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Progress Toward Measles Elimination — World Health Organization Eastern Mediterranean Region, 2019–2022

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Abstract

In 2015, all 22 World Health Organization Eastern Mediterranean Region (EMR) countries and areas (countries) pledged to achieve measles elimination by 2020. Despite success in several countries, most countries in the region still have not eliminated measles. This report updates a previous report and describes progress toward measles elimination in EMR during 2019–2022. During that period, estimated regional coverage with the first and second doses of a measles-containing vaccine (MCV) was 82%–83% and 76%–78%, respectively. During 2019–2022, approximately 160 million children were vaccinated during national or subnational supplementary immunization activities. Reported confirmed regional measles incidence decreased from 29.8 cases per 1 million population in 2019 to 7.4 in 2020, but then increased 68%, to 50.0 in 2022 because of challenges providing immunization services and conducting surveillance during the COVID-19 pandemic. Surveillance indicators deteriorated in 11 (50%) of the 22 EMR countries. During 2019–2022, four countries in the region were verified as having achieved measles elimination, but other countries reported immunity gaps and increased measles incidence in 2022. To achieve measles elimination in EMR, national immunization programs, especially in those countries with high measles incidence, will need to continue to recover from the COVID-19 pandemic, increase overall vaccination coverage to close immunity gaps, and maintain high-quality disease surveillance.

Introduction

In 2020, the World Health Assembly and partners endorsed the Immunization Agenda 2030 (IA2030) (*1*), a new global vision and strategy aiming to reach underimmunized and unimmunized children. This strategy builds on lessons learned from the Global Vaccine Action Plan (*2*) and emphasizes measles incidence and vaccination coverage as critical monitoring indicators for improving immunization services and strengthening primary health care. It also highlights the importance of rigorous measles surveillance to document immunity gaps and achieve ≥95% coverage with 2 doses of measles- and rubella-containing vaccines. The 2021–2030 Global Measles and Rubella Strategic Framework (*3*) and the 2021–2023 Global Measles Outbreak Strategic Response Plan (*4*) are also aligned with IA2030 to achieve measles and rubella elimination. In 2015, all 22 countries and areas (countries) of the World Health Organization (WHO) Eastern Mediterranean Region (EMR) endorsed the 2016–2020 Eastern Mediterranean Vaccine Action Plan and implemented

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country-specific strategic plans to achieve measles elimination (*5*). This report updates a previous report (*6*), describes the current epidemiology of measles in the EMR, and outlines what will be needed to reach the goal of regional measles elimination.

Methods

Immunization Activities

Data on administrative vaccination coverage* with the first and second doses of measles-containing vaccine (MCV) are reported each year from all EMR countries to WHO and UNICEF through the Joint Reporting Form (*7*). WHO and UNICEF use reported administrative coverage and available survey results to generate annual estimates of vaccination coverage through routine immunization services. Supplementary immunization activities (SIAs)† are conducted in countries with low routine coverage and are an effective strategy for boosting population immunity. Data on SIAs are reported periodically by countries. SIA data and estimates of national and subnational vaccination coverage collected during 2019–2022 were reviewed for all EMR countries.

Summary

What is already known about this topic?

In 2015, all 22 countries and areas (countries) of the World Health Organization Eastern Mediterranean Region (EMR) pledged to achieve measles elimination by 2020. Despite success in several countries, most countries in the region still have not eliminated measles.

What is added by this report?

During 2019–2022, four EMR countries achieved measles elimination. However, regional coverage with the first and second measles vaccine doses remained at 82%–83% and 76%–78%, respectively, and surveillance performance deteriorated, in part because of effects of the COVID-19 pandemic. Annual regional measles incidence increased 68%, from 29.8 per 1 million population in 2019 to 50.0 in 2022.

What are implications for public health practice?

The regional measles elimination goal can be achieved through collaborative efforts to increase routine measles vaccination coverage, implement timely high-quality campaigns, and strengthen case-based surveillance.

Surveillance, Measles Incidence, and Measles Virus Genotypes

Case-based measles surveillance§ has been established in all EMR countries except Somalia. Case definitions for suspected

* Administrative vaccination coverage is the number of vaccine doses administered divided by the estimated target population.

† Two SIA approaches are used: 1) a nationwide catch-up SIA, targeting wide age groups to eliminate population susceptibility, and 2) periodic follow-up SIAs every 2–4 years, targeting all children born since the last SIA. The exact age range for follow-up SIAs depends on the age-specific measles incidence, coverage with routine MCV, and the interval since the last SIA.

§ Case-based measles surveillance includes individual case investigation and blood specimen collection for laboratory testing.

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measles include fever and rash, and measles cases are reported monthly using standardized reporting templates. Suspected measles cases are confirmed based on laboratory findings, an epidemiologic link to a confirmed case, or clinical criteria. All 22 national laboratories in the region provide serologic confirmation, and three perform genotyping of circulating viruses to facilitate monitoring of regional spread of measles virus genotypes (*8*). Sequence data are reported to the WHO global measles nucleotide surveillance database.¶ Case-based measles surveillance in EMR is monitored using seven important performance indicators**; four of these (timeliness and completeness of case investigations, adequacy of collection and testing of specimens, reporting of laboratory results within 4 days, and sensitivity of surveillance) are described in this report. Measles case data and surveillance performance indicators were summarized and analyzed descriptively. This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.††

Regional Verification of Measles Elimination

The EMR Verification Commission for Measles and Rubella Elimination was established in February 2018 to evaluate the status of measles elimination in EMR countries based on documentation submitted annually by national verification committees (*9*). Reports of the commission were reviewed for this report.

Results

Immunization Activities

Estimated regional coverage with a first MCV dose (MCV1) remained stable at 82%–83% during 2019–2022 (Table 1); however, these were the lowest coverage levels since 2008. Regional coverage with a second MCV dose (MCV2) increased from 76% in 2019 to 78% in 2022. The number of countries achieving ≥95% national 2-dose MCV coverage increased from eight (36%) in 2019 to ten (45%) in 2021 but declined to 2019 levels in 2022 (Table 2). Only four (18%) countries achieved ≥95% MCV2 coverage in all districts during 2019–2022. During this period, 160 million persons were vaccinated during 40 SIAs conducted in 16 countries, with a weighted regional SIA coverage of 97% (Supplementary Table, https://stacks.cdc.gov/view/cdc/147631).

Surveillance, Measles Incidence, and Measles Virus Genotypes

During 2019–2022, the number of EMR countries that met the national target for surveillance sensitivity (two or more suspected cases per 100,000 population discarded as non-measles and nonrubella) declined from 14 (64%) in 2019 to 11 (50%) in 2022 (Table 2). During 2019–2022, the number of countries that achieved the target for timely and complete investigation of suspected measles cases increased from five (23%) in 2019 to 10 (45%) in 2022. The number that met the target of adequate specimens collected for laboratory testing decreased from 21 (95%) in 2019 to 17 (77%) in 2022, and the number with laboratory results reported within 4 days of specimen receipt decreased from 12 (55%) in 2019 to eight (36%) in 2022.

In EMR, the number of reported measles cases decreased by two thirds (66%) from 22,549 in 2019 to 7,630 in 2020, but then more than doubled (121% increase) to 16,860 in 2021, and then further increased (133%) from 2021 to 39,266 in 2022 (Table 1) (Figure). The increase in measles cases during 2021–2022 occurred primarily because of outbreaks in Afghanistan, Pakistan, and Yemen. Annual regional measles incidence (cases per 1 million population) decreased 75%, from 29.8 in 2019 to 7.4 in 2020, but increased 30% to 9.6 in 2021 and further increased by 421% from 9.6 in 2021 to 50.0 in 2022. The number and percentage of countries reporting a measles incidence of ≥5 per million decreased from 12 (55%) in 2019 to five (23%) in 2021 but increased to nine (41%) in 2022 (Table 2). During 2019–2022, two circulating measles genotypes were detected among 1,345 specimens sequenced in EMR, including 1,298 (97%) of genotype B3 in 16 countries and 44 (3%) of genotype D8 in seven countries.

Regional Verification of Measles Elimination

The Verification Commission for Measles and Rubella Elimination convened four times during 2019–2022. By the end of 2019, three (14%) EMR countries (Bahrain, Iran, and Oman) were verified as having achieved measles elimination, and in 2021, Egypt was also verified. By the end of 2022, these four countries were confirmed to have maintained measles elimination (Bahrain, Iran, and Oman for 3 years, and Egypt for 1 year).

¶ https://who-gmrln.org/means2

** Important surveillance performance indicators monitored at the regional level include 1) reporting rate of discarded nonmeasles nonrubella cases at the national level (two cases per 100,000 population per year); 2) proportion of suspected measles and rubella cases that have had an adequate investigation initiated within 48 hours of notification (80% of suspected cases); 3) proportion of suspected cases with adequate specimens collected for detecting acute measles or rubella infection collected and tested in a proficient laboratory (80%); 4) proportion of specimens received at the laboratory within 5 days of collection (80%); 5) proportion of immunoglobulin M results reported to national public health authorities by the laboratory within 4 days of specimen receipt (80%); 6) proportion of laboratory-confirmed measles outbreaks with specimens adequate for detecting measles virus collected and tested in an accredited laboratory (80%); and 7) percentage of confirmed cases for which source of transmission is classified as endemic, imported, or importation-related (80%).

†† 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. Measles-containing vaccine vaccination schedule, estimated coverage with the first and second doses of measles-containing vaccine,* number of confirmed measles cases,† and confirmed measles incidence,§ by country or area — World Health Organization Eastern Mediterranean Region, 2019–2022

Country/Area	MCV schedule¶		2019			2020			2021			2022		
	First dose age, mos	Second dose age, mos	Coverage, %		No. of measles cases** (incidence)§	Coverage, %		No. of measles cases** (incidence)§	Coverage, %		No. of measles cases** (incidence)§	Coverage, %		No. of measles cases** (incidence)§
			MCV1	MCV2		MCV1	MCV2		MCV1	MCV2		MCV1	MCV2	
Total	—	—	**83**	**76**	**22,549 (29.8)**	**83**	**77**	**7,630 (7.4)**	**82**	**77**	**16,860 (9.6)**	**83**	**78**	**39,266 (50.0)**
Afghanistan	9	18	64	41	212 (6.6)	66	43	512 (14.0)	63	44	2,916 (74.4)	68	49	5,090 (123.8)
Bahrain	12	18	99	99	0 (—)	99	99	0 (—)	99	99	0 (—)	99	99	18 (—)
Djibouti	9	15	83	81	0 (NR)	62	60	0 (NR)	50	48	0 (NR)	50	48	182 (162.4)
Egypt	12	18	95	94	0 (—)	94	94	0 (—)	96	96	0 (—)	96	96	14 (—)
Iran	12	18	99	98	0 (—)	99	98	1 (—)	99	98	104 (1.3)	99	98	231 (0.3)
Iraq	9	15	82	86	3,619 (31.7)	76	94	312 (8.4)	75	83	15 (0.5)	88	97	36 (0.8)
Jordan††	12	18	87	93	45 (4.5)	76	90	0 (—)	76	90	2 (0.2)	76	90	21 (1.9)
Kuwait§§	12	24	97	94	12 (2.9)	95	94	0 (—)	94	94	4 (0.7)	99	94	7 (1.6)
Lebanon††	12	18	82	63	1,046 (182.2)	74	64	15 (2.6)	67	59	5 (0.7)	67	59	86 (15.7)
Libya	12	18	73	72	188 (27.0)	73	72	20 (2.9)	73	72	5 (2.0)	73	72	13 (1.9)
Morocco	9	18	99	99	12 (0.3)	99	99	5 (0.1)	99	99	0 (—)	99	99	2 (0.1)
Oman	12	18	99	99	0 (—)	99	99	0 (—)	99	99	0 (—)	97	98	5 (—)
Pakistan	9	15	81	74	2,066 (9.7)	83	77	2,732 (12.1)	81	79	7,040 (31.3)	82	79	7,068 (30.0)
Palestine	12	18	99	99	228 (48.5)	99	99	833 (177.0)	98	99	0 (—)	97	93	0 (—)
Qatar	12	18	99	98	5 (1.8)	90	88	3 (1.1)	99	99	0 (—)	99	99	18 (1.9)
Saudi Arabia††,§§	12	18	95	96	1,035 (31.8)	96	96	29 (0.9)	98	97	13 (2.5)	98	98	149 (4.1)
Somalia	9	15	46	NA¶¶	4,482 (322.3)	46	NA¶¶	2,518 (198.8)	46	4	746 (59.5)	46	8	805 (45.8)
Sudan	9	18	90	74	3,555 (76.6)	86	68	354 (7.6)	81	63	627 (15.1)	81	63	1,272 (27.1)
Syria	12	18	65	54	27 (1.1)	59	53	14 (0.6)	59	53	11 (0.6)	41	38	217 (9.8)
Tunisia	12	18	98	97	4,669 (407.9)	98	96	11 (1.0)	95	98	2 (0.1)	95	98	10 (0.8)
United Arab Emirates§§	12	18	99	94	186 (20.4)	99	92	49 (5.5)	99	96	29 (3.5)	98	91	98 (10.4)
Yemen	9	18	67	46	1,162 (42.4)	68	46	222 (8.1)	71	52	5,341 (142.3)	73	56	23,924 (710.0)

Abbreviations: MCV = measles-containing vaccine; MCV1 = first MCV dose; MCV2 = second MCV dose; NA = not applicable; NR = not reported; WHO = World Health Organization; WUENIC = WHO and UNICEF estimates of national immunization coverage.

* According to WUENIC. For MCV1, among children aged 1 year or, if MCV1 is given at age ≥1 year, among children aged 24 months. For MCV2, among children at the recommended age for administration of MCV2, per the national immunization schedule. The WUENIC were last revised on July 15, 2023. https://immunizationdata.who.int/index.html

† Includes cases confirmed by laboratory testing or epidemiologic linkage and clinically compatible cases. Clinically compatible cases met the WHO measles clinical case definition, had no adequate specimen collected, and could not be epidemiologically linked to a laboratory-confirmed case of measles.

§ Cases per 1 million population.

¶ MCV schedule is the 2022 schedule.

** Case totals based on WHO-UNICEF Joint Reporting Forms.

†† Additional 9-month dose provided nationally.

§§ Additional dose provided nationally at age 5–6 years (United Arab Emirates), 6 years (Saudi Arabia), or 12 years (Kuwait).

¶¶ Dose was not included in the vaccination schedule for that year.

Discussion

Despite the regional challenges, 11 (50%) of the 22 EMR countries are progressing toward measles elimination, and elimination has been verified in four (18%) countries. Important characteristics of these four countries include having health ministries committed to measles elimination, sustained high (≥95%) immunization coverage, and strong surveillance systems and laboratory support. An additional seven countries (Kuwait, Morocco, Palestine, Qatar, Saudi Arabia, Tunisia, and United Arab Emirates) are near elimination based on high measles immunization coverage, low measles incidence, and high-quality surveillance.

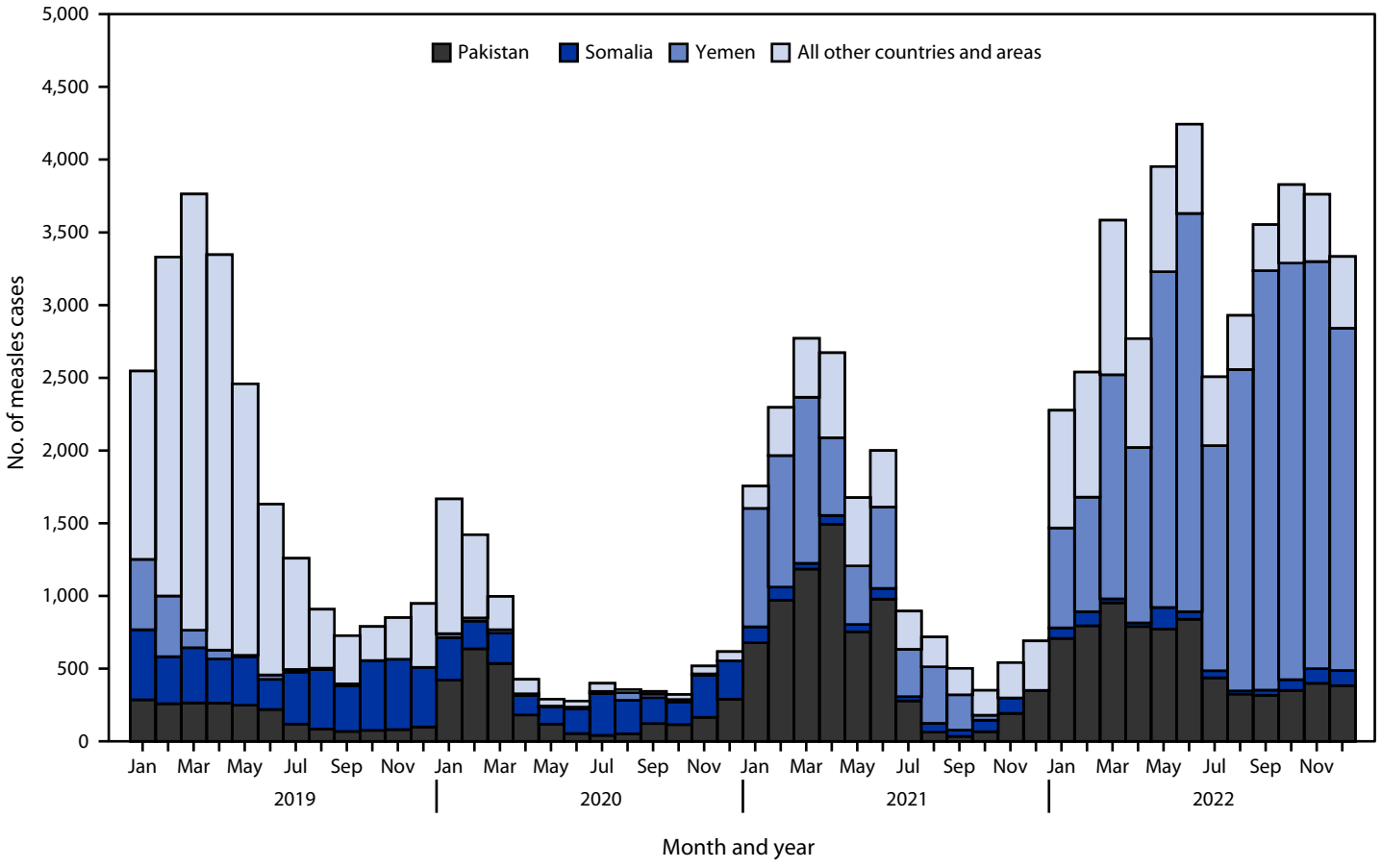
However, eleven (50%) EMR countries are experiencing conflicts or humanitarian crises that prevent immunization system strengthening and prioritization of measles elimination. These challenges have resulted in underperforming immunization programs, leading to measles immunity gaps. Of particular concern are undervaccinated children (those who have not received 2 MCV doses) and unvaccinated children (those who have not received any MCV or other vaccine doses). These children generally reside in hard-to-reach locations and experience conflict-related insecurity, misinformation, and underperforming vaccination campaigns. Communities with large numbers of undervaccinated and unvaccinated children are at increased risk for measles outbreaks and measles-related deaths.

TABLE 2. Countries and areas achieving measles immunization coverage, surveillance indicators, and incidence — World Health Organization Eastern Mediterranean Region, 2019–2022

Domain/Indicator	Indicator	Year, no. (%) of countries and areas meeting the indicator			
		2019	2020	2021	2022
Routine immunization performance					
National 2-dose MCV coverage	**≥95%**	8 (36)	7 (32)	10 (45)	8 (36)
Districts with ≥95% 2-dose MCV coverage (%)	**100%**	4 (18)	4 (18)	4 (18)	4 (18)
Surveillance quality					
Timeliness and completeness of suspected measles case investigation	**≥80%**	5 (23)	2 (9)	5 (23)	10 (45)
Percentage of suspected cases with adequate specimens collected, tested in a proficient laboratory	**≥80%**	21 (95)	21 (95)	14 (64)	17 (77)
Percentage of IgM laboratory results reported to national public health authorities within 4 days	**≥80%**	12 (55)	12 (55)	11 (50)	8 (36)
Annualized discarded (nonmeasles) case rate per 100,000 population	**≥2**	14 (64)	9 (41)	8 (36)	11 (50)
Endemic measles incidence*	**0**	3 (14)	5 (23)	6 (27)	5 (23)
	>0 and <5	7 (32)	9 (41)	11 (50)	8 (36)
	≥5	12 (55)	8 (36)	5 (23)	9 (41)

Abbreviations: IgM = immunoglobulin M; MCV = measles-containing vaccine.
* Cases per 1 million population.

FIGURE. Confirmed measles cases,* by month and year of rash onset — World Health Organization Eastern Mediterranean Region, 2019–2022



Abbreviation: WHO = World Health Organization.
* Confirmed and clinically compatible measles cases reported to WHO by countries and areas. A case of measles was laboratory-confirmed when measles-specific immunoglobulin M antibodies were detected in serum, or measles-specific RNA was detected by polymerase chain reaction testing in a person who was not vaccinated during the 30 days before rash onset. A case of measles lacked serologic confirmation but was confirmed by epidemiologic linkage when linked in time and place to a case of laboratory-confirmed measles. During 2013–2019, a case of measles meeting the WHO case definition but without a specimen collected could be reported as clinically compatible.

Among countries with fragile health systems and measles immunity gaps, increasing MCV1 and MCV2 coverage and conducting high-quality SIAs with a focus on reaching populations at high risk, particularly those living in areas with civil strife, are needed. A strong global partnership is needed to work together to build measles immunity and prevent measles mortality through routine immunization services and preventive SIAs. Conducting preventive SIAs in areas with complex humanitarian emergencies, however, requires strong coordination among global and local partners and stakeholders in all facets of vaccination campaigns for these SIAs to be successful.

In addition, conducting surveillance in areas with political instability, insecurity, and a complex operating environment is challenging. This challenge is often compounded by the absence of strong data systems that prevent efficient reporting, analysis, and use of data for action. As a result, responses to outbreaks might not be timely and effective. Further, poor immunization and surveillance data quality in many countries hamper their ability to assess measles immunity gaps and plan timely campaigns to prevent outbreaks. Overcoming these challenges will require partnerships and support at global, national, and local levels to optimize surveillance and ensure rapid detection and response to measles cases and outbreaks.

Limitations

The findings in this report are subject to at least three limitations. First, administrative coverage might be inaccurate because data quality and consistency vary substantially among different countries. Second, measles cases might be underestimated because not all measles patients seek health care, not all cases are reported or investigated, and measles surveillance quality varies among countries. Finally, this report did not consider measles mortality because few EMR countries monitored or reported measles-related deaths.

Implications for Public Health Practice

Measles cases increased in EMR after the COVID-19 pandemic because of inadequate vaccination coverage, resulting in widening of immunity gaps, and declining measles surveillance performance. Routine measles vaccination activities and SIA implementation need to continue or increase in those countries, and efforts to conduct timely case-based surveillance and laboratory testing need to resume. Supporting countries with fragile health systems and reaching undervaccinated and unvaccinated children with ≥2 MCV doses are critical to achieving regional measles elimination.

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Outbreak of *Mycobacterium orygis* in a Shipment of Cynomolgus Macaques Imported from Southeast Asia — United States, February–May 2023

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Abstract

Nonhuman primates (NHP) can become infected with the same species of *Mycobacteria* that cause human tuberculosis. All NHP imported into the United States are quarantined and screened for tuberculosis; no confirmed cases of tuberculosis were diagnosed among NHP during CDC-mandated quarantine during 2013–2020. In February 2023, an outbreak of tuberculosis caused by *Mycobacterium orygis* was detected in a group of 540 cynomolgus macaques (*Macaca fascicularis*) imported to the United States from Southeast Asia for research purposes. Although the initial exposure to *M. orygis* is believed to have occurred before the macaques arrived in the United States, infected macaques were first detected during CDC-mandated quarantine. CDC collaborated with the importer and U.S. Department of Agriculture's National Veterinary Services Laboratories in the investigation and public health response. A total of 26 macaques received positive test results for *M. orygis* by culture, but rigorous occupational safety protocols implemented during transport and at the quarantine facility prevented cases among caretakers in the United States. Although the zoonotic disease risk to the general population remains low, this outbreak underscores the importance of CDC's regulatory oversight of NHP importation and adherence to established biosafety protocols to protect the health of the United States research animal population and the persons who interact with them.

Introduction

CDC regulates nonhuman primate (NHP) importation and quarantine under the Public Health Service Act (42 U.S. Code 264). All NHP entering the United States must be imported by CDC-registered facilities and are required to undergo quarantine and tuberculosis testing under 42 Code of Federal Regulations Section 71.53. Imported NHP must have at least three negative tuberculin skin tests (TSTs) using mammalian old tuberculin injected intradermally into the eyelid at a minimum of 2-week intervals before being released from CDC-mandated quarantine. Importers are required to submit samples from any NHP that dies or is euthanized during quarantine and is suspected to have tuberculosis for confirmatory culture. During 2013–2020, 19 imported NHP (0.009% of all NHP imported during this period) received a positive tuberculin skin test result; none had culture-confirmed tuberculosis during the quarantine period.

Sources of NHP imported for research changed markedly during the COVID-19 pandemic: whereas 60% of NHP imported in 2019 came from China, by 2021, imports from China had ceased completely, and 65% of imported NHP originated in Southeast Asia.*

In January 2023, a shipment of 540 captive-bred cynomolgus macaques (*Macaca fascicularis*) was imported by air to the United States from Southeast Asia for research purposes. The macaques were quarantined at a CDC-approved facility, where they were housed in multiple quarantine rooms, each of which had a separate air handling system that maintained manometer-verified negative air pressure relative to the anteroom or hallway. Disinfection protocols for transport and quarantine included the use of a U.S. Environmental Protection Agency-registered tuberculocidal product. Regulations require that transporters and quarantine facility staff members who come within 5 feet (1.52 m) of NHP wear specific personal protective equipment, including a fit-tested, National Institute for Occupational Safety and Health–Approved N95 filtering facepiece respirator or higher-level respirator (42 U.S. Code 71.73). CDC-registered importers must have an occupational health program that includes medical clearance, respirator fit testing and training, and tuberculosis screening at least annually. This report describes the investigation of and response to a positive TST reaction in a macaque, identified on February 7, 2023.

Investigation and Results

Identification of *Mycobacterium orygis*

On February 7, 2023, the importer notified CDC of a macaque with a positive TST reaction. The macaque was humanely euthanized, and the carcass underwent postmortem examination, including sample collection for histopathologic and microbiologic testing. Histopathology findings, including acid-fast staining, were consistent with mycobacterial infection, and samples were submitted to U.S. Department of

* https://www.cdc.gov/importation/bringing-an-animal-into-the-united-states/monkeys.html

Agriculture's National Veterinary Services Laboratories (NVSL) for mycobacterial polymerase chain reaction (PCR) testing and culture. PCR testing (*1*) of lung tissue and tracheobronchial lymph nodes for *Mycobacterium tuberculosis* complex (MTBC) was positive; however, because this assay has not been validated for NHP, this finding was not considered confirmatory. The case was confirmed when culture and whole-genome sequencing (WGS) conducted at NVSL later identified the presence of *Mycobacterium orygis*, a species of MTBC that is believed to be most frequently found among humans and animals in South Asia (*2*). WGS and analysis were performed according to methods published in 2021 (*3*), using *M. tuberculosis* H37Rv as the reference. This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.[†]

Additional Cases Among Macaques

In accordance with CDC regulations, the remaining macaques were required to undergo extended quarantine and have at least five additional negative TST results at a minimum of 2-week intervals. On February 21, the importer notified CDC of eight additional macaques with positive TST reactions. Based on preliminary postmortem diagnostics, seven animals were considered to have suspected tuberculosis (Box); all seven were later confirmed to be infected with *M. orygis*, based on culture results of affected tissues and WGS.

Macaques with positive TSTs were reported until May 30; a total of 32 macaques received a positive TST result during the outbreak (Table). All animals with a positive TST result were humanely euthanized and had samples submitted for postmortem testing, including histopathology with acid-fast staining, MTBC PCR, culture and, when applicable, WGS. Histopathology was performed by a commercial pathology laboratory, and the remaining tests were performed at NVSL. A total of 26 macaques (4.8% of the shipment) received a positive MTBC culture during the outbreak, including 24 (75%) of 32 with a positive TST result and two of 508 (0.4%) with a negative TST result. All isolates were confirmed to be *M. orygis* and shared a common ancestor, which had acquired 85 single nucleotide polymorphisms since the most common ancestor in the NVSL database. Starting early in the outbreak, the importer submitted blood samples from TST-positive macaques to a private laboratory for experimental interferon-gamma release assay (IGRA) testing. In early April, all remaining macaques in the cohort were tested with IGRA, which revealed one positive and four indeterminate results. Two macaques (one positive and one indeterminate) were confirmed by postmortem examination to be culture-positive for *M. orygis*. Overall, macaques receiving positive culture results were identified from 67% of quarantine rooms. The remaining macaques in the cohort were released from quarantine on August 8, 2023, all having received the required five negative TST results after the last TST-positive macaque was removed from the cohort.

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

BOX. Tuberculosis case definitions for nonhuman primates undergoing diagnostic testing after a positive tuberculin skin test reaction or positive or indeterminate interferon-gamma release assay test result — United States, January–August 2023

Confirmed*
- Positive MTBC culture result

Suspected†
- Negative or pending culture result, and
  - Acid-fast bacteria on histopathology, or
  - Positive MTBC PCR test result

Negative
- No acid-fast bacteria on histopathology, and
- Negative MTBC PCR, and
- Negative MTBC culture

Abbreviations: CFR = code of federal regulations; MTBC = *Mycobacterium tuberculosis* complex; NHP = nonhuman primate; PCR = polymerase chain reaction.

* NHP import regulation (42 CFR 71.53). https://www.ecfr.gov/current/title-42/chapter-I/subchapter-F/part-71/subpart-F/section-71.53

† Includes diagnostic tests that are considered confirmatory in humans but are not specifically mentioned in the import regulation.

Public Health Response

After the importer reported multiple positive TST results and confirmed evidence of active tuberculosis in the first animal with a positive TST, CDC informed the state health department and initiated a human exposure risk assessment. Because of administrative and engineering controls and personal protective equipment required during transport and quarantine, risk for exposure among transporter and quarantine facility staff members was presumed to be low. However, in accordance with CDC regulations, all staff members who worked in affected rooms were required to undergo tuberculosis screening at more frequent intervals after the identification of culture-positive NHP. As of February 2024 (8 months after the last positive macaque was detected), none of these persons has received a positive TST or IGRA test result.

CDC notified the airline and airport staff members and transporters that NHP in the shipment had tested positive for tuberculosis and recommended they contact their health care providers for a risk assessment to determine whether follow-up monitoring was recommended. CDC also recommended that

TABLE. Tuberculosis testing results* among cynomolgus macaques imported from Southeast Asia (N = 540) — United States, January–August 2023

Skin test result	No. of animals (%)†
Positive tuberculin skin test result (n = 32; 6%)	
Positive IGRA	22 (69)
Acid-fast bacteria on histopathology	23 (72)
Positive MTBC PCR	20 (63)
Positive MTBC culture	24 (75)
Negative tuberculin skin test result (n = 508; 94%)	
Positive/Indeterminate IGRA	5 (1.0)
Acid-fast bacteria on histopathology	1 (0.2)
Positive MTBC PCR	2 (0.4)
Positive MTBC culture	2 (0.4)

Abbreviations: IGRA = interferon-gamma release assay; MTBC = *Mycobacterium tuberculosis* complex; PCR = polymerase chain reaction.

* If multiple tissues were tested, the animal was considered to have received a positive test result if at least one tissue tested positive.

† Percentages of positive tuberculin skin test results calculated among 32 animals with positive tuberculin skin test results; percentages of negative skin test results calculated among 508 animals with negative tuberculin skin test results.

the importer notify recipients of NHP after their release from quarantine about the potential risk for tuberculosis exposure, because tuberculosis can have a long incubation period, and TSTs are subject to false-negative results. A veterinary health alert was distributed in July 2023 to relevant professional organizations, including the Association of Primate Veterinarians, National Association of Animal Health Officials, the National Association of State Public Health Veterinarians, and all CDC-registered NHP importers. CDC also developed a fact sheet about tuberculosis among NHP (CDC, unpublished data, 2023) and distributed it with the veterinary health alert. To date, human infection has not been reported in the United States in connection with this outbreak. No information was available about the tuberculosis status of workers at the supplier facility in Southeast Asia.

Discussion

Preventing outbreaks of tuberculosis in NHP facilities is important to protect the health of workers and animals and to avoid affecting research outcomes. NHP research facilities in the United States typically have routine tuberculosis screening programs for their employees to reduce the risk for tuberculosis spread to and from their facilities. However, in many cases, it might not be possible to confirm that foreign suppliers follow similar protocols. Because macaques from multiple quarantine rooms were affected, and the isolates were genetically close by phylogenetic analysis, the group is presumed to have been infected from a common human or animal source before importation. This presumption is supported by the fact that the isolate was identified as *M. orygis*, a species of MTBC that has been detected primarily in South Asia (*2*).

Summary

What is already known about this topic?

Because nonhuman primates (NHP) can become infected with the same species of *Mycobacteria* that cause human tuberculosis, all NHP imported into the United States are quarantined and screened for tuberculosis. During 2013–2020, no confirmed cases of tuberculosis were diagnosed among NHP during CDC-mandated quarantine.

What is added by this report?

During February–May 2023, *Mycobacterium orygis* was detected during CDC quarantine among 26 cynomolgus macaques from a shipment of 540 imported from Southeast Asia. No associated human cases were identified.

What are the implications for public health?

Although the zoonotic disease risk to the general population remains low, this outbreak demonstrated the importance of regulatory oversight of NHP importation to prevent the introduction of infectious diseases and protect the health of facility staff members.

M. orygis was identified as a separate species of MTBC in 2012 (*4*), and its epidemiology remains poorly understood. *M. orygis* infection has been reported both in humans (*5*) and animals; animal cases have mostly been in ungulates (*6*,*7*), but there has been one report in two captive, wild-caught NHP housed at a zoo (*6*). Most reported cases have had a known connection to South Asia. The prevalence of *M. orygis* in this region is unknown but is suspected to be higher than was previously recognized because common diagnostic tests might not differentiate it from other MTBC species (*2*).

This outbreak highlights the importance of public health oversight for imported NHP. Although current surveillance methods successfully detected this outbreak, tuberculosis screening among NHP can be challenging. The clinical presentation of tuberculosis among NHP varies widely, from asymptomatic infection to acute fulminant and chronic disease (*8*). TST using mammalian old tuberculin is an important component of current import surveillance, but it is an imperfect test, subject to both false-positive and false-negative results (*8*). A testing protocol that incorporates multiple different tests has been suggested as a potential way to improve sensitivity and specificity (*9*,*10*) but, to date, no such protocol has been validated. Rigorous occupational safety and health programs based on the hierarchy of controls (i.e., elimination, substitution, engineering controls, administrative controls, and personal protective equipment)§ will remain critical to protect NHP workers, especially those who have close contact with imported NHP. In this outbreak, meticulous adherence to regulations by

§ https://www.cdc.gov/niosh/topics/hierarchy/default.html

the importer and a strong public-private partnership between the importer and CDC might have prevented human cases of tuberculosis.

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Notes from the Field

Reemergence of *Mycoplasma pneumoniae* Infections in Children and Adolescents After the COVID-19 Pandemic, United States, 2018–2024

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Mycoplasma pneumoniae is a common cause of respiratory infections, particularly in school-aged children. Most infections display as a mild respiratory illness sometimes referred to as "walking pneumonia." However, some persons experience severe pneumonia and require hospitalization. Significant cyclical increases in *M. pneumoniae* infections have been observed every 3–5 years, likely because of changes in the predominant circulating strain (*1*). *M. pneumoniae* infections are typically treated using macrolide antibiotics. Macrolide resistance varies globally, with the highest resistance prevalence (>90%) in Asia (*2*). After implementation of nonpharmaceutical interventions in response to COVID-19, the frequency of identified *M. pneumoniae* infections substantially declined beginning in 2020 (*3*). This pattern was also observed for other respiratory pathogens. Beginning in the fall of 2023, China and other countries identified a reemergence of this bacterium (*2*,*4*).

Using data from CDC's National Syndromic Surveillance Program (NSSP),* the percentage of *M. pneumoniae*–related diagnoses among all pneumonia emergency department visits were compared before, during, and after the COVID-19 pandemic. Data from the New Vaccine Surveillance Network (NVSN)† were analyzed to compare the percentage of positive *M. pneumoniae* laboratory test results in the United States during the same periods. During September 2023–January 2024, 14 *M. pneumoniae*–positive specimens collected at four NVSN sites were sent to CDC for molecular testing to identify common genetic changes that confer macrolide resistance. This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.§

Investigation and Outcomes

NSSP includes *International Classification of Diseases, Tenth Revision* (ICD-10) diagnostic codes from more than 6,500 emergency departments (ED) and urgent care facilities located in all 50 states, the District of Columbia, and Guam. For this analysis, data from NSSP were restricted to ED visits by children and adolescents. NVSN conducts prospective, active, population-based surveillance among children and adolescents for acute respiratory illness¶ at seven U.S. pediatric medical centers. All children enrolled in NVSN from four sites received *M. pneumoniae*–inclusive multi-pathogen panel testing, and enrollees from the other three sites had *M. pneumoniae* test results included if conducted for diagnostic purposes. Three periods were defined and analyzed: January 2018–April 2020 (prepandemic period), May 2020–August 2023 (pandemic period), and September 2023–December 2023 (postpandemic period).

NSSP data** were searched for ED visits with a diagnosis of pneumonia†† with *M. pneumoniae*–related diagnostic

* https://www.cdc.gov/nssp/overview.html
† https://www.cdc.gov/surveillance/nvsn/index.html

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

¶ Acute respiratory illness is defined as the occurrence of one or more of the following symptoms during a defined period before the enrollment encounter (<14 days during January 2018–October 2022 or ≤10 days during November 2022–December 2023): fever, cough, earache, nasal congestion, runny nose, sore throat, vomiting after coughing, wheezing, shortness of breath, rapid or shallow breathing, apnea, apparent life-threatening event, or brief resolved unexplained event.

** NSSP emergency department data come from a substantial percentage of emergency departments in the United States. However, the number of facilities sharing data has changed over time. To reduce the potential impact of changes in reporting patterns, analyses were restricted to facilities consistently reporting an average weekly informative discharge diagnosis of ≥75% and with a coefficient of variation ≤40. Among all emergency departments sending data to CDC, 46% consistently reported more complete data and had at least one pneumonia emergency department visit during 2018–2023.

†† Influenza due to identified novel influenza A virus with pneumonia (J09.X1); influenza due to other identified influenza virus with pneumonia (J10.00–01, J10.08); influenza due to unidentified influenza virus with pneumonia (J11.00, J11.08); viral pneumonia, not elsewhere classified (J12.0–.3, J12.8–.9); pneumonia due to *Streptococcus pneumoniae* (J13); pneumonia due to *Haemophilus influenzae* (J14); bacterial pneumonia, not elsewhere classified (J15.0–9); pneumonia due to other infectious organisms, not elsewhere classified (J16.0, J16.8); pneumonia in diseases classified elsewhere (J78); J18.0 bronchopneumonia, unspecified organism (J18.0–2; J18.8–.9); acute respiratory distress syndrome (J80); Legionnaires disease (A48.1); and acute bronchitis due to *Mycoplasma pneumoniae* (J20.0).

Summary

What is already known about this topic?

Mycoplasma pneumoniae is a common cause of mild respiratory illness, though severe infection can lead to pneumonia. Resistance to macrolides, the recommended treatment, is widespread in Asia though uncommon in the United States. *M. pneumoniae* infections decreased globally during the COVID-19 pandemic.

What is added by this report?

Data from the National Syndromic Surveillance Program and the New Vaccine Surveillance Network showed an increase in *M. pneumoniae* in the United States beginning in fall 2023, though below prepandemic levels.

What are the implications for public health practice?

Providers might consider *M. pneumoniae* during fall and winter respiratory illness seasons. Macrolides remain the first-line treatment for *M. pneumoniae* infections in the United States.

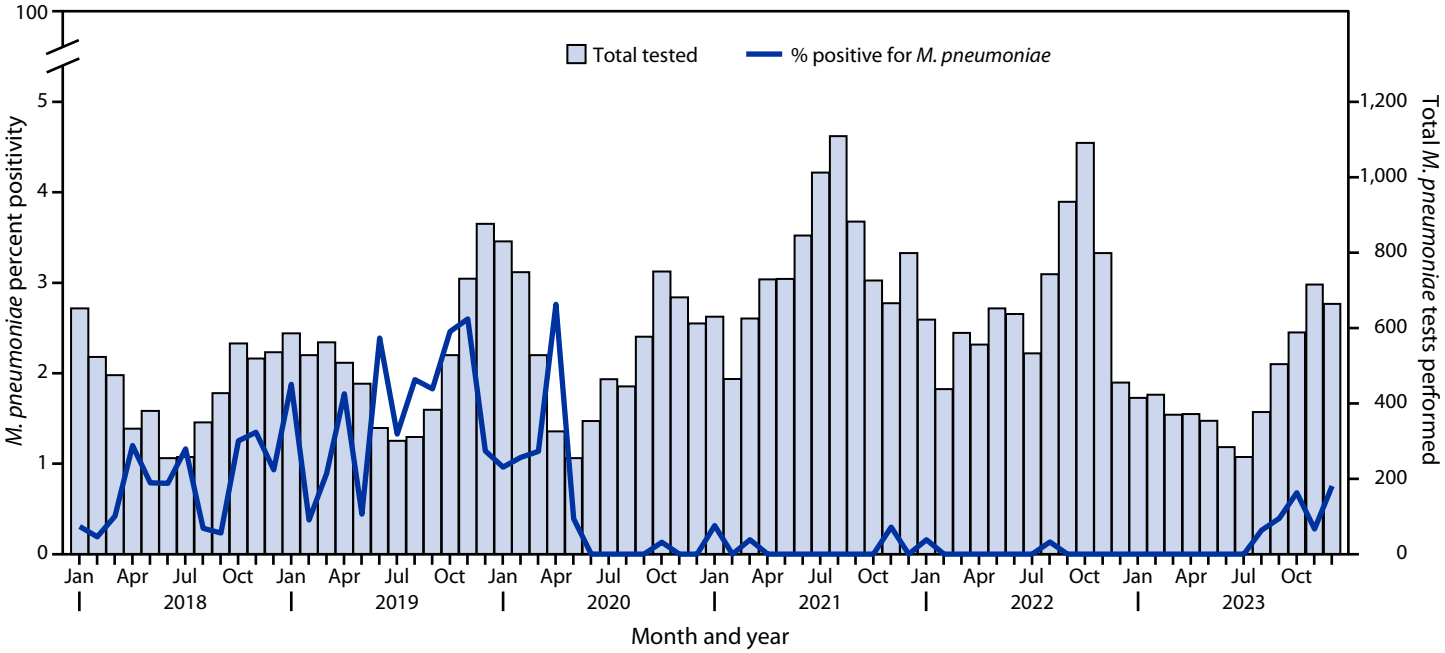
codes (ICD-10 J15.7 and J20.0[§§]). The percentage of *M. pneumoniae*–related diagnoses among pneumonia ED visits reported in NSSP decreased from 1.15% (4,681 of 407,514) during the prepandemic period to 0.35% (1,233 of 355,508) during the pandemic period and then increased to 0.89% (597 of 66,736) during the postpandemic period. Similarly, the percentage of test results within the NVSN network that were positive for *M. pneumoniae* decreased from 1.2% (165 of 13,800) during the prepandemic period to 0.04% (10 of 24,256) during the pandemic period and then increased to 0.53% (13 of 2,470) during the postpandemic period (Figure). Fourteen *M. pneumoniae*–positive specimens collected at four NVSN sites during September 2023–January 2024 were sent to CDC for macrolide resistance testing. Among 14 specimens, 13 were determined to be susceptible to macrolides.

[§§] J.15.7: Pneumonia due to *Mycoplasma pneumoniae*; J20.0: acute bronchitis due to *Mycoplasma pneumoniae*.

Preliminary Conclusions and Actions

Data collected by NSSP and NVSN demonstrate that the percentage of *M. pneumoniae* diagnoses and positive *M. pneumoniae* test results decreased during the COVID-19 pandemic. The percentage of diagnoses and positive test results have increased since September 2023 but remain below prepandemic levels. Among the small number of specimens available for testing, resistance to macrolides was uncommon. This report highlights the need for continued surveillance for *M. pneumoniae* infections and macrolide-resistant *M. pneumoniae* in the United States. Providers should consider *M. pneumoniae* as part of the differential diagnosis for cases of community-acquired pneumonia during fall and winter respiratory illness seasons. Despite ongoing concerns regarding antimicrobial resistance, macrolides remain the recommended first-line treatment for *M. pneumoniae* infections in the United States (*5*).

FIGURE. Monthly number of *Mycoplasma pneumoniae* tests performed and percentage of positive test results among children and adolescents with acute respiratory illness — four sites, New Vaccine Surveillance Network, 2018–2023



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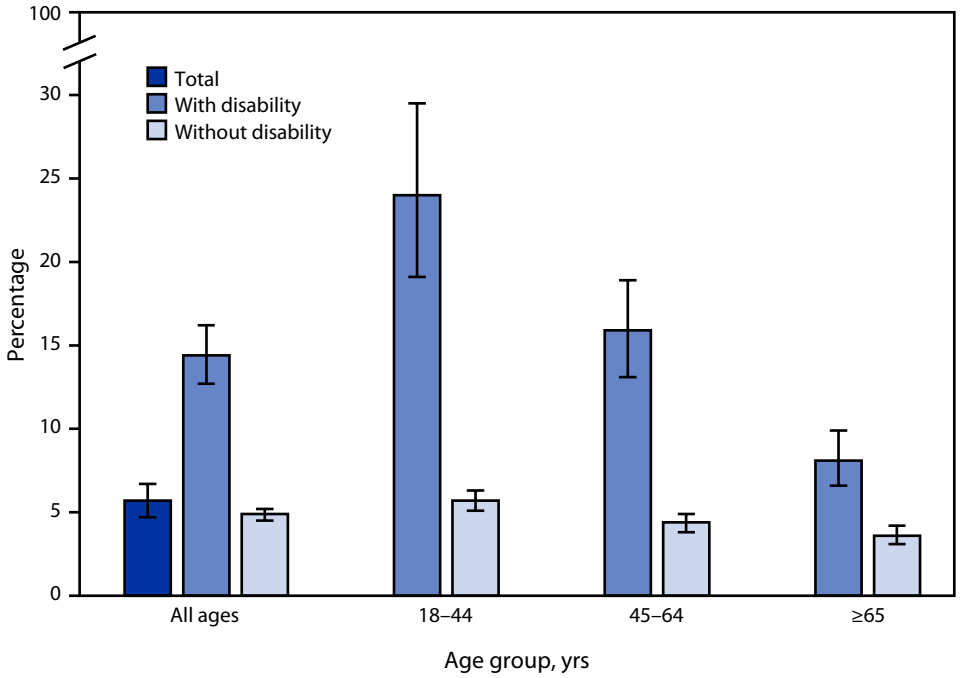
QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Percentage* of Adults Aged ≥18 Years Who Lacked Reliable Transportation for Daily Living in the Past 12 Months,† by Disability Status§ and Age Group — National Health Interview Survey, United States, 2022¶



* With 95% CIs indicated by error bars.
† Based on a response of "yes" to the question, "In the past 12 months, has a lack of reliable transportation kept you from medical appointments, meetings, work, or from getting things you needed for daily living?"
§ Disability was defined by the reported level of difficulty in response to questions about six domains of functioning: "Do you have any difficulty… seeing, even if wearing glasses; hearing, even if wearing hearing aids; walking or climbing stairs; communicating, for example understanding or being understood; remembering or concentrating; and self-care, such as washing all over or dressing." Response categories were "no difficulty," "some difficulty," "a lot of difficulty," or "cannot do at all." Adults who responded "a lot of difficulty" or "cannot do at all" to at least one domain were classified with disability.
¶ Estimates are based on household interviews of a sample of the civilian, noninstitutionalized U.S. population.

In 2022, 5.7% of adults aged ≥18 years lacked reliable transportation for daily living in the past 12 months. The percentage lacking reliable transportation for daily living among those with disability was higher (14.4%) compared with those without disability (4.9%). The percentages among persons with disability were higher than percentages among those without disability in all age groups (18–44 years: 24.0% versus 5.7%; 45–64 years: 15.9% versus 4.4%; and ≥65 years: 8.1% versus 3.6%). Regardless of disability status, the percentage of adults who lacked reliable transportation for daily living decreased with increasing age.

Source: National Center for Health Statistics, National Health Interview Survey, 2022. https://www.cdc.gov/nchs/nhis/index.htm

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