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Extreme Heat Exposure: Access and Barriers to Cooling Centers — Maricopa and Yuma Counties, Arizona, 2010–2020

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Extreme heat exposure increases the risk for heat-related illnesses (HRIs) and deaths, and comprehensive strategies to prevent HRIs are increasingly important in a warming climate (*1*). An estimated 702 HRI-associated deaths and 67,512 HRI-associated emergency department visits occur in the United States each year (*2*,*3*). In 2020, Phoenix and Yuma, Arizona, experienced a record 145 and 148 days, respectively, of temperatures >100°F (37.8°C), and a record 522 heat-related deaths occurred in the state. HRIs are preventable through individual and community-based strategies*,†; cooling centers,§ typically air-conditioned or cooled buildings designated as sites to provide respite and safety during extreme heat, have been established in Maricopa and Yuma counties to reduce HRIs among at-risk populations, such as older adults. This analysis examined trends in HRIs by age during 2010–2020 for Maricopa and Yuma counties and data from a survey of older adults related to cooling center availability and use in Yuma County during 2018–2019. Data from CDC's Social Vulnerability Index (SVI) were also used to overlay cooling center locations with SVI scores. During 2010–2020, heat days, defined as days with an excessive heat warning issued by

* Individual and community-based prevention strategies are enhanced when they include comprehensive approaches to address the structural and social conditions that influence health disparities. The Vital Conditions for Health and Well-Being Framework outlines seven essential domains to consider in a comprehensive health prevention strategy: humane housing, reliable transportation, meaningful work and wealth, lifelong learning, basic needs for health and safety, belonging and civic muscle (e.g., public participation and collaboration), and thriving natural world. A person or community has a greater likelihood of increasing heat resilience and protect against elevated risk for heat-related mortality or morbidity when they are able to experience the optimal conditions for all of these domains.

† Arizona Department of Health Services and Yuma and Maricopa counties have deployed several strategies to reduce HRI inequities. Yuma County survey data helped identify priority areas for new cooling center locations posted as an online map and those that might be improved through SVI overlays. Bilingual fact sheets on HRI and resources on social services to check on neighbors not using air conditioning were posted to the Yuma County website. Public service announcements on cooling centers were aired on the county's public television channel. Maricopa County Department of Public Health, which has contributed substantial findings to the body of evidence on cooling center usage from past evaluations, is planning a cooling center evaluation for 2023 that will help provide additional evidence to reduce barriers to cooling center use and help with choosing appropriate adaptive strategies. https://adhsgis.maps.arcgis.com/apps/webappviewer/index.html?id=2e12ca8b1d6540f0ae8de41e93936efb; https://www.yumacountyaz.gov/government/health-district/divisions/emergency-preparedness-program/hot-news-how-you-can-prepare-for-the-heat; https://doi.org/10.1175/WCAS-D-16-0033.1

§ Cooling centers might be a government-owned building such as a library or school, an existing community, religious, or recreation center, or a private business such as a coffee shop, shopping mall, or movie theater.

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the National Weather Service Phoenix Office,[¶] for any part of Maricopa and Yuma counties (*4*), increased in both Maricopa County (1.18 days per year) and Yuma County (1.71 days per year) on average. Adults aged ≥65 years had higher rates of HRI hospitalization compared with those aged <65 years. In a survey of 39 adults aged ≥65 years in Yuma County, 44% reported recent HRI symptoms, and 18% reported electricity cost always or sometimes constrained their use of air conditioning. Barriers to cooling center access among older adults include awareness of location and transportation. Collaboration among diverse community sectors and health profession education programs is important to better prepare for rising heat exposure and HRIs. States and communities can implement adaptation and evaluation strategies to mitigate and assess heat risk, such as the use of cooling centers to protect communities disproportionately affected by HRI during periods of high temperatures.

Hospital discharge records for Maricopa and Yuma counties, excluding U.S. Department of Defense, Veterans' Affairs, and Indian Health Service facilities, were used to identify HRI-associated inpatient admissions (hospitalizations) during 2010–2020. HRI hospitalizations were defined as those in an Arizona resident during months when HRIs are most often observed (May–September) with one or more codes related to excessive natural heat or sunlight exposure in primary or other diagnoses from the *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) (992, E900.0, and E900.9) or *International Classification of Diseases, Tenth Revision, Clinical Modification* (ICD-10-CM) (T67, X30, and X32).[**] Data were assessed for adults aged ≥65 and <65 years and presented as inpatient admissions per 100,000 population within each cohort. The two age groups were compared using rate ratios. Heat days were summarized by annual average trends assessed using linear regression. Data were analyzed using SAS (version 9.4; SAS Institute).

Yuma County cooling center evaluation data from the Arizona Department of Health Services' Climate-Ready States and Cities Initiative implemented during the summers of 2018 and 2019 were used to evaluate risk perception and awareness of resources among older adults (*5*). A survey was conducted among participants in the Yuma Regional Medical Center Silver Care Program, attendees of an Aging Well Resource Fair, the Senior Nutrition Center, the Cocopah

[¶] Excessive heat warnings are an adaptive measure of heat risk sensitive to daytime and overnight temperature and humidity relative to normal conditions for a locality at that time of year, the duration of heat, and whether temperatures are at levels that pose elevated risks of heat-related health effects. The criteria used to define heat warnings by the local weather forecasting office is continually refined to better reflect risk and protect health. Declared excessive heat warnings are used in this analysis to reflect existing conditions at the time of declaration, which informed heat response. https://www.weather.gov/psr/Heat

[**] Data were prepared using data standards established by the Environmental Public Health Tracking Program for Heat Stress Hospitalizations. Visits were defined using ICD-9-CM codes for inpatient admissions during January 2010–September 2015 and ICD-10-CM codes for inpatient admissions during October 2015–December 2020. The diagnostic codes were used to search the 25 diagnoses fields and six external cause-of-injury fields contained within each discharge record. Visits where E900.1 (man-made source of heat) or W92 (exposure to excessive man-made source of heat) listed anywhere in the discharge record were excluded.

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Indian Tribe, and the Yuma County website and Facebook page. The Institutional Review Board at Arizona State University reviewed, approved, and deemed this protocol nonresearch (evaluation). This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[††]

Maricopa County cooling center data were collected from the Maricopa Association of Governments and include only cooling centers that were part of the Heat Relief Regional Network; cooling centers established as part of the COVID-19 response were not included. The presence of cooling centers in areas where persons were at higher risk for HRI was analyzed using the SVI, recalculated in R (version 4.1.2; R Foundation) at the census tract scale, and overlaid with cooling center locations in Maricopa and Yuma counties (*6*). Census tracts in the top 25% of SVI scores within each county were considered highly vulnerable. The total number of cooling centers in 2019 was compared with that in 2020.

During 2010–2020, the number of heat days increased by an average of 1.18 per year in Maricopa County and 1.71 per year in Yuma County (Figure). Persons aged ≥65 years in both counties were at higher risk for HRI-related hospitalizations than those aged <65 years. In Maricopa and Yuma counties, the average rate ratios comparing hospitalizations among persons aged ≥65 years with those among persons aged <65 years were 2.31 (range = 1.83–2.97) and 2.72 (range = 1.46–4.02), respectively. Adults aged <65 years in Maricopa and Yuma counties experienced an average increase in the HRI-related hospitalization rate of 0.36 and 0.27 per 100,000 population, respectively, each year, compared with 0.26 and 0.76 for adults aged ≥65 years. During 2019–2020, HRI hospitalization rates among adults aged ≥65 years and <65 years increased from 18.56 to 21.04 and from 8.15 to 11.52, respectively, in Maricopa County; in Yuma County, rates in these age groups decreased from 30.11 to 23.00 and from 7.50 to 6.32, respectively.

In surveys that included a total of 39 residents aged ≥65 years in Yuma County, 36% were male, and 69% were White persons. Overall, 26% of respondents felt their health was endangered on very hot days, and 15% always or sometimes felt too hot at home (Table). Overall, 44% of respondents reported experiencing heat-related medical symptoms during the last year. Respondents also indicated challenges ensuring reliable air conditioning at home, with 18% reporting that the cost of electricity always or sometimes prevented the use of air conditioning. In addition, devices not working, cost of repairs, and confusing technology were reported as limiting factors in air conditioning use. Overall, 54% of respondents indicated they knew what a cooling center was, and 36% knew of cooling center locations in their area. Additional limitations to cooling center use included transportation and inability to bring pets. Alternative options, such as libraries, restaurants, and friend or family homes, were listed as locations to seek cooling.

In both 2019 and 2020, approximately one half of cooling centers in Maricopa County (54.3% and 48.1%, respectively) were in an area with high social vulnerability. In Yuma County, 60.0% and 83.3% of cooling centers were in high social vulnerability areas in 2019 and 2020, respectively.

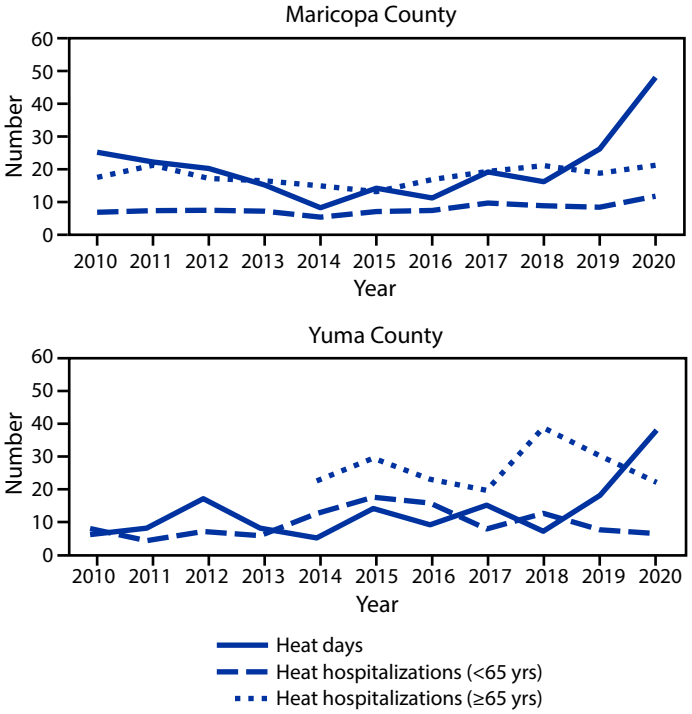
Discussion

Increasing HRIs in Arizona are consistent with higher temperatures observed during 2010–2020, although other social factors have likely influenced this trend. Older adults in Yuma County have reported heat-related medical symptoms and feeling that their health was in danger during hot weather. HRIs disproportionately affect populations at higher risk for heat impact, including those experiencing homelessness, nonnative English speakers or those with limited communication, those with limited financial resources, outdoor workers, communities of color, those with mental health disability or chronic medical conditions, those without access to air conditioning, older adults, and children; several of these groups were included in the CDC SVI (*7*).

Rising heat exposure and HRIs observed in Arizona are not limited to the Southwest region. Extreme heat is a growing problem nationally because heat waves have increased

[††] 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.

FIGURE. Number of heat days* and heat-related inpatient hospitalizations, by age group — Maricopa and Yuma counties, Arizona, 2010–2020



* Days with an excessive heat warning issued by the National Weather Service, Phoenix Office, for any part of Maricopa and Yuma counties.

TABLE. Experiences related to severe heat and characteristics related to cooling center use among persons aged ≥65 years (N = 39) — Yuma County, Arizona, 2018–2019

Experiences related to severe heat	No. (%)
Medical symptoms related to heat*	
Yes	17 (44)
No	20 (51)
Not answered	2 (5)
Frequency of feeling too hot in home†	
Always or sometimes	6 (15)
Rarely or never	29 (74)
Not answered	4 (10)
Feel health in danger during very hot days§	
Yes	10 (26)
No	25 (64)
Not answered	4 (10)
Characteristics related to cooling center use	
Know what a cooling center is¶	
Yes	21 (54)
No	18 (46)
Know where a cooling center is**	
Yes	14 (36)
No	25 (64)
Ever visited a cooling center††	
Yes	3 (8)
No	19 (49)
Not answered	17 (44)
Electricity costs prevent keeping home cool§§	
Always or sometimes	7 (18)
Rarely or never	28 (72)
Not answered	4 (10)

* Assessed using the question, "During the past year, have you had medical symptoms related to heat? For example, muscle cramps, dizziness, tiredness, weakness, throbbing headache, nausea or vomiting, fainting, or paleness?"
† Assessed using the question, "In the summer, how frequently do you feel too hot inside your home?"
§ Assessed using the question, "On very hot days do you ever feel your health is in danger?"
¶ Assessed using the question, "Do you know what a cooling center is?"
** Assessed using the question, "Do you know where cooling centers are located in your area?"
†† Assessed using the question, "Have you ever visited a cooling center in Yuma County?"
§§ Assessed using the question, "How often does the cost of electricity prevent you from keeping your home cool?"

in intensity, duration, and frequency in recent decades (*8*). Higher urban temperatures might enhance the risk for HRIs among urban residents because of urban heat islands, in which concentrations of pavement, buildings, and other surfaces that absorb and retain heat elevate ambient temperatures in cities by up to 22°F (12.2°C) (*9*). The disproportionate impact of heat on older adults has been observed previously, including in the 2021 Pacific Northwest heat wave (*10*).

Cooling centers might be a useful strategy to reduce heat exposure when access to air conditioning is limited. In a warming climate, cities and towns can use cooling centers to provide relief from extreme heat as part of a comprehensive heat response strategy. However, several barriers inhibit cooling center use, including the inability to bring pets and limited access by public transportation. To improve access, public health departments can enhance communication campaigns to increase awareness of benefits and locations of cooling centers and open cooling centers in locations of high social vulnerability. Cooling center managers can increase hours of operation and provide multilingual communications materials. Local jurisdictions can also extend cooling center access in locations such as libraries or enhance public-private partnerships with businesses to expand access during extreme heat events. More research is needed to determine the optimal amount of time spent in a cooling center relative to home temperature to achieve health-related benefits.[§§,¶¶]

The findings in this report are subject to at least four limitations. First, analysis by more discrete age and demographic groups was not possible in Yuma County because of data suppression limitations (i.e., health privacy concerns and any group with fewer than six hospitalizations per year). Second, a small convenience sample was used for the survey, which limits generalizability. Third, the number of cooling centers overlaid with SVI data was taken as a snapshot in time from a single data source that did not include centers opened as part of the pandemic response. Finally, the survey only assessed cooling centers, which are one of many factors that can help reduce HRIs. For example, the Arizona Corporation Commission implemented a temporary ban on power shutoffs to help maintain air conditioning access during the summers of 2019 and 2020.

Summary

What is already known about this topic?

Exposure to excessive heat is an increasing threat in a warming climate. Some groups, including older adults, are disproportionately affected by heat exposure.

What is added by this report?

Heat exposure and heat-related illness (HRI) increased in Maricopa and Yuma counties, Arizona, during 2010–2020. Heat-related hospitalizations were higher among adults aged ≥65 years than those aged <65 years. Barriers to cooling center access among older adults include awareness of location and transportation.

What are the implications for public health practice?

States and communities can implement adaptation and evaluation strategies to mitigate and assess heat risk, such as the use of cooling centers to protect communities disproportionately affected by HRI during periods of high temperatures.

§§ Cooling center best practices including COVID-19 precautions. https://www.cdc.gov/climateandhealth/docs/UseOfCoolingCenters.pdf
¶¶ COVID-19 and cooling centers. https://www.cdc.gov/coronavirus/2019-ncov/php/cooling-center.html

Collaboration among diverse community sectors and health profession education programs is important to better prepare for rising heat exposure and HRIs. A comprehensive system of heat mitigation planning and response through both behavioral and infrastructural interventions can improve heat resilience and protect communities disproportionately affected by HRI during periods of high temperatures.

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Genetic Characterization of Novel Oral Polio Vaccine Type 2 Viruses During Initial Use Phase Under Emergency Use Listing — Worldwide, March–October 2021

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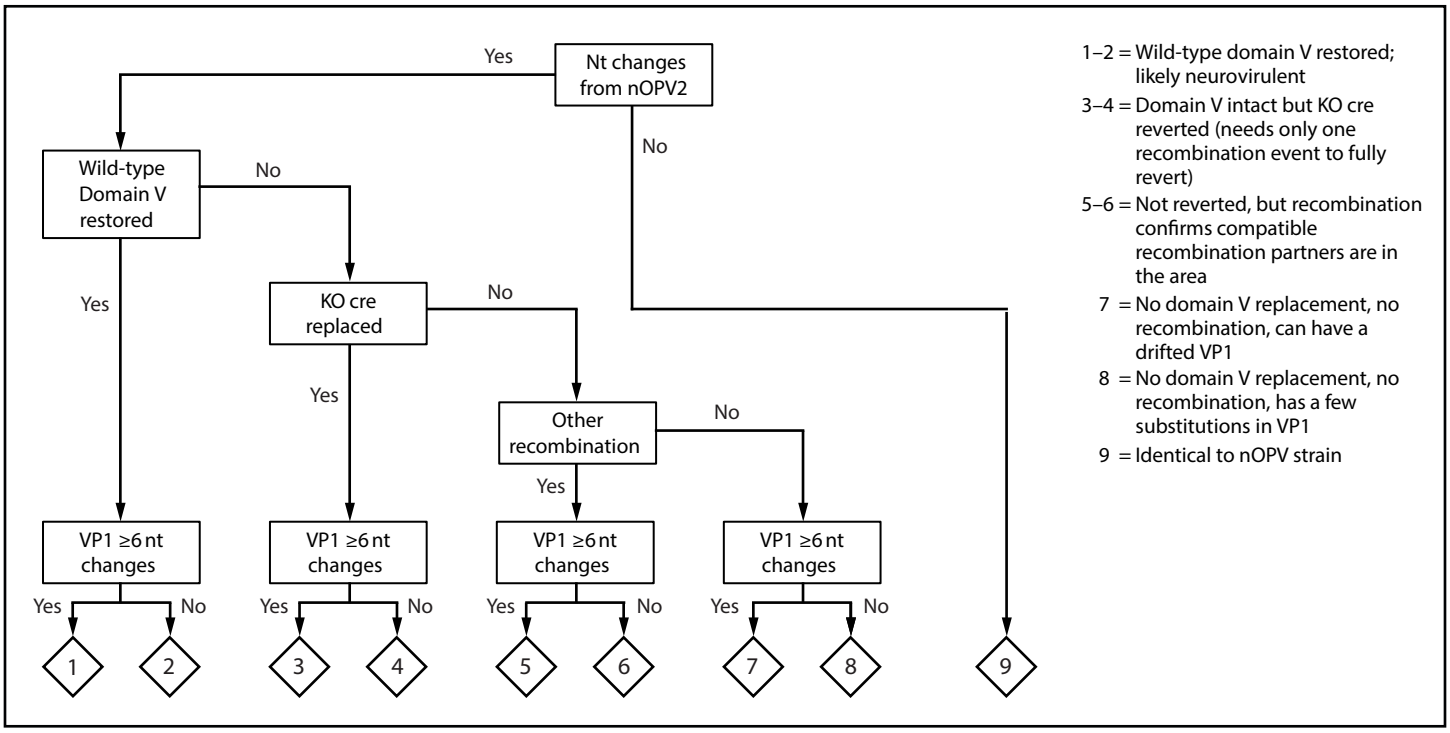
The emergence and international spread of neurovirulent circulating vaccine-derived polioviruses (cVDPVs) across multiple countries in Africa and Asia in recent years pose a major challenge to the goal of eradicating all forms of polioviruses. Approximately 90% of all cVDPV outbreaks are caused by the type 2 strain of the Sabin vaccine, an oral live, attenuated vaccine; cVDPV outbreaks typically occur in areas of persistently low immunization coverage (*1*). A novel type 2 oral poliovirus vaccine (nOPV2), produced by genetic modification of the type 2 Sabin vaccine virus genome (*2*), was developed and evaluated through phase I and phase II clinical trials during 2017–2019. nOPV2 was demonstrated to be safe and well-tolerated, have noninferior immunogenicity, and have superior genetic stability compared with Sabin monovalent type 2 (as measured by preservation of the primary attenuation site [domain V in the 5' noncoding region] and significantly lower neurovirulence of fecally shed vaccine virus in transgenic mice) (*3–5*). These findings indicate that nOPV2 could be an important tool in reducing the risk for generating vaccine-derived polioviruses (VDPVs) and the risk for vaccine-associated paralytic poliomyelitis cases. Based on the favorable preclinical and clinical data, and the public health emergency of international concern generated by ongoing endemic wild poliovirus transmission and cVDPV type 2 outbreaks, the World Health Organization authorized nOPV2 for use under the Emergency Use Listing (EUL) pathway in November 2020, allowing for its first use for outbreak response in March 2021 (*6*). As required by the EUL process, among other EUL obligations, an extensive plan was developed and deployed for obtaining and monitoring nOPV2 isolates detected during acute flaccid paralysis (AFP) surveillance, environmental surveillance, adverse events after immunization surveillance, and targeted surveillance for adverse events of special interest (i.e., prespecified events that have the potential to be causally associated with the vaccine product), during outbreak response, as well as through planned field studies. Under this monitoring framework, data generated from whole-genome sequencing of nOPV2 isolates, alongside other virologic data for isolates from AFP and environmental surveillance systems, are reviewed by the genetic characterization subgroup of an nOPV working group of the Global Polio Eradication Initiative. Global nOPV2 genomic surveillance during March–October 2021 confirmed genetic stability of the primary attenuating site. Sequence data generated through this unprecedented global effort confirm the genetic stability of nOPV2 relative to Sabin 2 and suggest that nOPV2 will be an important tool in the eradication of poliomyelitis. nOPV2 surveillance should continue for the duration of the EUL.

Approximately 111 million doses of nOPV2 were administered worldwide during the initial use phase (March–October 2021). During this period, 128 nOPV2 isolates were detected from stool specimens collected as part of routine AFP surveillance from six countries, and 123 nOPV2 isolates corresponding to 39 distinct environmental surveillance samples were detected from seven countries. Whole-genome sequences were generated for these 251 nOPV2 cell-culture isolates.* Intervals from nOPV2 supplementary immunization activity (SIA) to sample collection ranged from zero to 81 days for AFP samples (mean = 12.5 days; median = 7 days) and from 4 to 67 days for environmental surveillance samples (mean = 22.8; median = 16). Each nOPV2 isolate sequence was compared with that of the nOPV2 vaccine strain (GenBank ID MZ245455), and isolates were classified into one of nine categories, based on their risk profile and loss of key attenuating nOPV2 mutations (Figure 1). Among the 251 isolates, 32 (13%) were classified as category 9 (no changes from nOPV2), and 213 (85%) were classified as category 8, showing no reverting mutations in domain V, no recombination, and 0–5 VP1 substitutions. In addition, six isolates were shown to be recombinant between nOPV2 and Sabin 1 or unidentified species C enteroviruses, with crossover points located in the P3 genomic region (classified as category 6). None of the isolates had changes in the primary attenuation site (domain V) that would be predicted to increase neurovirulence (i.e., no changes that strengthen the stability of the secondary structure of the RNA base-pairing [stem]). The most frequent mutations were noted at nucleotide positions that have been shown or inferred to slightly decrease attenuation when present individually (Supplementary Figure, URL https://stacks.cdc.gov/view/cdc/118054). Individual genomes contained from zero to five of these mutations in different combinations (Table). In some cases, second-site mutations compensating for

* Sequences deposited in GenBank.

FIGURE 1. Classification of novel oral poliovirus vaccine isolates into nine categories* based on genome sequence composition — worldwide, March–October 2021



Abbreviations: KO cre = knockout of cis-acting replication element; nOPV2 = novel oral poliovirus vaccine type 2; nt = nucleotide; VP1 = viral capsid protein 1.
* Category groups are ranked according to level of concern based on expected neurovirulence, with 1 being the highest and 9 being the lowest.

the effect of such mutations were observed. The number of mutations increased with time after corresponding SIA campaigns (*7*–*9*) (Figure 2). A higher frequency of mutations reducing attenuation was observed in nOPV2 isolates from environmental surveillance samples than from AFP isolates. None of these excreted viruses has been tested for neurovirulence using the polio transgenic mouse model, but most are similar to viruses evaluated during fecal shedding in clinical trials, which showed no evidence for reversion in the primary attenuation site (*3*). In addition, molecular clones constructed to contain increasing numbers of the observed variants have thus far failed to demonstrate neurovirulence similar to or higher than that of Sabin 2 with the A481G reversion alone in transgenic mice, which is observed almost universally within 14 days of replication in Sabin OPV2 recipients (*3*,*5*,*10*) (Andrew Macadam, PhD, et al., National Institute for Biological Standards and Control, personal communication, April 2022).

In addition to nOPV2 isolates, whole-genome sequences of 331 cVDPV2 isolates from outbreaks in countries geographically associated with nOPV2 use were determined. None was found to contain any of the three nOPV2-specific nucleotides in the capsid-coding region at positions 814, 817, and 1,375, suggesting that none of the cVDPV2 isolates sequenced represented an nOPV2-derived recombinant virus.

Discussion

The most consequential risks known to be associated with use of live attenuated Sabin OPVs include the emergence of VDPVs resulting from reversion to neurovirulence, circulation of the vaccine strain in certain population settings, and the rare cases of vaccine-associated paralytic poliomyelitis in vaccine recipients or their close contacts. Since 2016, after cessation of routine use of type 2-containing OPV, the risk for seeding cVDPV2 emergence and spread with use of monovalent Sabin OPV2 in response to cVDPV2 outbreaks in areas of low background immunity has been a concern (*1*). Although nOPV2 is not expected to eliminate these risks from a biologic perspective, a primary goal of nOPV2 development and deployment was to substantially reduce the risks. Data from preclinical, phase I, and phase II studies with nOPV2 demonstrated the superior genetic stability of the primary attenuating site compared with Sabin OPV2 (*3*,*4*). However, given the complexity of evolution of live viruses, interplay with host and environmental factors, and the rarity of some of the outcome indicators of genetic and phenotypic stability, large-scale nOPV2 use in immunization campaigns and corresponding monitoring of genetic stability of isolates from the field presented unique opportunities to further augment

TABLE. Number of novel oral polio virus vaccine type 2 isolates with different combinations of mutations affecting attenuation of the virus — worldwide, March–October 2021

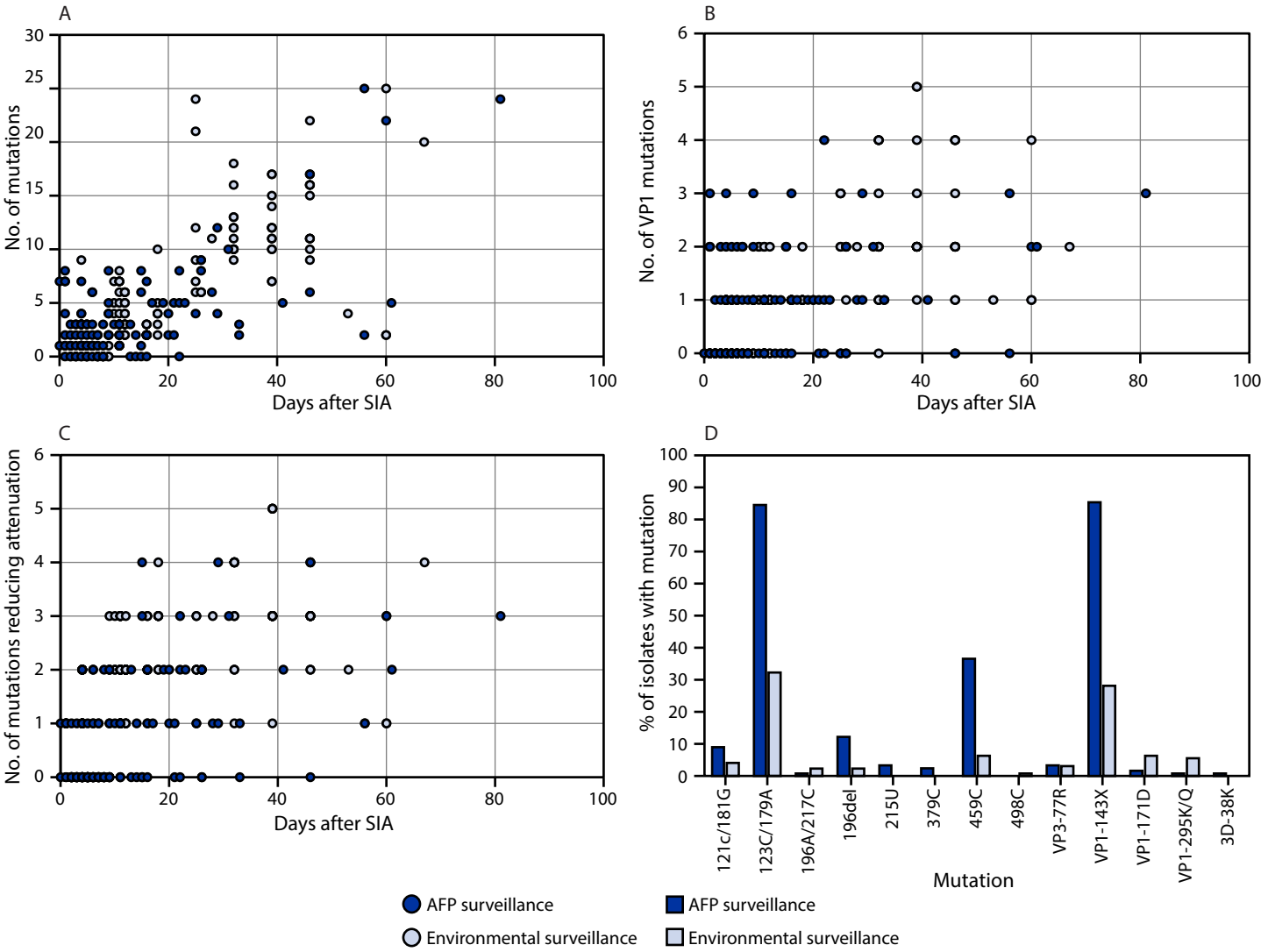
No. of mutations	No. of isolates	C121U	U123C	G179A	A181G	196A	196del	A215U	U217C	U379C	U459C	U498C	A2969G VP1-I143V	U2970X VP1-I143T,S, and N	A3053G VP1-N171D	G6159A 3D-R38K
1	2	C121U	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	14	—	U123C	—	—	—	—	—	—	—	—	—	—	—	—	—
	6	—	—	G179A	—	—	—	—	—	—	—	—	—	—	—	—
	2	—	—	—	—	—	196del	—	—	—	—	—	—	—	—	—
	1	—	—	—	—	—	—	—	—	—	U459C	—	—	—	—	—
	23	—	—	—	—	—	—	—	—	—	—	—	—	U2970X	—	—
	5*	—	—	—	—	—	—	—	—	—	—	—	—	—	A3053G	—
2	8	—	U123C	—	—	—	—	—	—	—	—	—	A2969G	—	—	—
	42†	—	U123C	—	—	—	—	—	—	—	—	—	—	U2970X	—	—
	1	—	U123C	—	—	—	—	—	—	—	U459C	—	—	—	—	—
	2§	—	U123C	—	—	—	—	—	—	—	—	—	—	—	A3053G	—
	1	—	—	G179A	—	—	—	—	—	—	U459C	—	—	—	—	—
	8	—	—	G179A	—	—	—	—	—	—	—	—	—	U2970X	—	—
	2	—	—	—	—	—	196del	—	—	—	—	—	—	U2970X	—	—
	1	—	—	—	—	—	—	—	—	—	U459C	—	—	U2970X	—	—
3	2	—	U123C	—	A181G	—	—	—	—	—	—	—	—	U2970X	—	—
	1	—	U123C	—	—	196A	—	—	—	—	—	—	—	U2970X	—	—
	6	—	U123C	—	—	—	196del	—	—	—	—	—	—	U2970X	—	—
	1	—	U123C	—	—	—	—	—	U217C	—	U459C	—	—	—	—	—
	2	—	U123C	—	—	—	—	—	—	—	U459C	—	A2969G	—	—	—
	18	—	U123C	—	—	—	—	—	—	—	U459C	—	—	U2970X	—	—
	1	—	U123C	—	—	—	—	—	—	—	U459C	—	—	—	A3053G	—
	1	—	—	G179A	A181G	—	—	—	—	—	U459C	—	—	—	—	—
	2	—	—	G179A	A181G	—	—	—	—	—	—	—	A2969G	—	—	—
	2	—	—	G179A	A181G	—	—	—	—	—	—	—	—	U2970X	—	—
	1	—	—	G179A	A181G	—	—	—	—	—	—	—	—	—	A3053G	—
	5	—	—	G179A	—	—	—	—	—	—	U459C	—	—	U2970X	—	—
	1	—	—	G179A	—	—	—	—	—	—	U459C	—	—	—	A3053G	—
	2	—	—	—	—	—	196del	—	—	—	U459C	—	—	U2970X	—	—
4	5	—	U123C	—	—	—	196del	—	—	—	U459C	—	—	U2970X	—	—
	1	—	U123C	—	—	—	—	—	U217C	—	U459C	U498C	—	—	—	—
	3	—	—	G179A	A181G	—	—	—	—	—	U459C	—	A2969G	—	—	—
	3	—	—	G179A	A181G	—	—	—	—	—	U459C	—	—	U2970X	—	—
	1	—	—	G179A	—	—	196del	—	—	—	U459C	—	—	U2970X	—	—
	1	—	—	G179A	—	—	—	—	U217C	—	U459C	—	—	U2970X	—	—
5	1¶	—	U123C	—	—	—	—	A215U	—	—	U459C	—	—	U2970X	—	G6159A
	3	—	U123C	—	—	—	—	A215U	—	U379C	U459C	—	—	U2970X	—	—
Total no. of isolates with this mutation	—	**2**	**108**	**35**	**14**	**1**	**18**	**4**	**3**	**3**	**53**	**1**	**15**	**126**	**10**	**1**

* These isolates also contained mutation G3425A (VP1-E295K), which counteracts the effect of VP1-N171D.
† One of these isolates also contained mutation C550U, likely increasing attenuation slightly.
§ One isolate also contained mutation G3425A (VP1-E295Q), which counteracts the effect of VP1-N171D and mutation C392U, likely increasing attenuation slightly. The second isolate also contained mutation A129G, likely increasing attenuation slightly.
¶ This isolate also contains mutation G139A, likely increasing attenuation slightly.

understanding of the vaccine's behavior and its potential public health impact.

Monitoring the genetic characteristics of nOPV2 isolates included identifying nOPV2-specific modifications in the genome and looking for changes that are known to reduce genetic stability and increase neurovirulence. Across 251 isolates analyzed during the period considered for this report, no reversions were detected in the primary attenuation site of nOPV2; this is in striking contrast to Sabin OPV2, which reverts in this site in nearly all vaccinees within a few days of vaccine administration. Mutations altering base pairing in RNA secondary structures in the 5' nontranslated region were observed, as well as capsid mutations affecting antigenicity and attenuation. However, few, if any, of the mutation combinations identified in nOPV2 isolates would cause the nOPV2 strain to approach the neurovirulence of Sabin 2 with the A481G reversion alone. Some nOPV2 viruses excreted during the initial use phase (March–October 2021) showed more extensive variation than that of viruses observed during clinical trials, as expected from the large number of nOPV2 isolates analyzed, although similar polymorphisms at all relevant sites (including sites at both the 5' nontranslated and capsid regions)

FIGURE 2. Numbers of total mutations (A), viral protein 1 mutations (B), mutations reducing attenuation (C), and percentage of novel type 2 oral poliovirus vaccine isolates with mutations (D)* found in consensus sequences† through acute flaccid paralysis surveillance and environmental surveillance, after supplementary immunization activities — worldwide, March–October 2021



Abbreviations: AFP = acute flaccid paralysis; nOPV2 = novel type 2 oral poliovirus vaccine; SIA = supplementary immunization activity; VP1 = viral protein 1.

* Mutations that have been shown/inferred to decrease attenuation (121C/181G, 123C/179A, 196A/217C, 196del, 215U, 379C, 459C, 498C, VP1-143X and VP1-171D), antigenic mutations VP3-77R and VP1-295K/Q, and reversion mutation 3D-38K.

† Whole-genome sequencing from viral RNA extracted from culture-amplified virus directly from culture or from Flinders Technology Associates cards spotted with culture supernatant was performed using next generation sequencing methods using a combination of random and poliovirus-specific primers to ensure whole-genome coverage. https://apps.who.int/iris/handle/10665/68762

were observed in the clinical trials. The higher frequency of mutations reducing attenuation observed in nOPV2 isolates from environmental surveillance samples was likely due, at least in part, to the longer average intervals between SIAs and sample collection for these samples compared with intervals between SIAs and collection of samples from AFP surveillance. Six nOPV2 isolates were found to be recombinants between nOPV2 and Sabin 1 or a species C enterovirus, resulting in loss of nOPV2 3D polymerase mutations. Such recombination events might increase the chance for further recombination but are not themselves expected to have a substantial effect on virus attenuation.

The findings in this report are subject to at least three limitations. First, time since first use is one of the main factors in OPV evolution. Thus, ongoing monitoring of isolates from the field will be important to confirm or modify the observations noted here. Second, several environmental surveillance samples were associated with multiple nOPV2 isolates, which might have skewed results for frequency and temporal analysis. Adequacy of surveillance in areas of use might have affected the analysis because the source data are dependent on the sensitivity of the

Summary

What is already known about this topic?

Sabin oral polio vaccine virus can revert to neurovirulence in populations with low immunity. A genetically stable novel type 2 oral poliovirus vaccine (nOPV2) was authorized for outbreak response use under a World Health Organization Emergency Use Listing.

What is added by this report?

Global nOPV2 genomic surveillance during March–October 2021 confirmed genetic stability of the primary attenuating site.

What are the implications for public health practice?

nOPV2 is used to respond to poliovirus outbreaks with comparatively low risk for generating new circulating strains. Given the background immunity, population dynamics, and scale of use, the consistent pattern of genetic characteristics of nOPV2 isolates is encouraging. nOPV2 surveillance should continue for the duration of the Emergency Use Listing.

AFP and environmental surveillance systems. Finally, triangulation of such analyses with clinical case characteristics, safety data, and other epidemiologic factors will be important to assess impact on disease or outbreak dynamics. Future analyses should focus on spatial and temporal relationship of nOPV2 SIAs with the pattern and impact of polymorphisms in the genome.

Overall, the unprecedented global health effort for field monitoring of nOPV2 use and genomic surveillance of confirmed nOPV2 isolates over the period of initial use under EUL authorization affirmed the genetic stability profile of nOPV2, with the World Health Organization approving wider use under EUL. Given the broad spectrum of background immunity, population dynamics, and scale of use, the consistency in the pattern of genetic characteristics of nOPV2 isolates is a promising trend.

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COVID-19 Cases and Hospitalizations Among Medicare Beneficiaries With and Without Disabilities — United States, January 1, 2020–November 20, 2021

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Approximately 27% of adults in the United States live with a disability,* some of whom qualify for Medicare benefits. Persons with disabilities are at increased risk for severe COVID-19–associated outcomes compared with the general population (*1*); however, existing studies have limited generalizability† or only pertain to a specific disability (e.g., intellectual) (*2*). Older age is also associated with COVID-19–associated hospitalization and death, but the extent to which age might contribute to increased risk for severe COVID-19–associated outcomes among persons with disabilities is unknown (*3*). To describe the impact of COVID-19 on persons with disabilities and whether and how age contributes to disease rates, CDC assessed COVID-19 cases and hospitalizations during January 2020–November 2021, among Centers for Medicare & Medicaid Services (CMS) Medicare beneficiaries aged ≥18 years who were either eligible because of a disability (disability-eligible§) or only eligible because of age ≥65 years (age-eligible). COVID-19 incidence and hospitalization rates were higher in the disability-eligible group (10,978 and 3,148 per 100,000 population, respectively) throughout the study period compared with the age-eligible group (8,102 and 2,129 per 100,000 population, respectively). Both COVID-19 incidence and hospitalization rates increased with age in both disability- and age-eligible beneficiaries. American Indian or Alaska Native (AI/AN) persons had the highest disability-eligible (4,962 per 100,000) and age-eligible (5,024 per 100,000) hospitalization rates. Among all other racial and ethnic groups, hospitalization rates were higher among disability-eligible than among age-eligible patients. COVID-19 incidence and hospitalization rates among disability-eligible Medicare beneficiaries were disproportionally higher than rates among age-eligible beneficiaries. Collection of disability status as a core demographic variable in public health surveillance data and identification, as well as the addition of disability questions in other existing data sources can guide research and development of interventions for persons with disabilities. Efforts to increase access to and use of COVID-19 prevention and treatment strategies, including activities that support equitable vaccine access regardless of the substantial challenges that older adults and persons with disability face, are critical to reducing severe COVID-19–associated outcomes among these groups.

Medicare fee-for-service claims data, Medicare Advantage Plans encounter data, and Medicare enrollment information were used to identify the first diagnosis or hospitalization¶ for CMS Medicare beneficiaries with COVID-19 during January 2020–November 2021. *International Classification of Diseases, Tenth Revision, Clinical Modification* (ICD-10-CM) codes B97.29 or U07.1 (starting in April 2020) were used to identify COVID-19 on a claim or encounter record from any health care setting (e.g., outpatient and inpatient hospital). To better evaluate the contribution of age to disease and hospitalization rates, COVID-19 cases and hospitalizations were stratified into two mutually exclusive groups: aged ≥65 years without disability (age-eligible) and aged ≥18 years with disability (disability-eligible); all disability-eligible adults were grouped together, irrespective of age. Approximately 44% of disability-eligible beneficiaries were also aged ≥65 years; these included persons with developmental, sensory, and mobility disabilities, as well as persons with other or uncategorized disabilities.

Monthly COVID-19 incidence and hospitalization rates were calculated using numbers of COVID-19 cases and hospitalizations among Medicare beneficiaries, divided by the Medicare population, or the population having hospital coverage for each month. Median length of hospital stay, underlying medical conditions, which were defined using measures of Chronic Condition Warehouse chronic disease indicators,** and hospitalization discharge status were compared by eligibility group. Deaths were defined as the number of patients listed as having died on the discharge date (in an inpatient or outpatient setting) or cases for which the inpatient discharge code indicated death. Because previous research suggests that vaccination coverage might differ between disability- and age-eligible groups, with persons with disabilities being less likely to be vaccinated (*4*), CMS guidance around analyzing and interpreting COVID-19 vaccine data was considered.†† In

* https://dhds.cdc.gov (Accessed May 5, 2022).

† https://www.medrxiv.org/content/10.1101/2021.06.10.21258693v1

§ Because Medicare eligibilities can change over time, two mutually exclusive groups were defined based on reasons for initial Medicare enrollment. https://www.cms.gov/Medicare/Eligibility-and-Enrollment/OrigMedicarePartABEligEnrol

¶ CMS released the Medicare data sets on December 17, 2021. COVID-19 hospitalizations were restricted to those among beneficiaries with an inpatient hospitalization claim or encounter record with a primary or secondary diagnosis code indicating COVID-19.

** https://www2.ccwdata.org/web/guest/condition-categories (Accessed April 20, 2022).

†† https://www.cms.gov/medicare-covid-19-vaccine-analysis (Accessed April 20, 2022).

keeping with this guidance, COVID-19 vaccination was not included in the analysis, as vaccination records were incomplete or not reflective of vaccine doses administered. Rate differences between groups were tested using two-tailed t-tests for continuous variables and Pearson's chi-square tests for categorical variables; p-values <0.05 were considered statistically significant. Statistical analyses were performed using SAS Enterprise Guide (version 7.1; SAS Institute). This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[§§]

The study population comprised 68,911,412 Medicare beneficiaries, including 53,814,118 (78%) who were age-eligible and 15,097,294 (22%) who were disability-eligible. Compared with age-eligible beneficiaries, among whom overall cumulative COVID-19 incidence was 8,102 per 100,000 population, incidence was higher among disability-eligible beneficiaries (10,978 per 100,000) (p<0.001) (Table). The overall COVID-19–associated hospitalization rate was also significantly higher among disability-eligible beneficiaries (3,148 per 100,000) than among age-eligible beneficiaries (2,129 per 100,000) (p<0.001). COVID-19 incidence and hospitalization rates were higher among disability-eligible beneficiaries throughout the study period (Figure 1). Among disability-eligible beneficiaries, hospitalization rates among females and males (3,175 and 3,121 per 100,000, respectively) were significantly higher than those among age-eligible beneficiaries (1,951 and 2,350 per 100,000, respectively) (p<0.001) (Table). Hospitalization rates increased with increasing age in both groups and were also significantly higher among disability-eligible beneficiaries of all age groups (p<0.001). Among disability-eligible beneficiaries aged <65 years, the COVID-19–associated hospitalization rate (2,423 per 100,000) was significantly higher than the overall hospitalization rate in the age-eligible group (2,129 per 100,000) (p<0.001).

By race and ethnicity, hospitalization rates were highest among AI/AN persons (both disability-eligible [4,962 per 100,000] and age-eligible [5,024 per 100,000]), followed by Black or African American (Black) persons, (disability-eligible = 4,323; age-eligible = 3,318). Hospitalization rates among disability-eligible beneficiaries were significantly higher than were those among age-eligible beneficiaries for all racial and ethnic groups other than AI/AN.

The median length of hospital stay for COVID-19 hospitalizations was 7 days for both disability- and age-eligible beneficiaries. Although place of residence before hospitalization was not identified, the largest proportion of patients were discharged to their home in both groups (58.0% of

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

TABLE. Characteristics of COVID-19 Medicare patients and COVID-19 incidence and hospitalization rates among Medicare beneficiaries, by age and disability eligibility* — United States, January 2020–November 2021

	Medicare beneficiaries no. (%)		COVID-19 incidence[†]			COVID-19–associated hospitalizations[§]		
Characteristic	**Disability-eligible**	**Age-eligible**	**Disability-eligible**	**Age-eligible**	**p-value[¶]**	**Disability-eligible**	**Age-eligible**	**p-value**
Total	**15,097,294 (100)**	**53,814,118 (100)**	**10,978**	**8,102**	**<0.001**	**3,148**	**2,129**	**<0.001**
Sex								
Female	7,503,614 (50)	29,825,183 (55.4)	12,042	8,336	<0.001	3,175	1,951	<0.001
Male	7,593,675 (50)	23,988,931 (44.6)	9,927	7,812	<0.001	3,121	2,350	<0.001
Unknown	5	4	—**	—	—	—	—	—
Age group, yrs								
Median age (IQR)	63 (55–70)	74 (69–80)	—	—	—	—	—	—
<65	8,472,025 (56.1)	NA	9,822	NA	—	2,423	NA	—
65–74	4,678,464 (31.0)	29,286,151 (54.4)	11,626	6,632	<0.001	3,618	1,373	<0.001
75–84	1,617,326 (10.7)	16,796,300 (31.2)	14,047	8,885	<0.001	5,051	2,636	<0.001
≥85	329,487 (2.2)	7,731,667 (14.4)	16,459	11,970	<0.001	5,792	3,896	<0.001
Race and ethnicity								
AI/AN	111,493 (0.7)	162,701 (0.3)	13,891	12,924	<0.001	4,962	5,024	0.469
Hispanic	1,843,803 (12.2)	4,792,789 (8.9)	13,180	10,369	<0.001	3,565	2,991	<0.001
Black	2,817,066 (18.7)	4,411,666 (8.2)	12,127	8,741	<0.001	4,323	3,318	<0.001
Asian	261,179 (1.7)	2,193,900 (4.1)	8,006	5,294	<0.001	2,566	1,570	<0.001
White, non-Hispanic	9,772,436 (64.7)	40,533,356 (75.3)	10,356	7,993	<0.001	2,756	1,954	<0.001
Other/Unknown	291,317 (1.9)	1,719,706 (3.2)	8,359	5,852	<0.001	2,104	1,284	<0.001

Abbreviations: AI/AN = American Indian or Alaska Native; NA = not applicable.

* Age-eligible beneficiaries were aged ≥65 years and had no disability; disability-eligible beneficiaries were aged ≥18 years and had one or more disabilities.

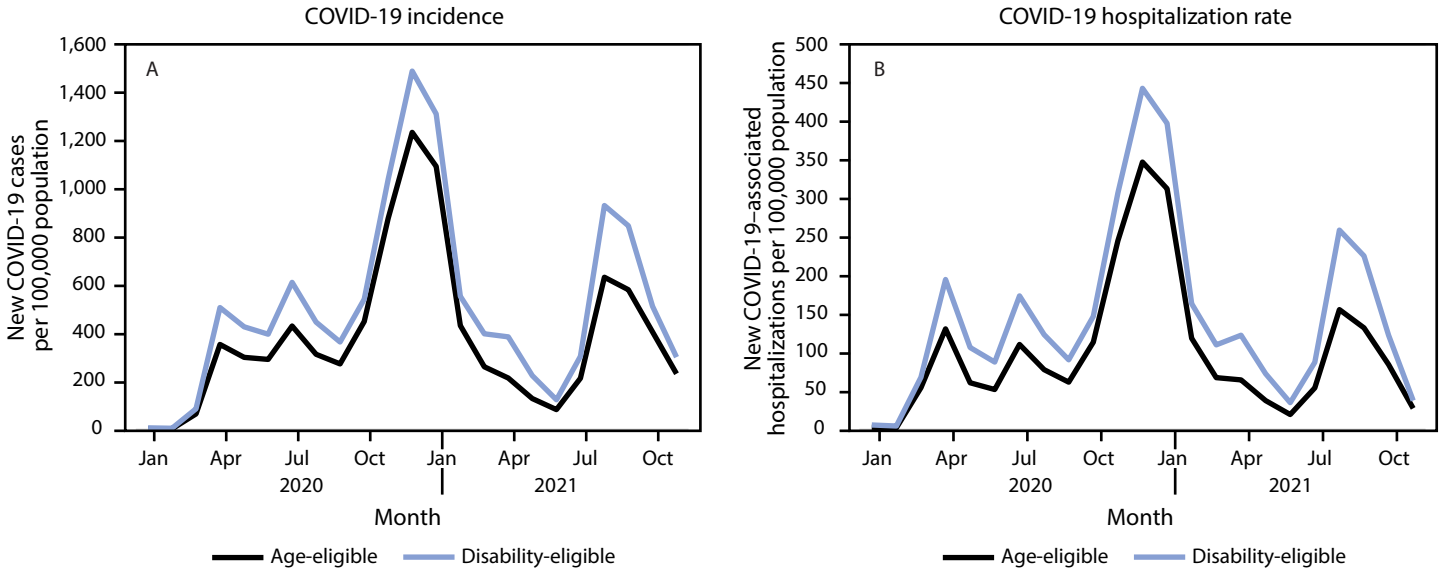
[†] COVID-19 cases 100,000 population.

[§] COVID-19–associated hospitalizations per 100,000 population.

[¶] Rate differences between age- and disability-eligible groups were tested with two-tailed Pearson's chi-square test; p-values <0.05 were considered statistically significant.

** Dashes indicate not applicable because the values are presented as rates per 100,000 persons,

FIGURE 1. Monthly COVID-19 incidence (A)*and hospitalization rate (B)[†,§] among age- and disability-eligible[¶] Medicare beneficiaries — United States, January 1, 2020–November 20, 2021



* COVID-19 cases per 100,000 population.
† COVID-19–associated hospitalizations per 100,000 population.
§ The y-axis scales for panels A and B are different.
¶ Age-eligible beneficiaries were aged ≥65 years and had no disability; disability-eligible beneficiaries were aged ≥18 years and had one or more disabilities.

disability-eligible and 54.4% of age-eligible), followed by discharge to a skilled nursing facility (16.9% of disability-eligible and 17.6% of age-eligible) (Supplementary Table, https://stacks.cdc.gov/view/cdc/118094). Overall, the in-hospital mortality rate was lower among disability-eligible patients (16.5%) than among age-eligible patients (19.0%). However, the mortality rate among disability-eligible beneficiaries aged ≥65 years was 19.1%, similar to that among age-eligible beneficiaries (19.0%).

Among 18 underlying medical conditions[¶¶] assessed among Medicare beneficiaries hospitalized with COVID-19, 91.4% of disability-eligible and 90.6% of age-eligible beneficiaries had two or more conditions (p<0.001). The prevalence of 16 of these conditions (including obesity, depression, chronic obstructive pulmonary disease, chronic kidney disease, heart failure, and anemia) were significantly higher in disability-eligible beneficiaries aged ≥65 years than in age-eligible beneficiaries (Figure 2).

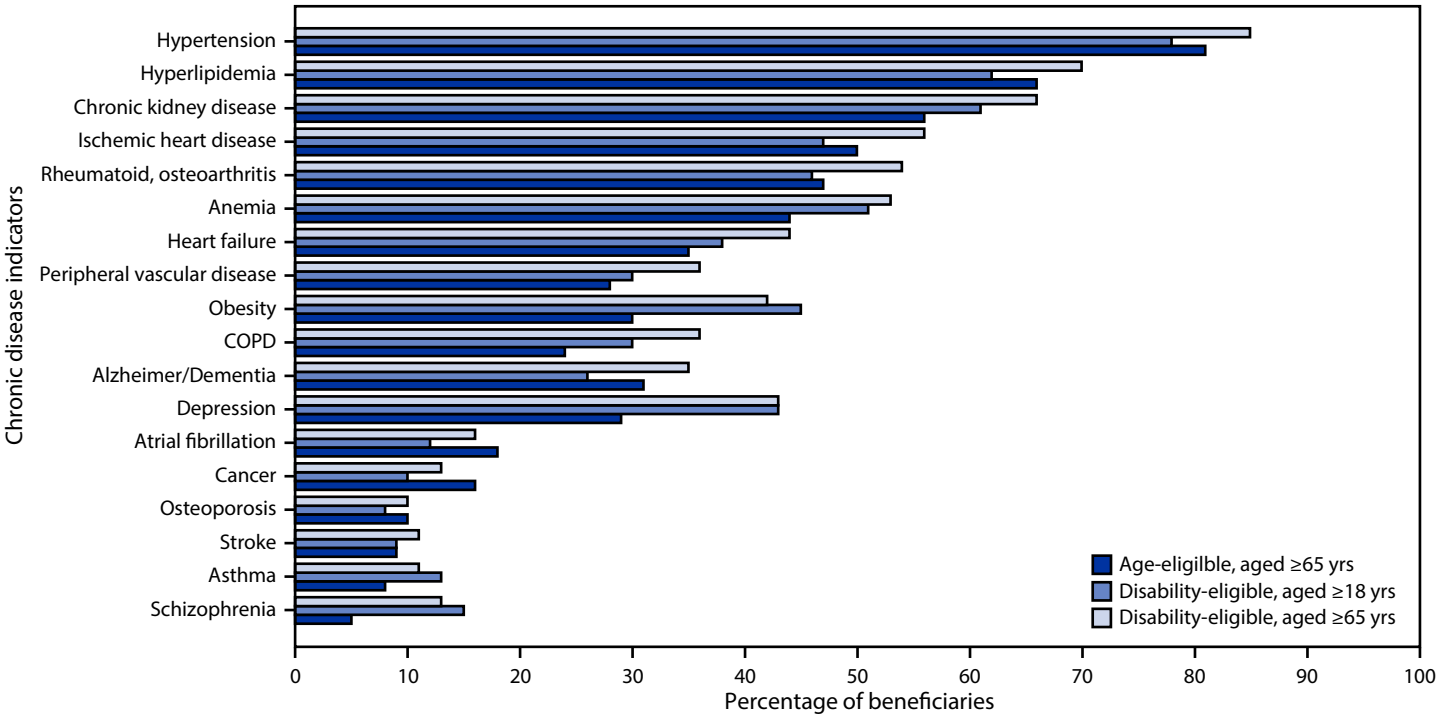
[¶¶] Eighteen underlying medical conditions: Alzheimer disease and dementia, anemia, asthma, atrial fibrillation, cancer (breast, colorectal, leukemia and lymphoma, lung, and prostate), chronic kidney disease, COPD and bronchiectasis, depression, heart failure, hyperlipidemia, hypertension, ischemic heart disease, obesity, osteoporosis, peripheral vascular disease, rheumatoid and osteoarthritis, schizophrenia, and stroke. Underlying medical conditions data are only available in full fee-for-service beneficiaries who had 12 months of Medicare Part A and B (or coverage until time of death) and had no Medicare Advantage coverage during 2020.

Discussion

This study found that COVID-19 incidence and hospitalization rates were disproportionately higher among disability-eligible Medicare beneficiaries aged ≥18 years than among age-eligible beneficiaries (i.e., aged ≥65 years). COVID-19 incidence and hospitalization rates also increased with age among both disability- and age-eligible beneficiaries, consistent with previous findings that age is an important risk factor for COVID-19–associated hospitalization (*5*). These finding suggest that the observed disparity among persons with disabilities is being driven, in part, by age; however, other factors, including lower vaccination access and coverage among persons with disabilities, and the high prevalence of underlying conditions that increase risk for severe outcomes likely also contribute to this disparity (*4*). Taken together, these findings reinforce the importance of increasing access to and implementing COVID-19 prevention and treatment strategies, including vaccination, among persons with disabilities.

AI/AN beneficiaries accounted for the smallest racial and ethnic group (0.7% of disability-eligible and 0.3% of age-eligible beneficiaries); however, this group experienced the highest rates of COVID-19 cases and hospitalizations among both age- and disability-eligible beneficiaries. Rates among Black and Hispanic adults with disabilities were also consistently higher than those among non-Hispanic White, non-Hispanic Asian adults, and

FIGURE 2. Percentage of Medicare beneficiaries hospitalized with COVID-19 with 18* selected underlying medical conditions,† by age and disability eligibility§ — United States, January 1, 2020–November 20, 2021



Abbreviation: COPD = chronic obstructive pulmonary disease.

* Eighteen underlying medical conditions: Alzheimer disease and dementia, anemia, asthma, atrial fibrillation, cancer (breast, colorectal, leukemia and lymphoma, lung, and prostate), chronic kidney disease, COPD and bronchiectasis, depression, heart failure, hyperlipidemia, hypertension, ischemic heart disease, obesity, osteoporosis, peripheral vascular disease, rheumatoid and osteoarthritis, schizophrenia, and stroke.

† Data on underlying medical conditions were only available for full fee-for-service beneficiaries who had 12 months of Medicare Part A and B coverage (or coverage until time of death) and no Medicare Advantage Plans coverage during 2020. The chronic disease indicators presented in the figure are a subset of the conditions from the Chronic Conditions Data Warehouse. https://www2.ccwdata.org/web/guest/home/

§ Age-eligible beneficiaries were aged ≥65 years and had no disability; disability-eligible beneficiaries were aged ≥18 years and had one or more disabilities.

adults of other or unknown race and ethnicity with disabilities. Previous studies have also identified higher COVID-19–associated risks among certain minority racial and ethnic groups (*6*,*7*). Additional intersectional research might help to better elucidate the factors that contribute to these racial and ethnic differences. CMS and CDC have fostered an interagency partnership to share administrative claims data for public health analyses during the COVID-19 pandemic; these data-sharing efforts augment the ability to examine the incidence and severity of disease faced by persons with disabilities. Primary prevention through continued COVID-19 vaccination efforts that focus on racial and ethnic subgroups with disabilities might further public health efforts to minimize mortality and morbidity (*5*) and reduce disparities.

CDC has also developed guidance and tools to help persons with disabilities and those who serve or care for them make decisions and protect their health.*** Several accessible materials and culturally competent COVID-19 resources have been developed for persons with disabilities and for health care providers who support them. To improve available support to persons with disabilities, CDC has funded partners such as the Administration for Community Living, which manages the Disability Information and Access Line,††† and regularly reviews the literature on the impact of COVID-19 on persons with disabilities; associated clinical evidence reviews are periodically updated and posted online.§§§

The findings in this report are subject to at least four limitations. First, claims submitted to Medicare are not representative of all persons with a disability or older adults, and as with all claims data, there is some delay in reporting data. Disability-eligible Medicare beneficiaries might be more likely to have more severe disabilities than persons without Medicare

*** https://www.cdc.gov/ncbddd/humandevelopment/covid-19/toolkit-for-people-with-disabilities.html?msclkid%C2%A0=%C2%A0ebc7d4a8af7f11ec9e6ca10c571304bahttps://www.cdc.gov/ncbddd/humandevelopment/covid-19/toolkit-for-people-with-disabilities.html?msclkid

††† Persons with a disability seeking assistance in getting a COVID-19 vaccine can call 888-677-1199, Monday–Friday from 9:00 a.m. to 8:00 p.m. EST or can email DIAL@n4a.org

§§§ https://www.cdc.gov/coronavirus/2019-ncov/downloads/clinical-care/C-Disability-Review.pdf

Summary

What is already known about this topic?

Persons with disabilities are at high risk for severe outcomes from COVID-19, including death.

What is added by this report?

COVID-19–associated hospitalization rates among disability-eligible Medicare beneficiaries (3,148 per 100,000) were approximately 50% higher than rates among age-eligible (i.e., ≥65 years) beneficiaries (2,129 per 100,000), and hospitalization rates increased by age in both groups. Among persons with disabilities, American Indian or Alaska Native persons experienced the highest rate of COVID-19–associated hospitalization (4,962 per 100,000).

What are the implications for public health practice?

Efforts to increase access to and implementation of COVID-19 prevention and treatment strategies, including vaccination, are critical to reducing severe COVID-19–associated outcomes among persons with disabilities.

because eligibility requires both a time component and disease documentation.¶¶¶ These requirements might differentially select for persons with a higher inherent risk for infection with SARS-CoV-2, the virus that causes COVID-19, or less access to medical treatment for COVID-19 than age-eligible beneficiaries. Second, vaccination coverage was not considered in this analysis because of limitations in administrative reporting and data; persons with disabilities are less likely to receive COVID-19 vaccination than are persons without disabilities (*3*). Third, SARS-CoV-2 genomic variants were not considered in this analysis, nor were rates compared by time; however, trends followed similar peaks identified in national incidence data (*8*). Finally, the ICD-10-CM codes used to identify COVID-19 diagnosis and associated hospitalization might include incidental COVID-19 cases that were identified during a care visit for another purpose. However, the misclassification bias was likely systematic and equally distributed between the groups, and thus unlikely to affect the observed findings.

Continuing COVID-19 prevention efforts and focused messaging to persons with disabilities remain high-impact public health priorities. Although progress has been made, more work remains to be done to prioritize persons with disabilities in public health programs, data systems, and preparedness and response activities at the federal, state, and local levels. Collection of disability status as a core demographic variable in public health surveillance data and identification, as well as the addition of disability questions in other existing data sources can guide research and development of interventions for persons with disabilities. Efforts to increase access to and use of COVID-19 prevention and treatment strategies, including activities that support equitable vaccine access in the face of the substantial challenges that older adults and those with disabilities face, are critical to reducing severe COVID-19–associated outcomes among these groups.****

¶¶¶ To be eligible for Social Security disability benefits, persons have to show an inability to engage in any substantial gainful activity by reason of any medically determinable physical or mental impairments, that can be expected to result in death or that have lasted or can be expected to last for a continuous period of not <12 months. https://www.ssa.gov/ (Accessed April 20, 2022).

**** https://www.cdc.gov/vaccines/covid-19/clinical-considerations/older-adults-and-disability/access.html

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Trends in Acute Hepatitis of Unspecified Etiology and Adenovirus Stool Testing Results in Children — United States, 2017–2022

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In November 2021, CDC was notified of a cluster of previously healthy children with hepatitis of unknown etiology evaluated at a single U.S. hospital (*1*). On April 21, 2022, following an investigation of this cluster and reports of similar cases in Europe (*2*,*3*), a health advisory* was issued requesting U.S. providers to report pediatric cases† of hepatitis of unknown etiology to public health authorities. In the United States and Europe, many of these patients have also received positive adenovirus test results (*1*,*3*). Typed specimens have indicated adenovirus type 41, which typically causes gastroenteritis (*1*,*3*). Although adenovirus hepatitis has been reported in immunocompromised persons, adenovirus is not a recognized cause of hepatitis in healthy children (*4*). Because neither acute hepatitis of unknown etiology nor adenovirus type 41 is reportable in the United States, it is unclear whether either has recently increased above historical levels. Data from four sources were analyzed to assess trends in hepatitis-associated emergency department (ED) visits and hospitalizations, liver transplants, and adenovirus stool testing results among children in the United States. Because of potential changes in health care–seeking behavior during 2020–2021, data from October 2021–March 2022 were compared with a pre–COVID-19 pandemic baseline. These data do not suggest an increase in pediatric hepatitis or adenovirus types 40/41 above baseline levels. Pediatric hepatitis is rare, and the relatively low weekly and monthly counts of associated outcomes limit the ability to interpret small changes in incidence. Ongoing assessment of trends, in addition to enhanced epidemiologic investigations, will help contextualize reported cases of acute hepatitis of unknown etiology in U.S. children.

Data in this report were obtained from the National Syndromic Surveillance Program (NSSP), the Premier Healthcare Database Special Release (PHD-SR), the Organ Procurement and Transplant Network (OPTN), and Labcorp, a large commercial laboratory network. NSSP collects electronic health data from EDs in all 50 states and the District of Columbia, representing 71% of nonfederal EDs in the United States. ED visits associated with hepatitis of unspecified etiology among children aged 0–4 and 5–11 years during January 2018–March 2022 were identified via *International Classification of Diseases, Tenth Revision, Clinical Modification* (ICD-10-CM) discharge diagnosis codes§ (*3*); data were queried on May 26, 2022, and restricted to facilities with high data quality¶ and consistent reporting during 2018–2022. Data on hospitalizations associated with hepatitis of unspecified etiology were obtained on May 25, 2022, from PHD-SR, which includes inpatient records from approximately 1,000 hospitals. Hospital admissions among children aged 0–4 and 5–11 years during January 2019–March 2022 were identified using the same ICD-10-CM codes as were used for ED data. Data on pediatric liver transplants were obtained on May 20, 2022 from the national registry managed by OPTN; these included monthly counts of liver transplants performed among patients aged <18 years in the United States during January 2017–March 2022, for whom the primary diagnosis at time of transplant was acute hepatic necrosis of unknown etiology.** Labcorp data, accessed on June 6, 2022, included deidentified results for all stool specimens tested for adenovirus types 40/41†† (Logical Observation Identifiers Names and Codes

* https://emergency.cdc.gov/han/2022/pdf/CDC_HAN_462.pdf

† Since April 2022, providers have been encouraged to report to public health authorities persons under investigation for acute hepatitis meeting the following definition: children aged <10 years with elevated aspartate aminotransferase or alanine aminotransferase levels (>500 U/L) with an unknown etiology for their hepatitis since October 1, 2021.

§ ICD-10-CM codes queried by NSSP and PHD-SR were as follows: B17.8 (other specified acute viral hepatitis); B17.9 (acute viral hepatitis, unspecified); B19.0 (unspecified viral hepatitis with hepatic coma); B19.9 (unspecified viral hepatitis without hepatic coma); K71.6 (toxic liver disease with hepatitis, not elsewhere classified); K72.0 (acute and subacute hepatic failure); K75.2 (nonspecific reactive hepatitis); and K75.9 (inflammatory liver disease, unspecified). These codes were previously used in a technical briefing published by the United Kingdom Health Security Agency.

¶ To reduce artifactual impact from changes in reporting patterns, analyses were restricted to facilities with a coefficient of variation ≤35% and >70% discharge diagnosis informativeness during 2018–2022. Visit data from a monthly average of 1,817 facilities were included in this analysis from state and regional jurisdictions representing 44 states.

** Recipient diagnosis at the time of liver transplant was acute hepatic necrosis (AHN) drug other specify; AHN etiology unknown; or AHN other, specify. https://optn.transplant.hrsa.gov/patients/by-organ/liver/

†† Adenovirus types 40 and 41 are both associated with acute gastroenteritis. Most commercial diagnostic tests do not distinguish between these two types.

[LOINC] code 82209–8) among children aged 0–4 and 5–9 years during October 2017–March 2022.

Weekly numbers of ED visits during October 2021–March 2022 were compared with a prepandemic baseline (January 2018–February 2020) using a modified Farrington Method[§§] (*5*). Monthly hospitalizations and liver transplants during October 2021–March 2022 were compared with those for the same months (January–March and October–December) during the calendar years 2017, 2018, and 2019, as available, using the Wilcoxon rank sum test. Data on hospitalizations and liver transplants during January 2020–September 2021 were excluded from each respective baseline because of possible impacts of the COVID-19 pandemic. Monthly stool specimen results are presented as total tests (all specimens with a negative or positive result) and percentage positive for adenovirus types 40/41. The percentage of stool specimens testing positive for adenovirus types 40/41 during October 2021–March 2022 was compared with that during the same months (October–March) of 2017–2018, 2018–2019, and 2019–2020, to minimize potential effects of seasonality. Analyses were conducted in R (version 4.1.1; R Foundation). This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[¶¶]

Compared with a pre–COVID-19 pandemic baseline, no increase in weekly ED visits with hepatitis-associated discharge codes was observed during October 2021–March 2022 among children aged 0–4 or 5–11 years (Figure 1). During January 2019–March 2022, a median of 22 (range = 9–29) and 10 (range = 4–19) hepatitis-associated hospitalizations among children aged 0–4 and 5–11 years, respectively, were recorded each month (Figure 2) (Supplementary Figure, https://stacks.cdc.gov/view/cdc/118245). No significant changes were detected in the number of hepatitis-associated hospitalizations during October 2021–March 2022 compared with the same months before the COVID-19 pandemic among children aged 0–4 years (22 and 19.5, respectively, p = 0.26) or 5–11 years (12 and 10.5, respectively, p = 0.42). A median of four (range = 0–10) liver transplants occurred among persons aged <18 years each month during January 2017–March 2022 (Figure 2) (Supplementary Figure, https://stacks.cdc.gov/view/cdc/118245). No significant increase in the number of monthly liver transplants was observed during October 2021–March 2022 (five) compared with the same months during 2017–2019 (four) (p = 0.19). During October 2017–March 2022, the monthly number of adenovirus tests ranged from 184 to 1,759 among children aged 0–4 years and from 140 to 725 among children aged 5–9 years (Figure 3). Among both age groups, the number of adenovirus tests was highest in March 2022. During October–March in 2017–2018, 2018–2019, and 2019–2020, the monthly percentage of specimens positive for adenovirus types 40/41 ranged from 5% to 19% among children aged 0–4 years and from 3% to 14% among children aged 5–9 years. After a decrease in testing volume and percentage positive during April 2020–September 2021, the percentage of specimens positive for adenovirus types 40/41 during October 2021–March 2022 returned to, but did not exceed, prepandemic levels in both age groups.

[§§] To monitor for recent anomalous increases in weekly trends, the modified Farrington algorithm was applied to ED visits during the weeks ending January 6, 2018, through the week ending April 2, 2022, excluding a predefined early pandemic period (weeks ending March 7, 2020, through October 2, 2021). The modified Farrington algorithm has traditionally been used on weekly count time series spanning multiple years. Weighted quasi-Poisson regression models are fit to multiple year baselines with a time term and 10-level factor to account for seasonality. The weighting strategy used by this algorithm is intended to down-weight baseline observations associated with historical outbreaks. When unweighted, baseline observations with abnormally high counts result in alerting thresholds that are too high and a reduction in sensitivity.

[¶¶] 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.

Discussion

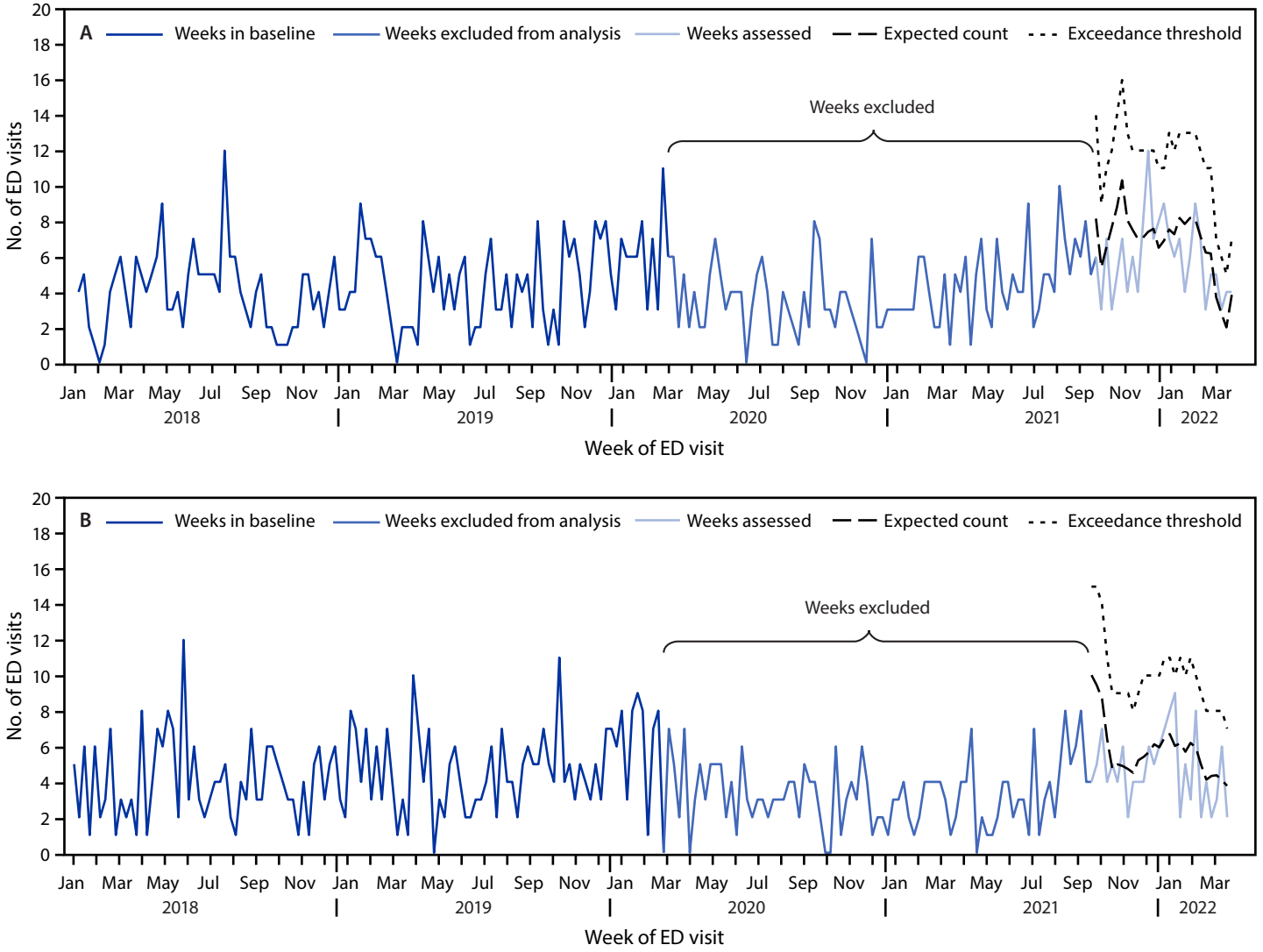
Data from four large administrative databases were analyzed to assess trends in pediatric hepatitis and percentage of stool specimens positive for adenovirus type 40/41. These data indicate that neither outcome has recently increased above pre–COVID-19 pandemic levels. Although this ecologic analysis cannot conclusively confirm or refute a potential association between pediatric hepatitis and adenovirus, it provides useful context for the ongoing investigation.

Data from two large electronic health record systems and the liver transplant registry did not indicate an increase in pediatric ED visits or hospitalizations associated with hepatitis of unspecified etiology or pediatric liver transplants in the United States. Historical data on pediatric hepatitis from other countries are also limited. Although the United Kingdom has observed increases in hepatitis among children aged 1–4 years when comparing 2022 with previous years (*6*), data from multiple other European and non-European countries have been inconclusive (*7*,*8*).

The percentage of specimens positive for adenovirus types 40/41 among children aged 0–4 and 5–9 years did not appear to increase above prepandemic historical levels, although the total number of specimens submitted for testing has increased over time. The United Kingdom has reported an increase in the number of adenovirus-positive stool specimen test results among children aged 1–4 years compared with prepandemic levels. However, United Kingdom data on testing volume and thus, percentage positive for adenovirus, are currently unavailable (*6*).

The findings in this report are subject to at least seven limitations. First, although liver transplants are well-documented, cases of hepatitis of unknown etiology are not reportable in the United States. This analysis assessed trends using electronic health data

FIGURE 1. Emergency department visits with hepatitis-associated *International Classification of Diseases, Tenth Revision, Clinical Modification* codes*,† by week§ of visit among children aged 0–4 years (A) and 5–11 years (B) — National Syndromic Surveillance Program, United States, January 2018–March 2022



Abbreviations: ED = emergency department; ICD-10-CM = *International Classification of Diseases, Tenth Revision, Clinical Modification*.

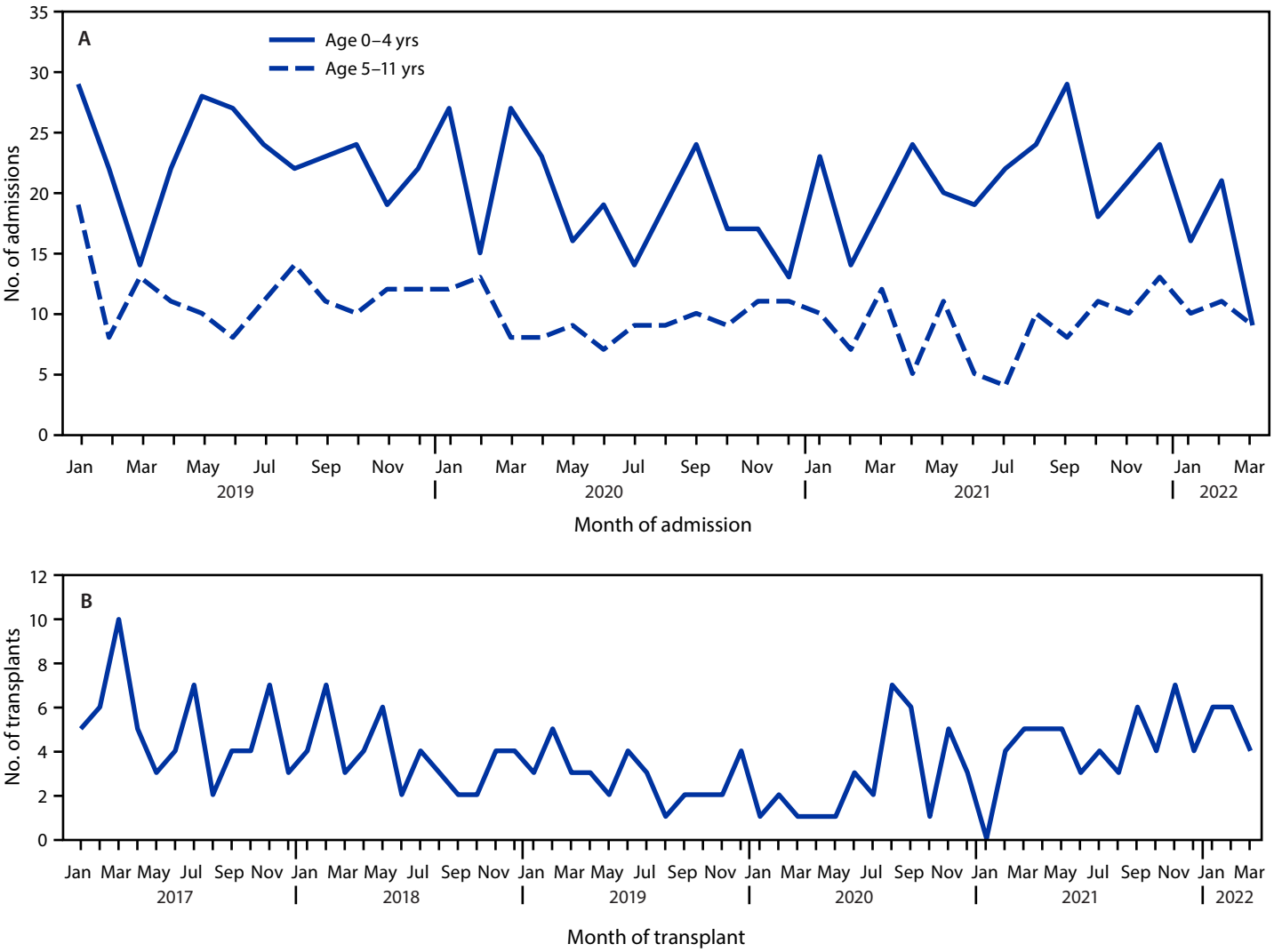
* ICD-10-CM Codes queried for hepatitis were as follows: B17.8 (other specified acute viral hepatitis); B17.9 (acute viral hepatitis, unspecified); B19.0 (unspecified viral hepatitis with hepatic coma); B19.9 (unspecified viral hepatitis without hepatic coma); K71.6 (toxic liver disease with hepatitis, not elsewhere classified); K72.0 (acute and subacute hepatic failure); K75.2 (nonspecific reactive hepatitis); and K75.9 (inflammatory liver disease, unspecified).

† To reduce artifactual impact from changes in reporting patterns, analyses were restricted to facilities with a coefficient of variation ≤35% and >70% discharge diagnosis informativeness during 2018–2022. Visit data from a monthly average of 1,817 facilities were included in this analysis from state and regional jurisdictions representing 44 states.

§ Weeks in baseline = January 2018–February 2020. Weeks excluded from analysis = March 2020–September 2021; this period was excluded from analysis because of possible effects of the COVID-19 pandemic. Weeks assessed = October 2021–March 2022. Expected counts = expected visit counts calculated from weighted regression model fit to baseline data. Exceedance threshold = upper bound defined as the 95th percentile of the negative binomial distribution with plug-in estimates for the mean and dispersion parameter. Weeks with observed weekly counts falling above this threshold were considered to be anomalies.

on pediatric hepatitis of unspecified etiology as a proxy, but the exact baseline remains unknown, as does the accuracy and completeness of the diagnostic codes used for identification. Second, data on hospitalizations and liver transplants have up to a 2–3-month lag between outcome and report; March 2022 data might be underreported. Third, the COVID-19 pandemic likely affected observed patterns during the analysis period because of its effects on health care–seeking behavior (*9*) and infectious disease epidemiology during 2020–2021, and these patterns might still be normalizing. Prepandemic data are limited to 2017–2019, and it is not known whether these data represent a reliable baseline. Fourth, although NSSP and PHD-SR capture a

FIGURE 2. Hospitalizations with hepatitis-associated *International Classification of Diseases, Tenth Revision, Clinical Modification* codes* among children aged 0–4 and 5–11 years, by month of admission (A)† and liver transplants§ among persons aged <18 years, by month of transplant (B)¶ — United States, January 2019–March 2022 and January 2017–March 2022



Abbreviations: AHN = acute hepatic necrosis; ICD-10-CM = *International Classification of Diseases, Tenth Revision, Clinical Modification*.

* ICD-10-CM Codes queried for hepatitis were as follows: B17.8 (other specified acute viral hepatitis); B17.9 (acute viral hepatitis, unspecified); B19.0 (unspecified viral hepatitis with hepatic coma); B19.9 (unspecified viral hepatitis without hepatic coma); K71.6 (toxic liver disease with hepatitis, not elsewhere classified); K72.0 (acute and subacute hepatic failure); K75.2 (nonspecific reactive hepatitis); and K75.9 (inflammatory liver disease, unspecified).

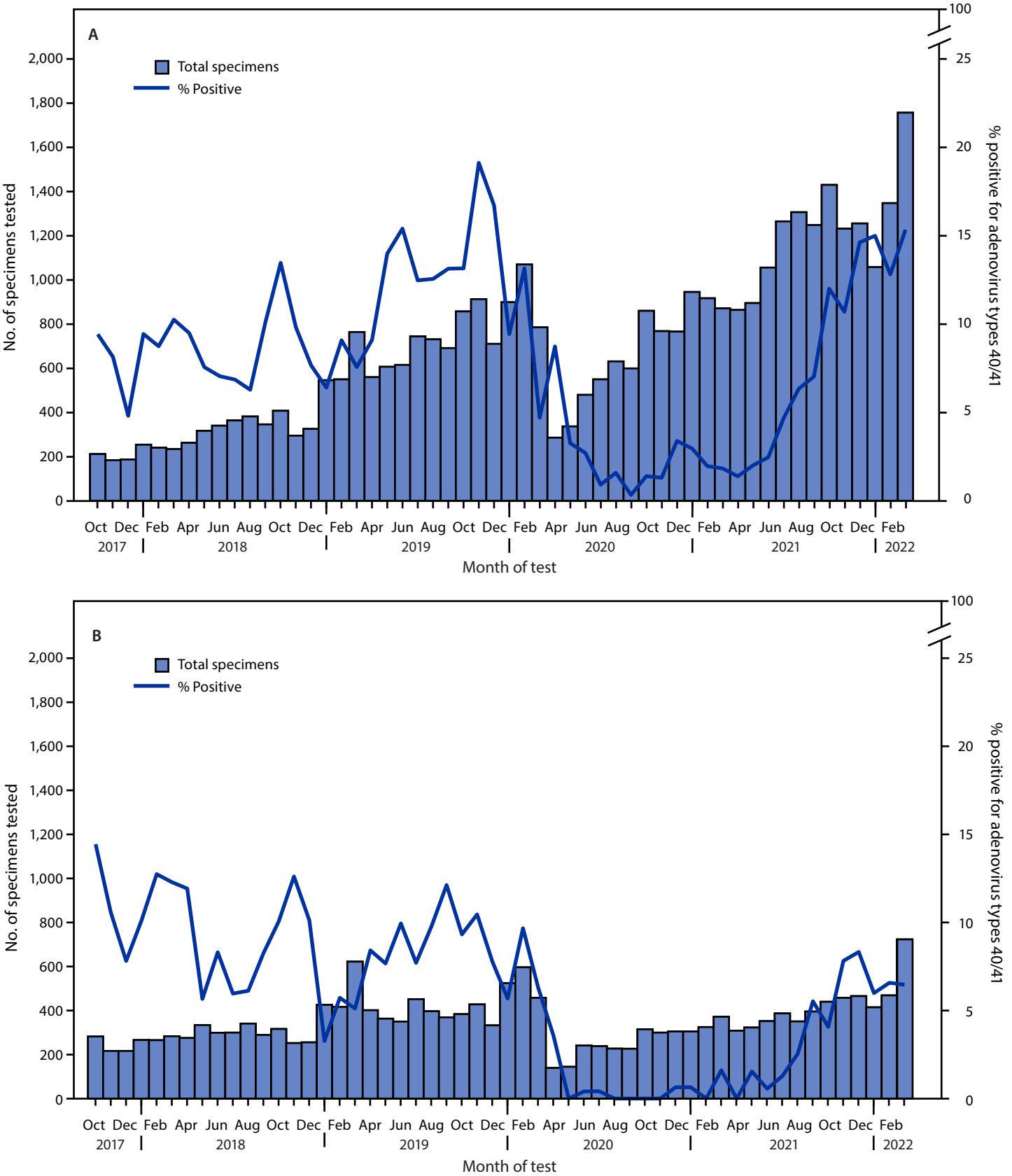
† Premier Healthcare Database Special Release.

§ Recipient diagnosis at the time of liver transplant was AHN drug other specify; AHN etiology unknown; or AHN other, specify.

¶ Organ Procurement and Transplant Network.

large number of ED visits and hospitalizations, respectively, they do not cover the entire U.S. population, nor do they represent the same catchment areas. Similarly, Labcorp data represent only one large laboratory network and are not deduplicated to the patient level. The extent to which changes in testing volume might be due to changes in laboratory market share or test-ordering practices could not be determined, although the percentage of positive test results should not be substantially affected. Fifth, although the Labcorp assay cannot distinguish between adenovirus types 40 and 41, nearly 90% of adenovirus detections in U.S. children with gastroenteritis are type 41 (*10*). Sixth, cases of acute hepatitis of unknown etiology are generally rare; thus, small changes in incidence might be difficult to detect and interpret. Finally, these results are intended to provide an overview of trends in pediatric acute hepatitis of unspecified etiology and adenovirus types 40/41 in the United States and cannot be used to infer or disprove a causal link between these two illnesses.

FIGURE 3. Number of stool specimens tested for adenovirus types 40/41 and percent positivity among children aged 0–4 years (A) and 5–9 years (B) — Labcorp, United States, October 2017–March 2022



Summary

What is already known about this topic?

Following identification of pediatric hepatitis cases of unknown etiology in the United States and the United Kingdom, CDC issued a request in April 2022 for U.S. providers to report additional cases. Many reported cases had test results positive for adenovirus, which is not known to cause hepatitis in immunocompetent children.

What is added by this report?

Analyses of four data sources did not indicate recent increases in hepatitis-associated emergency department visits or hospitalizations, liver transplants, or adenovirus types 40/41 percent positivity among U.S. children compared with pre–COVID-19 pandemic levels.

What are the implications for public health practice?

Current data do not suggest an increase in pediatric hepatitis or adenovirus types 40/41 above pre–COVID-19 pandemic baseline levels; continued surveillance is important to monitor changes over time.

These analyses, based on four data sources, did not indicate a recent increase in hepatitis-associated ED visits or hospitalizations among children aged 0–11 years, liver transplants among children aged 0–17 years, or percentage of specimens positive for adenovirus types 40/41 among children aged 0–9 years in the United States compared with pre–COVID-19 pandemic levels. The potential role of adenovirus in the etiology of the newly reported hepatitis cases is unknown; ongoing investigations are assessing this hypothesis along with the possible role of other factors, including current or past infections with SARS-CoV-2, the virus that causes COVID-19. It remains unknown whether the recently reported cases represent a novel etiology of pediatric acute hepatitis or a previously existing phenomenon that is now being detected. The rarity of this outcome makes it difficult to detect small changes, and pandemic-associated disruptions in health care–seeking behavior and infectious disease epidemiology might still be normalizing. Ongoing assessment of trends in addition to enhanced epidemiologic investigations will help contextualize reported cases of acute hepatitis of unknown etiology in U.S. children.

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Notes from the Field

COVID-19–Associated Mortality Risk Among Long-Term Care Facility Residents and Community-Dwelling Adults Aged ≥65 Years — Illinois, December 2020 and January 2022

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U.S. adults aged ≥65 years are at increased risk for severe illness and death from COVID-19 (*1*). The communal nature of long-term care facilities (LTCFs), and the vulnerability of the LTCF population (typically aged ≥65 years, and often having underlying chronic conditions, cognitive and physical impairments, immunocomprised status, or other disabilities) further increases risk for COVID-19 infection, hospitalization, and death in this group (*2*). Although multiple studies highlight these risks (*3*), there is limited information comparing the risk among LTCF residents with that in an age-comparable population living in the community. This report estimates the risk for death among LTCF residents by comparing COVID-19–associated mortality rates among LTCF residents aged ≥65 years and persons aged ≥65 years who are not LTCF residents (community-dwelling adults) in Illinois. Illinois infectious disease registry data and population data from state regulatory sources and the U.S. Census Bureau were used to calculate COVID-19 death rates among persons aged ≥65 years living within and outside of LTCFs during a prevaccination baseline month (December 2020) and a comparison month 1 year after COVID-19 vaccination began (January 2022).

For Illinois LTCFs, data on total population, population aged ≥65 years, and vaccination coverage percentage were collected for four types of facilities*: 1) skilled nursing facilities (63,601, 48,973, and 88%, respectively)†; 2) veterans homes (560, 552, and 97%, respectively)§; 3) assisted living facilities (22,859, 22,562, and 96%, respectively)¶ and; 4) supportive living facilities (11,980, 10,954, and 92%, respectively).** The population of community-dwelling adults was obtained by subtracting the LTCF group's population from the U.S. Census Bureau's July 2021 estimate for the overall Illinois population aged ≥65 years.†† COVID-19 vaccination coverage rates among community-dwelling adults were obtained from the Illinois Comprehensive Automated Immunization Registry Exchange.§§

Numbers of COVID-19 deaths among LTCF residents¶¶ and community-dwelling adults were abstracted from the Illinois National Electronic Disease Surveillance System (I-NEDSS) for December 2020 and January 2022 and divided by the corresponding resident populations to produce death rates per 100,000 population for both groups. Only deaths classified as "from COVID-19" (i.e., COVID-19–related deaths, as opposed to COVID-19 cases in persons dying from a cause unrelated to COVID-19) in the I-NEDSS record are included in this analysis.*** To gauge the combined effect of focused COVID-19 control measures (e.g., vaccination, infection control, and a rigorous testing regimen) on the risk for death from COVID-19 among LTCF residents, their risk was compared with the risk among community-dwelling adults during a prevaccination month and a postvaccination month, both of which included a local maximum for deaths. This activity was reviewed by the Illinois Department of Public Health (IDPH) Institutional Review Board and was conducted in accordance with applicable laws and policies protecting human research subjects.††† SAS statistical softsware (version 9.4M6; SAS Institute) was used for analyses.

Although the COVID-19 mortality rate has been lower among community-dwelling adults aged ≥65 years than among LTCF residents aged ≥65 years throughout the pandemic, the rate among the

* The four types of facilities are defined in the following Illinois state legislative acts: 210 ILCS 45/; 210 ILCS 9/; and 305 ILCS 5/. https://www.ilga.gov/legislation/ilcs/ilcs.asp

† Total and aged ≥65 years populations: Kaiser Family Foundation (https://www.kff.org/state-category/providers-service-use/nursing-facilities/ and https://www.kff.org/statedata/custom-state-report/?i=148824&g=il&view=3, respectively); vaccination rate: National Healthcare Safety Network (NHSN) Long-Term Care (LTCF) COVID-19 Module. https://www.cdc.gov/nhsn/ltc/index.html

§ Illinois Department of Veterans' Affairs (https://www2.illinois.gov/veterans/Pages/default.aspx) internal data, supplied January 31, 2022.

¶ IDPH internal data, based in part on LTCF COVID-19 Vaccination and Testing Reporting Survey results supplied February 28, 2022 (survey form: https://app.smartsheet.com/b/form/fa2d7abfb102490b9d2622a2ba490744 as of March 26, 2022).

** Illinois Department of Healthcare and Family Services (https://www2.illinois.gov/hfs/Pages/default.aspx), Medicaid Management Information System internal data, supplied April 6, 2022.

†† https://www.census.gov/quickfacts/IL (Accessed March 26, 2022).

§§ https://dph.illinois.gov/topics-services/prevention-wellness/immunization/icare.html (Accessed March 26, 2022).

¶¶ I-NEDSS records are routinely matched with existing listings of LTCFs to ensure that persons associated with an LTCF are identified as such in the I-NEDSS database. LTCF deaths were distinguished by the presence of an LTCF identifier in either the patient residence or potential exposure fields.

*** The primary inclusionary criterion is that the term "COVID-19" or "SARS-CoV-2" or an equivalent is listed on death certificate as immediate or underlying cause of death or as a significant condition contributing to death. On a case-by-case basis, other evidence might be used to identify a COVID-19–related death (e.g., time from positive laboratory result to death, clinical history, medical records, or autopsy findings).

††† 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.

LTCF group declined 69% during the study period, from 1,932 per 100,000 at baseline (December 2020) to 594 during the comparison month (January 2022) (p<0.01), whereas among community-dwelling adults, this rate increased by nearly 8%, from 120 per 100,000 to 129 (Table). The ratio of the COVID-19 mortality rate among LTCF residents to that among community-dwelling adults decreased by 71%, from 16.1 to 4.6, during this period. In January 2022, 91% of LTCF residents and 85% of community-dwelling adults were fully vaccinated, and 75% and 61%, respectively, had received a booster dose; no one in either group was fully vaccinated in December 2020.

These findings are subject to at least three limitations. First, a decline in mortality risk for LTCF residents would be expected over time even in the absence of prevention efforts, because of the disproportionate loss of the most susceptible members of this group (*4*). Thus, it is not possible to distinguish how much of the decrease in the mortality rate ratio might be attributable to specific mitigation measures (e.g., vaccination of residents and LTCF staff members, testing programs, and mask use). Second, the disproportionate distribution of deaths by race and ethnicity (*5*) was not assessed because Illinois LTCF population data stratified by race and ethnicity are not available. Finally, it was not possible to examine more discrete age groups; compared with community-dwelling adults, the average age of LTCF residents was likely higher and probably included larger shifts in age distribution over the period examined.

Throughout the pandemic, IDPH led efforts to strengthen adherence to core infection prevention and control measures in LTCFs, consistent with CDC, Centers for Medicare & Medicaid Services, and department-issued guidelines.[§§§,¶¶¶,****] These measures included screening staff members for COVID-19 symptoms, retricting visitors, and rapidly identifying new cases through a combination of reverse transcription–polymerase chain reaction and rapid testing. Since March 2020, IDPH has been working with infection control specialists trained in long-term care procedures and processes to update LTCF COVID-19 guidelines; issue emergency rules; conduct weekly statewide webinars for local health departments, LTCF administrators, and clinical staff members; and deliver nearly 2,000 consultations for health departments and LTCFs on mask use, physical distancing, ventilation, and quarantine and isolation.

The COVID-19–associated mortality rate among Illinois LTCF residents aged ≥65 years declined markedly from December 2020 to January 2022, both in absolute terms and compared with the change in risk among community-dwelling adults. Vaccination coverage in January 2022 was high in both groups, suggesting that nonvaccine interventions also played a role in protecting LTCF residents. Uncontrolled variables, including differences in incidence and characteristics of virus strains circulating during those times, also likely had an effect.[††††,§§§§] These findings reinforce that COVID-19 prevention and control strategies, including vaccination, can substantially reduce COVID-19–associated mortality among LTCF residents.

§§§ https://www.cdc.gov/coronavirus/2019-ncov/hcp/nursing-home-long-term-care.html (Accessed May 24, 2022).
¶¶¶ https://www.cms.gov/nursing-homes/providers-partners/covid-19 (Accessed May 24, 2022).
**** https://dph.illinois.gov/covid19/community-guidance/long-term-care.html (Accessed May 24, 2022).

†††† https://www.cdc.gov/mmwr/volumes/71/wr/mm7104e4.htm
§§§§ https://www.cdc.gov/mmwr/volumes/71/wr/mm7106a4.htm?s_cid=mm7106a4_w

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TABLE. COVID-19–associated deaths in long-term care facility residents and community-dwelling adults* aged ≥65 years — Illinois, December 2020 and January 2022

Metric	December 2020			January 2022		
	Total	LTCF residents	Community-dwelling adults	Total	LTCF residents	Community-dwelling adults
No. of adults†	**2,040,107**	83,041	1,957,066	**2,040,107**	83,041	1,957,006
No. of deaths	**3,946**	1,604	2,342	**3,026**	493	2,533
Rate§	**193**	1,932	120	**148**	594	129
Rate ratio¶	**16.1**	—	—	**4.6**	—	—

Abbreviation: LTCF = long-term care facility.
* Adults who are not residents of an LTCF.
† Total number of adults obtained from the U.S. Census Bureau estimate for the overall Illinois population aged ≥65 years; total number of LTCF residents obtained by various methods, depending upon facility type; total number of community-dwelling adults obtained by subtracting the number of LTCF residents from the total population. For the purposes of this analysis, population estimates were assumed constant across the study period; the effects of actual differences on results and conclusions, if any, would be negligible.
§ Deaths per 100,000 persons aged ≥65 years.
¶ Rate in LTCF residents divided by rate in adults living in the community.

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Notes from the Field

Diagnosis and Investigation of Pneumonic Plague During a Respiratory Disease Pandemic — Wyoming, 2021

Allison W. Siu, DVM[1]; Courtney Tillman, MPH[2]; Clay Van Houten, MS[2]; Ashley Busacker, PhD[2,3]; Alexia Harrist, MD[2]

In September 2021, the Wyoming Department of Health (WDH) was notified of a suspected case of pneumonic plague in an adult who was admitted to a Wyoming hospital following a 48-hour history of worsening cough, dyspnea, and acute onset of hemoptysis. The patient reported no recent travel history or ill contacts but noted interacting with two pet cats that were ill. Health care providers initially suspected COVID-19 because of compatible symptoms, no history of COVID-19 vaccination, and increased SARS-CoV-2 (the virus that causes COVID-19) community transmission in Wyoming during this period.

Approximately 48 hours after symptom onset, the patient received a negative SARS-CoV-2 antigen test result at a provider's office. The patient was hospitalized later that day for worsening symptoms and received two negative SARS-CoV-2 laboratory-based nucleic acid amplification test results. Lung imaging was consistent with community-acquired pneumonia. Respiratory specimens tested negative for common viral pathogens on a respiratory panel. Within 48 hours of admission, the patient required mechanical ventilation and developed sepsis. The patient was treated for pneumonia and sepsis with azithromycin, piperacillin-tazobactam, and vancomycin. Seventy-two hours after the patient was admitted to the hospital, blood and sputum cultures did not indicate a causative pathogen. Because of the patient's history of exposure to cats that were ill, an infectious diseases specialist recommended repeating a sputum culture with Gram stain and empiric treatment with ciprofloxacin. Gram-negative bacilli were detected, and the Wyoming Public Health Laboratory subsequently confirmed *Yersinia pestis* as the pathogen.

WDH immediately conducted interviews to determine exposure source, identify close contacts requiring postexposure prophylaxis (PEP) (*1*), and guide public health prevention measures. Interviews with veterinary clinic staff members and review of records revealed that one cat had died from an undiagnosed severe illness after onset of respiratory symptoms; serologic testing of specimens from the surviving cat for *Y. pestis* by CDC was negative. WDH interviews with local animal control and state wildlife officials revealed no known epizootic near the patient's residence, which was in a rural area of Wyoming; however, both pet cats were known to spend time indoors and outdoors and were not treated with flea control products.

To guide PEP recommendations, WDH reviewed medical records, collaborated with hospital infection preventionists, and interviewed the patient's friends, family members, neighbors, and work colleagues. Twenty-two close contacts were identified (19 health care workers and three personal contacts). All received PEP within 1 week of the patient's symptom onset, and none developed illness. The patient recovered and was discharged 35 days after hospital admission.

Environmental assessment of the patient's residence was conducted by a professional pest management company. Plague prevention measures included flea mitigation and rodent habitat elimination to reduce abundance of potential flea-harboring rodents. WDH shared plague prevention materials by press release and disseminated educational materials to community members.

Y. pestis is reportable in Wyoming (*2*) and is endemic in rodents and their fleas statewide. Persons can become infected through the bite of an infected flea or contact with infected animals including pets (*3*), underscoring the importance of year-round flea control for pets. Pneumonic plague is the only clinical form of the disease that can be transmitted between persons through respiratory droplets and if left untreated is almost always fatal (*1*). This is the second case of primary pneumonic plague and the seventh of any form of plague in Wyoming's documented history. Nationwide, 18 cases of pneumonic plague were reported during 1942–2018 (*4*).

Rapid identification and diagnosis of *Y. pestis* is crucial for effective patient treatment and public health response. Despite the delay in diagnosis, WDH was able to rapidly coordinate timely public health intervention and effective community outreach. Furthermore, recognition of patient contact with cats that were ill was critical in prompting change to first-line antibiotic treatment effective against plague. Exposure to infected cats is a substantial plague risk in the United States (*5*), highlighting the importance of animal contact history during patient intake.

Overlooked diagnoses of rare pathogens can lead to significant consequences. This investigation highlights challenges associated with diagnosis and treatment of an illness from a rare pathogen whose symptoms mimic those of a pandemic illness, in this case, COVID-19. Timelier diagnosis might have resulted in initiation of effective antibiotic treatment closer to disease onset and decreased illness severity and hospitalization. Clinicians should be aware of the possibility of plague in patients with compatible symptoms and exposure history in areas where plague is endemic.

Acknowledgments

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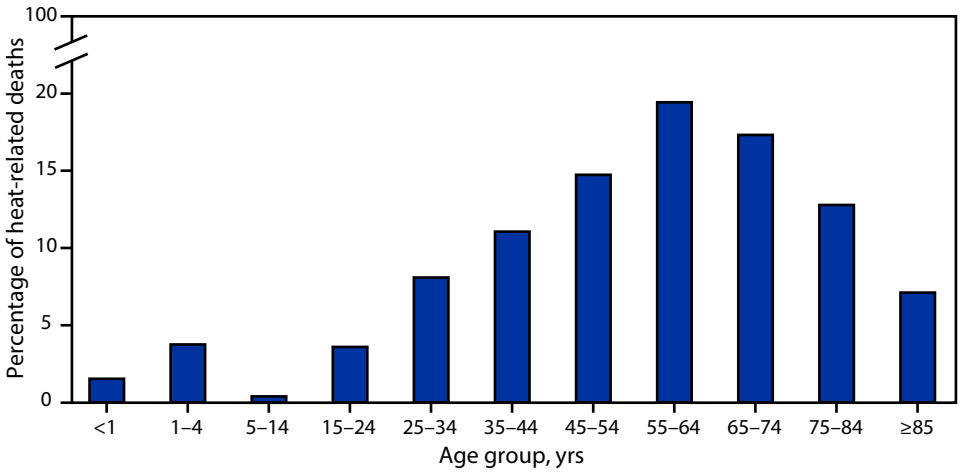
QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Percentage Distribution of Heat-Related Deaths,* by Age Group — National Vital Statistics System, United States, 2018–2020



* Deaths associated with exposure to natural heat were defined as deaths with any underlying or contributing causes of death having *International Classification of Diseases, Tenth Revision* codes X30, P81.0, or T67. Any records including code W92 ("Exposure to excessive heat of man-made origin") were excluded. In total, 3,066 heat-related deaths occurred during 2018–2020.

During 2018–2020, a total of 3,066 heat-related deaths occurred. The highest percentage of heat-related deaths occurred among persons aged 55–64 years (19%), and the lowest percentage occurred among those aged 5–14 years (1%). Among those aged 5–14 through aged 55–64 years, the percentage of heat-related deaths increased with age, then decreased through those aged ≥85 years (7%). Approximately 2% of heat-related deaths occurred among those aged <1 year and 4% among those aged 1–4 years.

Source: National Vital Statistics System, Multiple Cause-of-Death Data, 2018–2020. https://wonder.cdc.gov/mcd.html

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For more information on this topic, CDC recommends the following link: https://ephtracking.cdc.gov/Applications/heatTracker/

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*.

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