among persons who had documentation of ≥1 measles vaccine dose ≥21 days before first known exposure, and four (7%) occurred among persons who

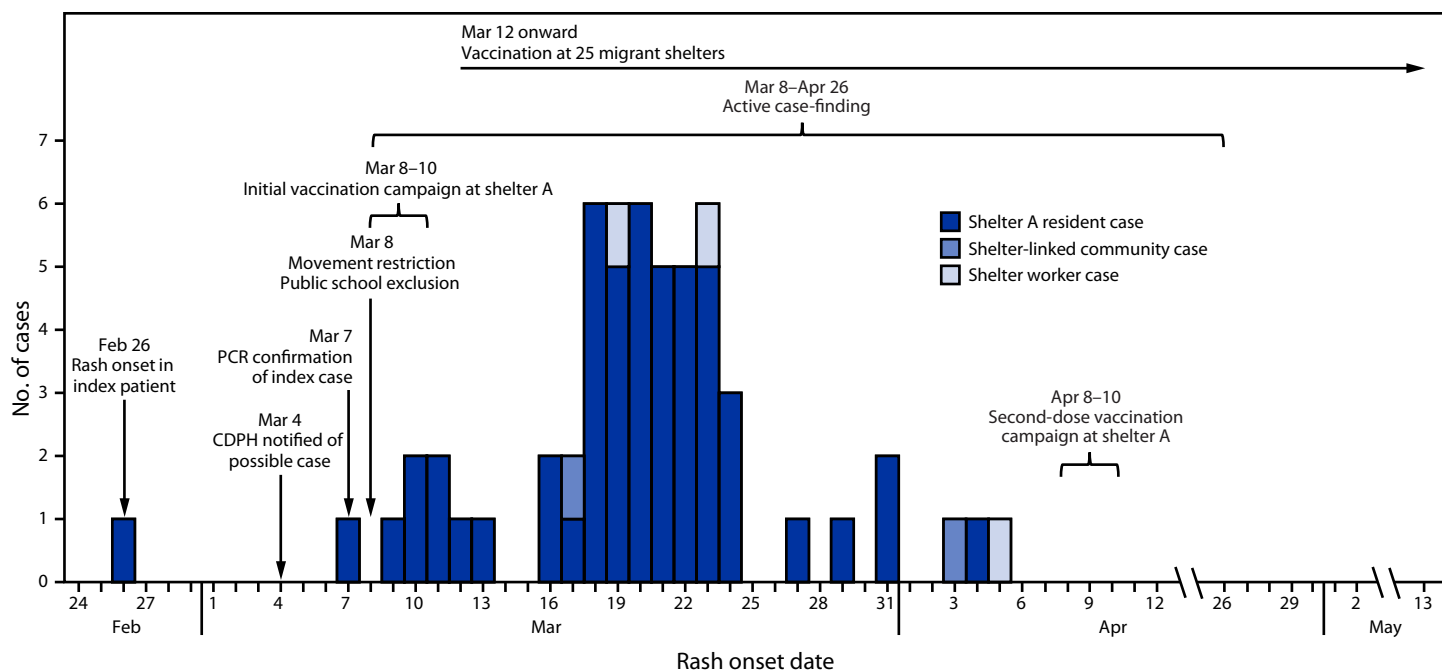
had documentation of ≥2 measles vaccine doses. The median age of previously vaccinated persons with confirmed measles infections was 9.5 years (range = 1–49 years); seven patients (44%) were aged <5 years. Two cases occurred among persons who resided at shelter A during February 22–March 7, but had resettled or transferred to less crowded shelters with private sleeping areas after March 7; no secondary cases occurred at those shelters. As of May 13, identical measles genotype D8 sequences were identified from 52 case specimens; the remaining five isolates could not be sequenced. Fifty-one persons (89%) were hospitalized for either or both isolation and measles complications; no deaths were reported. As of May 13, the date of last known exposure at shelter A was April 5.

**Public Health Response**

After identification of the index case, CDPH instituted a mass campaign to provide vaccination and verify vaccination records, active case-finding, and shelter movement restrictions (Figure). To deliver culturally and linguistically accessible messaging about measles infection and the importance of vaccination and quarantine, CDPH collaborated with trusted community health workers and leaders. These persons, who

<sup>‡</sup> 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. Measles cases associated with a migrant shelter (shelter A),\* by rash onset date<sup>†</sup> and public health interventions<sup>‡</sup> — Chicago, Illinois, February 26–May 13, 2024**



**Abbreviations:** CDPH = Chicago Department of Public Health; PCR = polymerase chain reaction.

\* Shelter A resident cases were defined as those among persons exposed while residing at Shelter A. Shelter-linked community cases were defined as those among persons exposed outside of shelter A and epidemiologically linked to a case in a shelter A resident. Shelter worker cases were defined as those among persons exposed while working at shelter A.

<sup>†</sup> Two persons with unknown or no rash onset were included by symptom onset date.

<sup>‡</sup> Interventions included active case-finding, vaccination events, and movement restriction.

included “promotores de salud,” were effective liaisons for communicating messages from CDPH because they were fluent in Spanish and possessed insight and understanding of the community served.

### Vaccination

CDPH implemented a rapid and comprehensive vaccination campaign at shelter A during March 8–10, within 1 day of confirmation of the index case (Figure). Staff members verified physical vaccination records and vaccination status in Illinois’ immunization information system. All nonpregnant residents aged  $\geq 6$  months without documentation of previous measles vaccination and residents aged  $\geq 1$  year who had received a first dose  $\geq 28$  days earlier were offered MMR vaccination.\*\* Shelter staff members and community partners were engaged to communicate the importance of vaccination and were recommended to provide evidence of measles immunity themselves.

During March 8–10, records documenting previous measles vaccination were verified for 784 (44%) of the 1,801 residents, and 882 (49%) eligible residents received MMR vaccine. By March 11, a total of 1,666 (93%) of 1,801 residents at shelter A had documentation of receipt of  $\geq 1$  dose of measles vaccine. As of May 13, CDPH had led approximately 130 mass vaccination events across 25 Chicago migrant shelters and administered approximately 9,500 MMR vaccine doses, prioritizing the shelters that had previously received residents from shelter A (all of whom were presumed to be exposed) and shelters with pregnant women and young children. This strategy included additional vaccination events at shelter A beginning on March 25, with a focused second-dose vaccination campaign during April 8–10 (Figure).

### Active Case-Finding

CDPH began active case-finding at shelter A on March 8 (Figure). Medical and shelter staff members walked bed to bed to screen residents for measles signs and symptoms.†† On the basis of the degree of clinical suspicion for measles,§§ symptomatic residents were either tested and remained on site or were immediately transported to a hospital for testing and isolation. The median interval from rash onset to isolation was 1 day, ranging from 3 days before to 3 days after rash onset.

### Movement Restriction

All shelter A residents without evidence of receipt of  $\geq 1$  dose of measles vaccine  $\geq 21$  days before first known exposure

**TABLE. Characteristics\* of persons with confirmed measles infections associated with a migrant shelter (N = 57) — Chicago, Illinois, February 26–May 13, 2024**

Characteristic	No. (%)
<b>Sex</b>	
Female	30 (53)
Male	27 (47)
<b>Age group</b>	
<6 mos	4 (7)
6 mos–4 yrs	29 (51)
5–19 yrs	6 (11)
20–49 yrs	17 (30)
$\geq 50$ yrs	1 (2)
<b>No. of verified measles vaccine doses received†</b>	
1	12 (21)
$\geq 2$	4 (7)
None or unknown	41 (72)
<b>Country of origin§</b>	
Venezuela	43 (84)
Peru	4 (8)
Ecuador	2 (4)
Chile	1 (2)
Unknown	1 (2)
<b>Shelter resident status</b>	
Shelter A resident	52 (91)
Shelter worker	3 (5)
Shelter-linked community member	2 (4)

\* Race data were reported as other or unknown for 25 (44%) persons; all were of Hispanic or Latino ethnicity.

† Occurred  $\geq 21$  days before rash onset.

§ Documented as the country of last residence before beginning migration. One U.S.-born shelter resident and five nonshelter residents were excluded.

were advised to quarantine in shelter A until 21 days from first MMR vaccination or, if unvaccinated, 21 days from last known exposure at shelter A. School exclusion for children in quarantine began on March 8 (Figure). Quarantine remained voluntary rather than imposed by city officials or law enforcement to encourage continued cooperation between CDPH and shelter A residents. Twenty-two family units with members who were at highest risk for infection (i.e., infants aged  $\leq 6$  months, nonimmune pregnant women, and immunocompromised persons) were transferred during March 11–12 to a repurposed hotel for quarantine. Intake of new residents to shelter A was halted on March 8, and movement of shelter A residents to nonquarantine shelters only occurred for persons with documentation of receipt of  $\geq 1$  dose of measles vaccine. Because of the inability to isolate symptomatic persons within shelter A, residents with laboratory-confirmed measles or high clinical suspicion of measles were isolated in Chicago hospitals for the remainder of their infectious periods.

### Discussion

After identification of a large measles outbreak among migrants, primarily from Venezuela, who resided in a shelter, active case-finding and rapid mass vaccination of residents

\*\* <https://www.cdc.gov/vaccines/vpd/mmr/hcp/recommendations.html>

†† Symptoms concerning for measles included fever, rash, cough, coryza, or conjunctivitis.

§§ High clinical suspicion included persons with fever and rash or fever and either cough, coryza, or conjunctivitis.



likely reduced transmission and outbreak size and duration (5). Engagement of community partners contributed to the success of these public health interventions.

Measles is a highly contagious respiratory virus (1), and this outbreak occurred in a densely populated congregate setting with high potential for transmission. Isolation space was needed although lacking for public health control measures, both at shelter A and in the larger community, placing a strain on Chicago hospitals. Persons isolated in hospitals occupied airborne infection isolation rooms during their infectious period or until measles was ruled out, underscoring the importance of having dedicated isolation space outside of hospitals for patients without medical need.

Measles is preventable with a highly effective vaccine (1); however, the national first-dose measles vaccination coverage among Venezuelan residents aged  $\geq 12$  months declined from 96% to 68% during 2017–2021 (4). Decreases in measles vaccination coverage, attributed to the disruption of routine immunization services during the COVID-19 pandemic, have been observed worldwide (6).

Measles postexposure prophylaxis (PEP) with MMR vaccine must be administered within 72 hours of exposure to be effective in preventing measles<sup>44</sup> (1). Mass vaccination at shelter A occurred outside the window for PEP after the initial exposure but likely prevented measles cases resulting from later exposures, thereby limiting the size and duration of the outbreak (5). Residents' ineligibility for PEP because of the 6-day delay in notification to CDPH highlights the importance of prompt notification of suspected and confirmed measles cases to health departments.

The percentage of measles cases among persons with a history of previous vaccination was higher than that reported through recent national surveillance in the United States (7), likely owing to a high degree of exposure from the congregate living situation (5). Infections in vaccinated persons can occur because of primary vaccine failure, in which an immunologic response to vaccination does not occur, or secondary vaccine failure, in which infection occurs despite previous response to vaccination. Primary vaccine failure occurs in approximately 4% of recipients of 1 MMR dose and is rare among recipients of 2 MMR doses (6). Secondary vaccine failure generally occurs because of prolonged or close exposure to measles virus and has been observed in congregate settings (8,9). A full assessment of whether these infections are due to primary or secondary vaccine failure is ongoing.

Measles was declared eliminated from the United States in 2000; however, with ongoing global transmission, infections

## Summary

### What is already known about this topic?

Measles, a highly contagious respiratory virus, was declared eliminated from the United States in 2000; however, with ongoing global transmission, infections in the United States still occur. Receipt of 1 and 2 doses of measles vaccine is 93% and 97% effective, respectively, in preventing measles.

### What is added by this report?

Fifty-seven measles cases were associated with residence in or contact with persons in a migrant shelter in Chicago, Illinois. Most cases occurred in unvaccinated persons. A prompt and coordinated response with a high-coverage mass vaccination campaign reduced the size and duration of the outbreak.

### What are the implications for public health practice?

Ensuring high measles vaccination coverage during an outbreak can control measles spread and prevent wider transmission.

in the United States still occur (2). Although persons in the community affected by this outbreak had recently arrived in the United States, the index patient's arrival in Chicago months before illness onset suggests that the disease was acquired locally. To date, a direct epidemiologic link to another case has not been identified. The risk for transmission within and outside of shelters can be mitigated by maintaining high MMR vaccination coverage among both established and newly arrived residents.

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<sup>44</sup> Measles incubation period ranges from 11 to 12 days, with rash onset typically occurring 14 days after exposure.

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# Real-Time Use of a Dynamic Model To Measure the Impact of Public Health Interventions on Measles Outbreak Size and Duration — Chicago, Illinois, 2024

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## Abstract

Measles is a highly infectious, vaccine-preventable disease that can cause severe illness, hospitalization, and death. A measles outbreak associated with a migrant shelter in Chicago occurred during February–April 2024, in which a total of 57 confirmed cases were identified, including 52 among shelter residents, three among staff members, and two among community members with a known link to the shelter. CDC simulated a measles outbreak among shelter residents using a dynamic disease model, updated in real time as additional cases were identified, to produce outbreak forecasts and assess the impact of public health interventions. As of April 8, the model forecasted a median final outbreak size of 58 cases (IQR = 56–60 cases); model fit and prediction range improved as more case data became available. Counterfactual analysis of different intervention scenarios demonstrated the importance of early deployment of public health interventions in Chicago, with a 69% chance of an outbreak of 100 or more cases had there been no mass vaccination or active case-finding compared with only a 1% chance when those interventions were deployed. This analysis highlights the value of using real-time, dynamic models to aid public health response, set expectations about outbreak size and duration, and quantify the impact of interventions. The model shows that prompt mass vaccination and active case-finding likely substantially reduced the chance of a large (100 or more cases) outbreak in Chicago.

## Introduction

Measles is an extremely infectious, vaccine-preventable febrile rash illness that can cause severe complications, including pneumonia, encephalitis, and death (1). Measles has a secondary attack rate among susceptible close contacts of >90%, making it one of the most infectious known diseases; prompt recognition and investigation of measles is important to limit its spread (1). On March 4, 2024, the Chicago Department of Public Health (CDPH) was notified of a suspected measles case in a resident of a temporary shelter for migrants primarily housing new arrivals from Venezuela. The shelter was a congregate setting with shared sleeping areas, with some rooms housing 500 or more residents (2). The patient had

been hospitalized with suspected measles on February 27, after developing a rash on February 26, and was infectious in the shelter during February 22–27 (2). As of May 13, a total of 57 confirmed measles cases were identified, including 52 among shelter residents (with dates of rash onset ranging from February 26 through April 4, 2024), three among staff members, and two among community members with a known link to the shelter. Upon request from CDPH, CDC created dynamic measles models to forecast outbreak size and duration among shelter residents and quantitatively assess the impact of public health interventions.

## Methods

### Population Characteristics

CDC obtained measles outbreak data from CDPH multiple times per week. The population of the shelter as of March 8, the day interventions began, was 1,877 persons. Active case-finding was implemented on March 8, and during March 8–10, a total of 882 measles, mumps, and rubella (MMR) vaccine doses were administered to persons without proof of vaccination, bringing the final measles vaccine coverage among shelter residents to 93% (2). Rash onset date was missing for two patients; for these persons, symptom onset date was used to parameterize the model.

### Model Design

CDC adapted a model of measles transmission in a congregate setting previously developed during the 2021 Operation Allies Welcome (OAW) response (3). In this model, persons are placed into compartments representing their state relative to measles infection (i.e., susceptible, exposed, infected, and removed), age, and pregnancy status. Compared with the OAW model (3), this model also included a time-varying intervention representing active case-finding and a case ascertainment delay (Supplementary Figure, <https://stacks.cdc.gov/view/cdc/155330>). Model structure and parameterization evolved over the course of the outbreak; in this report, the retrospective predictions from the final model version are presented.\*

\* Code used to produce the analyses in this report is available at <https://github.com/CDCgov/measles-model-chicago-2024>.

## Statistical Methods

An age-specific measles immunity profile of Venezuela in 2024 was constructed using a previously described approach (4) (Supplementary Table 1, <https://stacks.cdc.gov/view/cdc/155328>). The effectiveness of a single MMR vaccine dose was assumed to be 84% for persons aged 6–11 months and 92.5% for persons aged  $\geq 12$  months (5). Natural history parameters for measles were derived from the literature and calibrated to available data using approximate Bayesian computation (Supplementary Table 2, <https://stacks.cdc.gov/view/cdc/155329>) (6). The model was simulated for 365 days beginning February 1, 2024, with 10,000 stochastic simulations per scenario.

Within each simulation, the model identified incident cases over time. Outbreak size forecasts were calibrated by selecting 100 simulations with the smallest absolute difference between predicted and observed daily cumulative measles cases among shelter residents. The model was run multiple times each week and fit to new data as outbreak cases were reported.

Counterfactual scenarios were simulated to determine potential outcomes if mass vaccination had started a week earlier (March 1, 2024) or a week later (March 15, 2024), as well as if active case-finding had not been implemented. Counterfactual outbreak trajectories were not calibrated to observed data. Simulations were conducted in R (version 4.3.0; R Foundation) using the *adaptivetau* package (7). This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.<sup>†</sup>

## Results

### Parameter Estimation for Public Health Response

The observed outbreak case series among shelter residents was found to be consistent with simulations using a basic reproduction number ( $R_0$ , the average number of secondary cases that would result from a single case in a completely susceptible population) for measles of 25. The case series was also consistent with active case-finding leading to a 25% reduction in the infectious period of measles cases, from an average of 5 days to 3.8 days.

### Real-Time Dynamic Model Results During an Outbreak

Model fit and prediction range improved as more case data became available; uncertainty was higher, and accuracy was lower earlier in the outbreak (Table 1). Using data available as of March 18, 2024, with 18 cases reported among shelter residents, the model forecasted a median final outbreak size

of 38 cases with a median final rash onset on April 18. Using data available as of March 25, with 47 cases reported among shelter residents, the model forecasted a median final outbreak size of 60 cases with a median final rash onset on April 20. On April 8, with 52 cases reported among shelter residents, the model forecasted a median final outbreak size of 58 cases.

### Counterfactual Analysis of Interventions

Counterfactual analyses of varied mass vaccination start dates and implementation or nonimplementation of active case-finding were performed (Table 2). If there had been no mass vaccination or active case-finding after the index case, the model predicted a 69% chance of an outbreak of 100 or more cases with an estimated median last rash onset occurring on May 26, 2024, which is consistent with a median outbreak size of 235 cases (IQR = 232–238) (Figure). In contrast, modeling CDPH's interventions (i.e., a mass vaccination campaign and active case-finding beginning March 8), the model predicted a 1% chance of an outbreak of 100 or more cases with an estimated median last rash onset occurring on April 9, 2024, a sixty-nine-fold decrease compared with the scenario with no intervention. A 1-week delay in mass vaccination increased the chance of an outbreak of 100 or more cases to 8% with active case-finding (an eightfold increase compared with the interventions CDPH deployed) and 15% without. If case notification to public health had occurred earlier and the mass vaccination campaign had been initiated on March 1, the chance of an outbreak of 100 or more cases would have been zero, and the chance of an outbreak of 50–99 cases would have been 2% with active case-finding and 3% without.

### Discussion

Dynamic disease models can be used and updated in real time to assist with public health response and resource planning as outbreaks unfold. During this measles outbreak, the model estimated high values of  $R_0$  (25), higher than the traditionally reported 12–18 (8), underscoring the potential for rapid transmission of measles and a high force of infection in a dense congregate setting. This parameter, estimated early during the outbreak and shared with partners in Chicago, emphasized the importance of active case surveillance because of the possibility of many secondary cases. CDPH used these findings, along with observed measles cases among shelter residents who had received a single dose of MMR vaccine, to demonstrate the need for continued vaccination campaigns during the outbreak, including a second dose campaign 28 days after the first dose, (2) and to recommend that shelter staff members and essential visitors provide evidence of immunity to measles.

<sup>†</sup> 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. Predictive model iterations week over week among shelter residents based on available case data during measles outbreak associated with a migrant shelter — Chicago, Illinois, 2024**

Date	No. of observed measles cases among shelter residents	Median model-predicted final outbreak size (IQR)	Median model-predicted final rash onset date	Relative % difference between median predicted and observed final outbreak size*
Mar 11	7	29 (20–39)	Apr 16	–44
Mar 18	18	38 (31–41)	Apr 18	–28
Mar 25	47	60 (57–65)	Apr 20	15
Apr 1	51	60 (58–63)	Apr 20	15
Apr 8	52	58 (56–60)	Apr 18	12

\* Calculated by taking the percent difference between the predicted outbreak size as of each date and the final observed outbreak size among shelter residents (52). Negative numbers reflect underestimates of total outbreak size, and positive numbers reflect overestimates of total outbreak size.

**TABLE 2. Counterfactual analysis of the impact of mass vaccination and active case-finding interventions on the chance of a large measles outbreak and median duration of a measles outbreak among shelter residents — Chicago, Illinois, 2024**

Intervention start dates		Chance of additional measles cases among shelter residents,* %					Duration
Mass vaccination	Active case-finding	Zero cases	1–9 cases	10–49 cases	50–99 cases	≥100 cases	Last rash onset in outbreak (median)
Never	Never	24	7	—	—	69	May 26
Mar 15	Never	24	10	23	28	15	Apr 21
	Mar 8	23	13	28	27	8	Apr 17
Mar 8	Never	24	15	40	21	1	Apr 14
	Mar 8	23	17	43	17	1	Apr 9
Mar 1	Never	24	24	49	3	—	Apr 3
	Mar 8	23	26	49	2	—	Mar 30

\* Number of measles cases beyond the index case.

The model provided an expectation of total outbreak size and duration weeks before the last rash onset occurred. CDPH shared model results with city leadership, other state and local government agencies, and health care partners to facilitate expectation-setting and resource planning. The model also highlighted the impact of early intervention on measles outbreaks in congregate settings, showing a sixty-nine-fold reduction (from 69% to 1%) in the chance of an outbreak of 100 or more cases and a median reduction in outbreak duration by 7 weeks when mass vaccination and active case-finding were initiated on March 8 compared with no intervention. If mass vaccination had been delayed by 1 week, there would have been an eightfold increase (from 1% to 8%) in the chance of an outbreak of 100 or more cases over the scenario in which mass vaccinations were deployed on March 8. These results are consistent with those from the OAW response, in which a modeled 7-day delay in vaccination would have yielded a 50% increase in median outbreak size (3). In addition, if public health notification of the index case had occurred when measles was first clinically suspected, an opportunity to implement mass vaccination would have occurred sooner, further reducing the chance of a large outbreak. Together, these results highlight the value of prompt mass vaccination and active case-finding to reduce the size and duration of measles outbreaks. Amid an increase in the number of measles cases reported during 2024 (9), development of rapid analytic tools to aid public health outbreak responses is critical.

### Summary

#### What is already known about this topic?

Measles is a highly infectious, vaccine-preventable disease. Fifty-seven measles cases were associated with residence in or contact with persons in a migrant shelter in Chicago, Illinois.

#### What is added by this report?

CDC developed dynamic models of shelter residents in real time to produce forecasts and assess the impact of interventions on outbreak size and duration. These models aided expectation-setting and resource planning and underscored the need for vaccination campaigns.

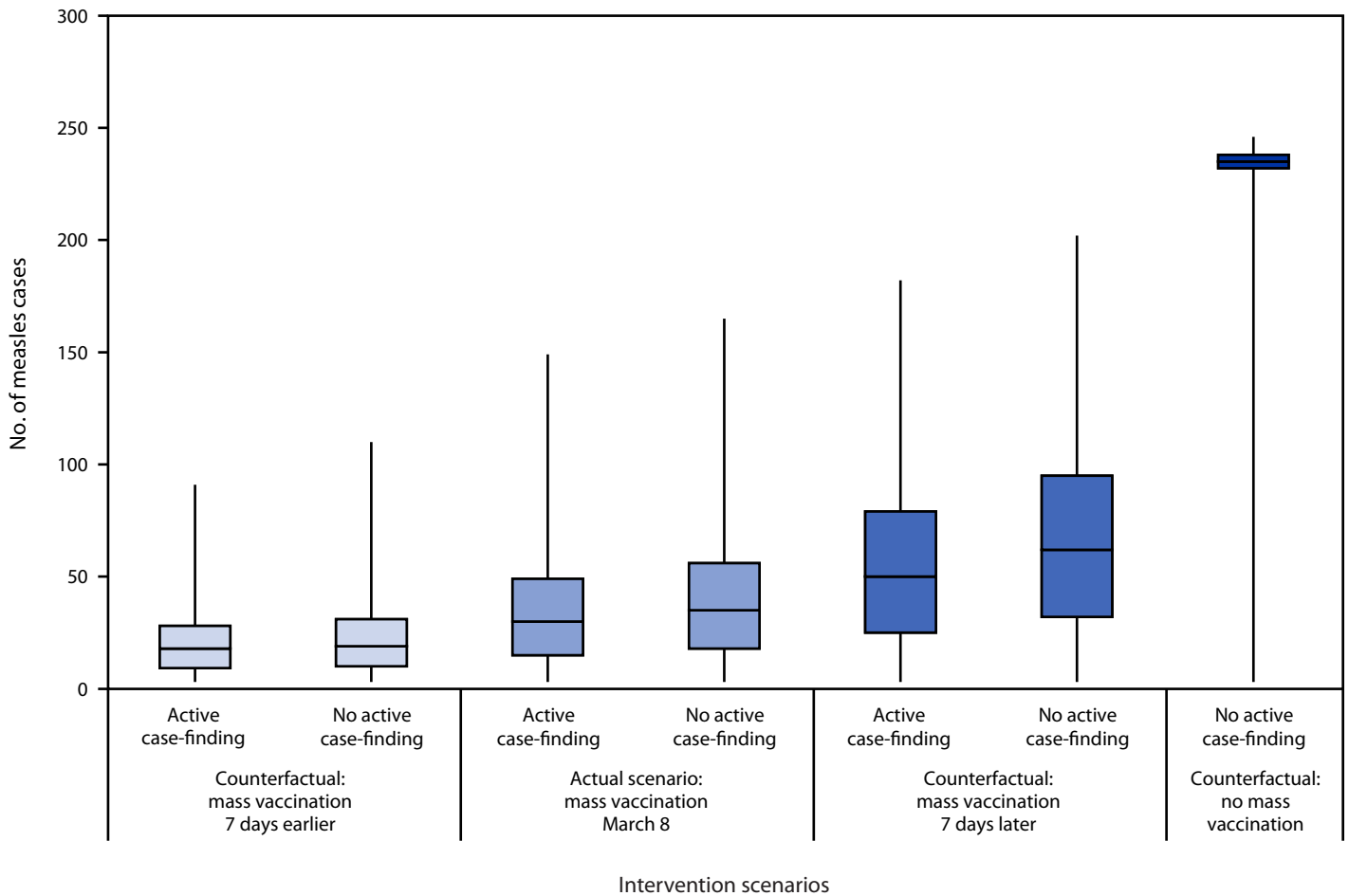
#### What are the implications for public health practice?

Real-time modeling can support public health response, set expectations about outbreak size and duration, and quantify the impact of interventions. Prompt mass vaccination and active case-finding likely substantially reduced the likelihood of a large measles outbreak in Chicago.

### Limitations

The findings in this report are subject to at least four limitations. First, parameters have substantial uncertainty, and reasonable values, guided by published literature and expert opinion, had to be selected because the outbreak was not large enough to estimate all parameters with high precision. Variability in outputs was due to stochastic variation rather than to parameter uncertainty. Second, the model structure overestimated the variability in the infectious period by

**FIGURE. Counterfactual analysis\* of the impact of mass vaccination and active case-finding interventions on the total number of measles cases among shelter residents, conditional on a measles outbreak† associated with a migrant shelter — Chicago, Illinois, 2024**



\* Boxplots represent median (horizontal line) and 25th (bottom) and 75th (top) percentiles across stochastic simulations, and the error bars extend from the minimum to maximum values.

† Three or more cases.

assuming that it is exponentially distributed across infected persons. Third, this model did not account for the relocation of 22 family units to a quarantine hotel on March 11–12, instead modeling the whole population together, and thus might have overestimated final outbreak size. Finally, although a measles susceptibility profile of Venezuela was used to estimate population susceptibility, the actual measles immunity status of the population was unknown.

### Implications for Public Health Practice

This outbreak occurred among persons in a dense congregate setting with vaccination coverage below the 95% threshold recommended for prevention of measles spread (10). This use of dynamic models, updated in real time as the outbreak unfolded, aided public health response, setting expectations

about likely outbreak trajectory and timing. The code for these models is publicly available for use by jurisdictional and academic partners at <https://github.com/CDCgov/measles-model-chicago-2024>. In addition, this modeling framework quantitatively assessed the impact of interventions using counterfactual scenarios to show that prompt mass vaccination and active case-finding likely substantially reduced the chance of a large outbreak in Chicago.

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# U.S. Preparedness and Response to Increasing Clade I Mpox Cases in the Democratic Republic of the Congo — United States, 2024

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## Abstract

Clade I monkeypox virus (MPXV), which can cause severe illness in more people than clade II MPXVs, is endemic in the Democratic Republic of the Congo (DRC), but the country has experienced an increase in suspected cases during 2023–2024. In light of the 2022 global outbreak of clade II mpox, the increase in suspected clade I cases in DRC raises concerns that the virus could spread to other countries and underscores the importance of coordinated, urgent global action to support DRC's efforts to contain the virus. To date, no cases of clade I mpox have been detected outside of countries in Central Africa where the virus is endemic. CDC and other partners are working to support DRC's response. In addition, CDC is enhancing U.S. preparedness by raising awareness, strengthening surveillance, expanding diagnostic testing capacity for clade I MPXV, ensuring appropriate specimen handling and waste management, emphasizing the importance of appropriate medical treatment, and communicating guidance on the recommended contact tracing, containment, behavior modification, and vaccination strategies.

## Introduction

The global clade II monkeypox virus (MPXV) outbreak that began in 2022 demonstrated the pandemic potential of mpox (1). Clade I MPXV is endemic in several Central African countries, including the Democratic Republic of the Congo (DRC); clade I is generally associated with higher case fatality rates (CFRs) (1.4% to >10%) compared with clade II MPXV (0.1% to 3.6%) (1–3). MPXV can spread to persons from contact with infected wildlife, or through close, prolonged contact with persons infected with MPXV; the global clade II MPXV outbreak spread primarily via sexual contact among gay, bisexual, or other men who have sex with men (MSM) (1). During 2023–2024, DRC has reported an unprecedented number of suspected clade I MPXV infections. Neighboring countries and the global community should help support

DRC's effort to contain the virus as well as prepare for the possibility of further spread. This report describes investigation of cases in DRC, CDC's support to DRC, and U.S. public health preparedness activities to date.

## DRC Investigation and Findings

### Epidemiology of Clade I MPXV in DRC

Data from DRC's national infectious disease surveillance system were analyzed for this report. This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.<sup>†</sup>

During January 1, 2023–April 14, 2024, DRC reported multiple provincial-level outbreaks, comprising 19,919 cases of suspected clade I mpox<sup>§</sup> and 975 (4.9%) deaths (Figure 1). During 2023 and 2024, clade I mpox cases were reported from 25 of 26 provinces and, for the first time, from the capital city of Kinshasa (Figure 2). In two outbreaks, sexual transmission of clade I MPXV was reported among MSM and both male and female sex workers and their contacts<sup>¶</sup> (4). Overall, two thirds (67%) of suspected cases and more than three quarters (78%) of suspected deaths have occurred in persons aged ≤15 years; children aged 12–59 months accounted for 28% of all suspected cases (Figure 3). Demographic characteristics of patients differed among provinces, with suspected cases in some provinces (e.g., Equateur) occurring primarily in persons aged ≤15 years (69%), whereas in other provinces (e.g., South Kivu and Kinshasa) persons aged >15 years accounted for the largest proportion of cases (69%). During January 1, 2023–April 14, 2024, 50% of DRC's suspected mpox cases were reported from Equateur province; during this period, Equateur province

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

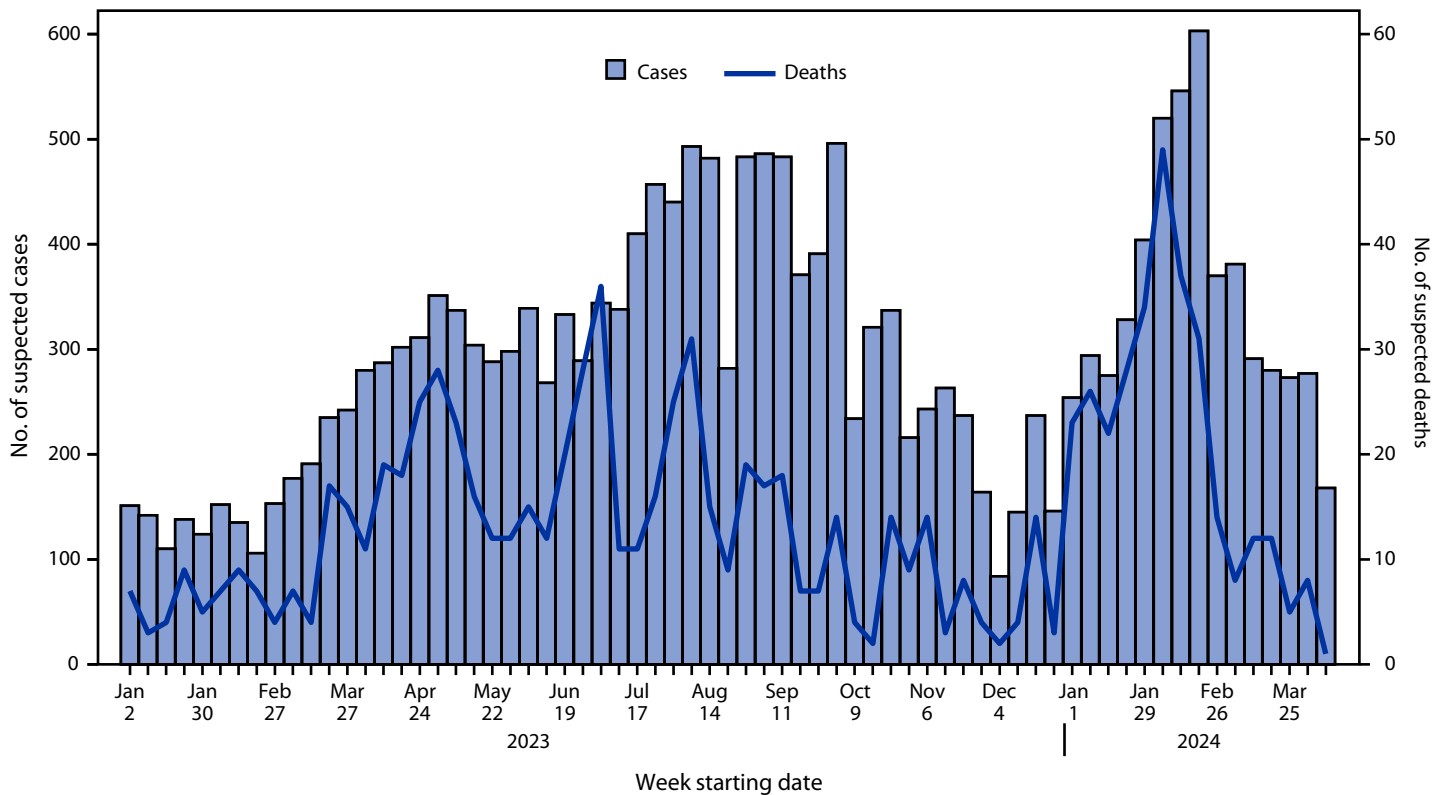
<sup>§</sup> In DRC, a "suspect case" is defined as "a person with sudden high fever followed by a vesiculo-pustular rash predominantly on the face and present on the palms of the hands and soles of the feet; or presence of at least 5 smallpox-type scars; or, anyone with fever >38.3°C (101°F), severe headache, lymphadenopathy, back pain, myalgia and intense asthenia, followed one to three days later by a progressive rash that often starts on the face and then spreads elsewhere on the body, including the soles of the feet and palms of the hands."

<sup>¶</sup> <https://www.medrxiv.org/content/10.1101/2024.03.05.24303395v1>

\*These senior authors contributed equally to this report.



FIGURE 1. Suspected clade I mpox cases and deaths\* — Democratic Republic of the Congo, January 1, 2023–April 14, 2024



\* Reporting of data from multiple sources might result in minor discrepancies between the numbers of cumulative cases and deaths reported to CDC by the Democratic Republic of the Congo Ministry of Health and those that appear in the figure.

also reported an elevated CFR (5.7%) compared with CFRs reported elsewhere in the country (4.3%). In remote locations, many suspected cases are not tested for MPXV, and testing varies widely by province. Among 2,016 specimens tested during January 1, 2023–March 24, 2024 (accounting for 11% of all suspected cases), 1,302 (65%) were laboratory-confirmed as positive. In a subset of 480 laboratory-confirmed positive cases reported during January 1–March 24, 2024, for which patient age was reported, 239 (50%) occurred in persons aged ≤15 years.

### Mpox Transmission and Outbreaks in DRC

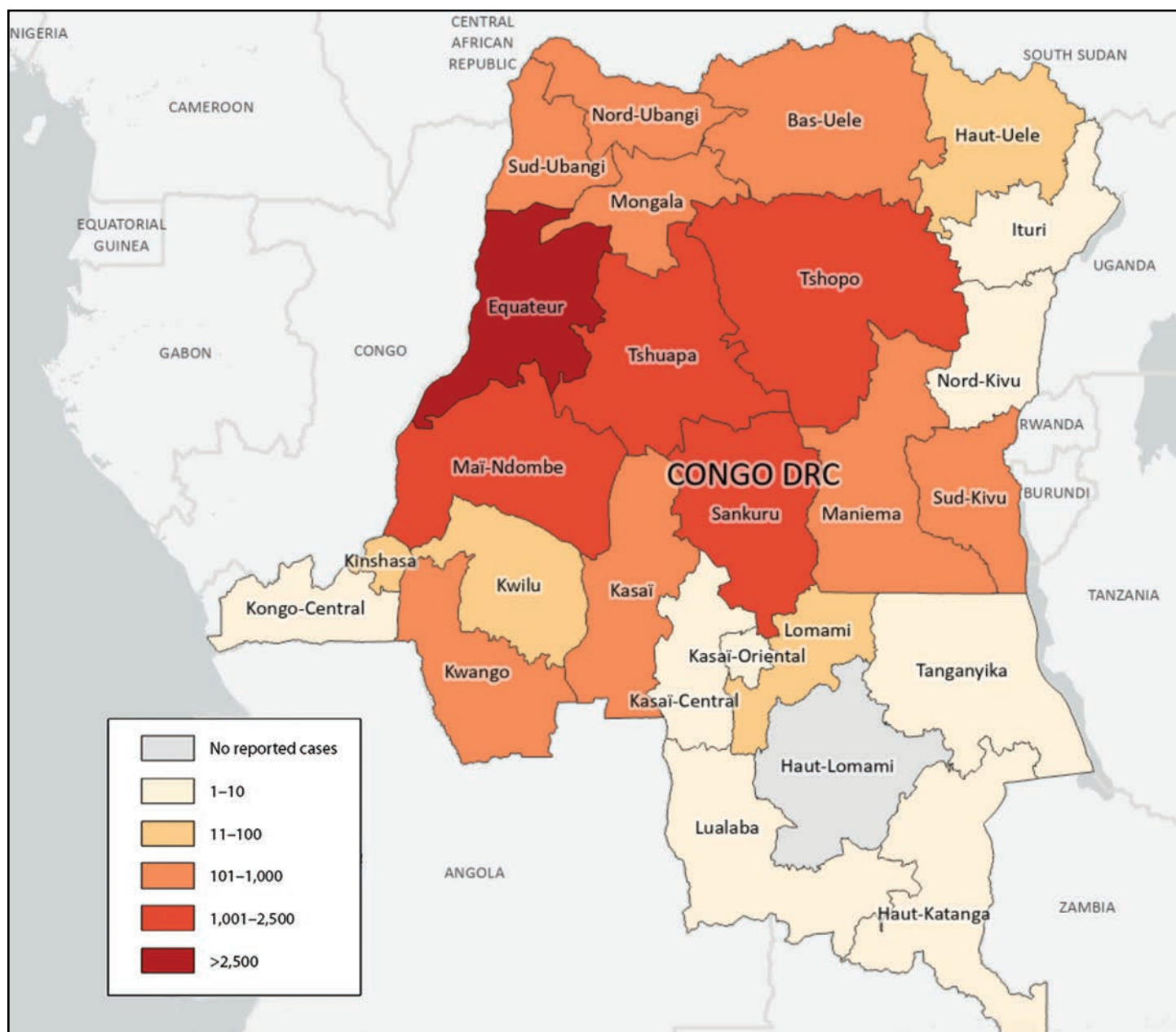
Limited data on genetic diversity among circulating clade I MPXV strains (L'Institut National de Recherche Biomédicale, DRC, unpublished data, 2024) suggests that outbreaks involve multiple introductions from animal hosts within DRC, rather than a single introduction that has spread nationwide. However, communicable spread to close contacts within households likely contributes substantially to the case count. Geographic differences in demographic characteristics and viral genetic diversity suggest various transmission drivers (i.e.,

zoonotic, household, or sexual) in different provinces, resulting in a complex epidemiologic picture. In South Kivu province, where sexual transmission has been reported, a distinct lineage of clade I MPXV was observed, including genetic markers suggesting sustained human-to-human transmission and a deletion in a nonessential segment of the genome that includes the C3 gene targeted by CDC's clade I-specific polymerase chain reaction (PCR) test (5,6).

### CDC Support to DRC

CDC's support for DRC's mpox-related activities during the last 15 years has included establishing laboratory testing and training, supporting diagnostic testing and genetic sequencing, conducting JYNNEOS vaccine clinical research, and training frontline health care workers. In response to the current outbreak, the U.S. government established an interagency response team to coordinate support to DRC and neighboring countries as well as to direct U.S. preparedness efforts. The U.S. government is providing funding, technical assistance, and personnel deployments to support the DRC response.

FIGURE 2. Number of suspected clade I mpox cases, by province — Democratic Republic of the Congo, January 1, 2023–April 14, 2024



## U.S. Public Health Preparedness and Response

### Notifications and At-Risk U.S. Populations

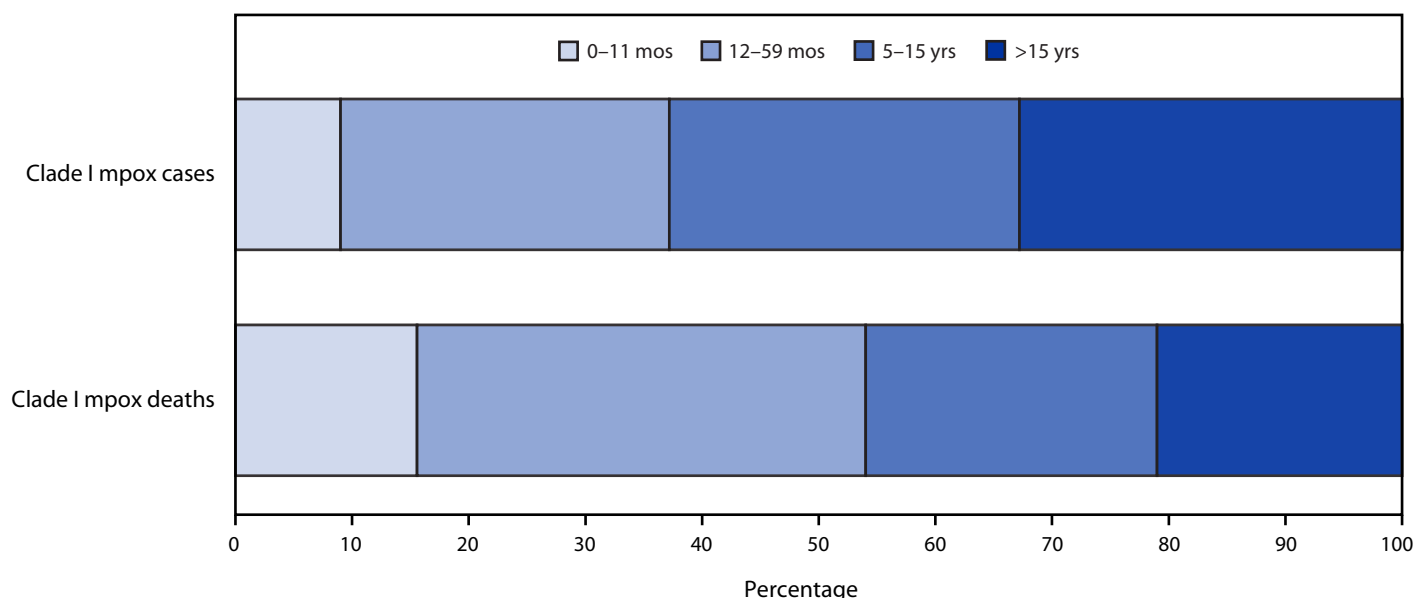
CDC issued a Health Alert Network notice on December 7, 2023, urging U.S. clinicians to consider clade I MPXV infection in persons with mpox signs and symptoms who had recently been in DRC. The notice recommended expedited clade-specific testing for those patients.\*\*

CDC also issued a Level 2 Travel Health Notice for DRC.†† To date, no cases of clade I mpox have been reported in the United States or in any countries where the virus is not endemic. However, given the documented sexual transmission of clade I MPXV in DRC, persons engaging in certain sexual behaviors (e.g., MSM with multiple sexual partners and sex workers) might be at increased risk if clade I mpox is introduced into the United States. Although clade I MPXV transmission in

\*\* [https://emergency.cdc.gov/han/2023/han00501.asp?trk=public\\_post\\_comment-text](https://emergency.cdc.gov/han/2023/han00501.asp?trk=public_post_comment-text)

†† <https://wwwnc.cdc.gov/travel/notices/level2/monkeypox-democratic-republic-of-congo>

FIGURE 3. Age distribution of suspected clade I mpox cases and deaths — Democratic Republic of the Congo, January 1, 2023–April 14, 2024



DRC is more commonly reported among children, widespread transmission among children in the United States is considered much less likely because of 1) absence of zoonotic reservoirs, 2) fewer household occupants, and 3) widely available cleaning and hygiene resources.

### Current CDC Activities and Recommendations

Working with U.S. jurisdictional partners, CDC revised existing mpox case reporting forms to include clade I MPXV-specific laboratory results to facilitate delivery of timely situational awareness to decision-makers. After technical consultation with CDC, the U.S. Department of Transportation published updated guidance,<sup>§§</sup> stating that diagnostic specimens (other than clade I MPXV culture) and clinical waste containing either clade I or clade II MPXV should be handled as Category B infectious substances,<sup>¶¶</sup> a classification for infectious substances that generally are not capable of causing permanent disability or life-threatening or fatal disease in otherwise healthy persons or animals. A March 2024 Internet survey<sup>\*\*\*</sup> of 100 U.S. health care providers (CDC, unpublished data, 2024) demonstrated gaps in knowledge about the diagnosis and treatment of clade I mpox; approximately two thirds of providers wanted more clinical management guidance. CDC has updated its online content to provide clade I

testing and reporting information<sup>†††</sup> and has shared updates on testing and preparedness with health care providers and state and local health departments. U.S. guidelines for clinical mpox management are applicable for clade I MPXV, with patient management decisions based on clinical presentation, disease severity, and underlying health risks, rather than virus clade (7). Diagnosis and reporting of clade I MPXV infections to health officials is important for limiting onward transmission by aiding early containment measures, including contact tracing, isolating patients, offering JYNNEOS vaccine to contacts, and strictly adhering to recommended infection prevention and control practices in health care settings.<sup>§§§</sup> In the United States, only 23% of persons at risk for clade II MPXV infection have completed the 2-dose JYNNEOS vaccination series.<sup>¶¶¶</sup> Through ongoing work with advocates and partners, CDC encourages persons who currently are at risk for clade II MPXV infection to be vaccinated with 2 doses of JYNNEOS.<sup>\*\*\*\*</sup> JYNNEOS is included in the routine adult immunization schedule and became available commercially in the United States in April, 2024.<sup>††††</sup> An additional benefit of vaccination is protection against clade I MPXV infection.

<sup>†††</sup> <https://www.cdc.gov/poxvirus/mpox/lab-personnel/report-results.html>

<sup>§§§</sup> <https://www.cdc.gov/poxvirus/mpox/clinicians/infection-control-healthcare.html>

<sup>¶¶¶</sup> <https://www.cdc.gov/poxvirus/mpox/cases-data/mpx-jynneos-vaccine-coverage.html>

<sup>\*\*\*\*</sup> <https://www.cdc.gov/poxvirus/mpox/interim-considerations/overview.html>

<sup>††††</sup> <https://www.cdc.gov/vaccines/schedules/hcp/imz/adult.html>

<sup>§§</sup> <https://www.phmsa.dot.gov/transporting-infectious-substances/planning-guidance-handling-category-solid-waste>

<sup>¶¶</sup> <https://www.phmsa.dot.gov/transporting-infectious-substances/transporting-infectious-substances-safely>

<sup>\*\*\*</sup> <https://styles.porternovelli.com/pn-view-panels/5>

## MPXV Testing

The U.S. mpox diagnostic testing strategy includes CDC's Food and Drug Administration (FDA)-cleared nonvariola orthopoxvirus (NVO) PCR test. A positive test result provides a presumptive diagnosis of mpox; however, the test cannot distinguish between clades (8). In addition, some Laboratory Response Network, state public health, and commercial laboratories offer laboratory-developed tests (LDTs)<sup>§§§§</sup> and FDA emergency use-authorized tests that can differentially detect clade II (thereby ruling out clade I); a few offer LDTs that differentially detect clade I. However, because of concerns about potential genomic deletions affecting test efficacy (5,6), CDC recommends that the NVO test be used in addition to clade-specific testing, and that positive NVO or negative clade II test results be further investigated through sequence analysis.<sup>¶¶¶¶</sup> In addition, CDC conducts surveillance using clade-specific PCR testing and sequence analysis of NVO-positive specimens received from other U.S. laboratories. During December 1, 2023–April 14, 2024, among 343 NVO-positive specimens tested by CDC, no clade I MPXV infections were identified. Similarly, no clade I MPXV was confirmed among approximately 900 specimens tested during this period by other U.S. laboratories with the capacity to detect clade I MPXV or to predict a high likelihood of clade I MPXV (NVO-positive and clade II MPXV-negative). U.S. wastewater surveillance testing for mpox<sup>\*\*\*\*\*</sup> was enhanced in late 2023 with a recommendation to use the NVO test; as of April 22, 2024, a total of 186 sites in 32 jurisdictions are using tests that can detect both clades. To date, all positive detections have coincided with locations with known clade II MPXV occurrence. During December 22, 2023–April 11, 2024, a total of 282 samples were collected from four U.S. airports and analyzed using the NVO test; no MPXV-positive samples were found.

## Discussion

Ten years ago, the 2014 West Africa Ebolavirus outbreak demonstrated the risks associated with a delayed global response to a serious pandemic threat (9). During the 2022 clade II MPXV outbreak, the United States launched a robust domestic response based on 2 decades of smallpox preparedness; however, the global public health community missed earlier opportunities to recognize the threat and help contain clade II mpox, which was spreading person-to-person in Nigeria as early as

<sup>§§§§</sup> <https://www.fda.gov/medical-devices/in-vitro-diagnostics/laboratory-developed-tests>

<sup>¶¶¶¶</sup> [https://www.cdc.gov/locs/2022/09-02-2022-lab-alert-MPXV\\_TNF\\_Receptor\\_Gene\\_Deletion\\_May\\_Lead\\_False\\_Negative\\_Results\\_Some\\_MPXV\\_Specific\\_LDTs.html](https://www.cdc.gov/locs/2022/09-02-2022-lab-alert-MPXV_TNF_Receptor_Gene_Deletion_May_Lead_False_Negative_Results_Some_MPXV_Specific_LDTs.html)

<sup>\*\*\*\*\*</sup> <https://www.cdc.gov/nwss/wastewater-surveillance/mpox-data.html>

## Summary

### What is already known about this topic?

Compared with clade II monkeypox virus (MPXV), which caused the 2022 global mpox outbreak, clade I MPXV can result in more persons with severe illness and higher mortality.

### What is added by this report?

The increasing number of reported suspected clade I mpox cases in the Democratic Republic of the Congo (DRC) poses a global threat for potential spread. No clade I cases have been reported in countries without endemic transmission. CDC is supporting DRC's response and containment efforts and ensuring U.S. preparedness by increasing awareness and surveillance, expanding clade I diagnostic testing capacity, and communicating guidance.

### What are the implications for public health practice?

U.S. clinicians and public health practitioners should be alert for possible cases in travelers from DRC and request clade-specific testing. Appropriate medical treatment is critical given the potential for severe illness, and contact tracing and containment strategies, including isolation, behavior modification and vaccination, will be important to prevent spread if any U.S. clade I mpox cases occur.

2016 (10). The recent increases in clade I MPXV transmission in DRC pose a new risk for global spread if the virus is not urgently contained. Reports of increased mpox in some bordering countries with endemic MPXV, including 19 confirmed cases in Republic of the Congo, reinforce this concern.<sup>††††</sup> In the United States, clinicians and public health practitioners should be aware of clade I MPXV and request clade-specific testing for possible cases in travelers from DRC. In addition to preparing for the possibility of spread beyond DRC, support to DRC from global partners is needed as the country works to increase testing and surveillance for clade I MPXV. Although vaccines and therapeutics are not currently authorized for use in DRC, the National Immunization Technical Advisory Group in DRC recently released recommendations supporting their use as part of the country's response. Collaboration among global public health partners is now urgently needed to assist DRC in procuring and delivering sufficient vaccine where it is most needed.

<sup>††††</sup> <https://www.reuters.com/world/africa/congo-republic-declares-mpox-epidemic-2024-04-24/>

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# Progress Toward Poliomyelitis Eradication — Worldwide, January 2022–December 2023

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## Abstract

In 1988, poliomyelitis (polio) was targeted for eradication. Global efforts have led to the eradication of two of the three wild poliovirus (WPV) serotypes (types 2 and 3), with only WPV type 1 (WPV1) remaining endemic, and only in Afghanistan and Pakistan. This report describes global polio immunization, surveillance activities, and poliovirus epidemiology during January 2022–December 2023, using data current as of April 10, 2024. In 2023, Afghanistan and Pakistan identified 12 total WPV1 polio cases, compared with 22 in 2022. WPV1 transmission was detected through systematic testing for poliovirus in sewage samples (environmental surveillance) in 13 provinces in Afghanistan and Pakistan, compared with seven provinces in 2022. The number of polio cases caused by circulating vaccine-derived polioviruses (cVDPVs; circulating vaccine virus strains that have reverted to neurovirulence) decreased from 881 in 2022 to 524 in 2023; cVDPV outbreaks (defined as either a cVDPV case with evidence of circulation or at least two positive environmental surveillance isolates) occurred in 32 countries in 2023, including eight that did not experience a cVDPV outbreak in 2022. Despite reductions in paralytic polio cases from 2022, cVDPV cases and WPV1 cases (in countries with endemic transmission) were more geographically widespread in 2023. Renewed efforts to vaccinate persistently missed children in countries and territories where WPV1 transmission is endemic, strengthen routine immunization programs in countries at high risk for poliovirus transmission, and provide more effective cVDPV outbreak responses are necessary to further progress toward global polio eradication.

## Introduction

Since the establishment of the Global Polio Eradication Initiative (GPEI) in 1988, wild poliovirus (WPV) types 2 and 3 have been eradicated, and WPV type 1 (WPV1) remains endemic only in Afghanistan and Pakistan. In November 2021, a WPV1 outbreak genetically linked to Pakistan was detected in the southeastern African country of Malawi and spread to neighboring Mozambique in 2022 (1). Circulating vaccine-derived polioviruses (cVDPVs) can emerge and cause outbreaks in underimmunized populations when attenuated oral poliovirus vaccine (OPV) strains undergo prolonged

person-to-person transmission that allows genetic mutation and recombination to occur, resulting in a reverted poliovirus with the ability to cause paralysis (2).

Polio eradication relies on achieving high population immunity to poliovirus through childhood routine immunization (RI) programs and supplementary immunization activities (SIAs) (vaccination campaigns). Since May 2016, bivalent OPV (bOPV), containing Sabin strains type 1 and 3 (instead of the trivalent OPV [tOPV] containing types 1, 2, and 3), and  $\geq 1$  dose of injectable, inactivated poliovirus vaccine (IPV, containing types 1, 2, and 3) have been used for RI programs in all OPV-using countries. RI and SIAs using bOPV raise immunity against poliovirus types 1 and 3, protecting against WPV1 spread in countries with endemic transmission and against emergence of cVDPV type 1 or type 3 outbreaks. Monovalent OPV Sabin-strain type 2 (mOPV2) and novel OPV2 (nOPV2) vaccine, a more genetically stable OPV2 vaccine, are reserved for cVDPV2 outbreak response (3,4). Used in SIAs since March 2021 under emergency use listing (EUL), nOPV2 received World Health Organization (WHO) prequalification in December 2023. Since the EUL, nOPV2 vaccine has been primarily used in response to cVDPV2 outbreaks; mOPV2 and tOPV were last used during SIAs in March 2023.

The GPEI goal to interrupt all types of poliovirus transmission was not achieved in December 2023 (5). This report summarizes the status of polio eradication during January 1, 2022–December 31, 2023, and updates previous reports (1,6).

## Methods

Surveillance and virologic data were gathered from WHO's global Polio Information System (POLIS).<sup>\*</sup> Immunization coverage data were retrieved from WHO's Immunization Dashboard and represent estimates made by WHO and UNICEF based on administrative reporting (i.e., vaccine doses administered divided by the estimated target population) and survey data (7). A cVDPV outbreak was defined as a case of acute flaccid paralysis (AFP) with laboratory-confirmed

<sup>\*</sup>POLIS is a centralized database that integrates polio case-based and environmental surveillance, with supplemental immunization activity data from all WHO regions. <https://extranet.who.int/polis> (Access is limited to members of GPEI partner organizations).

cVDPV and evidence of community transmission or at least two positive cVDPV isolations from environmental sampling taken from two different sites without overlapping catchment areas, or from the same site, with  $\geq 1$  month between isolations.<sup>†</sup> Descriptive analyses were conducted using R software (version 4.3.1; R Foundation). This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.<sup>§</sup>

## Results

### Poliovirus Vaccination

In 2022, WHO recommended that all children worldwide be vaccinated against all polio types with  $\geq 3$  IPV doses (for countries using an IPV-only schedule) or  $\geq 3$  bOPV doses plus 2 IPV doses, in countries using a combined OPV-IPV schedule.<sup>¶</sup> The estimated global RI coverage with  $\geq 3$  doses of IPV or OPV (Pol3) by age 12 months was 84% in 2022, compared with 81% in 2021 and 83% in 2020 (7). Coverage during 2020–2022 remained below the 85%–87% range reported annually during 2014–2019 (7), before COVID-19 pandemic-associated disruptions in RI programs. In 2022, estimated coverage with 1 full dose or 2 fractional doses of IPV (IPV1; one fifth of a full IPV dose administered intradermally) was 84%, an increase from 80% in 2020 and 2021 and above the pre-COVID-19 pandemic high of 83% in 2019 (7). In 2022, estimated national coverage with Pol3 and IPV1 was 76% and 71%, respectively, in Afghanistan and 85% and 90%, respectively, in Pakistan (7). Subnational administrative data indicate much lower RI polio vaccination coverage in WPV1 reservoir areas.

In 2023, a total of 119 SIAs were conducted in 30 countries worldwide. Approximately 675 million doses of bOPV were administered in 10 countries (including 114 million doses in Afghanistan and 264 million in Pakistan), 10 million doses of mOPV2 were administered in Sudan, 524 million doses of nOPV were administered in 24 countries, and 8 million doses of tOPV were administered in two countries (Somalia and Yemen). Although nOPV2 is the preferred vaccine for cVDPV2 outbreak response because it is more genetically stable than the Sabin strain in tOPV or mOPV2 (which is more likely than the nOPV2 strain to revert to neurovirulence), production by a single manufacturer has resulted in vaccine supply shortages.

<sup>†</sup> <https://polioeradication.org/wp-content/uploads/2022/09/Standard-Operating-Procedures-For-Responding-to-a-Poliovirus-Event-Or-Outbreak-20220905-V4-EN.pdf>

<sup>§</sup> 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.

<sup>¶</sup> <https://www.who.int/publications/i/item/WHO-WER9725-277-300>

### Poliovirus Surveillance

Case-based surveillance for AFP in persons aged <15 years is the primary means for detecting WPV and cVDPV transmission. Environmental surveillance (ES), the testing of sewage samples for poliovirus, supplements AFP surveillance and can detect poliovirus circulation in the absence of AFP cases. Reported AFP cases are confirmed if poliovirus is isolated in a stool specimen at one of the 144 WHO-accredited laboratories in the Global Polio Laboratory Network (8). The two indicators used to monitor polio surveillance performance are the nonpolio AFP rate (a rate of two or more cases per 100,000 persons aged <15 years indicates sufficiently sensitive AFP surveillance) and stool adequacy (collection of two stool specimens of sufficient quality  $\geq 24$  hours apart and within 14 days of paralysis onset and received in good condition at a WHO-accredited laboratory via reverse cold chain for >80% of AFP cases). In 2023, eight\*\* of 28 (29%) countries at high risk for poliovirus spread<sup>††</sup> failed to meet global AFP surveillance indicator targets at the national level. In 2023, a total of 15,886 ES samples from 1,462 sites in 68 countries were tested, representing an increase from 14,498 samples (10% increase) from 1,117 sites (31% increase) in 69 countries in 2022.

### Reported Poliovirus Cases and Isolations

**Countries reporting WPV cases and isolations.** In 2023, Afghanistan and Pakistan reported six WPV1 cases each, compared with two in Afghanistan and 20 in Pakistan in 2022 (Table 1) (Figure) (9,10). In Afghanistan, all six reported cases in 2023 were from Nangarhar province, and the two cases reported in 2022 were from Paktika and Kunar provinces. These three provinces are located along the country's eastern border with Pakistan and have security challenges (9).

Four of the six 2023 WPV1 cases in Pakistan were from Khyber Pakhtunkhwa province, a northern province bordering Afghanistan, and two cases were from the southern Sindh province, specifically Karachi city. In 2022, WPV1 cases were confined to Khyber Pakhtunkhwa province, which is an area known for security and health access challenges (10).

\*\* Angola, Botswana, Burundi, Indonesia, Niger, Papua New Guinea, Sudan, and Zambia.

<sup>††</sup> Priority countries were selected for this report because of gaps in surveillance and vulnerability to poliovirus circulation, as determined in the WHO Global Polio Surveillance Action Plan, 2022–2024 (<https://polioeradication.org/wp-content/uploads/2022/05/GPSAP-2022-2024-EN.pdf>), updated June 2023. Countries include the following: *African Region* (21): Angola, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Democratic Republic of the Congo, Ethiopia, Guinea, Kenya, Madagascar, Malawi, Mali, Mozambique, Niger, Nigeria, South Sudan, Tanzania, Zambia, and Zimbabwe; *Eastern Mediterranean Region* (five): Afghanistan, Pakistan, Somalia, Sudan, and Yemen; *South-East Asia Region* (one): Indonesia; and *Western Pacific Region* (one): Papua New Guinea.

**TABLE 1. Number of poliovirus cases and isolations detected through environmental surveillance of wild poliovirus type 1 and circulating vaccine-derived polioviruses — worldwide, January 1, 2022–December 31, 2023\***

Country or territory (poliovirus type)	No. of poliovirus cases				No. of isolations of poliovirus through ES			
	2022		2023		2022		2023	
	WPV1	cVDPV	WPV1	cVDPV	No. of samples	No. (%) positive	No. of samples	No. (%) positive
<b>Reporting WPV1<sup>†</sup></b>								
Afghanistan	2	0	6	0	698	22 (3)	521	62 (12)
Pakistan	20	0	6	0	1,199	36 (3)	2,202	124 (6)
Mozambique (1,2)	8	26	0	5	133	0 (—)	211	0 (—)
<b>Reporting cVDPV<sup>†</sup></b>								
Algeria (2)	0	3	0	0	76	18 (24)	142	27 (19)
Angola (2)	0	0	0	0	128	0 (—)	122	1 (1)
Benin (2)	0	13	0	3	109	9 (8)	116	4 (3)
Botswana (2)	0	0	0	0	22	5 (23)	135	5 (4)
Burkina Faso (2)	0	0	0	3	151	0 (—)	154	0 (—)
Burundi (2)	0	1	0	1	34	7 (21)	50	13 (26)
Cameroon (2)	0	3	0	0	410	0 (—)	597	13 (2)
Canada (2)	0	0	0	0	2	2 (100)	0	0 (—)
Central African Republic (2)	0	6	0	14	212	9 (4)	222	1 (0.5)
Chad (2)	0	44	0	55	86	7 (8)	92	3 (3)
Congo (1)	0	1	0	0	238	0 (—)	246	2 (1)
Côte d'Ivoire (2)	0	0	0	6	157	3 (2)	262	43 (16)
Democratic Republic of the Congo (1,2)	0	522	0	223	327	13 (4)	441	37 (8)
Djibouti (2)	0	0	0	0	11	11 (100)	43	0 (—)
Egypt (2)	0	0	0	0	641	6 (1)	696	11 (2)
Eritrea (2)	0	1	0	0	0	0 (—)	0	0 (—)
Ethiopia (2)	0	1	0	0	31	0 (—)	29	0 (—)
Ghana (2)	0	3	0	0	197	20 (10)	167	0 (—)
Guinea (2)	0	0	0	47	123	0 (—)	146	19 (13)
Indonesia (2)	0	1	0	6	143	0 (—)	107	1 (1)
Israel (2,3)	0	1	0	1	82	80 (98)	0	0 (—)
Kenya (2)	0	0	0	8	200	0 (—)	227	8 (4)
Madagascar (1)	0	16	0	24	668	156 (23)	551	99 (18)
Malawi (1,2)	0	4	0	0	353	0 (—)	276	1 (0.4)
Mali (2)	0	2	0	15	46	0 (—)	67	6 (9)
Mauritania (2)	0	0	0	1	82	0 (—)	62	3 (5)
Niger (2)	0	16	0	2	301	14 (5)	501	4 (1)
Nigeria (2)	0	48	0	87	2,242	82 (4)	1,598	84 (5)
Occupied Palestinian Territory (3)	0	0	0	0	9	9 (100)	0	0 (—)
Senegal (2)	0	0	0	0	286	0 (—)	321	1 (0.3)
Somalia (2)	0	5	0	8	11	4 (36)	230	9 (4)
South Sudan (2)	0	0	0	3	49	0 (—)	230	0 (—)
Sudan (2)	0	1	0	0	154	1 (1)	89	5 (6)
Tanzania (2)	0	0	0	2	151	0 (—)	210	6 (3)
Togo (2)	0	2	0	0	87	0 (—)	96	0 (—)
United Kingdom (2)	0	0	0	0	26	6 (23)	1	0 (—)
United States (2)	0	1	0	0	31	0 (—)	0 (—)	0 (—)
Yemen (2)	0	160	0	8	34	26 (76)	33	10 (30)
Zambia (2)	0	0	0	1	117	3 (3)	254	2 (12)
Zimbabwe (2)	0	0	0	1	0	0 (—)	55	17 (31)
<b>Total</b>	<b>30</b>	<b>881</b>	<b>12</b>	<b>524</b>	<b>9,606</b>	<b>549 (6)</b>	<b>10,782</b>	<b>621 (5)</b>

**Abbreviations:** cVDPV = circulating vaccine-derived poliovirus; ES = environmental surveillance; WPV1 = wild poliovirus type 1.

\* Data current as of April 10, 2024.

<sup>†</sup> Countries listed are only those with reported poliovirus cases or isolations.

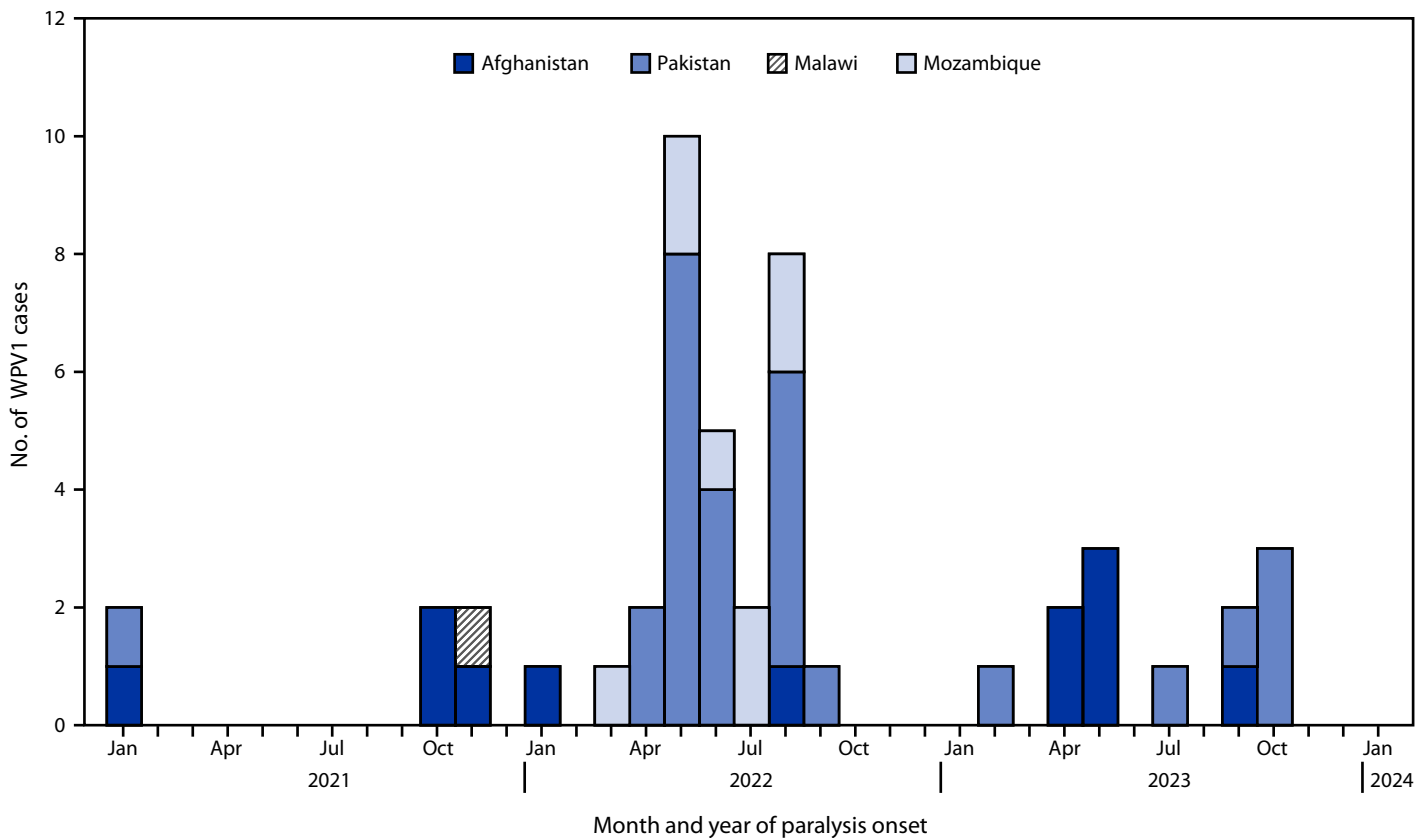
In 2023, among 521 environmental samples tested for poliovirus from Afghanistan, 62 (12%) were positive for WPV1, compared with 22 of 698 (3%) samples tested in 2022 (Table 1). Whereas this finding represents a 25% decrease in the total number of samples tested from 2022 to 2023, the percentage that tested positive quadrupled. ES isolates were identified in eight provinces, including seven that did not

report any WPV1 cases identified by AFP surveillance. Seven of the eight provinces with positive ES isolates were near the border with Pakistan.

In Pakistan, 124 of 2,202 (6%) environmental samples tested for poliovirus in 2023 were positive for WPV1, representing an 84% increase compared with those tested in 2022 (1,199), and a doubling of the 3% positivity rate (36 of 1,199) in 2022.



FIGURE. Wild poliovirus type 1 cases — worldwide, January 2021–December 2023



Abbreviation: WPV1 = wild poliovirus type 1.

These ES isolates came from five provinces covering most of the country, including three that did not report any WPV1 cases identified by AFP surveillance. Within Afghanistan and Pakistan, the number of provinces with WPV1 environmental isolates nearly doubled from seven in 2022 to 13 in 2023 (Table 2).

The 2021–2022 WPV1 outbreak in Africa included one WPV1 case in Malawi (November 2021) and eight cases in one province in Mozambique in 2022 (1). All Mozambique cases were genetically linked to the Malawi case and the Malawi case was linked to Pakistan. No WPV1 cases have been reported outside of Afghanistan and Pakistan since August 10, 2022.

**Countries reporting cVDPV cases and isolations.** The total number of cVDPV cases worldwide decreased 41% from 2022 (881 cases: 193 cVDPV1, 687 cVDPV2, and one cVDPV3 case) to 2023 (524 cases: 133 cVDPV1 and 391 cVDPV2) (Table 1), representing a 31% decrease in cVDPV1 cases and a 43% decrease in cVDPV2 cases. The Democratic Republic of the Congo and Mozambique each reported both cVDPV1 and cVDPV2 cases in 2022 and 2023. No country reported cVDPV3 in 2023, although one case was reported in Israel in 2022.

### Summary

#### What is already known about this topic?

Afghanistan and Pakistan are the remaining countries with endemic transmission of wild poliovirus (WPV); however, multiple countries and regions are experiencing circulating vaccine-derived poliovirus (cVDPV) outbreaks.

#### What is added by this report?

Although the number of WPV cases in Afghanistan and Pakistan decreased during 2023, environmental surveillance detected WPV transmission outside known reservoir areas. Eight new countries reported cVDPV outbreaks, indicating a wider geographic spread of cVDPVs in 2023 compared with 2022.

#### What are the implications for public health practice?

To interrupt poliovirus transmission, a renewed focus on increasing routine immunization coverage in endemic areas and implementing higher quality supplementary immunization activities is necessary.

Although only 23 countries reported cVDPV polio cases in 2022 and 2023, active cVDPV outbreaks confirmed only through ES isolation were reported in an additional nine

**TABLE 2. Number of administrative areas with poliovirus detections through acute flaccid paralysis surveillance and environmental surveillance, by poliovirus type and administrative area — worldwide, January 1, 2017–December 31, 2021\***

Poliovirus type/ Administrative area	No. of areas						
	2017	2018	2019	2020	2021	2022	2023
<b>WPV1</b>							
Countries	2	2	3	2	3	3	2
Provinces	15	14	18	25	9	8	13
Districts	37	52	94	116	28	26	48
<b>cVDPV (any type)</b>							
Countries	4	9	22	33	32	32	32
Provinces	8	36	106	205	145	137	148
Districts	16	75	230	598	447	386	328
<b>cVDPV1</b>							
Countries	0	2	5	4	2	5	3
Provinces	0	10	7	6	9	17	19
Districts	0	16	13	18	19	45	45
<b>cVDPV2</b>							
Countries	4	7	19	30	31	29	31
Provinces	8	26	103	200	137	123	133
Districts	16	59	223	581	429	357	294

**Abbreviations:** cVDPV = circulating vaccine-derived poliovirus; cVDPV1 = CVDPV type 1; cVDPV2 = cVDPV type 2; WPV1 = wild poliovirus type 1.

\* Data are current as of April 10, 2024.

countries each year (Table 1). Among these 32 countries, eight<sup>§§</sup> that reported cVDPVs in 2022 stopped their outbreaks and did not report cVDPVs in 2023. Among the 32 countries reporting cVDPVs in 2023,<sup>¶¶</sup> eight countries<sup>\*\*\*</sup> that had not reported any cVDPV cases or isolates in 2022 had new outbreaks (Table 1) (Table 2). Despite completing planned outbreak response SIAs, 24 countries<sup>†††</sup> with cVDPV detections in 2022 failed to stop their outbreaks, indicating that enough children are persistently missed during the SIAs to sustain cVDPV transmission.

## Discussion

Global WPV1 eradication efforts remain hindered by continuing transmission in areas of Afghanistan and Pakistan with ongoing security issues that limit health service access. In Afghanistan and Pakistan, WPV cases were detected in only a total of three provinces in 2023. However, in both countries, ES detected WPV1 across multiple provinces remote from the location of WPV1 cases, indicating widespread WPV1

transmission, with ongoing local transmission in some areas. Efforts to increase SIA quality and access more children, synchronize campaigns at the Pakistan-Afghanistan border, and strengthen active AFP surveillance aimed at disrupting WPV1 transmission in both countries are continuing.

Ongoing cVDPV outbreaks pose additional challenges to global polio eradication efforts. In 2023, eight countries reported new cVDPV outbreaks and cVDPV transmission continued in 24 countries with outbreaks ongoing since 2022, indicating that children continue to be missed during SIA vaccination rounds. Substantial improvement in response efforts is needed. However, with a single nOPV2 manufacturer, new cVDPV2 outbreaks, and uninterrupted transmission, nOPV2 vaccine supply has been insufficient to meet outbreak response needs. Interruptions in nOPV2 vaccine availability during 2024 will delay SIAs for cVDPV2 outbreak responses, risking further spread. Continued focus on high-quality, appropriately scaled SIA responses is critical to interrupting cVDPV2 circulation. In countries with prolonged cVDPV outbreaks, serious access issues, and security concerns, alternative strategies are required to reach missed children.

## Limitations

The findings in this report are subject to at least two limitations. First, administrative vaccination coverage estimates are based on population estimates that might be inaccurate in areas lacking recent census data or those with substantial population migration. As a result, RI and SIA coverage might be over- or underestimated. Second, AFP surveillance results rely on accurately identifying AFP cases; the numbers presented

<sup>§§</sup> Canada, Djibouti, Eritrea, Ethiopia, Ghana, Togo, United Kingdom, and United States.

<sup>¶¶</sup> Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Egypt, Guinea, Indonesia, Israel, Kenya, Madagascar, Malawi, Mali, Mauritania, Mozambique, Niger, Nigeria, Senegal, Somalia, South Sudan, Sudan, Tanzania, Yemen, Zambia, and Zimbabwe.

<sup>\*\*\*</sup> Angola, Burkina Faso, Guinea, Kenya, Mauritania, South Sudan, Tanzania, and Zimbabwe.

<sup>†††</sup> Algeria, Benin, Botswana, Burundi, Cameroon, Central African Republic, Chad, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Egypt, Indonesia, Israel, Madagascar, Malawi, Mali, Mozambique, Niger, Nigeria, Senegal, Somalia, Sudan, Yemen, and Zambia.

in this report might include cases that do not meet the AFP case definition and exclude cases not reported to the program.

### Implications for Public Health Practice

Accelerating progress toward polio eradication will require reaching persistently missed children by implementing effective, innovative campaigns in areas with ongoing insecurity concerns, increasing community stakeholders' engagement in vaccination efforts, and enhancing accountability at national and community levels, including frontline supervision. Ensuring sufficient vaccine supply for outbreak response practices and limiting the geographic spread of outbreaks into poliovirus-free areas are also needed. These improvements are critical to interrupting endemic and outbreak-associated poliovirus transmission and achieving the goal of global polio eradication.

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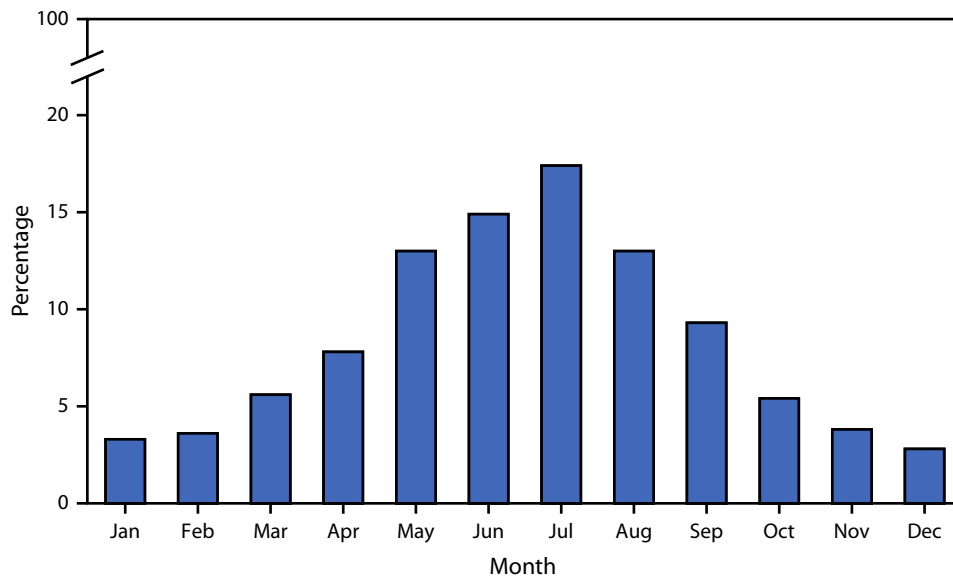
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## QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

## Percentage Distribution of Deaths Involving Injuries from Recreational and Nonrecreational Use of Watercraft,\* by Month — United States, 2020–2022



\* Deaths were identified using *International Classification of Diseases, Tenth Revision* underlying cause of death codes V90–V94 (water transport). Water transport includes both recreational and nonrecreational use of motorized (e.g., merchant ship, ferry, passenger ship, fishing boat, and jet ski) and nonmotorized (e.g., canoe, kayak, inflatable craft, surfboard, and windsurfer) watercraft. Deaths resulted from drowning, submersion, and other types of injuries. All water transport deaths are unintentional.

During 2020–2022, a total of 1,481 deaths occurred involving injuries from recreational and nonrecreational use of watercraft. The highest percentage of these deaths (17.4%) occurred in July, with the majority occurring during May–September.

**Supplementary Table:** <https://stacks.cdc.gov/view/cdc/155045>

**Source:** National Center for Health Statistics, National Vital Statistics System, Mortality Data, 2020–2022. <https://www.cdc.gov/nchs/nvss/deaths.htm>

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For more information on this topic, CDC recommends the following link: <https://www.cdc.gov/drowning/prevention/index.html>



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