Centers for Disease Control and Prevention

MMWR

Morbidity and Mortality Weekly Report

Weekly / Vol. 71 / No. 47

November 25, 2022

Progress Toward Regional Measles Elimination — Worldwide, 2000–2021

Anna A. Minta, MD[1]; Matt Ferrari, PhD[2]; Sebastien Antoni, MPH[1]; Allison Portnoy, ScD[3]; Alyssa Sbarra, MPH[4]; Brian Lambert[2]; Sarah Hauryski[2]; Cynthia Hatcher, MPH[5]; Yoann Nedelec, MPH[1]; Deblina Datta, MD[5]; Lee Lee Ho, MPH[1]; Claudia Steulet, MPH[1]; Marta Gacic-Dobo, MSc[1]; Paul A. Rota, PhD[6]; Mick N. Mulders, PhD[1]; Anindya S. Bose, MD[1]; William A. Perea[1]; Patrick O'Connor, MD[1]

All six World Health Organization (WHO) regions have committed to eliminating measles.* The Immunization Agenda 2021–2030 (IA2030)† aims to achieve the regional targets as a core indicator of impact and positions measles as the tracer of a health system's ability to deliver essential childhood vaccines. IA2030 highlights the importance of ensuring rigorous measles surveillance systems to document immunity gaps and achieve 95% coverage with 2 timely doses of measles-containing vaccine (MCV) among children. This report describes progress toward measles elimination during 2000–2021 and updates a previous report (*1*). During 2000–2021, estimated global coverage with a first MCV dose (MCV1) increased from 72% to a peak of 86% in 2019, but decreased during the COVID-19 pandemic to 83% in 2020 and to 81% in 2021, the lowest MCV1 coverage recorded since 2008. All countries conducted measles surveillance, but only 47 (35%) of 135 countries reporting discarded cases§ achieved the sensitivity indicator target of two or more discarded cases per 100,000 population in 2021, indicating surveillance system underperformance in certain countries. Annual reported measles incidence decreased 88% during 2000–2016, from 145 to 18 cases per 1 million population, then rebounded to 120 in 2019 during a global resurgence (*2*), before declining to 21 in 2020 and to 17 in 2021. Large and disruptive outbreaks were reported in 22 countries. During 2000–2021, the annual number of estimated measles deaths decreased 83%, from 761,000 to 128,000; an estimated 56 million measles deaths were averted by vaccination. To regain progress and achieve regional measles elimination targets during and after the COVID-19 pandemic, accelerating targeted efforts is necessary to reach all children with 2 MCV doses while implementing robust surveillance and identifying and closing immunity gaps to prevent cases and outbreaks.

* 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.

† https://www.who.int/teams/immunization-vaccines-and-biologicals/strategies/ia2030

§ A discarded measles case is defined as a suspected case that has been investigated and determined to be neither measles nor rubella by using either 1) laboratory testing in a proficient laboratory, or 2) epidemiologic linkage to a laboratory-confirmed outbreak of a communicable disease that is not measles or rubella. The discarded case rate is used to measure the sensitivity of measles surveillance.

Immunization Activities

WHO and UNICEF use data from 1) administrative coverage (calculated by dividing the number of vaccine doses administered by the estimated target population reported annually), 2) country estimates,¶ and 3) vaccination coverage surveys to estimate MCV1 and second dose MCV (MCV2) coverage through routine immunization services (i.e., not mass campaigns).** During 2000–2010, estimated MCV1 coverage

¶ Estimates based on administrative data as well as any other available information on factors affecting immunization coverage, including private or nongovernmental organization sector contributions to immunization, difficulties with demographic data, and incomplete reporting.

** Calculated for MCV1, among children aged 1 year or, if MCV1 is administered 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.ncbi.nlm.nih.gov/pmc/articles/PMC8464208/

INSIDE

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

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

increased worldwide from 72% to 84%. However, coverage stagnated at 84% to 86% during 2010–2019, decreased to 83% in 2020 during the COVID-19 pandemic, and further declined to 81% in 2021. Although regional variation exists, all six WHO regions reported a decline in MCV1 coverage since 2019, with only the European Region plateauing from 2020 to 2021 (Table 1).

Among 194 WHO member states, 91 (47%) achieved ≥90% MCV1 coverage in 2021; however, among these countries, only 24 (26%) reported MCV1 coverage of ≥80% in all districts. In 2021, 24.7 million infants did not receive MCV1 through routine immunization services, an increase of 2.4 million (11%) from 2020. The 10 countries with the highest number of infants who did not receive MCV1 were Nigeria (3.1 million), India (2.5 million), Democratic Republic of the Congo (1.7 million), Ethiopia (1.7 million), Indonesia (1.2 million), Pakistan (1.2 million), Philippines (1.0 million), Angola (0.8 million), Brazil (0.7 million), and Tanzania (0.5 million). These countries accounted for 59% of all children who did not receive MCV1. Estimated MCV2 coverage quadrupled from 17% in 2000 to 72% in 2020, then declined slightly, to 71% in 2021. The number of countries offering MCV2 increased by 92%, from 95 (50%) in 2000 to 182 (94%) in 2021. Three countries (Comoros, Côte d'Ivoire, and Equatorial Guinea) introduced MCV2 in 2021.[††]

[††] Data as of September 20, 2022. http://immunizationdata.who.int/pages/vaccine-intro-by-antigen/mcv2.html?ISO_3_CODE = &YEAR =

Approximately 150 million persons received MCV during supplementary immunization activities (SIAs)[§§] in 18 countries in 2021. An additional 4 million persons received MCV during measles outbreak response activities. As of December 2021, 25 MCV campaigns that had been postponed since the start of the COVID-19 pandemic had been conducted; however, 18 MCV campaigns planned since March 2020 had still not been conducted, which resulted in an estimated 61 million postponed or missed MCV doses.

Surveillance Performance and Reported Measles Incidence

WHO's Global Measles and Rubella Laboratory Network (GMRLN) supports countries in providing standardized quality-controlled laboratory testing for measles and rubella. Among the 135 (70%) countries that reported discarded cases, 47 (35%) achieved the sensitivity indicator target of two or more discarded cases per 100,000 population in 2021, compared with 45 (31%) of 143 countries reporting in 2020. In

[§§] SIAs are typically carried out using two target age ranges: 1) an initial catch-up SIA focuses on infants, children, and adolescents aged 9 months–14 years to eliminate susceptibility to measles in a population, and 2) periodic follow-up SIAs then focus on infants and children aged 9–59 months born since the last SIA. Follow-up SIAs typically are conducted nationwide every 2–4 years to eliminate measles susceptibility in recent birth cohorts because of low MCV coverage and to protect infants, children, and adolescents who did not respond to MCV1. Countries can provide additional data to WHO, and data are updated retrospectively. https://immunizationdata.who.int/listing.html?topic = &location =

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

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

Centers for Disease Control and Prevention

Rochelle P. Walensky, MD, MPH, *Director*
Debra Houry, MD, MPH, *Acting Principal Deputy Director*
Daniel B. Jernigan, MD, MPH, *Deputy Director for Public Health Science and Surveillance*
Rebecca Bunnell, PhD, MEd, *Director, Office of Science*
Jennifer Layden, MD, PhD, *Deputy Director, Office of Science*
Leslie Dauphin, PhD, *Director, Center for Surveillance, Epidemiology, and Laboratory Services*

MMWR Editorial and Production Staff (Weekly)

Charlotte K. Kent, PhD, MPH, *Editor in Chief*
Jacqueline Gindler, MD, *Editor*
Tegan K. Boehmer, PhD, MPH, *Guest Science Editor*
Paul Z. Siegel, MD, MPH, *Associate Editor*
Mary Dott, MD, MPH, *Online Editor*
Terisa F. Rutledge, *Managing Editor*
Teresa M. Hood, MS, *Lead Technical Writer-Editor*
Leigh Berdon, Glenn Damon,
Tiana Garrett-Cherry, PhD, MPH, Srila Sen, MA,
Stacy Simon, MA, Morgan Thompson,
Technical Writer-Editors

Martha F. Boyd, *Lead Visual Information Specialist*
Alexander J. Gottardy, Maureen A. Leahy,
Julia C. Martinroe, Stephen R. Spriggs, Tong Yang,
Visual Information Specialists
Quang M. Doan, MBA, Phyllis H. King,
Terraye M. Starr, Moua Yang,
Information Technology Specialists

Ian Branam, MA,
Acting Lead Health Communication Specialist
Kiana Cohen, MPH, Symone Hairston, MPH,
Leslie Hamlin, Lowery Johnson,
Health Communication Specialists
Dewin Jimenez, Will Yang, MA,
Visual Information Specialist

MMWR Editorial Board

Timothy F. Jones, MD, *Chairman*

Matthew L. Boulton, MD, MPH
Carolyn Brooks, ScD, MA
Jay C. Butler, MD
Virginia A. Caine, MD
Jonathan E. Fielding, MD, MPH, MBA

David W. Fleming, MD
William E. Halperin, MD, DrPH, MPH
Jewel Mullen, MD, MPH, MPA
Jeff Niederdeppe, PhD
Celeste Philip, MD, MPH

Patricia Quinlisk, MD, MPH
Patrick L. Remington, MD, MPH
Carlos Roig, MS, MA
William Schaffner, MD
Morgan Bobb Swanson, BS

TABLE 1. Estimates of regional immunization coverage with the first and second doses of measles-containing vaccine administered through routine immunization services, reported measles cases, and measles incidence, by World Health Organization region — worldwide, 2000–2021

	Percentage					
Yr/WHO region (no. of countries in region)	MCV1* coverage	Countries with ≥90% MCV1 coverage†	MCV2* coverage	Reporting countries with <5 measles cases per 1 million population§,¶	No. of reported measles cases§ (% of total cases)	Measles incidence§,¶,**
Total (all regions)						
2000 (191)	**72**	**44**	**17**	**33**	**853,479 (100)**	**145**
2010 (193)	**84**	**63**	**42**	**59**	**343,806 (100)**	**50**
2016 (194)	**85**	**61**	**67**	**64**	**132,490 (100)**	**18**
2019 (194)	**86**	**62**	**71**	**44**	**873,022 (100)**	**120**
2020 (194)	**83**	**51**	**72**	**57**	**159,073 (100)**	**21**
2021 (194)	**81**	**47**	**71**	**66**	**123,981 (100)**	**17**
African						
2000 (46)	53	9	5	6	520,102 (60.9)	832
2010 (46)	72	36	5	30	199,174 (57.9)	232
2016 (47)	68	34	22	49	36,269 (27.4)	37
2019 (47)	70	30	33	34	618,595 (70.9)	560
2020 (47)	69	19	40	30	115,369 (72.5)	106
2021 (47)	68	23	41	34	89,602 (72.3)	83
Americas						
2000 (35)	93	63	65	89	1,754 (0.2)	2
2010 (35)	93	74	67	100	247 (0.1)	0.3
2016 (35)	92	66	80	97	97 (0.1)	0.1
2019 (35)	87	69	72	89	21,971 (2.5)	32
2020 (35)	85	43	72	97	9,996 (6.3)	10
2021 (35)	84	31	75	97	682 (0.6)	0.7
Eastern Mediterranean						
2000 (21)	71	57	27	14	38,592 (4.5)	87
2010 (21)	76	62	52	38	10,072 (2.9)	17
2016 (21)	82	57	73	52	6,275 (4.7)	10
2019 (21)	83	52	76	38	18,458 (2.1)	26
2020 (21)	83	48	77	48	6,769 (4.3)	10
2021 (21)	82	48	77	52	26,089 (21.0)	40
European						
2000 (52)	91	60	48	38	37,421 (4.4)	50
2010 (53)	94	83	80	68	30,625 (8.9)	34
2016 (53)	93	81	88	77	4,440 (3.4)	5
2019 (53)	96	85	92	30	106,130 (12.2)	117
2020 (53)	94	77	91	70	10,945 (6.9)	14
2021 (53)	94	70	91	91	99 (0.1)	0.1
South-East Asia						
2000 (10)	62	27	3	0	78,558 (9.2)	51
2010 (11)	83	45	15	36	54,228 (15.8)	30
2016 (11)	89	64	75	27	27,530 (20.8)	14
2019 (11)	94	73	83	27	29,389 (3.4)	15
2020 (11)	88	64	80	45	9,389 (5.9)	5
2021 (11)	86	55	78	55	6,448 (5.2)	3
Western Pacific						
2000 (27)	85	48	2	26	177,052 (20.7)	106
2010 (27)	97	63	87	63	49,460 (14.4)	28
2016 (27)	96	63	93	48	57,879 (43.7)	31
2019 (27)	95	70	93	41	78,479 (9.0)	41
2020 (27)	94	63	94	37	6,605 (4.2)	4
2021 (27)	91	59	91	48	1,061 (0.9)	0.6

Abbreviations: MCV1 = first dose of measles-containing vaccine; MCV2 = second dose of measles-containing vaccine; WHO = World Health Organization.
* https://immunizationdata.who.int/pages/coverage/mcv.html (Accessed September 29, 2022).
† Denominator is the number of WHO member states.
§ https://immunizationdata.who.int/pages/incidence/measles.html (Accessed September 29, 2022).
¶ Population data from United Nations Department of Economic and Social Affairs, Population Division, 2022. Any country not reporting measles cases for that year was removed from both the numerator and denominator in calculating incidence.
** Cases per 1 million population.

2021, GMRLN laboratories received 122,735 specimens for measles testing compared with 122,116 specimens in 2020.

Countries report the number of incident measles cases to WHO and UNICEF annually, using the Joint Reporting Form.¶¶ During 2000–2016, the number of reported measles cases decreased by 84%, from 853,479 to 132,490. Reported measles cases peaked at 873,022 in 2019, then declined to 159,073 in 2020, and 123,981 in 2021. From 2000 to 2016, annual measles incidence decreased 88%, from 145 cases per 1 million population to 18; measles incidence then increased to 120 cases per million in 2019 and decreased 82% to 21 in 2020 and 22% to 17 in 2021. In 2021, 22 countries in two WHO regions were affected by large and disruptive outbreaks***; 18 (82%) outbreaks occurred in countries in the African Region and four (18%) in the Eastern Mediterranean Region (Supplementary Table, https://stacks.cdc.gov/view/cdc/122049).

Genotypes detected from measles cases††† were reported by 27 (33%) of the 82 countries reporting at least one measles case in 2021, compared with 45 (39%) of 115 countries reporting at least one measles case in 2020. The number of genotypes detected decreased from 13 in 2002 to six in 2014, three in 2020, and two in 2021. A total of 1,615 sequences were reported in 2020; among 648 reported sequences in 2021, 221 (34%) were D8 and 426 (66%) were B3.

Measles Case and Mortality Estimates

A previously described model (*3*) for estimating measles cases and deaths was updated with 2021 measles data and United Nations 2000–2021 population estimates.§§§ Data on case fatality from an updated systematic review and a suite of covariates with known relationships to case fatality were used in a Bayesian meta-regression modeling framework to produce estimates of measles case fatality ratios¶¶¶ (*4*). The updated estimates reflect heterogeneity among countries, years, and ages. On the basis of the revised model and 2021 data, the estimated number of measles cases decreased 72%, from 34,013,000 in 2000 to 9,484,000 in 2021; estimated annual measles deaths decreased 83%, from 761,000 to 128,000 (Table 2). However, the estimated numbers of both cases and deaths were higher in 2021 compared with those in 2020. During 2000–2021, compared with no measles vaccination, measles vaccination prevented an estimated 56 million deaths globally (Figure).

Regional Verification of Measles Elimination

By the end of 2021, 76 (39%) countries had been verified by independent regional commissions as having achieved or maintained measles elimination status. No WHO region had achieved and sustained elimination, and no African Region country has yet been verified to have eliminated measles. WHO's Region of the Americas achieved verification of measles elimination in 2016; however, endemic measles transmission was reestablished in Venezuela (2016) and Brazil (2018). Since 2016, endemic transmission has been reestablished in eight other countries (Albania, Cambodia, Lithuania, Mongolia, Slovakia, the Czech Republic, the United Kingdom, and Uzbekistan) that had previously achieved verification of measles elimination.

Discussion

All WHO regions remain committed to measles elimination; however, no region has achieved and sustained elimination targets. Drops in MCV1 coverage and declines in surveillance performance that started or continued during the COVID-19 pandemic persisted in 2021 (*5*–*7*). Among regions, the Southeast Asia Region faced the largest decrease in MCV1 coverage (from 94% to 86%) between 2019 and 2021, and only the European Region maintained MCV1 coverage from 2020 to 2021. None of the WHO regions have recovered MCV1 or MCV2 coverage levels from 2019, which were still below the 95% coverage needed to achieve and sustain measles elimination (*8*).

¶¶ Only countries that reported data are in the numerator and denominator. Countries do not provide WHO with their reasons for not reporting measles cases. https://immunizationdata.who.int/pages/incidence/measles.html (Accessed September 20, 2022).

*** The IA2030 global monitoring framework defines large and disruptive outbreaks as having at least 20 cases per 1 million population.

††† Data as of September 20, 2022. https://who-gmrln.org/means2

§§§ State-space model of unobserved measles incidence during 2000–2021 generated using the following inputs from all member countries: 1) total annual reported measles cases, 2) annual MCV1 coverage from WHO-UNICEF estimates of national immunization coverage, 3) annual MCV2 coverage from WHO-UNICEF estimates of national immunization coverage, 4) annual SIAs with coverage and age targets (subnational SIAs are discounted by the proportion of the total population targeted), 5) annual total population size, 6) total annual births, and 7) list of all countries and years for which reporting was enhanced.

¶¶¶ The model fitted the reported case fatality ratios from the systematic review as a function of the following covariates: 1) gross domestic product per capita, 2) HIV prevalence, 3) maternal education, 4) MCV1 coverage, 5) proportion urban, 6) total fertility rate, 7) mortality rate among children aged <5 years, 8) vitamin A deficiency prevalence, 9) war and terrorism mortality rate, 10) wasting prevalence, and 11) measles incidence. Annual measles incidence for each country was based on this fitted state-space model. High income countries were excluded from this analysis.

TABLE 2. Estimated number of measles cases and deaths,* by World Health Organization region — worldwide, 2000 and 2021

Yr/WHO region (no. of countries in region)	No. (95% CI) Estimated no. of measles cases	Estimated no. of measles deaths	Estimated reduction in measles mortality, % 2000–2021	Cumulative no. of measles deaths averted by vaccination 2000–2021
Total, all regions				
2000 (191)	**34,012,634 (27,393,416–42,901,683)**	**761,038 (561,895–993,312)**	**83**	**55,812,741**
2021 (194)	**9,484,464 (5,681,867–14,881,517)**	**127,656 (74,444–197,500)**		
African				
2000 (46)	10,965,152 (7,134,948–14,649,839)	356,299 (227,304–488,539)	81	19,499,793
2021 (47)	4,430,595 (2,619,358–7,030,815)	66,229 (38,811–106,293)		
Americas				
2000 (35)	8,770 (4,385–35,080)	NA[†]	61	4,343,128
2021 (35)	3,410 (1,705–13,640)	NA[†]		
Eastern Mediterranean				
2000 (21)	4,370,190 (3,295,576–6,213,952)	150,299 (115,962–205,857)	67	9,553,930
2021 (21)	2,303,170 (1,304,581–3,075,854)	48,979 (26,638–72,045)		
European				
2000 (52)	911,710 (733,732–1,353,344)	3,869 (3,098–4,747)	97	1,146,475
2021 (53)	86,196 (25,252–208,956)	132 (34–352)		
South-East Asia				
2000 (10)	12,395,953 (11,108,235–14,268,354)	224,822 (192,623–266,165)	95	16,546,297
2021 (11)	1,702,699 (1,399,591–2,321,389)	10,230 (8,328–13,538)		
Western Pacific				
2000 (27)	5,360,859 (5,116,541–6,381,114)	25,746 (22,907–27,993)	92	4,723,119
2021 (27)	958,395 (331381–2,230,863)	2,085 (633–5,267)		

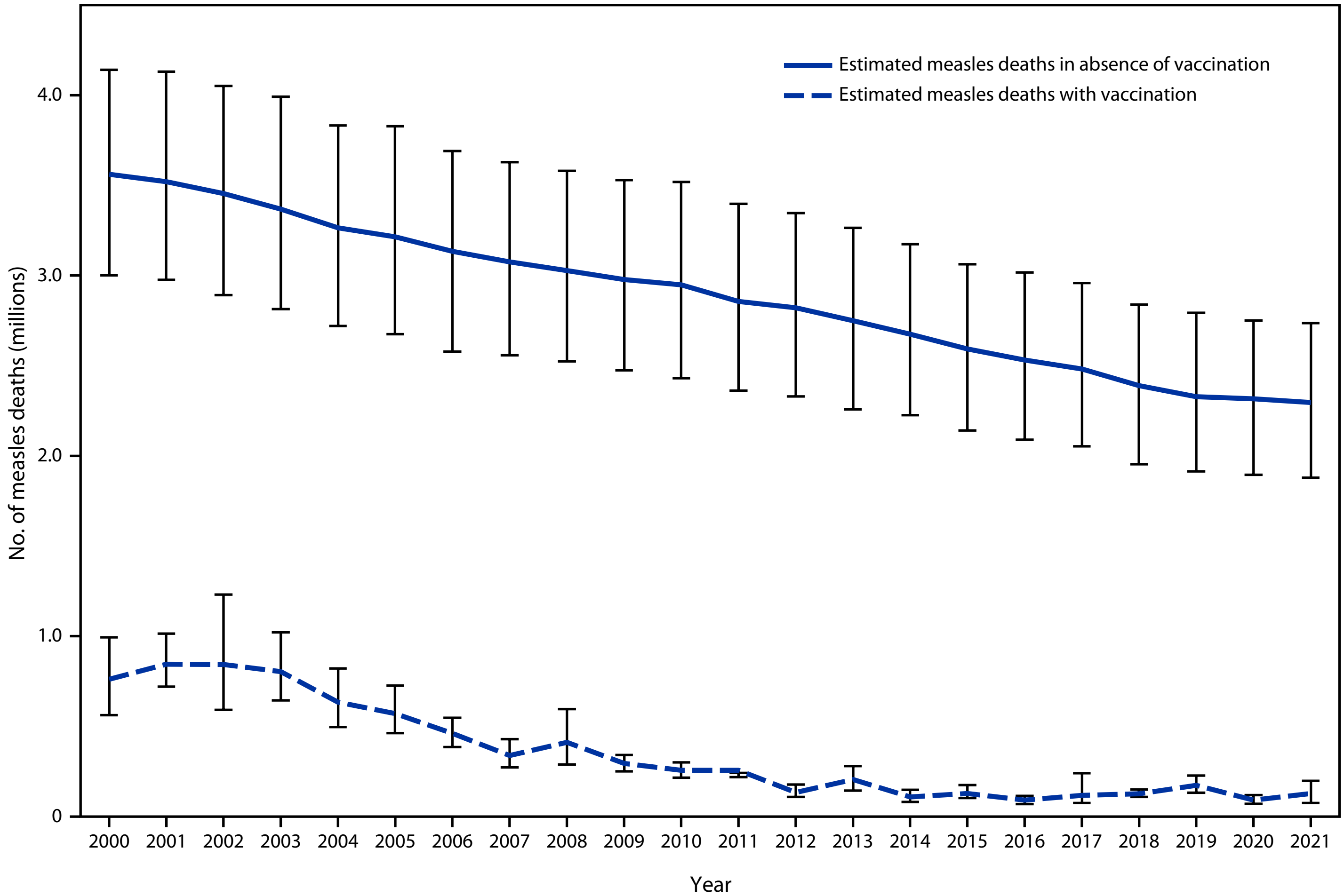
Abbreviations: NA = not applicable; WHO = World Health Organization.
* The measles mortality model used to generate estimated measles cases and deaths is rerun each year using the new and revised annual WHO-UNICEF estimates of national immunization coverage data as well as updated surveillance data. In 2021, data on case fatality from an updated systematic review and a suite of covariates with known relationships to case fatality were used in a Bayesian meta-regression modeling framework to produce estimates of measles case fatality ratios; therefore, the estimated number of cases and mortality estimates for 2000–2020 in this report differs from previous reports.
† Estimated measles mortality was too low to allow reliable measurement of mortality reduction.

SIAs represent an opportunity to reach children with missing MCV doses from the routine immunization program and close immunity gaps.**** In 2021, the implementation of 25 campaigns that had been delayed because of COVID-19 indicates some pandemic recovery; however, 18 pending SIAs that had not yet been conducted as of December 2021 present a risk for measles outbreaks.

The observed decrease in measles incidence in 2020 and 2021 could reflect actual changes related to increased immunity after a 2017–2019 global resurgence of measles, reduced viral transmission associated with COVID-19 mitigation measures, limited detection resulting from surveillance system underperformance, or a combination of multiple factors (*1*,*2*,*9*). Sensitivity of measles surveillance remained low in 2021, with continued low numbers of specimens received for laboratory testing and few countries achieving the surveillance sensitivity indicator. Sustained declines in surveillance not only affect the timely detection of cases and outbreaks but also undermine a program's ability to use measles as a tracer to highlight gaps in the overall immunization system.

**** https://apps.who.int/iris/handle/10665/340657; https://apps.who.int/iris/handle/10665/360891

FIGURE. Estimated number of annual measles deaths with measles vaccination and in the absence of measles vaccination — worldwide, 2000–2021*



* Deaths prevented by vaccination are estimated by the area between estimated deaths with vaccination and those without vaccination (cumulative total of 56 million deaths prevented during 2000–2021). Vertical bars represent 95% CIs around the point estimate.

The findings in this report are subject to at least three limitations. First, not all countries report complete, or any, data for SIAs and outbreak response activities; therefore, the numbers on these activities provided in this report could be underestimated. Second, the measles estimation model was updated this year, which limits comparability with estimates from previous years. Finally, the number of specimens submitted for genotyping represents a fraction of measles cases; hence, data presented in this report might not reflect the actual global distribution of genotypes.

Declining routine MCV coverage and delays in SIAs in 2021 left millions of children with zero or only 1 dose of MCV. In the absence of a high-performing surveillance system to promptly detect cases, a growing population of susceptible children is at risk for measles disease and outbreaks. In alignment with IA2030, the Measles and Rubella Strategic Framework 2021–2030[††††] outlines strategies for countries to build robust, case-based surveillance for measles to detect immunity gaps and outbreaks, identify root causes of undervaccination, and develop targeted solutions, including catch-up immunization for those who missed routine immunization doses during the pandemic, to reach all children with 2 doses of MCV. Accelerating these measures will help regain historical progress toward regional measles elimination.

†††† https://www.who.int/publications/i/item/measles-and-rubella-strategic-framework-2021-2030

Summary

What is already known about this topic?

Progress toward measles elimination experienced setbacks in 2020 during the COVID-19 pandemic.

What is added by this report?

During 2000–2021, measles vaccination prevented an estimated 56 million deaths worldwide. In 2021, only 81% of children received their first dose of measles containing vaccine (MCV), the lowest coverage reported since 2008, leaving 25 million children vulnerable to measles. Measles surveillance continues to be suboptimal, and large and disruptive outbreaks were reported in 22 countries.

What are the implications for public health practice?

Reaching all children with 2 doses of MCV and strengthening measles surveillance is critical to close immunity gaps, prevent outbreaks, and recover progress lost during the pandemic.

Acknowledgments

Country surveillance and immunization program staff members.

Corresponding author: Anna A. Minta, mintaa@who.int.

[1]Department of Immunization, Vaccines, and Biologicals, World Health Organization, Geneva, Switzerland; [2]Center for Infectious Disease Dynamics, Pennsylvania State University, University Park, Pennsylvania; [3]Center for Health Decision Science, Harvard T.H. Chan School of Public Health, Harvard University, Boston, Massachusetts; [4]Department of Infectious Disease Epidemiology, London School of Hygiene & Tropical Medicine, London, United Kingdom; [5]Global Immunization Division, Center for Global Health, CDC; [6]Division of Viral Diseases, National Center for Immunization and Respiratory Diseases, CDC.

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. Matt Ferrari reports grants from the Bill and Melinda Gates Foundation, the World Health Organization (WHO), and Gavi, The Vaccine Alliance to develop measles models. Allison Portnoy reports grant support from the Bill and Melinda Gates Foundation to develop models. Lee Lee Ho reports support as a consultant for WHO. No other potential conflicts of interest were disclosed.

References

1. Dixon MG, Ferrari M, Antoni S, et al. Progress toward regional measles elimination—worldwide, 2000–2020. MMWR Morb Mortal Wkly Rep 2021;70:1563–9. PMID:34758014 https://doi.org/10.15585/mmwr.mm7045a1
2. Patel MK, Goodson JL, Alexander JP Jr, et al. Progress toward regional measles elimination—worldwide, 2000–2019. MMWR Morb Mortal Wkly Rep 2020;69:1700–5. PMID:33180759 https://doi.org/10.15585/mmwr.mm6945a6
3. Eilertson KE, Fricks J, Ferrari MJ. Estimation and prediction for a mechanistic model of measles transmission using particle filtering and maximum likelihood estimation. Stat Med 2019;38:4146–58. PMID:31290184 https://doi.org/10.1002/sim.8290
4. Sbarra AN, Mosser JF, Jit M, Portnoy A. Estimating national-level measles case fatality ratios: an updated systematic review and modelling study. medRxiv [Preprint posted online October 5, 2022]. https://www.medrxiv.org/content/10.1101/2022.10.05.22280730v1
5. Kim S, Headley TY, Tozan Y. Universal healthcare coverage and health service delivery before and during the COVID-19 pandemic: a difference-in-difference study of childhood immunization coverage from 195 countries. PLoS Med 2022;19:e1004060. PMID:35972985 https://doi.org/10.1371/journal.pmed.1004060
6. Shet A, Carr K, Danovaro-Holliday MC, et al. Impact of the SARS-CoV-2 pandemic on routine immunisation services: evidence of disruption and recovery from 170 countries and territories. Lancet Glob Health 2022;10:e186–94. PMID:34951973 https://doi.org/10.1016/S2214-109X(21)00512-X
7. Ho LL, Gurung S, Mirza I, et al. Impact of the SARS-CoV-2 pandemic on vaccine-preventable disease campaigns. Int J Infect Dis 2022;119:201–9. PMID:35398300 https://doi.org/10.1016/j.ijid.2022.04.005
8. World Health Organization. Measles vaccines: WHO position paper—April 2017. Wkly Epidemiol Rec 2017;92:205–27. PMID:28459148
9. Masresha B, Luce R, Katsande R, et al. The impact of the COVID-19 pandemic on measles surveillance in the World Health Organisation African Region, 2020. Pan Afr Med J 2021;39:192. PMID:34603573 https://doi.org/10.11604/pamj.2021.39.192.29491

Progress Toward Global Eradication of Dracunculiasis — Worldwide, January 2021–June 2022

Donald R. Hopkins, MD[1]; Adam J. Weiss, MPH[1]; Sarah Yerian, MPH[1]; Sarah G.H. Sapp, PhD[2]; Vitaliano A. Cama, PhD[2]

Dracunculiasis (Guinea worm disease), caused by the parasite *Dracunculus medinensis*, is acquired by drinking water containing small crustacean copepods (water fleas) infected with *D. medinensis* larvae. Recent evidence suggests that the parasite also appears to be transmitted by eating fish or other aquatic animals. About 1 year after infection, the worm typically emerges through the skin on a lower limb of the host, causing pain and disability (*1*). No vaccine or medicine is available to prevent or treat dracunculiasis. Eradication relies on case containment* to prevent water contamination and other interventions to prevent infection, including health education, water filtration, treatment of unsafe water with temephos (an organophosphate larvicide), and provision of safe drinking water (*1*,*2*). CDC began worldwide eradication efforts in October 1980, and in 1984 was designated by the World Health Organization (WHO) as the technical monitor of the Dracunculiasis Eradication Program (*1*). In 1986, with an estimated 3.5 million cases† occurring annually in 20 African and Asian countries§ (*3*), the World Health Assembly called for dracunculiasis elimination. The Guinea Worm Eradication Program (GWEP),¶ led by The Carter Center and supported by partners that include WHO, UNICEF, and CDC, began assisting ministries of health in countries with endemic disease. In 2021, a total of 15 human cases were identified and three were identified during January–June 2022. As of November 2022, dracunculiasis remained endemic in five countries (Angola, Chad, Ethiopia, Mali, and South Sudan); cases reported in Cameroon were likely imported from Chad. Eradication efforts in these countries are challenged by infection in animals, the COVID-19 pandemic, civil unrest, and insecurity. Animal infections, mostly in domestic dogs, some domestic cats, and in Ethiopia, a few baboons, have now surpassed human cases, with 863 reported animal infections in 2021 and 296 during January–June 2022. During the COVID-19 pandemic all national GWEPs remained fully operational, implementing precautions to ensure safety of program staff members and community members. In addition, the progress toward eradication and effectiveness of interventions were reviewed at the 2021 and 2022 annual meetings of GWEP program managers, and the 2021 meeting of WHO's International Commission for the Certification of Dracunculiasis Eradication. With only 15 human cases identified in 2021 and three during January–June 2022, program efforts appear to be closer to reaching the goal of eradication. However, dog infections and impeded access because of civil unrest and insecurity in Mali and South Sudan continue to be the greatest challenges for the program. This report describes progress during January 2021–June 2022 and updates previous reports (*2*,*4*).

In affected countries, the national GWEP receives monthly case reports from supervised volunteers in each village under active surveillance.** Villages in which endemic transmission has ended (i.e., zero human cases or animal infections reported for ≥12 consecutive months) are kept under active surveillance for 2 additional years. WHO certifies a country as dracunculiasis-free after adequate nationwide surveillance for ≥3 consecutive years with no indigenous human cases or animal infections.††

Since 1986, WHO has certified 199 countries, areas, and territories as dracunculiasis-free; only the five countries with endemic dracunculiasis, plus the Democratic Republic of the Congo and Sudan still lack certification.§§ Representatives of seven countries with current or former endemic dracunculiasis, the United Arab Emirates, The Carter Center, and WHO renewed their commitment to completing Guinea worm eradication at a Guinea Worm Summit in Abu Dhabi in March 2022.

* Human cases are contained when all of the following criteria are met: 1) infected patients are identified ≤24 hours after worm emergence; 2) patients have not entered any water source since worm emergence; 3) a village volunteer/health care provider properly treats the lesion until all detectable worms are fully removed and educates the patient not to contaminate water sources; 4) the containment process is validated by a GWEP supervisor ≤7 days after worm emergence and 5) all contaminated and potentially contaminated sources of drinking water are treated with temephos.

† A dracunculiasis case is defined as an infection occurring in a person exhibiting a skin lesion or lesions with emergence of one or more worms that is laboratory-confirmed as *Dracunculus medinensis* at CDC. Because *D. medinensis* has a 10–14-month incubation period, each infected person is counted as having a case only once during a calendar year.

§ Initially 20 countries, but the former country of Sudan officially separated into two countries (Sudan and South Sudan) on July 9, 2011.

¶ https://www.who.int/activities/eradicating-dracunculiasis

** Villages under active surveillance are those that have endemic dracunculiasis or are at high risk for importation. Active surveillance involves daily searches of households by village volunteers (supported by their supervisors) for persons or animals with signs of dracunculiasis.

†† An indigenous dracunculiasis human case or animal infection is defined as an infection consisting of a skin lesion or lesions with emergence of one or more Guinea worms in a person or animal who had no history of travel outside their residential locality during the preceding year.

§§ https://apps.who.int/iris/bitstream/handle/10665/354570/WER9721-22-eng-fre.pdf?sequence=1&isAllowed=y

In 2021, Chad, Ethiopia, Mali, and South Sudan reported 15 human cases compared with 27 human cases in 2020, the smallest number of human cases ever reported annually (Table 1). Cameroon, Chad, Ethiopia, and Mali reported 863 infected animals (mostly dogs), compared with 1,601 animal infections reported in 2020. During January–June 2022, three human cases and 296 infected animals were reported, representing 40% and 34% reductions in human cases and animal infections, respectively, compared with five human cases and 450 infected animals reported during January–June 2021 (Table 2). During January–June 2022, CDC received 20 specimens from humans for morphologic or molecular identification, including three (15%) that were laboratory-confirmed *D. medinensis*[¶¶] (Table 3), compared with 13 specimens received and five (38%) confirmed during January–June 2021. During the

¶¶ Specimens are laboratory-confirmed as *D. medinensis* at CDC by morphologic examination under a microscope or polymerase chain reaction assay. https://www.cdc.gov/dpdx/dxassistance.html

TABLE 1. Reported dracunculiasis human cases and animal infections, surveillance, and status of local interventions in villages with endemic disease, by country — worldwide, 2021

	Country					
Human cases/Surveillance/Intervention status	**Chad***	**Ethiopia**	**Mali†**	**South Sudan**	**Angola**	**Total**
Reported human cases						
No. indigenous	8	1	2	4	0	**15**
No. imported§	0	0	0	0	0	**0**
% Contained¶ (no./total no.)	75 (6/8)	100	50 (1/2)	25 (1/4)	NA	**60 (9/15)**
% Change (no. change) in indigenous human cases in villages/localities under surveillance, 2020–2021	−38 (13 to 8)	−91 (11 to 1)	100 (1 to 2)	300 (1 to 4)	−100 (1 to 0)	**−44 (27 to 15)**
Reported animal cases						
No. indigenous	843**	3	17	0	0	**863**
No. imported††	0	0	0	0	0	**0**
% Contained¶ (no./total no.)	81 (681/843)	67 (2/3)	59 (10/17)	NA	NA	**80 (693/863)**
% Change (no. of cases in 2020) in indigenous animal infections in villages or localities under surveillance	−47 (1,577)	−80 (15)	89 (9)	NA	NA	**−46 (1,601)**
Villages under active surveillance, 2021						
No. of villages	2,358	198	2,216	2,174	61	**7,007**
No. (%) reporting monthly	2,358 (100)	198 (100)	2,216 (100)	1,975 (91)	8 (13)	**6,755 (96)**
No. reporting ≥1 human case	8	1	1	4	0	**14**
No. reporting only imported†† human cases	0	0	0	0	0	**0**
No. reporting indigenous human cases	8	1	1	4	0	**14**
No. reporting ≥1 animal infection	321	3	10	0	0	**334**
No. reporting only imported†† animal infections	0	0	0	0	0	**0**
No. reporting indigenous animal infections	321	3	10	0	0	**334**
Status of interventions in villages with human dracunculiasis, 2021						
No. of villages with human dracunculiasis, 2021	8	1	1	4	NA	**14**
% Reporting monthly§§ (no./total no.)	75 (6/8)	100 (1/1)	100 (1/1)	100 (4/4)	NA	**86 (12/14)**
% Filters in all households§§ (no./total no.)	38 (3/8)	100 (1/1)	100 (1/1)	100 (4/4)	NA	**64 (9/14)**
% Using temephos§§	75 (6/8)	100 (1/1)	100 (1/1)	100 (4/4)	NA	**86 (12/14)**
% With ≥1 source of safe water§§ (no./total no.)	38 (3/8)	100 (1/1)	100 (1/1)	25 (1/4)	NA	**43 (6/14)**
% Provided health education§§ (no./total no.)	75 (6/8)	100 (1/1)	100 (1/1)	100 (4/4)	NA	**86 (12/14)**
Status of interventions in villages with animal dracunculiasis, 2021						
No.of villages with animal dracunculiasis 2021	340	3	10	0	0	**353**
% Reporting monthly§§ (no./total no.)	95 (323/340)	100 (3/3)	100 (10/10)	NA	NA	**95 (336/353)**
% Using temephos§§ (no./total no.)	61 (208/340)	100 (3/3)	100 (10/10)	NA	NA	**63 (221/353)**
% Provided health education§§ (no./total no.)	95 (323/340)	100 (3/3)	100 (10/10)	NA	NA	**95 (336/353)**

Abbreviations: GWEP = Guinea Worm Eradication Program; NA = not applicable.

* Participants at the annual Chad GWEP review meeting in November 2014 adopted "1+ case village" as a new description for villages in Chad affected by human cases of Guinea worm disease or dogs infected with Guinea worms and defined it as "a village with one or more indigenous and imported cases of Guinea worm infections in humans, dogs, and cats in the current calendar year or previous year."

† Civil unrest and insecurity since a coup d'état in 2012 continued to constrain GWEP operations (i.e., supervision, surveillance, and interventions) in regions with endemic dracunculiasis (Gao, Kidal, Mopti, Segou, and Timbuktu) during January 2020–June 2021.

§ Imported from another country.

¶ Human cases are contained when all of the following criteria are met: 1) infected patients are identified ≤24 hours after worm emergence; 2) patients have not entered any water source since worm emergence; 3) a village volunteer/health care provider properly treats the lesion until all detectable worms are fully removed and educates the patient not to contaminate water sources; 4) the containment process is validated by a GWEP supervisor ≤7 days after worm emergence; and 5) all contaminated and potentially contaminated sources of drinking water are treated with temephos.

** Chad reported 833 animal cases in 2021. Ten animal cases were reported from Cameroon in 2021, all in villages along the Chad-Cameroon border; these are believed to have been acquired in Chad.

†† Imported from another in-country disease-endemic village.

§§ The denominator is number of villages with endemic human dracunculiasis during 2020–2021.

TABLE 2. Number of reported indigenous dracunculiasis cases, by country — worldwide, January 2020–June 2022

Country	No. (% contained)		% Change Jan–Dec 2020 to Jan–Dec 2021	No. (% contained)		% Change Jan–Jun 2021 to Jan–Jun 2022
	Jan–Dec 2020	Jan–Dec 2021		Jan–Jun 2021	Jan–Jun 2022	
Human cases						
Chad	12 (42)	8 (75)	−33	4 (75)	3 (33)	−25
Ethiopia	11 (100)	1 (100)	−91	1 (100)	0 (—)	−100
Mali*	1 (0)	2 (50)	100	0 (—)	0 (—)	NA
South Sudan	1 (100)	4 (25)	300	0 (—)	0 (—)	NA
Angola	1 (0)	0 (—)	−100	0 (—)	0 (—)	NA
Cameroon†	1 (100)	0 (—)	−100	0 (—)	0 (—)	NA
Total	**27 (67)**	**15 (60)**	**−44**	**5 (80)**	**3 (33)**	**−40**
Animal infections§						
Chad	1,571 (81)	833 (81)	−47	438 (79)	264 (71)	−40
Ethiopia	15 (73)	3 (67)	−80	0 (—)	0 (—)	NA
Mali	9 (56)	17 (59)	89	2 (100)	2 (100)	0
Cameroon†	6 (100)	10 (100)	67	10 (100)	26 (100)	160
South Sudan	0 (—)	0 (—)	NA	0 (—)	0 (—)	NA
Angola	0 (—)	0 (—)	NA	0 (—)	7 (0)	NA
Total	**1,601 (81)**	**863 (80)**	**−46**	**450 (80)**	**299 (72)**	**−34**

Abbreviations: GWEP = Guinea Worm Eradication Program; NA = not applicable.

* Civil unrest and insecurity since a coup d'état in 2012 continued to constrain GWEP operations (i.e., supervision, surveillance, and interventions) in regions with endemic dracunculiasis (Gao, Kidal, Mopti, Segou, and Timbuktu) during January 2020–June 2021.

† One human case, 38 infected dogs, and one cat were detected in an area of Cameroon near the border with Chad during January 2020–June 2022; these infections are believed to have been acquired in Chad.

§ In 2021, Chad reported infections in dogs and some cats; Ethiopia reported infections in dogs, cats, and baboons; and Mali reported infections in dogs and one cat; in 2020, Angola reported infections in dogs and Cameroon in dogs and one cat.

first 6 months of 2022, CDC received 12 animal specimens, 10 of which were laboratory-confirmed *D. medinensis*, compared with six confirmed among 36 specimens received during January–June 2021. Previous genetic studies confirmed that Guinea worms collected from both animals and humans are *D. medinensis* (*5*). This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.***

Country Reports

Angola. Details of the unexpected discovery of dracunculiasis in three persons during 2018–2020 who had no history of foreign travel and in one dog in 2019 have been described. During March 29, 2020–March 28, 2022, no cases among humans or dogs were detected during ongoing active surveillance in 61 villages and routine integrated case searches (e.g., during National Immunization Days); seven infected dogs were detected during March–May 2022 in the same province as the previous human cases and dog infections (Table 2). Angola offers cash reward equivalent to US$450 for reporting an infected human or animal. Genetic analysis of Angola's Guinea worm specimens did not help elucidate a source because no clear link to other previously analyzed *D. medinensis* was detected (*6*).

Chad. Chad reported eight human cases among eight villages in 2021 (Table 1). During the first half of 2022, Chad reported three human cases, compared with four human cases reported during January–June 2021. In 2021, Chad reported 833 animal infections (767 dogs and 66 cats), compared with 1,571 (1,508 dogs and 63 cats) reported in 2020 (Table 2). During January–June 2022, 43% fewer infected dogs (239) and 67% more infected cats (25) were reported compared with data from January–June 2021. In Chad, transmission of *D. medinensis* is hypothesized to have occurred from consumption of inadequately cooked fish, other aquatic transport hosts, or paratenic hosts (infected hosts in which the larval parasite does not develop) (*7*). As of June 2022, The Carter Center has been helping Chad's Ministry of Health in implementing village-based surveillance for animal and human infections in 2,438 at-risk villages, an increase of 80 villages compared with the 2,358 in December 2021 (Table 1). The active surveillance generated 41,135 rumored reports about possible Guinea worm infections among humans or dogs during January–June 2022, a 33% decline compared with 61,341 rumored reports during the same period in 2021.

Since 2010, Chad's Ministry of Health has offered a reward equivalent to US$100 for reporting a confirmed human dracunculiasis case. In addition, since 2013, Chad's GWEP implemented educational interventions to avoid transmission through fish or fish entrails. Reporting and tethering dogs with dracunculiasis-compatible signs started in 2014, and this intervention was enhanced in 2015 with a US$20 equivalent

*** 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 3. Characteristics of specimens from humans and animals received at CDC for laboratory diagnosis of *Dracunculus medinensis* — January 2021–June 2022

Characteristic	2021 Jan–Dec 2021	2021 Jan–Jun 2021	2021 Jul–Dec 2021	2022 Jan–Jun 2022
Human specimens				
Total no. received	**45**	**13**	**32**	**20**
No. (%) positive*	14[†] (31)	5 (38)	9[†] (28)	3[†] (15)
Country of origin, no. of positive specimens (no. of patients)				
Chad	7[†] (7)	4 (4)	3 (3)	3 (3)
Ethiopia	1 (1)	1 (1)	—[§]	—
Mali	2 (2)	—	2 (2)	—
South Sudan	4 (4)	—	4 (4)	—
No (%) negative*	31 (68)	8 (62)	23 (72)	17 (85)
Negative specimens, no. (%) of other laboratory identifications				
Onchocerca sp.	—	—	—	6 (35)
Free-living nematode[¶]	8 (26)	2 (25)	6 (26)	1 (6)
Other parasitic nematode**	2 (6)	—	2 (9)	1 (6)
Sparganum	5 (16)	3 (38)	2 (9)	3 (18)
Cestode (non-sparganum)	1 (3)	—	1 (4)	—
Annelid	2 (6)	—	2 (9)	—
Animal-origin tissue	9 (29)	2 (25)	7 (30)	4 (24)
Plant material	2 (6)	—	2 (4)	2 (12)
Unknown origin	2 (6)	1 (13)	1 (4)	—
Animal specimens				
Total no. received	**73**	**36**	**37**	**12**
No. (%) positive*	38 (52)	6 (17)	32 (86)	10 (83)
Positive specimens, country/species of origin, no. of specimens (no. of animals)				
Angola				
Dog	—	—	—	6 (6)
Cameroon				
Dog	10 (10)	—	10	—
Central African Republic				
Dog	1 (1)	1	—	—
Chad				
Cat	2 (2)	—	2	2 (2)
Dog	4 (4)	2	2	—
Other animals (wildcats)	2 (2)	1	1	—
Ethiopia				
Cat	1 (1)	—	1	—
Dog	2 (2)	—	2	—
Mali				
Cat	1 (1)	—	1	—
Dog	15 (15)	2	13	2 (2)
No. (%) negative specimens*,††	35 (48)**	30 (83)	5 (14)	2 (17)[§§]

* Positive specimens were confirmed as *D. medinensis*; negative specimens ruled out as *D. medinensis*.
† CDC received 15 specimens from human cases in 2022 and 14 in 2021. The remaining specimen received in February 2022 was from a human case in Chad.
§ Dashes indicate no specimens received.
¶ Free-living nematodes primarily included adult Mermithidae and other nematodes identified as belonging to nonparasitic taxa. Other parasitic nematodes included non-*Onchocerca* nematodes identified as belonging to parasitic taxa.
** Other parasitic nematodes submitted in association with human cases during January–December 2021 included one ascarid, a *Eustrongylides*-like nematode; in 2022, the one other parasitic nematode was ascarid.
†† The 35 negative specimens from animals were identified as follows: 24 Filaroidea from which three were *Setaria* sp., 12 were in the subfamily Dirofilariinae (e.g., *Dirofilaria*, *Skjrabinodera*), and nine were only identified at the superfamily level (Filarioidea); among the 11 remaining negative specimens five were free-living nematodes, two *Mastophorus* or *Protospirura*-like nematodes, one *Eustrongylides* sp., two were not identified past superfamily Spiruroidea, and one was a horsehair worm (*Nematomorpha*).
§§ One specimen was identified only at the superfamily level (Filarioidea), and the other was a nematode in the family Diplotriaenidae.

reward for reporting confirmed infected dogs. In 2017, the program initiated the systematic use of temephos, focusing on small ponds in villages with the most infected dogs, and launched a nationwide communication campaign to increase awareness about the reporting and prevention of Guinea worm infection. In March 2020, Chad launched a new strategy to tether all dogs proactively during the 4 months of peak dracunculiasis incidence in all villages with five or more dracunculiasis infections during the previous year, and is currently working to expand proactive tethering among all villages reporting one or more dog infections.

Since June 2017, monitoring and evaluation efforts have indicated that approximately 81% of households assessed monthly in at-risk communities were burying fish entrails to avoid consumption by dogs, and 81% and 70% of eligible dogs were tethered in 2021 and during January–June 2022, respectively. The decrease in tethering coverage reflects the expansion of the intervention in 2022 to include all villages with one or more infections compared with 2021 when only villages with three or more infections were included. Water treatment with temephos reached 61% of 348 villages with dog (340) or human (eight) infections by December 2021 and 68% of 82 villages by June 2022. In December 2021, 79% of villages reporting infections among dogs or humans had at least one source of copepod-free drinking water. In areas under surveillance in Chad, 92% of residents surveyed in 2021, and 70% of those surveyed during January–June 2022 were aware of the cash rewards for reporting human or animal infections. These additional actions might be favorably affecting the elimination of dracunculiasis, and these effects will continue to be assessed.

Cameroon. Cameroon reported 10 infected dogs in 2021 and 23 during January–June 2022 (Table 2) in an area <3 miles (5 km) from the Chad-Cameroon border. Investigations indicate that dogs were likely infected in Chad, because the affected villages include families that permanently live on both sides of the border, and owners of infected dogs reportedly took their dogs to Chad during the period when the dogs would have become infected.

Ethiopia. During 2021, Ethiopia reported one human case and three infected animals (two dogs and one cat); no human case or infected animal was reported during January–June 2022 (Table 2), and for the first time in 9 years, no infected baboons were detected during January 2021–June 2022. For the past several years, all animal infections and human cases have occurred in Gog district of Gambella Region. Since 2017, The Carter Center has supported Ethiopia's public health and wildlife authorities in a baboon and dog epidemiology project (*4*). Since 2021, the Ethiopia Dracunculiasis Eradication Program has conducted active surveillance of 198 villages and 201 nonvillage areas (e.g., commercial farms and temporary hunting settlements). The program applies temephos monthly to nearly all water sources known to have been used by humans in the at-risk area of Gog district. Beginning in 2022, remote sensing data from Maxar Technologies is identifying new water sources that need to be treated. Since April 2018, among villages in which infected animals were most commonly detected, Ethiopia has supported villager-initiated, constant tethering of approximately 1,900 dogs and cats to prevent their exposure to water sources in adjacent forests in which transmission apparently occurs (*4*). In 2018, Ethiopia increased its reward for reporting human dracunculiasis cases to an equivalent of US$360 and for reporting and tethering infected animals to US$40. In 2021, 92% of persons surveyed in active surveillance areas knew of the rewards; in January–May 2022, 96% were aware. In May 2022, the minister of health visited areas with endemic dracunculiasis to promote and support dracunculiasis eradication efforts.

Mali. Mali reported two human cases in 2021, and none during January–June 2022, compared with one case in 2020 and none during January–June 2021 (Table 2). In 2021, one infected cat and 16 infected dogs were reported, compared with nine dogs and no cats in 2020. During January–June 2022, Mali reported two confirmed infected dogs, the same number reported during January–June 2021. Among the 16 infected dogs identified in all of 2021, 10 were detected in Segou Region and six were detected in the adjacent Mopti Region. Segou Region is accessible to the program, but the dogs were bred and apparently became infected in areas of Mopti Region that have remained partly inaccessible to the program since 2012 because of civil unrest. The two infected dogs were detected and reportedly contained during January–June 2022 in Segou Region. In 2021 Mali had 2,216 villages under active surveillance (Table 1), with cash rewards equivalent to US$340 for reporting a human case and an equivalent of US$20 for reporting and tethering an infected animal. In areas under active surveillance in 2021, 90% of persons queried knew of the rewards for reporting an infected person or animal, and in January–June 2022, 92% and 81% knew of the rewards for reporting an infected person or animal, respectively. In addition, Mali introduced proactive tethering of some dogs late in 2021.

South Sudan. South Sudan reported four human cases in 2021, compared with one in 2020 (Table 2). No human cases or infected animals were reported during January–June 2021 or January–June 2022. Only one infected animal has ever been reported (in 2015), which belonged to a household in which a human infection had occurred. The high population mobility of cattle herders and others in South Sudan presents a special challenge, in addition to sporadic insecurity. By December 2021, South Sudan's GWEP had 2,174 villages under active surveillance (Table 1). The reward for reporting a case of dracunculiasis or an infected animal is approximately equivalent to US$75. A 2021 survey of residents found 84% of respondents knew of the reward for reporting an infected person.

Discussion

Stopping dracunculiasis transmission among dogs in Chad is now the principal challenge to the GWEP. During January 2021–June 2022, Chad reported 1,108 (94%) of the world's 1,177 *D. medinensis* infections, 1,059 (96%) of which were in dogs. In a pattern peculiar to Chad, Guinea worm infections there usually affect many dogs and few humans (*7*). This challenge is being addressed through innovative interventions and research supported by The Carter Center, WHO, and CDC. Also involved are multiple research institutions helping to understand the unusual epidemiology of dracunculiasis in the remaining affected countries and assessing antihelminthic treatment of dogs (*8*). Research from the University of Georgia indicated that fish could serve as transport hosts for *Dracunculus* spp. and that *D. medinensis* can use frogs as paratenic hosts.[†††] In addition, *Dracunculus* larvae have been recovered from multiple wild frogs in Chad (*9*,*10*). If the hypothesis that the parasite's life cycle in Chad involves a transport or paratenic host is correct (*10*), increased active surveillance, proactive tethering of dogs, temephos application, and fish entrail burial should reduce transmission. The reductions in human cases and infected dogs in Chad in January 2021–June 2022 suggests that these interventions are successful.

Adequate security is important to achieving eradication goals, especially in Mali and South Sudan. In 2021, Mali reported two human cases, whereas the endemic transmission of Guinea worm among dogs and cats appears to be geographically limited. In 2020, the program in Chad began working with ministry of health, regional, and local leaders in a Peace-Health Initiative to reduce insecurity in one district with endemic dracunculiasis and expanded to four districts in 2022. South Sudan is poised to achieve zero-case status soon as a result of strong technical leadership, strong governmental political support, and no known animal infections, highlighting the importance of maintaining adequate security.

Areas of transmission in Ethiopia and Angola are limited. In 2021, Ethiopia reported one human case, and animal infections appear to be geographically limited. The ecologic study of baboons and proactive tethering of dogs in Gog district might help clarify the dynamics of residual Guinea worm infections in Ethiopia and identified the likely sources of all four infections in 2021. Now Ethiopia appears close to interrupting transmission. In Angola, three confirmed human cases and seven infected dogs reported between 2018 and 2022 suggest that the problem in this country is limited, but active surveillance throughout the areas at risk, and appropriate control measures and investigations are still needed.

The identification of dracunculiasis cases in villages in Cameroon that border areas in Chad with endemic dracunculiasis highlights the risks for exportation and the need for ongoing active surveillance and appropriate control measures in neighboring countries (Cameroon and Central African Republic). The current prominence of infections in domestic dogs and cats requires increased measures to limit those animals' access to water sources for human consumption and waste from discarded fish and other aquatic animals.

With only 15 human cases identified in 2021 and three during January–June 2022, program efforts appear to be closer to reaching the goal of eradication. However, dog infections and impeded access because of civil unrest and insecurity in Mali and South Sudan continue to be the greatest challenges for the program.

Summary

What is already known about this topic?

Human cases of dracunculiasis (Guinea worm disease) have decreased from an estimated 3.5 million in 1986 to 15 in 2021. Emergence of Guinea worm infections in dogs in 2012 has complicated eradication efforts.

What is added by this report?

Fifteen cases in humans were reported in 2021 and three during January–June 2022. As of November 2022, dracunculiasis remained endemic in five countries (Angola, Chad, Ethiopia, Mali, and South Sudan).

What are the implications for public health practice?

With only 15 human cases identified in 2021 and three during January–June 2022, program efforts appear to be closer to reaching the goal of eradication. However, dog infections and impeded access because of civil unrest and insecurity in Mali and South Sudan continue to be the greatest challenges for the program.

Corresponding author: Vitaliano A. Cama, vec5@cdc.gov, 404-718-4131.

[1]The Carter Center, Atlanta, Georgia; [2]World Health Organization Collaborating Center for Dracunculiasis Eradication, Division of Parasitic Diseases and Malaria, Center for Global Health, CDC.

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

References

1. Ruiz-Tiben E, Hopkins DR. Dracunculiasis (Guinea worm disease) eradication. Adv Parasitol 2006;61:275–309. PMID:16735167 https://doi.org/10.1016/S0065-308X(05)61007-X
2. Hopkins DR, Weiss AJ, Roy SL, Yerian S, Cama VA. Progress toward global eradication of dracunculiasis—January 2020–June 2021. MMWR Morb Mortal Wkly Rep 2021;70:1527–33. PMID:34735420 https://doi.org/10.15585/mmwr.mm7044a1
3. Watts SJ. Dracunculiasis in Africa in 1986: its geographic extent, incidence, and at-risk population. Am J Trop Med Hyg 1987;37:119–25. PMID:2955710 https://doi.org/10.4269/ajtmh.1987.37.119
4. Hopkins DR, Weiss A, Torres-Velez FJ, Sapp SGH, Ijaz K. Dracunculiasis eradication: end-stage challenges. Am J Trop Med Hyg 2022;107:373–82. PMID:35895421 https://doi.org/10.4269/ajtmh.22-0197

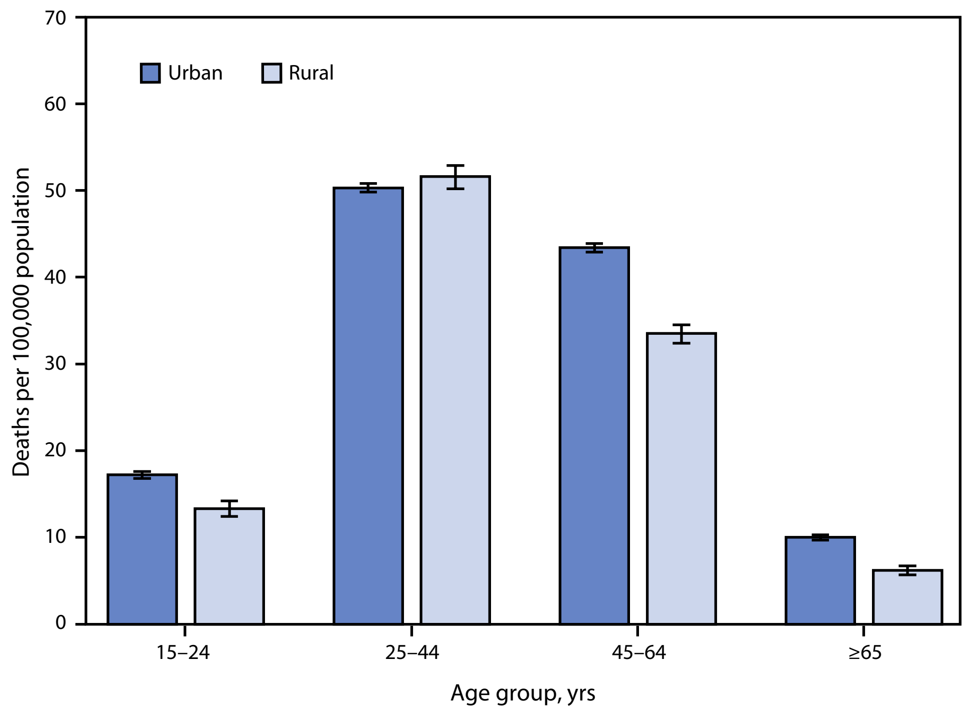
[†††] An intermediate host in which no parasite development occurs but which serves to maintain the viability of larval stages of a parasite.

5. Thiele EA, Eberhard ML, Cotton JA, et al. Population genetic analysis of Chadian Guinea worms reveals that human and non-human hosts share common parasite populations. PLoS Negl Trop Dis 2018;12:e0006747. PMID:30286084 https://doi.org/10.1371/journal.pntd.0006747
6. Durrant C, Thiele EA, Holroyd N, et al. Population genomic evidence that human and animal infections in Africa come from the same populations of *Dracunculus medinensis*. PLoS Negl Trop Dis 2020;14:e0008623. PMID:33253172 https://doi:10.1371/journal.pntd.0008623
7. Eberhard ML, Ruiz-Tiben E, Hopkins DR, et al. The peculiar epidemiology of dracunculiasis in Chad. Am J Trop Med Hyg 2014;90:61–70. PMID:24277785 https://doi.org/10.4269/ajtmh.13-0554
8. World Health Organization. Meeting of the International Task Force for Disease Eradication, October 2017. Wkly Epidemiol Rec 2018;93:33–8. PMID:29372633
9. Eberhard ML, Yabsley MJ, Zirimwabagabo H, et al. Possible role of fish and frogs as paratenic hosts of *Dracunculus medinensis*, Chad. Emerg Infect Dis 2016;22:1428–30. PMID:27434418 https://doi.org/10.3201/eid2208.160043
10. Cleveland CA, Eberhard ML, Thompson AT, et al. A search for tiny dragons (*Dracunculus medinensis* third-stage larvae) in aquatic animals in Chad, Africa. Sci Rep 2019;9:375. PMID:30675007 https://doi.org/10.1038/s41598-018-37567-7

QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Drug Overdose Death Rates* Among Persons Aged ≥15 Years, by Age Group and Urban-Rural Status† — National Vital Statistics System, United States, 2020



* Deaths per 100,000 population; 95% CIs indicated by error bars. Drug overdose deaths were identified using the *International Classification of Diseases, Tenth Revision* underlying cause-of-death codes X40–X44 (unintentional), X60–X64 (suicide), X85 (homicide), or Y10–Y14 (undetermined intent).

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

During 2020, death rates for drug overdose causes were higher in urban areas than in rural areas for those aged 15–24 years (17.2 compared with 13.3), 45–64 years (43.4 compared with 33.5), and ≥65 years (10.0 compared with 6.2). Among adults aged 25–44, drug overdose death rates were not significantly different between urban and rural areas (50.3 compared with 51.6). Drug overdose death rates were lower for adults aged ≥65 years compared with other age groups in both urban and rural areas.

Source: National Center for Health Statistics, National Vital Statistics System, Mortality Data, 2020 (https://www.cdc.gov/nchs/nvss/deaths.htm); CDC Wonder online database. https://wonder.cdc.gov/ucd-icd10.html

Reported by: Ellen A. Kramarow, PhD, ebk4@cdc.gov, 301-458-4325; Betzaida Tejada-Vera, MS.

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

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

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

All material in the MMWR Series is in the public domain and may be used and reprinted without permission; citation as to source, however, is appreciated.

MMWR and *Morbidity and Mortality Weekly Report* are service marks of the U.S. Department of Health and Human Services.

Use of trade names and commercial sources is for identification only and does not imply endorsement by the U.S. Department of Health and Human Services.

References to non-CDC sites on the Internet are provided as a service to *MMWR* readers and do not constitute or imply endorsement of these organizations or their programs by CDC or the U.S. Department of Health and Human Services. CDC is not responsible for the content of these sites. URL addresses listed in *MMWR* were current as of the date of publication.

ISSN: 0149-2195 (Print)