Centers for Disease Control and Prevention
MMWR
Morbidity and Mortality Weekly Report
Weekly / Vol. 70 / No. 22
June 4, 2021

Estimated Annual Number of HIV Infections — United States, 1981–2019

Karin A. Bosh, PhD[1]; H. Irene Hall, PhD[1]; Laura Eastham, MPH[1]; Demetre C. Daskalakis, MD[1]; Jonathan H. Mermin, MD[2]

The first cases of *Pneumocystis carinii* (*jirovecii*) pneumonia among young men, which were subsequently linked to HIV infection, were reported in the *MMWR* on June 5, 1981 (*1*). At year-end 2019, an estimated 1.2 million persons in the United States were living with HIV infection (*2*). Using data reported to the National HIV Surveillance System, CDC estimated the annual number of new HIV infections (incidence) among persons aged ≥13 years in the United States during 1981–2019. Estimated annual HIV incidence increased from 20,000 infections in 1981 to a peak of 130,400 infections in 1984 and 1985. Incidence was relatively stable during 1991–2007, with approximately 50,000–58,000 infections annually, and then decreased in recent years to 34,800 infections in 2019. The majority of infections continue to be attributable to male-to-male sexual contact (63% in 1981 and 66% in 2019). Over time, the proportion of HIV infections has increased among Black/African American (Black) persons (from 29% in 1981 to 41% in 2019) and among Hispanic/Latino persons (from 16% in 1981 to 29% in 2019). Despite the lack of a cure or a vaccine, today's HIV prevention tools, including HIV testing, prompt and sustained treatment, preexposure prophylaxis, and comprehensive syringe service programs, provide an opportunity to substantially decrease new HIV infections. Intensifying efforts to implement these strategies equitably could accelerate declines in HIV transmission, morbidity, and mortality and reduce disparities.

To estimate annual HIV incidence among persons aged ≥13 years in the United States during 1981–2019, CDC applied mathematical modeling to data reported to the National HIV Surveillance System. Three eras of HIV incidence estimates were used based on changes in methodology and available data (*3*,*4*).* The cumulative number of HIV infections over the period was estimated by summing annual incidence estimates. The distributions of HIV incidence were compared overall and by sex at birth, race/ethnicity, and transmission category for the period examined at the beginning (1981), at the peak number of annual infections (1984–1985), and at the end of the study period (2019). Trends in the annual number of HIV infections over the entire period were assessed for selected racial/ethnic groups and transmission categories.† For racial/ethnic groups, only trends among Black, Hispanic/Latino, and White persons were described.§ Increases or decreases in the numbers and proportions are reported for relative changes of ≥5%.

* HIV incidence estimates for 1981–2006 were derived from the extended back-calculation approach applied to HIV surveillance data reported to CDC through June 2007. HIV incidence in 2007 was estimated using the stratified extrapolation approach applied to HIV surveillance data reported to CDC through June 2011 (https://www.cdc.gov/hiv/pdf/library/reports/surveillance/cdc-hiv-surveillance-supplemental-report-vol-17-4.pdf). HIV incidence estimates during 2008–2019 were derived from the CD4 model applied to HIV surveillance data reported to CDC through December 2020.

† Transmission categories were assigned on the basis of sex at birth, regardless of gender identity.

§ Trends were not assessed for racial/ethnic groups other than White, Black, and Hispanic/Latino because of changes in data collection that were required in 2003 to align with revised standards for classification of federal data on race and ethnicity for other racial categories, as well as the small number of infections.

INSIDE

807 COVID-19 Severity and COVID-19–Associated Deaths Among Hospitalized Patients with HIV Infection — Zambia, March–December 2020
811 Impact of Policy and Funding Decisions on COVID-19 Surveillance Operations and Case Reports — South Sudan, April 2020–February 2021
818 Patterns in COVID-19 Vaccination Coverage, by Social Vulnerability and Urbanicity — United States, December 14, 2020–May 1, 2021
825 Excess Death Estimates in Patients with End-Stage Renal Disease — United States, February–August 2020
830 QuickStats

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

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

During 1981–2019, there were an estimated 2.2 million new HIV infections among persons aged ≥13 years in the United States. The estimated number of infections increased from 20,000 in 1981 (Figure 1) to 130,400 in 1984 and 1985, then declined rapidly to between 84,200 and 84,800 annually during 1986–1990. HIV incidence remained relatively stable from 1991 to 2007, with about 50,000 to 58,000 infections per year, and declined in recent years to an estimated 34,800 in 2019. HIV incidence decreased by 73% from the highest annual number of infections (130,400 in 1984 and 1985) to 34,800 in 2019.

A larger proportion of infections occurred among females in 2019 (18%) than did in 1981 (8%) or in 1984–1985 (12%). The number of HIV infections among White persons decreased during 1985–2019 (Table) (Figure 2) and the proportion of infections among White persons decreased from 56% in 1981 to 25% in 2019. The number of infections among Black persons increased during 1981–1990 and then decreased through 2019. In 1988, the number of infections among Black persons surpassed the number among White persons and remained higher than in any other racial/ethnic group through 2019. Black persons accounted for 29% of infections in 1981, 30% of infections in 1984–1985, and 41% of infections in 2019. Hispanic/Latino persons represented 16% of infections in 1981, 14% of infections in 1984–1985, and 29% of infections in 2019.

Male-to-male sexual contact accounted for more than one half of infections in all years except during 1988–2002, when infections attributed to heterosexual contact increased. The proportion of infections attributed to male-to-male sexual contact or male-to-male sexual contact and injection drug use was 75% in 1981, 67% in 1984–1985, and 70% in 2019. The proportion of infections attributed to heterosexual contact was higher in 2019 (22%) than in 1981 (2%) or in 1984–1985 (6%), whereas the proportion of infections among persons who inject drugs was lower in 2019 (7%) than in 1981 (22%) or in 1984–1985 (25%).

Discussion

Since the peak of the HIV epidemic, models show that incidence decreased substantially, from 130,400 in the mid-1980s to 34,800 in 2019. However, disparities continue, and some have worsened over time. For example, in 2019, Black persons accounted for 41% of new HIV infections but for only 12% of the U.S. population.¶ Hispanic/Latino persons accounted for 29% of new HIV infections in 2019, although they represent 17% of the population. Infections among men who have sex with men, including those who inject drugs, accounted for 70% of infections in 2019, but men who have sex with men account for only an estimated 2% of the

¶ https://www.census.gov/programs-surveys/popest/data/data-sets.html

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

Suggested citation: [Author names; first three, then et al., if more than six.] [Report title]. MMWR Morb Mortal Wkly Rep 2021;70:[inclusive page numbers].

Centers for Disease Control and Prevention

Rochelle P. Walensky, MD, MPH, *Director*
Anne Schuchat, MD, *Principal Deputy Director*
Daniel B. Jernigan, MD, MPH, *Acting Deputy Director for Public Health Science and Surveillance*
Rebecca Bunnell, PhD, MEd, *Director, Office of Science*
Jennifer Layden, MD, PhD, *Deputy Director, Office of Science*
Michael F. Iademarco, MD, MPH, *Director, Center for Surveillance, Epidemiology, and Laboratory Services*

***MMWR* Editorial and Production Staff (Weekly)**

Charlotte K. Kent, PhD, MPH, *Editor in Chief*
Jacqueline Gindler, MD, *Editor*
Brian A. King, PhD, MPH, *Guest Science Editor*
Paul Z. Siegel, MD, MPH, *Associate Editor*
Mary Dott, MD, MPH, *Online Editor*
Terisa F. Rutledge, *Managing Editor*
Teresa M. Hood, MS, *Lead Technical Writer-Editor*
Glenn Damon, Soumya Dunworth, PhD,
Srila Sen, MA, Stacy Simon, MA,
Jeffrey D. Sokolow, MA,
Technical Writer-Editors

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

Ian Branam, MA, Ginger Redmon, MA,
Co-Acting Lead Health Communication Specialists
Shelton Bartley, MPH,
Lowery Johnson, Amanda Ray,
Jacqueline N. Sanchez, MS,
Health Communication Specialists
Will Yang, MA,
Visual Information Specialist

***MMWR* Editorial Board**

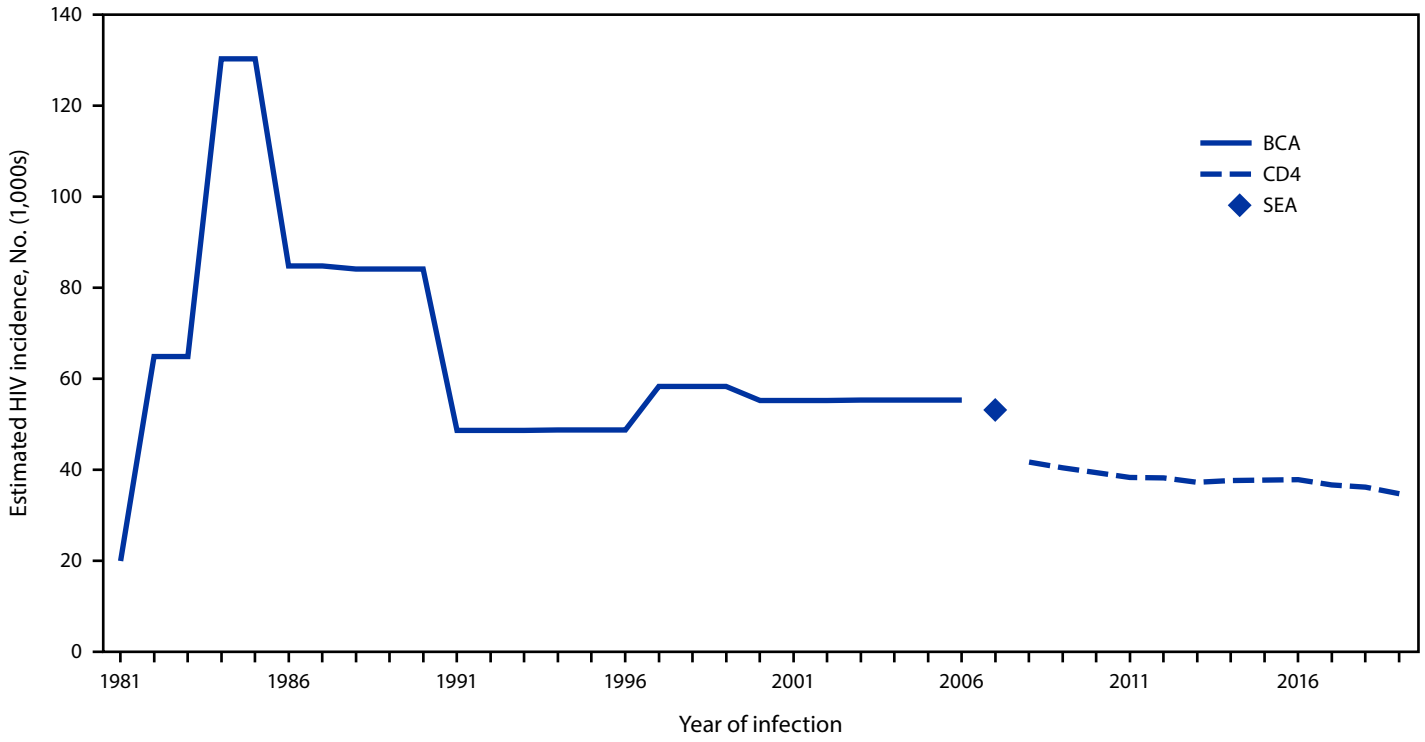
Timothy F. Jones, MD, *Chairman*

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

William E. Halperin, MD, DrPH, MPH
Christopher M. Jones, PharmD, DrPH, MPH
Jewel Mullen, MD, MPH, MPA
Jeff Niederdeppe, PhD
Celeste Philip, MD, MPH
Patricia Quinlisk, MD, MPH

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

FIGURE 1. Estimated HIV incidence* among persons aged ≥13 years — United States, 1981–2019



Abbreviations: BCA = back-calculation approach; CD4 = CD4+ T-lymphocyte model; SEA = stratified extrapolation approach.
* HIV incidence estimates for 1981–2006 were derived from the extended BCA applied to HIV surveillance data reported to CDC through June 2007. HIV incidence in 2007 was estimated using the SEA applied to HIV surveillance data reported to CDC through June 2011. HIV incidence estimates during 2008–2019 were derived from the CD4 model applied to HIV surveillance data reported to CDC through December 2020.

population (*5*). Transgender women also are significantly at risk for HIV infection; a recent CDC report found that four in 10 transgender women surveyed in seven major U.S. cities have HIV infection.**

During the past 4 decades, the largest relative reduction in HIV incidence occurred among persons who inject drugs; incidence decreased 93% from the highest annual number, 34,500 in 1988–1990, to 2,500 in 2019. Incidence has not decreased during the past decade, likely, in part, because of the opioid epidemic, which is associated with increased drug use and needle sharing.†† The decrease in injection drug use–associated HIV infections followed the implementation of syringe service programs, which have been widely shown to be effective in preventing transmission of HIV.§§ However, syringe service programs are not available in all areas.

A major factor in the reduction of HIV infection has been the participation of persons that have or are at risk for HIV, community activists, scientists, politicians, and public health officials in steering the national and community response to this epidemic (*6*). Communication and collaboration between these groups has resulted in a more robust, equitable, and effective response.

Reductions in incidence during 1981–2019 likely reflect increased availability of and access to HIV diagnostics, including high throughput laboratory-based technology, point-of-care tests, and over-the-counter test kits; implementation of routine HIV screening and antiretroviral therapy regardless of immune status or disease stage; and programmatic efforts to increase linkage to care, re-engagement in care, behavior change, use of pre- and postexposure prophylaxis, and syringe service programs. Efforts to increase availability of and access to HIV diagnostics have led to an increase in the proportion of estimated persons living with HIV who know their status.¶¶ The effectiveness of antiretroviral therapy has improved substantially, and sustained viral suppression prevents sexual transmission of HIV. Today, persons who receive an HIV diagnosis soon after infection and who maintain viral suppression have a nearly normal lifespan (*7*).

** https://www.cdc.gov/hiv/pdf/library/reports/surveillance/cdc-hiv-surveillance-special-report-number-27.pdf
†† https://www.cdc.gov/pwid/opioid-use.html
§§ https://www.federalregister.gov/documents/2011/02/23/2011-3990/determination-that-a-demonstration-needle-exchange-program-would-be-effective-in-reducing-drug-abuse
¶¶ https://www.cdc.gov/nchhstp/atlas/index.htm

TABLE. Estimated HIV incidence among persons aged ≥13 years, by selected characteristics — United States, 1981, 1984–1985, and 2019

Characteristic	No. (%)		
	1981*	1984–1985*	2019†
Sex at birth			
Male	18,600 (93)	115,500 (89)	28,400 (82)
Female	1,500 (8)	15,100 (12)	6,400 (18)
Race/Ethnicity			
American Indian/ Alaska Native	0 (—)	400 (0)	230§ (1§)
Asian¶	N/A	N/A	550 (2)
Asian/Pacific Islander¶	0 (—)	900 (1)	N/A
Black/African American	5,800 (29)	38,800 (30)	14,300 (41)
Hispanic/Latino**	3,100 (16)	18,200 (14)	10,200 (29)
Native Hawaiian/ Other Pacific Islander¶	N/A	N/A	—††
White	11,100 (56)	72,100 (55)	8,600 (25)
Multiple races¶	N/A	N/A	900 (3)
Transmission category§§			
Male-to-male sexual contact	12,500 (63)	75,800 (58)	23,100 (66)
Injection drug use	4,400 (22)	32,000 (25)	2,500 (7)
Male-to-male sexual contact and injection drug use	2,400 (12)	11,400 (9)	1,400 (4)
Heterosexual contact¶¶	400 (2)	8,000 (6)	7,800 (22)
Total	**20,000 (100)**	**130,400 (100)**	**34,800 (100)**

Abbreviation: N/A = not applicable.

* Estimates derived from the extended back-calculation model applied to HIV surveillance data reported to CDC through June 2007. Estimates are rounded to the nearest 100 and subtotals for sex at birth and transmission category do not sum to the overall total. Percentages were calculated using rounded estimates and might not sum to 100%. The highest numbers of annual HIV infections during 1981–2019 occurred in 1984–1985.

† Estimates derived from the CD4+ T-lymphocyte model applied to HIV surveillance and CD4 data reported to CDC through December 2020. Estimates rounded to the nearest 100 for estimates >1,000 and to the nearest 10 for estimates ≤1,000 to reflect model uncertainty. Percentages were calculated using rounded estimates and might not sum to 100%.

§ Estimate with a relative standard error of 30%–50%; estimate should be used with caution.

¶ HIV surveillance data collection requirements for race and ethnicity changed in 2003 to align with the revisions to the standards for the classification of federal data on race and ethnicity mandated by the Office of Management and Budget. In 1981, multiple racial categories could not be collected for a person and data for all Asian and Pacific Islander persons were collected as a single racial category. In 2019, multiple racial categories could be collected for a person and data for Asian persons were collected separately from Native Hawaiian and other Pacific Islander persons.

** Hispanic/Latino persons can be of any race.

†† Estimates with a relative standard error of >50% are not shown.

§§ Transmission categories assigned on the basis of sex at birth and include transgender persons. Data by transmission category have been adjusted to account for missing risk-factor information.

¶¶ Heterosexual contact with a person known to have, or with a risk factor for, HIV infection.

Preexposure prophylaxis (i.e., antiretroviral medication taken before potential exposure to prevent infection) has considerable promise in further decreasing HIV incidence, and medication is >99% effective in preventing acquisition of HIV when taken as prescribed. However, only 23% of persons who could benefit from preexposure prophylaxis were using it in 2019 (*2*). Racial and ethnic disparities in preexposure prophylaxis prescribing are pronounced; preexposure prophylaxis was prescribed for 63% of the estimated number of White persons who could benefit from it but was prescribed for only 8% of Black persons and 14% of Hispanic/Latino persons who could benefit from it. Prevention tools are increasingly effective, but they need to reach the populations most affected.

Gaps in service access and other social and economic determinants, including stigma and discrimination, are ongoing obstacles that hinder adherence to antiretroviral therapy and viral suppression, and thereby perpetuate disparities. The Ryan White Care Program, which provides comprehensive HIV primary medical care, support services, and medications for low-income persons with HIV infection, is an example of how an integrated program can reduce disparities in viral suppression across populations (*8*).

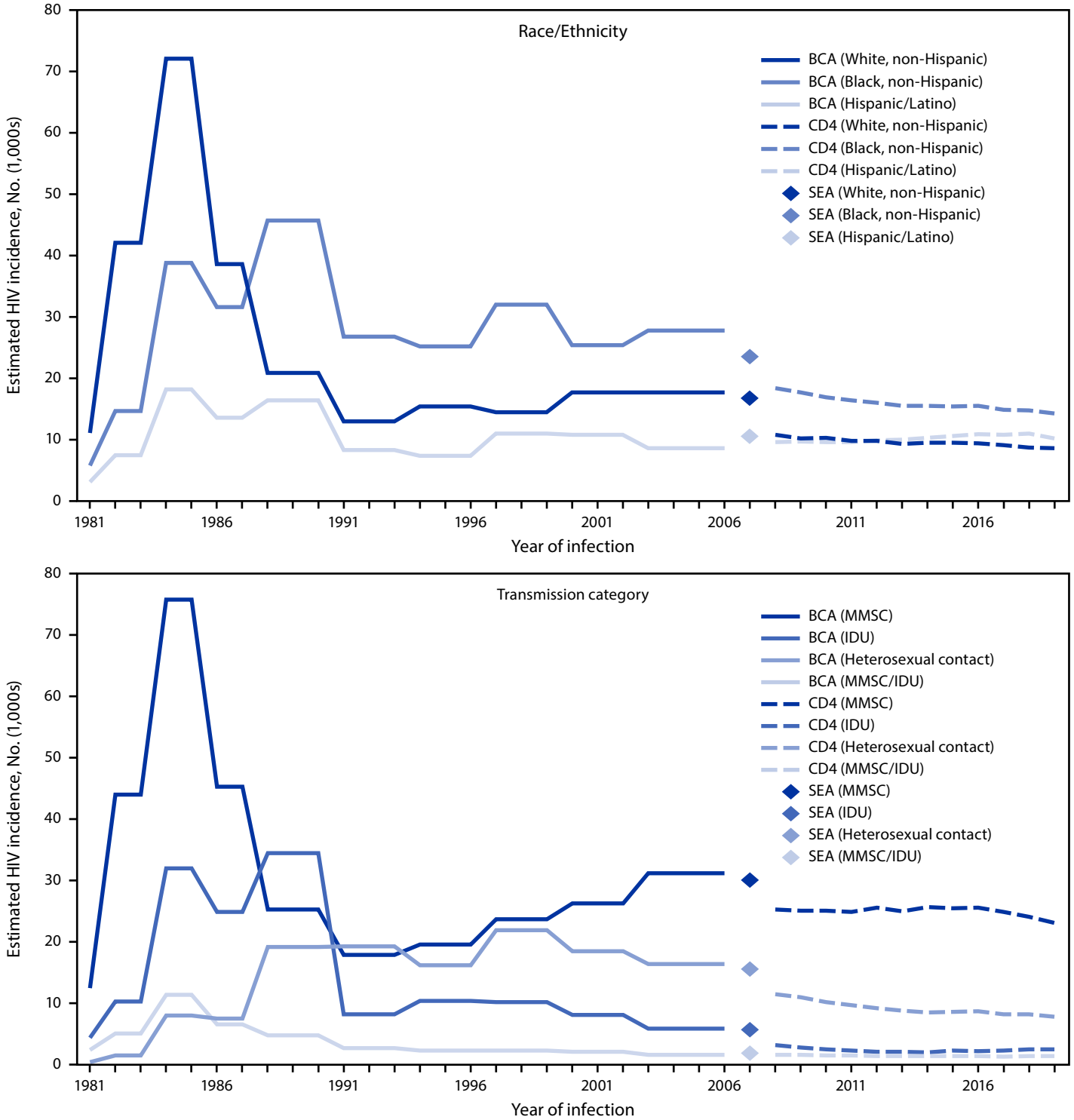
Underlying causes for many disparities highlight the importance of social and economic determinants of health. Efforts to end the HIV epidemic that center on accelerating implementation of treatment and prevention technology can do so more effectively by focusing on root social causes of these well-documented HIV-related disparities. These systemic barriers, which include systemic racism, poverty, homelessness, discrimination, homophobia, and transphobia, impede access to testing, treatment, and prevention services and drive inequity (*9*).

The findings in this report are subject to at least three limitations. First, three mathematical models were used to estimate incidence over different portions of the analysis period. Each model is subject to assumptions that might result in different estimates of incidence; however, a previous analysis of HIV incidence from 2008–2013 using three models found incidence trends were generally corroborated across the models (*10*). Second, the back-calculation approach, which was used to estimate incidence for 1981–2006, did not produce single-year estimates, but rather average estimates over a 2- to 4-year interval. Therefore, year-to-year changes in HIV incidence cannot be assessed through 2006. Finally, estimates derived from all three models are subject to uncertainty attributable to assumptions such as accurate diagnosis dates, accuracy of models to identify diagnosis delays, and the impact of migration. However, trend data comparing subpopulations is likely to be robust for each period examined.

The prevention tools available today, including HIV testing, prompt and sustained treatment, preexposure prophylaxis, and comprehensive syringe service programs, as well as new technologies being developed, such as long-acting antiretroviral agents, self-testing, and telemedicine, provide an opportunity to substantially decrease new HIV infections.*** Ongoing priorities should include maximizing critical partnerships, implementing treatment and prevention services at scale, and ensuring a focus on decreasing disparities. Ending the HIV

*** https://www.cdc.gov/HIV/basics/prevention.html

FIGURE 2. Estimated HIV incidence* among persons aged ≥13 years, by selected race/ethnicity† and transmission category§ — United States, 1981–2019



Abbreviations: BCA = back-calculation approach; CD4 = CD4+ T-lymphocyte model; IDU = injection drug use; MMSC = male-to-male sexual contact; SEA = stratified extrapolation approach.

* HIV incidence estimates for 1981–2006 were derived from the extended BCA applied to HIV surveillance data reported to CDC through June 2007. HIV incidence in 2007 was estimated using the SEA applied to HIV surveillance data reported to CDC through June 2011. HIV incidence estimates during 2008–2019 were derived from the CD4 model applied to HIV surveillance data reported to CDC through December 2020.

† Hispanic/Latino persons can be of any race.

§ Transmission categories assigned on the basis of sex at birth and include transgender persons. Data by transmission category have been adjusted to account for missing risk-factor information.

Summary

What is already known about this topic?

HIV incidence decreased from the 1980s through 2019.

What is added by this report?

HIV incidence decreased by 73% from the highest number of infections (130,400) in 1984 and 1985 to 34,800 in 2019. A larger proportion of infections was among Black/African American and Hispanic/Latino persons in 2019 than in 1981.

What are the implications for public health practice?

HIV treatment and prevention services should be tailored to the most affected communities and their service providers and address social and economic obstacles contributing to HIV-related health disparities. Ending the HIV epidemic requires equitable implementation of prevention tools to diagnose HIV infection early, treat persons with HIV to rapidly achieve viral suppression, and link persons to preventive services.

epidemic requires addressing health disparities. Equitable implementation of prevention tools to diagnose HIV infection early, treat persons with HIV to rapidly achieve viral suppression, and link persons to preventive services to reduce new transmissions will hasten the decrease in HIV incidence.

Acknowledgment

Ruiguang Song, CDC.

Corresponding author: Karin A. Bosh, hxx8@cdc.gov, 404-639-3615.

[1]Division of HIV/AIDS Prevention, National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention, CDC; [2]National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention, CDC.

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

References

1. CDC. Pneumocystis pneumonia—Los Angeles. MMWR Morb Mortal Wkly Rep 1981;30:250–2. PMID:6265753 https://www.cdc.gov/mmwr/preview/mmwrhtml/lmrk077.htm
2. CDC. HIV surveillance data tables. Vol 2, no. 2. Core indicators for monitoring the Ending the HIV Epidemic initiative (early release): National HIV Surveillance System data reported through December 2020; and preexposure prophylaxis (PrEP) data reported through September 2020. Atlanta, GA: US Department of Health and Human Services, CDC; 2021. https://www.cdc.gov/hiv/library/reports/surveillance-data-tables/vol-2-no-2/index.html
3. Hall HI, Song R, Rhodes P, et al.; HIV Incidence Surveillance Group. Estimation of HIV incidence in the United States. JAMA 2008;300:520–9. PMID:18677024 https://doi.org/10.1001/jama.300.5.520
4. Song R, Hall HI, Green TA, Szwarcwald CL, Pantazis N. Using CD4 data to estimate HIV incidence, prevalence, and percent of undiagnosed infections in the United States. J Acquir Immune Defic Syndr 2017;74:3–9. PMID:27509244 https://doi.org/10.1097/QAI.0000000000001151
5. Purcell DW, Johnson CH, Lansky A, et al. Estimating the population size of men who have sex with men in the United States to obtain HIV and syphilis rates. Open AIDS J 2012;6:98–107. PMID:23049658 https://doi.org/10.2174/1874613601206010098
6. Killen J, Harrington M, Fauci AS. MSM, AIDS research activism, and HAART. Lancet 2012;380:314–6. PMID:22819655 https://doi.org/10.1016/S0140-6736(12)60635-7
7. Samji H, Cescon A, Hogg RS, et al. North American AIDS Cohort Collaboration on Research and Design (NA-ACCORD) of IeDEA. Closing the gap: increases in life expectancy among treated HIV-positive individuals in the United States and Canada. PLoS One 2013;8:e81355. PMID:24367482 https://doi.org/10.1371/journal.pone.0081355
8. Mandsager P, Marier A, Cohen S, Fanning M, Hauck H, Cheever LW. Reducing HIV-related health disparities in the Health Resources and Services Administration's Ryan White HIV/AIDS Program. Am J Public Health 2018;108(Suppl 4):S246–50. PMID:30383416 https://doi.org/10.2105/AJPH.2018.304689
9. Andrasik M, Broder G, Oseso L, Wallace S, Rentas F, Corey L. Stigma, implicit bias, and long-lasting prevention interventions to end the domestic HIV/AIDS epidemic. Am J Public Health 2020;110:67–8. PMID:31800273 https://doi.org/10.2105/AJPH.2019.305454
10. Hall HI, Song R, Tang T, et al. HIV trends in the United States: diagnoses and estimated incidence. JMIR Public Health Surveill 2017;3:e8. PMID:28159730 https://doi.org/10.2196/publichealth.7051

COVID-19 Severity and COVID-19–Associated Deaths Among Hospitalized Patients with HIV Infection — Zambia, March–December 2020

Duncan Chanda, MBChB[1]; Peter A. Minchella, PhD[2]; Davies Kampamba, MPH[1]; Megumi Itoh, MD[2]; Jonas Z. Hines, MD[2]; Sombo Fwoloshi, MMed[1]; Mary Adetinuke Boyd, MD[2]; Kalongo Hamusonde, MSc[2]; Lameck Chirwa, MSc[1]; Kotey Nikoi[1]; Robert Chirwa[1]; Mpanji Siwingwa, MPH[1]; Suilanji Sivile, MMed[1]; Khozya D. Zyambo, MMed[1]; Aggrey Mweemba, MMed[1]; Nyuma Mbewe, MBChB[1]; Katongo H. Mutengo, MMed[1]; Kennedy Malama, MBChB[1]; Simon Agolory, MD[2]; Lloyd B. Mulenga, MD, PhD[1]

The effect of HIV infection on COVID-19 outcomes is unclear. Studies in South Africa (*1*) and the United Kingdom (*2*) found an independent association between HIV infection and COVID-19 mortality; however, other studies have not found an association between poor COVID-19 outcomes and either HIV status among hospitalized patients (*3*–*5*) or HIV-associated factors such as CD4 count, viral load, or type of antiretroviral therapy (ART) (*6*). The effect of HIV infection on COVID-19 outcomes remains an urgent question in sub-Saharan Africa, where many countries are experiencing dual HIV and COVID-19 epidemics, and capacity to treat severe COVID-19 is limited. Using data from patients with probable or confirmed COVID-19 admitted to specialized treatment centers during March–December 2020 in Zambia, the Zambian Ministry of Health and CDC assessed the relationship between HIV infection and severe COVID-19 and COVID-19–associated death. Among 443 patients included in the study, 122 (28%) were HIV-positive, and of these, 91 (89%) were receiving ART at the time of hospitalization. HIV status alone was not significantly associated with severe COVID-19 at admission or during hospitalization or with COVID-19–associated death. However, among HIV-positive persons, those with severe HIV disease were more likely to develop severe COVID-19 and were at increased risk for COVID-19–associated death. Ensuring that persons maintain HIV disease control, including maintaining ART continuity and adherence, achieving viral suppression, and addressing and managing underlying medical conditions, could help reduce COVID-19–associated morbidity and mortality in sub-Saharan Africa.

Zambia is a landlocked country in southeastern Africa, with an estimated population of 17.4 million* and a generalized HIV/AIDS epidemic with HIV prevalence among persons aged ≥15 years of 12.1% (*7*). Beginning in March 2020, patients with a diagnosis of probable or laboratory-confirmed COVID-19 in Zambia were admitted to one of five Zambia Ministry of Health specialized COVID-19 treatment centers located in the capital city of Lusaka (two treatment centers) and in Ndola, Kabwe, and Livingstone. Confirmed cases were those with positive reverse transcription–polymerase chain reaction or rapid antigen test results for SARS-CoV-2, the virus that causes COVID-19. Patients with diagnosed probable cases had radiologic evidence suggestive of COVID-19 with acute respiratory symptoms. Treatment centers have specifically designated isolation and treatment units staffed by clinicians and nurses trained in COVID-19 clinical management. All patients who received medical care for COVID-19 in these centers during March–December 2020 and who provided verbal consent to receive treatment were enrolled in the COVID-19 clinical outcomes study. Patient demographic, clinical, and survival time data were collected during hospitalization until patients died or were discharged. Data were primarily collected electronically in real time by trained staff members using a standardized case record form†; among patients who had received COVID-19 care before the start of data collection, medical records were reviewed and abstracted into the case record form. Study staff members contacted discharged patients by telephone 28 days after admission to determine their health status.

Severe COVID-19 was defined as having an oxygen saturation <90%, respiratory rate >30 breaths/minute, or a need for oxygen therapy.§ COVID-19 severity was assessed at admission and during hospitalization. HIV status was self-reported, and patients with unknown status or deemed eligible and consented for testing were tested at admission. Underlying medical conditions were self-reported and included cardiac disease, hypertension, diabetes, other pulmonary disease, active tuberculosis (TB), previous TB, asthma, kidney disease, liver disease, neurologic disorder, asplenia, malignant neoplasm, and current smoking. The number of underlying conditions was summed for each patient. Patients with severe HIV disease were defined as those meeting one or more of the following criteria: 1) severely anemic (hemoglobin <8.0 g/dL); 2) CD4 <200 cells/μL; 3) active TB, including patients taking anti-TB medication; or 4) underweight (body mass index [BMI] <18.5 kg/m^2). HIV-positive patients who did not meet any of the conditions were considered to have controlled HIV infection.

* https://www.cia.gov/the-world-factbook/static/16a49aca1982c8b59274c8eb0cf6ff0b/ZA-summary.pdf

† https://www.who.int/teams/health-care-readiness-clinical-unit/covid-19/data-platform

§ https://apps.who.int/iris/rest/bitstreams/1328457/retrieve

The three primary outcomes assessed in the study were 1) severe COVID-19 at admission; 2) severe COVID-19 during hospitalization; and 3) death. Mixed-effects logistic regression models were used to assess associations between exposure variables (age, sex, number of underlying conditions, and HIV status) and the two severe COVID-19 outcomes (at admission and during hospitalization). Mixed-effects Cox proportional hazards regression models were used to examine time to COVID-19–associated death in relation to exposure variables. All models included a random-effects term for treatment center, and other covariates were sex, age, and number of underlying health conditions. Cox models were also adjusted for COVID-19 severity at admission. Similar mixed-effects logistic regression and mixed-effects Cox proportional hazards models were used to assess COVID-19 outcomes among HIV-positive persons stratified by HIV infection control status; covariates in these models included sex, age, and treatment center (random effects term). Data were analyzed using R (version 4.0.2; R Foundation). An alpha level of 0.05 was used to assess statistical significance. The study protocol was approved by the University of Zambia Biomedical Research Ethics Committee, reviewed by CDC, and conducted consistent with applicable federal law and CDC policy.[¶]

Among 612 hospitalized patients who were eligible for the study, 443 (72%) had HIV status recorded. Among those patients, 122 (28%) were HIV-positive, and among the 102 HIV-positive persons who provided information on ART status, 91 (89%) were receiving ART (Table 1). Although sex and mean age did not differ by HIV status, among HIV-negative patients, the proportion of those aged ≥60 years was higher than the proportion of those aged <60 years (p = 0.002). HIV-positive patients also were more likely to be anemic (defined as hemoglobin [Hb] <12 g/dL for women and Hb <13 g/dL for men) (p<0.001) or severely anemic (Hb <8 g/dL) (p = 0.004) and to report having two or more underlying medical conditions than were HIV-negative patients (p = 0.017).

Age ≥60 years and having two or more underlying medical conditions were associated with severe COVID-19; however, HIV status alone was not associated with severe COVID-19 at admission or during hospitalization (Table 2). Similarly, male sex, age ≥60 years, and reporting two or more underlying medical conditions were significantly associated with COVID-19–associated death, but HIV status was not. However, among HIV-infected patients, compared with patients with controlled HIV, severe HIV disease was associated with severe COVID-19 at admission (adjusted odds ratio [aOR] = 3.91; 95% confidence interval [CI] = 1.69–9.69) or during hospitalization (aOR = 4.42; 95% CI = 1.83–11.66) and with increased COVID-19–associated death (aOR = 3.27; 1.21–8.79).

Discussion

HIV infection was not independently associated with worse outcomes among patients hospitalized for COVID-19 in Zambia. This finding is consistent with results from smaller studies among hospitalized patients in North America (*3*), Europe (*4*), and South Africa (*5*). However, among HIV-positive patients hospitalized for COVID-19, those with severe HIV disease were more likely to develop severe COVID-19 or to die of COVID-19 compared with those with controlled HIV disease. Ensuring that HIV-positive persons maintain disease control, including sustaining ART continuity and adherence, achieving viral suppression (<1,000 copies of HIV RNA per mL), and addressing underlying medical conditions, could reduce COVID-19–associated morbidity and mortality in sub-Saharan Africa, including Zambia.

The relationship between severe HIV disease and poor COVID-19 outcomes underscores the importance of Zambia's progress toward ending the HIV epidemic and of efforts to maintain HIV services during the COVID-19 pandemic. As of June 2020, approximately 90% of an estimated 1.2 million HIV-positive Zambians were receiving ART, and nearly 90% of those patients were virally suppressed (*7*). In addition, since 2019, approximately 350,000 HIV-positive Zambians have completed a course of TB preventive treatment.[**] Since the first COVID-19 cases were detected in Zambia in March 2020, the national HIV program has made a concerted effort to continue to identify persons with new HIV infections and initiate ART as part of routine HIV case management. To ensure that all patients receiving ART have safe and uninterrupted access to treatment, the national program also took steps to accelerate dispensation of multimonth ART prescriptions for stable patients (K Mweebo, CDC, unpublished data, 2021). These efforts might have helped some HIV-positive patients adhere to ART and possibly avoid more severe COVID-19 as well as complications from HIV. However, there is still much that remains unknown about the impact of COVID-19 on persons living with HIV infection.

The findings in this report are subject to at least three limitations. First, the small sample size might have contributed to the absence of a significant association between HIV status and COVID-19 outcomes. Whereas cohort studies with larger populations in South Africa (*1*) and the United Kingdom (*2*) reported that HIV-positive persons were at increased risk for COVID-19–associated death, smaller studies among

[¶] 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.

[**] U.S. President's Emergency Plan for AIDS Relief data for Zambia. https://data.pepfar.gov/

TABLE 1. Demographic and clinical characteristics of persons hospitalized for confirmed or probable COVID-19 (N = 443),* by HIV status — Zambia, March–December 2020

Characteristic	No. (%) HIV-negative (n = 321)	No. (%) HIV-positive (n = 122)	p-value†
Confirmed SARS-CoV-2 infection§	238 (74)	87 (71)	0.69
Demographic			
Male	190 (59)	64 (52)	0.24
Mean age, yrs (SD)	48.9 (18.1)	46.4 (12.9)	0.11
<15	4 (1)	0 (—)	
15–34	71 (22)	21 (17)	
35–49	99 (31)	53 (43)	
50–59	46 (14)	28 (23)	
≥60	101 (31)	20 (16)	0.002
HIV-positive patient indicator of disease control			
On ART¶	N/A	91 (89)**	—
VL <1,000 copies of HIV RNA/mL	N/A	24 (86)**	—
CD4 ≥200 cells/μL	N/A	16 (50)**	—
Anemia††	84 (37)**	49 (69)**	<0.001
Underweight (BMI <18.5 kg/m^2)	12 (6)**	10 (15)**	0.059
Laboratory value			
Severe anemia§§	10 (4)**	11 (15)**	0.004
Median WBC (IQR)	7.42 (5.12–11.1)	7.32 (4.5–12)	0.55
WBC <4 IU	23 (10)**	11 (16)**	0.25
CRP >30 mg/L	62 (51)**	28 (62)**	0.26
Underlying medical condition¶¶			
None	154 (48)	54 (44)	0.017†
1	101 (31)	29 (24)	
≥2	66 (21)	39 (32)	
Diabetes	46 (14)	18 (15)	1.00
Hypertension	114 (36)	32 (26)	0.081
Active tuberculosis	5 (2)	16 (13)	<0.001
Outcome			
Severe COVID-19*** at admission	176 (55)	62 (51)	0.52
Severe COVID-19*** during hospitalization	188 (59)	68 (56)	0.52
Died	61 (19)	17 (14)	0.27

Abbreviations: ART = antiretroviral therapy; BMI = body mass index; CRP = C-reactive protein; Hb = hemoglobin; IQR = interquartile range; IU = international units; N/A = not applicable; SD = standard deviation; TB = tuberculosis; VL = viral load; WBC = white blood cell count.

* Reported as number (%) unless indicated otherwise. Denominator is total number by HIV status unless indicated otherwise. HIV status was self-reported and confirmed by HIV test at hospital admission (if the patient specifically consented to an HIV test).

† P-values <0.05 were considered statistically significant. Comparison of proportions was via chi-square test, comparison of normally distributed variables was via Welch's two sample t-test, and comparison of nonnormally distributed variables was via Wilcoxon test. P-values for age ≥60 years and two or more comorbidities are for binary variables (i.e., <60 versus ≥60 years and less than two versus two or more comorbidities).

§ COVID-19 cases were confirmed via SARS-CoV-2 reverse transcription–polymerase chain reaction or SARS-CoV-2 antigen detecting rapid diagnostic test. Probable cases had acute respiratory symptoms with radiological evidence that was suggestive of COVID-19.

¶ ART status was self-reported.

** Denominator was less than the total number by HIV status.

†† Anemia was defined as Hb <12 g/dL for women and Hb <13 g/dL for men.

§§ Severe anemia was defined as Hb <8 g/dL.

¶¶ Comorbidities composite term is based on the number of self-reported comorbidities. Eligible comorbidities included chronic cardiac disease, hypertension, pulmonary disease, active TB, previous TB, asthma, kidney disease, liver disease, neurologic disorder, diabetes, current smoking, asplenia, and malignant neoplasm. Conditions commonly linked to COVID-19 severity (diabetes and hypertension) and related to HIV (active TB) are listed in the table.

*** Severe COVID-19 was defined as one or more of the following conditions: oxygen saturation <90%, respiratory rate >30 breaths/minute, and need for oxygen therapy.

hospitalized patients (including the current study) have not (*3*–*5*). Second, differences in findings between these two types of studies might also be attributable to collider bias (wherein HIV and COVID-19 might independently lead to hospitalization, distorting the association between the conditions) (*8*), which might also limit the generalizability of these findings beyond hospitalized patients. Finally, as with many studies conducted during emergency responses, data completeness was a limitation because clinicians who were responsible for data collection were also responding to other urgent demands at the COVID-19 treatment centers. Approximately one quarter of eligible patients were excluded from the study because critical information about them was missing; moreover, some data, including CD4 counts and HIV viral load testing results, were sparse among included patients.

The findings from this study indicate that HIV-positive persons with severe HIV disease appear to be more likely to develop severe COVID-19 and die of COVID-19 than those with controlled HIV infections. In Zambia and other sub-Saharan African countries with high HIV prevalence and limited

TABLE 2. Factors* associated with severe COVID-19† at hospital admission, severe COVID-19 during hospitalization, and COVID-19–associated death among hospitalized patients with HIV infection§ — Zambia, March–December 2020

Factor	aOR (95% CI)		aHR (95% CI)
	Severe COVID-19 at admission	Severe COVID-19 during hospitalization	COVID-19–associated death
Male sex	1.31 (0.92–1.87)	1.20 (0.84–1.71)	1.71 (1.07–2.76)
Age ≥60 yrs	2.64 (1.72–4.03)	3.10 (2.01–4.83)	2.09 (1.32–3.29)
Two or more underlying medical conditions*	2.79 (1.71–4.56)	2.57 (1.57–4.29)	1.78 (1.11–2.83)
HIV-positive¶	0.92 (0.59–1.46)	1.00 (0.63–1.57	0.88 (0.49–1.56)
Controlled HIV (n = 85)	Ref	Ref	Ref
Severe HIV disease (n = 37)¶	3.91 (1.69–9.69)	4.42 (1.83–11.66)	3.27 (1.21–8.79)

Abbreviations: aHR = adjusted hazard ratio; aOR = adjusted odds ratio; BMI = body mass index; CI = confidence interval; Ref = referent; TB = tuberculosis.

* Underlying medical conditions included cardiac disease, hypertension, diabetes, other pulmonary disease, active TB, previous TB, asthma, kidney disease, liver disease, neurologic disorder, asplenia, malignant neoplasm, and current smoking.

† Oxygen saturation <90%, respiratory rate >30 breaths/minute, or need for oxygen therapy.

§ Mixed-effects logistic regression models were used for severe COVID-19 outcomes. Models were adjusted for sex, age (<60 and ≥60 years), comorbidities (fewer than two and two or more), and treatment center (random effects term). Cox proportional hazards models were used for COVID-19–associated death outcome. Models were adjusted for sex, age (<60 and ≥60 years), underlying medical conditions (fewer than two and two or more), COVID-19 severity at admission (mild and severe) and treatment center (random effects term). Reference categories for exposure variables in all models were female sex, age <60 years, fewer than two underlying medical conditions, and HIV-negative status.

¶ HIV-positive patients were classified as having severe HIV disease if they met one or more of the following conditions: severely anemic (<8.0 g/dL), CD4 <200 cells/μL, active TB, and underweight (BMI <18.5 kg/m^2).

Summary

What is already known about this topic?

The effect of HIV infection on COVID-19 outcomes is unclear.

What is added by this report?

HIV infection was not associated with poor outcomes among patients hospitalized for COVID-19 in Zambia. However, HIV-positive patients with severe HIV disease were more likely to develop severe COVID-19 or die of COVID-19.

What are the implications for public health practice?

Ensuring that persons maintain HIV disease control, including by maintaining ART treatment continuity and adherence, achieving viral suppression, and addressing underlying medical conditions, could help reduce COVID-19–associated morbidity and mortality in sub-Saharan Africa.

capacity to treat severe COVID-19, continued efforts to ensure that HIV-positive persons maintain control of their HIV infections through retention in care and adherence to ART and by addressing and managing their underlying medical conditions, could help limit COVID-19–associated morbidity and mortality and HIV-associated morbidity. Larger studies that include more robust data on CD4 counts and viral loads might provide a more nuanced picture of the potential impact of HIV disease status on COVID-19–associated morbidity and mortality.

Acknowledgments

Study participants, hospital management, and staff members at Levy Mwanawasa Teaching Hospital, University Teaching Hospital, Kabwe General Hospital, Ndola Teaching Hospital, and Livingstone General Hospital.

Corresponding author: Peter A. Minchella, klf9@cdc.gov.

[1]Zambian Ministry of Health, Lusaka, Zambia; [2]CDC, Lusaka, Zambia.

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

References

1. Boulle A, Davies MA, Hussey H, et al. Risk factors for COVID-19 death in a population cohort study from the Western Cape Province, South Africa. Clin Infect Dis 2020. Epub August 29, 2020. PMID:32860699 https://doi.org/10.1093/cid/ciaa1198
2. Bhaskaran K, Rentsch CT, MacKenna B, et al. HIV infection and COVID-19 death: a population-based cohort analysis of UK primary care data and linked national death registrations within the OpenSAFELY platform. Lancet HIV 2021;8:e24–32. PMID:33316211 https://doi.org/10.1016/S2352-3018(20)30305-2
3. Sigel K, Swartz T, Golden E, et al. Coronavirus 2019 and people living with human immunodeficiency virus: outcomes for hospitalized patients in New York City. Clin Infect Dis 2020;71:2933–8. PMID:32594164 https://doi.org/10.1093/cid/ciaa880
4. Gervasoni C, Meraviglia P, Riva A, et al. Clinical features and outcomes of patients with human immunodeficiency virus with COVID-19. Clin Infect Dis 2020;71:2276–8. PMID:32407467 https://doi.org/10.1093/cid/ciaa579
5. Parker A, Koegelenberg CFN, Moolla MS, et al. High HIV prevalence in an early cohort of hospital admissions with COVID-19 in Cape Town, South Africa. S Afr Med J 2020;110:982–7. PMID:33205724 https://doi.org/10.7196/SAMJ.2020.v110i10.15067
6. Inciarte A, Gonzalez-Cordon A, Rojas J, et al. Clinical characteristics, risk factors, and incidence of symptomatic coronavirus disease 2019 in a large cohort of adults living with HIV: a single-center, prospective observational study. AIDS 2020;34:1775–80. PMID:32773471 https://doi.org/10.1097/QAD.0000000000002643
7. Joint United Nations Programme on HIV and AIDS. AIDSinfo. Geneva, Switzerland: United Nations, Joint United Nations Programme on HIV and AIDS; 2021. Accessed March 2, 2021. http://aidsinfo.unaids.org/
8. Griffith GJ, Morris TT, Tudball MJ, et al. Collider bias undermines our understanding of COVID-19 disease risk and severity. Nat Commun 2020;11:5749. PMID:33184277 https://doi.org/10.1038/s41467-020-19478-2

Impact of Policy and Funding Decisions on COVID-19 Surveillance Operations and Case Reports — South Sudan, April 2020–February 2021

Talya Shragai[1,2,3]; Aimee Summers[2,3]; Olu Olushayo[4]; John Rumunu[5]; Valerie Mize[4]; Richard Laku[5]; Sudhir Bunga[6]

Early models predicted substantial COVID-19-associated morbidity and mortality across Africa (*1*–*3*). However, as of March 2021, countries in Africa are among those with the lowest reported incidence of COVID-19 worldwide (*4*). Whether this reflects effective mitigation, outbreak response, or demographic characteristics, (*5*) or indicates limitations in disease surveillance capacity is unclear (*6*). As countries implemented changes in funding, national policies, and testing strategies in response to the COVID-19 pandemic, surveillance capacity might have been adversely affected. This study assessed whether changes in surveillance operations affected reporting in South Sudan;* testing and case numbers reported during April 6, 2020–February 21, 2021, were analyzed relative to the timing of funding, policy, and strategy changes. South Sudan, with a population of approximately 11 million, began COVID-19 surveillance in February 2020 and reported 6,931 cases through February 21, 2021. Surveillance data analyzed were from point of entry screening, testing of symptomatic persons who contacted an alert hotline, contact tracing, sentinel surveillance, and outbound travel screening. After travel restrictions were relaxed in early May 2020, international land and air travel resumed and mandatory requirements for negative pretravel test results were initiated. The percentage of all testing accounted for by travel screening increased >300%, from 21.1% to 91.0% during the analysis period, despite yielding the lowest percentage of positive tests among all sources. Although testing of symptomatic persons and contact tracing yielded the highest percentage of COVID-19 cases, the percentage of all testing from these sources decreased 88%, from 52.6% to 6.3% after support for these activities was reduced. Collectively, testing increased over the project period, but shifted toward sources least likely to yield positive results, possibly resulting in underreporting of cases. Policy, funding, and strategy decisions related to the COVID-19 pandemic response, such as those implemented in South Sudan, are important issues to consider when interpreting the epidemiology of COVID-19 outbreaks.

COVID-19 surveillance in South Sudan is operated by the South Sudan Ministry of Health (MOH) with support from implementing partners. The surveillance system collected testing and case data from five sources:† 1) screening of inbound travelers at points of entry, 2) rapid response team testing of persons with COVID-19–compatible symptoms who called an alert hotline (alert), 3) contact tracing, 4) testing of symptomatic persons seeking health care for any reason (sentinel surveillance), and 5) screening of persons before outbound travel (travel screening). Symptomatic persons were tested by alert and sentinel surveillance testing; persons with a known exposure were tested through contact tracing, point of entry surveillance and travel screening tested asymptomatic persons with no known exposure. Testing was conducted free of charge at the National Public Health Laboratory (NPHL), at public mobile laboratories, or at private laboratories (in which testing costs were approximately $40–$150 USD per test). Testing was performed on oropharyngeal or nasopharyngeal swab specimens using reverse transcription–polymerase chain reaction. Surveillance staff members completed a paper form upon specimen collection, which was attached to the laboratory results and physically transported or emailed from the testing laboratory to the Public Health Emergency Operations Center in Juba, South Sudan, by the MOH and supported by implementing partners,§ for entry into the central COVID-19 surveillance database.

During the course of the COVID-19 pandemic in South Sudan, national-level changes affected travel (including travel restrictions and travel testing requirements), testing strategies, funding and logistical support, and laboratory capacity.

* As of May 2021, South Sudan remains at Level 4 travel advisory (https://travel.state.gov/content/travel/en/traveladvisories/traveladvisories/south-sudan-travel-advisory.html). Most testing for SARS CoV-2 is poorly targeted and occurs largely among asymptomatic individuals as part of pretravel screening. Given the low testing rates and poorly targeted testing, the reported low incidence rate and case counts (which are dependent on testing volume) are not reflective of the actual magnitude of the outbreak.

† Points of entry included major airports and land borders (primarily the land border with Uganda). Alert surveillance also included postmortem testing of persons suspected to have died from COVID-19. Sentinel surveillance sites tested persons seeking health care for any reason who had symptoms of COVID-19. Outbound travel screening also included some asymptomatic persons tested for nontravel-related reasons. Surveillance source testing was available for all persons in South Sudan regardless of citizenship. All persons who tested positive were supported through case management programs that either support home-based care for asymptomatic, mild, or moderate cases or provided care at a dedicated COVID-19 medical facility for severe or critical cases.

§ South Sudan's COVID-19 response is funded by donors, including the Bureau for Humanitarian Assistance, U.S. Agency for International Development; European Civil Protection and Humanitarian Aid Operations, European Commission; Foreign, Commonwealth & Development Office, Government of the United Kingdom; and CDC.

For this analysis, information on these changes was obtained through interviews with national-level personnel and review of published documents.[¶] Temporal trends in the weekly number tests for SARS-CoV-2 , the virus that causes COVID-19, performed and the percentage of tests with positive results were analyzed, based on the result reporting date. Results were examined at the national level and by surveillance source before, during, and after major policy, strategy, and funding changes that affected surveillance procedures and practices. Records with missing specimen collection date or surveillance source were excluded. The surveillance source variable was standardized across records.[**] This activity was reviewed by CDC and conducted consistent with applicable federal law and policy.[††]

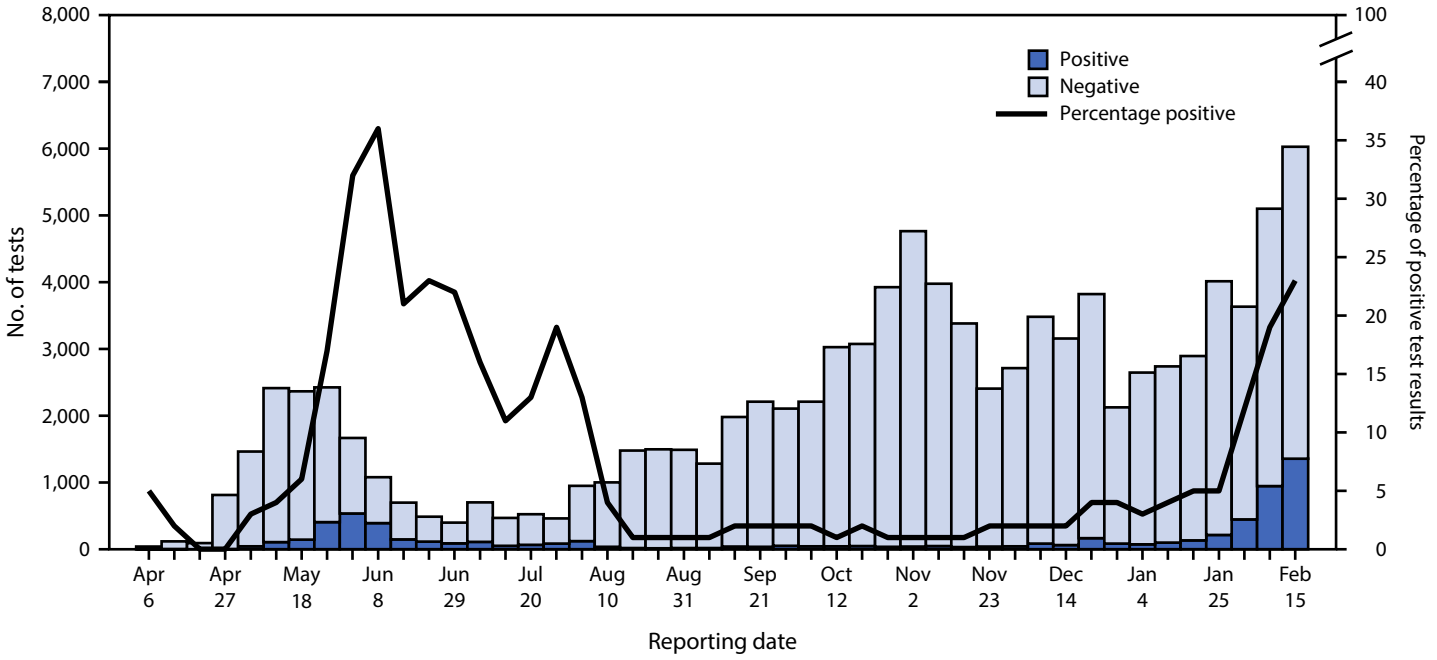
Among 101,021 COVID-19 tests performed during April 6, 2020–February 21, 2021, a total of 99,533 (98.5%) were included in this analysis; the remainder were excluded because of missing data. Overall, 6,766 (6.8%) tests yielded positive results for SARS-CoV-2. The number of weekly tests peaked three times: during the week beginning May 25, 2020 (2,423 tests [2.4%]), the week beginning November 2, 2020 (4,767 tests [4.8%]), and the week beginning February 15, 2021 (6,031 tests [6.1%]), which is the last week for which data were available (Figure 1). The percentage of tests yielding positive results first peaked during the first week of June 2020 (537 of 1,668 [32.2%] positive), and again the week beginning February 15, 2021 (1,385 of 6,031 [22.5%] positive). Among all 99,533 tests, 78,146 (78.5%) were from travel screening (4,559 [5.8%] positive), 3,742 (3.8%) were collected as part of contact tracing (961 [25.7%] positive), 3,224 (3.2%) were from alerts (695 [21.6%] positive), 11,443 (11.5%) were from

¶ Interviews were conducted in person, over the phone, or via email with national-level personnel coordinating the COVID-19 response and leading operations of each surveillance source. These persons were asked to identify any major funding, policy, or strategy changes that affected COVID-19 testing, to describe the impact on surveillance operations, and to provide published documentation of any identified changes as available. Documents reviewed were high level COVID-19 task force communications, weekly situation reports on COVID-19, South Sudan COVID-19 response guidelines and standard operating procedures, and daily updates from the South Sudan MOH, which were distributed via an email listserv and intermittently uploaded to the MOH website.

** In consultation with the South Sudan COVID-19 response data management unit, records that included "screening before travel," "screening bef travel," "screening," and "screening to know status" were all categorized as travel screening; records with "alert," "suspect," and "suspected COVID-19" were all categorized as alert; and those with "POE" and "screening POE" were categorized as point of entry screening. All records were transformed to lower case, and all punctuation was removed to standardize differences in spelling. Any surveillance source with a Levenshtein distance (i.e., the minimum number of single-character edits between two words required to change one word into the other) of no more than two, excluding differences in capitalization and punctuation, was recategorized to the surveillance source that most closely matched the spelling after the standardization process.

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

FIGURE 1. COVID-19 test results, by test reporting* date (N = 99,553) — South Sudan, April 6, 2020–February 21, 2021



* Surveillance data analyzed were from point of entry screening, testing of symptomatic persons who contacted an alert hotline, contact tracing, sentinel surveillance, and outbound travel screening.

point of entry screening (256 [2.2%] positive), and 2,978 (3.0%) were from sentinel sites (295 [9.9%] positive).

A number of policy, strategy, and funding changes affected COVID-19 surveillance in South Sudan during the project period (Table). Travel screening testing increased after domestic and international travel restrictions were relaxed and travel testing requirements began in mid-May 2020 (Figure 2). Travel screening initially decreased after testing requirements for domestic travel were relaxed in late May 2020, but increased after travel restrictions were further relaxed through August 2020. Travel screening again decreased in early December 2020 after testing transitioned from the NPHL to private laboratories, followed by an increase later in the month after data sharing agreements were established between private laboratories and the MOH. During the week beginning February 15, 2021, travel screening testing represented 90.1% of all testing, an increase of >300% from June 2020, when it represented 21.1% of testing (Supplementary Figure, https://stacks.cdc.gov/view/cdc/106331).

In July 2020, reductions in funding and logistical support for the alert and contact tracing systems occurred, and the national contact testing strategy changed from recommending testing of all contacts to testing only symptomatic persons or those considered to be at increased risk for adverse outcomes. After this change, the percentage of testing through contact tracing and alerts declined from 52.6% in June 2020 to 3.4% in January 2021 (Table) (Figure 2) (Supplementary Figure, https://stacks.cdc.gov/view/cdc/106331). In early January 2021, the policy to test all contacts irrespective of symptoms was reinstated, and although subsequent contact tracing and alert testing increased, these sources represented just 6.3% of testing during the week beginning February 15, 2021.

During the week beginning May 5, 2020, point of entry surveillance represented one half (50.6%) of all SARS-CoV-2 testing; however, because of limited resources, the NPHL discontinued testing these specimens, after which these specimens declined to <1% of all testing during June–July 2020 (Table) (Figure 2) (Supplementary Figure https://stacks.cdc.gov/view/cdc/106331). A mobile laboratory was established in late July at the Ugandan border and testing of specimens from points of entry subsequently increased and represented 2%–8% of all testing through the week beginning February 15, 2021.

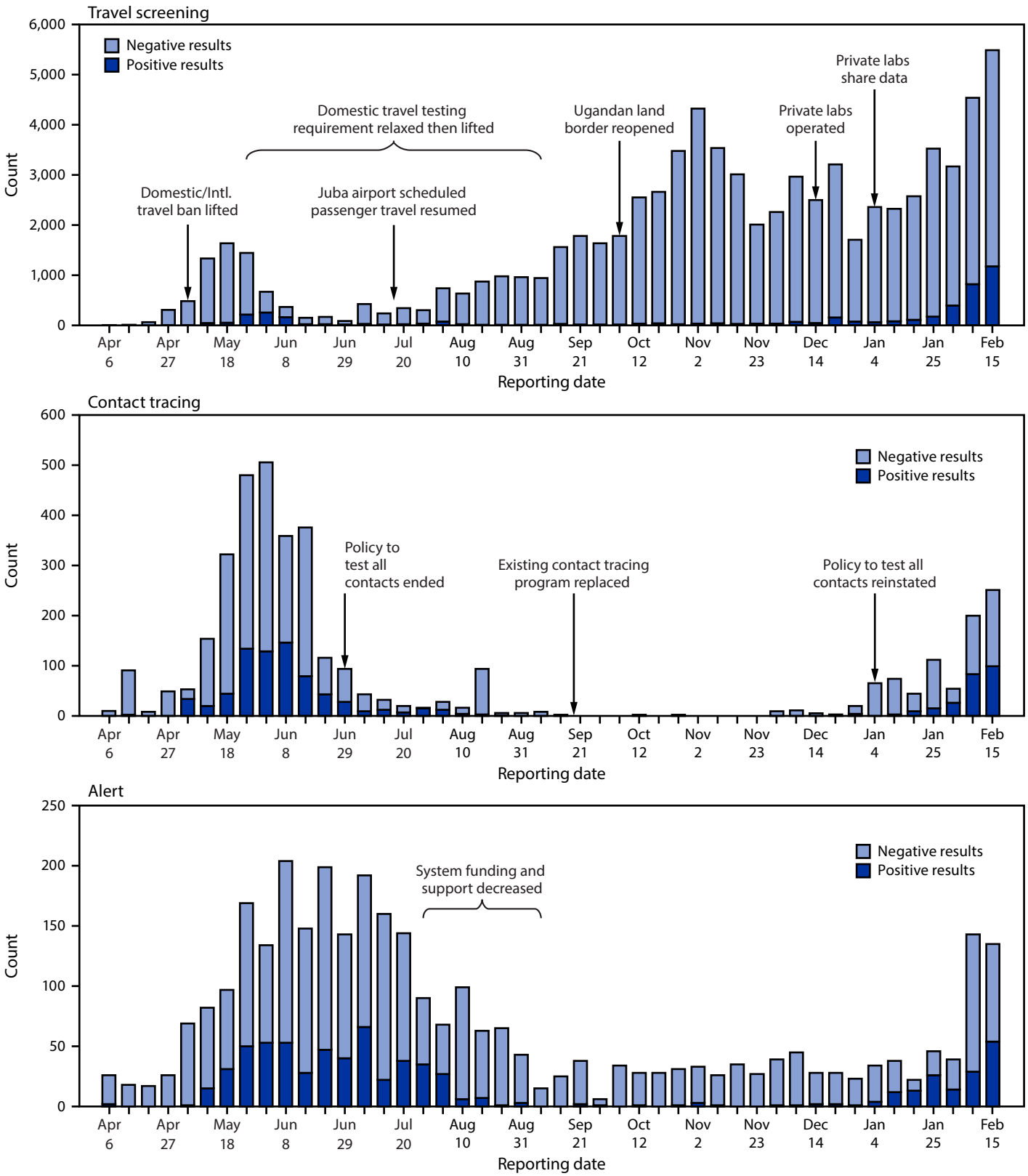
Sentinel surveillance began with three sites in April 2020 and increased to 45 in May 2020. Tests from sentinel sites fluctuated during August 2020–January 2021, likely because of variations in weekly reporting rates, and decreased after the number of sites was reduced to 18 on January 1, 2021 and then to three later in the month (Figure 2) (Supplementary Figure, https://stacks.cdc.gov/view/cdc/106331).

TABLE. Policy, strategy, and funding changes affecting COVID-19 surveillance operations, by surveillance source and date of change — South Sudan, April 2020–January 2021

Source/Date*	Policy, strategy, or funding change
Travel screening surveillance	
Mar 24, 2020	International borders were closed to passenger travel; domestic travel ban imposed soon after.
May 11, 2020	International and domestic travel bans were lifted.
May–Aug 26, 2020	Requirement of negative test certificate before domestic travel was relaxed in May and ended in August.
Jul 9, 2020	Regularly scheduled passenger travel resumed at Juba International Airport.
Oct 1–15, 2020	Ugandan land border was opened for passenger travel.
Dec 5, 2020	Travel screening was transferred to a private laboratory.
Dec 28, 2020	Data sharing agreements between private laboratories and South Sudan MOH were enacted.
Jan 18, 2021	A second private laboratory was opened (cost = $40–$150 per test).
Contact tracing surveillance	
Jul 2020	Contact testing strategy was changed from testing all contacts to testing only symptomatic contacts or contacts at increased risk of adverse outcomes.
Sep 2020	Contact tracing program activities were transferred to a new organization.
Jan 4, 2021	Policy to test all contacts, symptomatic and asymptomatic, was reinstated.
Alert surveillance	
Jul–Sep 2020	Funds and logistical support were reduced for the rapid response teams and alert hotline system.
Points of entry surveillance	
Jun 2020	National laboratory testing of most samples shipped from points of entry was discontinued because of limited testing capacity.
Jul 25, 2020	Mobile laboratory established at Nimule border crossing with Uganda began data sharing with South Sudan MOH.
Sentinel site surveillance	
May 2020	Forty-five health facilities were enlisted for the sentinel site surveillance system.
Jan 1, 2021	Number of sentinel sites were reduced to 18.
Jan 14, 2021	Number of sentinel sites were reduced to three.

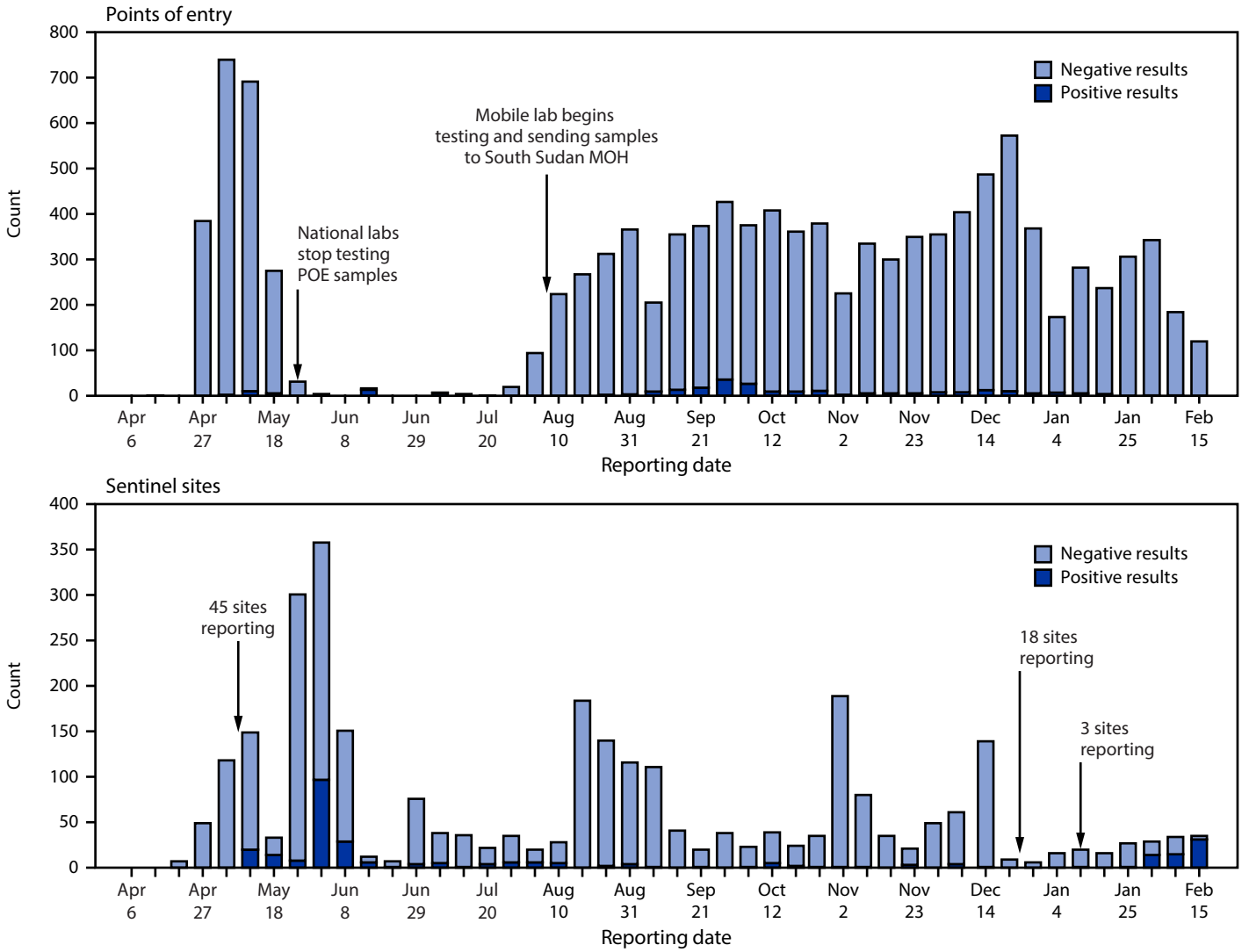
Abbreviation: MOH = Ministry of Health.
* Dates are specified to the day if the exact date or range of dates is known, or to the month and year when exact date or range of dates is unknown.

FIGURE 2. Number* and results of COVID-19 tests, by surveillance source,† and major policy and funding changes correlated with changes in testing/positive case counts — South Sudan, April 6, 2020–February 21, 2021.



See figure footnotes on the next page.

FIGURE 2. (*Continued*) Number* and results of COVID-19 tests, by surveillance source,† and major policy and funding changes correlated with changes in testing/positive case counts — South Sudan, April 6, 2020–February 21, 2021.



Abbreviations: MOH = Ministry of Health; POE = point of entry

* Y-axes scaled differently in each panel.

† Travel screening tested outbound travelers. Contact tracing tested those with a known exposure to a confirmed positive case. Alert testing consisted of rapid response teams testing persons with COVID-19–compatible symptoms who called the COVID-19 alert hotline. Point of entry screening tested persons as part of screening during inbound travel. Sentinel site surveillance was conducted at health facilities and tested persons who sought care for any reason and were experiencing COVID-19–compatible symptoms.

Discussion

COVID-19 data can be better understood in the context of a country's funding, policy, and strategy changes. In South Sudan, testing through alert and contact tracing decreased after changes in policy, strategy, and funding affected those programs, which are typically associated with high percentages of positive test results. Changes in travel policies drove increased demand for travel screening, which, in February 2021, accounted for more than 90% of daily tests. Overall, testing increased in South Sudan over the project period, but shifted toward sources less likely to yield a positive result; outbound travel screening, which tested asymptomatic populations with no known exposure to a case, had the lowest overall yield of positive results throughout the project period. These changes might have resulted in substantial underreporting of positive cases.

Other African countries experienced a second wave of COVID-19 cases in early 2021, and in some, this has been linked to the more highly transmissible B.1.351 COVID-19 variant (*7*). Cases also increased in South Sudan during January–February 2021, from 73 cases during the first week of January to 1,358 during the week beginning February 15;

Summary

What is already known about this topic?

As of March 2021, African countries have reported fewer COVID-19 cases than have countries in other regions. The extent to which this is due to surveillance limitations is unknown.

What is added by this report?

Policy, funding, and strategy changes in South Sudan influenced the number of SARS CoV-2 tests performed and the populations tested. Underreporting of testing rates and detected cases, including a February 2021 COVID-19 surge, might have occurred after policy changes led to an increase in travel screening of asymptomatic persons with no known contact with a positive case and a decrease in testing of suspected cases

What are the implications for public health practice?

Policy, funding, and strategy decisions related to the COVID-19 pandemic response, such as those in South Sudan, are important considerations when interpreting the epidemiology of COVID-19 outbreaks.

however, because of inability to conduct genomic sequencing in-country and because official reported numbers likely underestimated cases, the scope of and reason for the surge in cases are not well understood. Accurate determination of SARS-CoV-2 transmission and COVID-19 disease incidence in South Sudan requires data-driven policies, funding, and logistic and human resource support for surveillance activities. Although travel-related testing that is low-yield and poorly targeted should take lower priority, the mandatory requirement of negative test results at a destination country imposes the need to prioritize travel testing in departure countries even in a resource constrained setting such as South Sudan. Policy decisions based on public health recommendations must ensure that testing focuses on higher-risk and higher-yield populations, not only to identify cases and better quantify the outbreak but to optimize the use of limited testing resources.

The findings in this report are subject to at least six limitations. First, the relationship between policy, funding, and strategy and changes in testing and cases might not imply causality. In addition, availability of supplies might have limited testing capabilities at different timepoints. Second, this study does not account for competing priorities. Responses to other disease outbreaks, malnutrition, and major flooding in July 2020 might have diverted resources from COVID-19 surveillance.[§§] Third, data collection methods, including categorization of surveillance source, varied over time; this analysis relied on several assumptions to standardize variables for comparison. Fourth, this analysis assumed that the surveillance source was correctly classified and that all testing was recorded, which could not be verified. Fifth, interpretation of surveillance and testing data is further limited by the absence of health care facility–level disaggregated data for comparison. Finally, SARS-CoV-2 diagnostic test numbers in this report are lower than those published by the South Sudan MOH (*8*) because records with missing specimen collection date or surveillance source were excluded from this analysis; however, the extent of exclusion was minimal (1.5%).

Interpretation of COVID-19 case reports and transmission patterns must be placed in geographic, temporal, resource, and policy context. For South Sudan, and possibly other countries where response funding, strategies, and policies have changed over time, surveillance data are likely driven by operational and resource realities rather than by transmission dynamics alone. Similarly, detailed analyses of outbreak data from other countries might help in understanding how policy decisions affect surveillance data, leading to more informed decisions about public health action.

[§§] Information on other health events was received from the Public Health Emergency Operations Center of South Sudan (all-hazards update), presented at their weekly meeting, which compiles information on ongoing outbreaks and events affecting public health in South Sudan.

Acknowledgments

James Ransom; Acaga Taban; Kennedy Muni; Ivan Duku; Habtamu Worku; Abraham Ajok; Sheila Baya; Ashley Greiner; Charlene Siza

Corresponding author: Talya Shragai, pqp6@cdc.gov.

[1]Epidemic Intelligence Service, CDC; [2]CDC COVID-19 Response Team; CDC; [3]Division of Global Health Protection, Center for Global Health, CDC; [4]Country Office, Juba, South Sudan, WHO; [5]Ministry of Health, Juba, South Sudan; [6]Country Office, Juba, South Sudan, Division of Global HIV & TB, Center for Global Health, CDC.

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

References

1. Massinga Loembé M, Tshangela A, Salyer SJ, Varma JK, Ogwell Ouma AE, Nkengasong JN. COVID-19 in Africa: the spread and response. Nat Med 2020;26:999–1003. PMID:32528154 https://doi.org/10.1038/s41591-020-0961-x
2. Nkengasong JN, Mankoula W. Looming threat of COVID-19 infection in Africa: act collectively, and fast. Lancet 2020;395:841–2. Epub Feb 27, 2020. PMID:32113508 https://doi.org/10.1016/S0140-6736(20)30464-5
3. El-Sadr WM, Justman J. Africa in the path of Covid-19. N Engl J Med 2020;383:e11. Epub April 17, 2020. PMID:32302075 https://doi.org/10.1056/NEJMp2008193
4. World Health Organization. Weekly epidemiological update–2 March 2021. Geneva, Switzerland: United Nations, World Health Organization; 2021. Accessed Mar 24, 2021. https://www.who.int/publications/m/item/weekly-epidemiological-update---2-march-2021

5. Chitungo I, Dzobo M, Hlongwa M, Dzinamarira T. COVID-19: unpacking the low number of cases in Africa. Public Health in Practice 2020;1:100038. Epub Dec 22, 2020. PMID:7485446 https://doi.org/10.1016/j.puhip.2020.100038
6. Rutayisire E, Nkundimana G, Mitonga HK, Boye A, Nikwigize S. What works and what does not work in response to COVID-19 prevention and control in Africa. Int J Infect Dis 2020;97:267–9. PMID:32535304 https://doi.org/10.1016/j.ijid.2020.06.024
7. Regional Office for Africa, World Health Organization. New COVID-19 variants fueling Africa's second wave. Geneva, Switzerland: United Nations, World Health Organization; 2020. https://www.afro.who.int/news/new-covid-19-variants-fuelling-africas-second-wave
8. Republic of South Sudan Ministry of Health. Update on COVID-19 Response. Juba, South Sudan: Republic of South Sudan, Ministry of Health; 2021. Accessed March 18, 2021: https://moh.gov.ss/daily_updates.php

Patterns in COVID-19 Vaccination Coverage, by Social Vulnerability and Urbanicity — United States, December 14, 2020–May 1, 2021

Vaughn Barry, PhD[1,2,*]; Sharoda Dasgupta, PhD[2,*]; Daniel L. Weller, PhD[2]; Jennifer L. Kriss, PhD[2]; Betsy L. Cadwell, MSPH[2]; Charles Rose, PhD[2]; Cassandra Pingali, MPH, MS[2]; Trieste Musial, MS[2,3]; J. Danielle Sharpe, MS[3]; Stephen A. Flores, PhD[2]; Kurt J. Greenlund, PhD[4]; Anita Patel, PharmD[2]; Andrea Stewart, PhD[2]; Judith R. Qualters, PhD[2]; LaTreace Harris, MPH[2]; Kamil E. Barbour, PhD[2]; Carla L. Black, PhD[2]

On May 28, 2021, this report was posted as an MMWR *Early Release on the* MMWR *website (https://www.cdc.gov/mmwr).*

Disparities in vaccination coverage by social vulnerability, defined as social and structural factors associated with adverse health outcomes, were noted during the first 2.5 months of the U.S. COVID-19 vaccination campaign, which began during mid-December 2020 (*1*). As vaccine eligibility and availability continue to expand, assuring equitable coverage for disproportionately affected communities remains a priority. CDC examined COVID-19 vaccine administration and 2018 CDC social vulnerability index (SVI) data to ascertain whether inequities in COVID-19 vaccination coverage with respect to county-level SVI have persisted, overall and by urbanicity. Vaccination coverage was defined as the number of persons aged ≥18 years (adults) who had received ≥1 dose of any Food and Drug Administration (FDA)-authorized COVID-19 vaccine divided by the total adult population in a specified SVI category.† SVI was examined overall and by its four themes (socioeconomic status, household composition and disability, racial/ethnic minority status and language, and housing type and transportation). Counties were categorized into SVI quartiles, in which quartile 1 (Q1) represented the lowest level of vulnerability and quartile 4 (Q4), the highest. Trends in vaccination coverage were assessed by SVI quartile and urbanicity, which was categorized as large central metropolitan, large fringe metropolitan (areas surrounding large cities, e.g., suburban), medium and small metropolitan, and nonmetropolitan counties.§ During December 14, 2020–May 1, 2021, disparities in vaccination coverage by SVI increased, especially in large fringe metropolitan (e.g., suburban) and nonmetropolitan counties. By May 1, 2021, vaccination coverage was lower among adults living in counties with the highest overall SVI; differences were most pronounced in large fringe metropolitan (Q4 coverage = 45.0% versus Q1 coverage = 61.7%) and nonmetropolitan (Q4 = 40.6% versus Q1 = 52.9%) counties. Vaccination coverage disparities were largest for two SVI themes: socioeconomic status (Q4 = 44.3% versus Q1 = 61.0%) and household composition and disability (Q4 = 42.0% versus Q1 = 60.1%). Outreach efforts, including expanding public health messaging tailored to local populations and increasing vaccination access, could help increase vaccination coverage in high-SVI counties.

COVID-19 vaccination data are reported to CDC through state, local, and territorial immunization information systems, the Vaccine Administration Management System, or direct data submission to the CDC Data Clearinghouse.¶ County-level data on FDA-authorized COVID-19 vaccines administered during December 14, 2020–May 1, 2021, and reported through May 5, 2021, were analyzed. County-level SVI data were obtained from the 2018 CDC SVI, which is used to prioritize public health resources for communities with the greatest needs during and following emergencies (*2*,*3*). Ranked scores ranging from 0–1 were created for all 3,142 U.S. counties based on 15 population-based social determinants of health measures, categorized into one of four themes: socioeconomic status, household composition and disability, racial/ethnic minority status and language, and housing type and transportation.** Scores for overall SVI and themes were analyzed as quartiles. The 15 individual SVI components were dichotomized at the median, based on distribution among all U.S. counties. County urbanicity was categorized as large central metropolitan, large fringe metropolitan, medium and small metropolitan, and nonmetropolitan.

Data from adults living in 3,129 (99%) U.S. counties were analyzed; California counties with populations <20,000 and all Hawaii counties were excluded because of lack of available county-level vaccination data. Vaccine recipients were categorized by SVI metrics and urbanicity, based on

* These authors contributed equally to this report.

† Vaccination coverage was calculated by summing the number of vaccinated adults in each SVI category and dividing by the total adult population in the specified SVI category. Population denominators were obtained from the U.S. Census Bureau.

§ Urbanicity was defined on the basis of the 2013 National Center for Health Statistics urban-rural classification scheme. For this analysis, categories included large central metropolitan counties, large fringe metropolitan counties, medium and small metropolitan counties, and nonmetropolitan counties. Large central metropolitan counties are counties in metropolitan statistical areas (MSAs) with ≥1 million population; large fringe metropolitan counties are counties in MSAs with ≥1 million population that did not qualify as large central metropolitan counties; medium metropolitan counties are counties in MSAs with populations of 250,000–999,999; small metropolitan counties are counties in MSAs with populations <250,000; nonmetropolitan counties are all micropolitan and noncore counties. https://www.cdc.gov/nchs/data_access/urban_rural.htm

¶ Entities including jurisdictions, pharmacies, and federal agencies reported vaccinations to CDC. A cloud-hosted data repository received, deduplicated, and deidentified vaccination data. https://www.cdc.gov/coronavirus/2019-ncov/vaccines/distributing/about-vaccine-data.html

county of residence. Trends in vaccination coverage were evaluated by epidemiologic week for SVI quartile, stratified by urbanicity. Generalized estimating equation models using binomial regression and an identity link were used to estimate vaccination coverage by SVI metrics, overall and by urbanicity.[††] Absolute coverage differences with corresponding 95% confidence intervals (CIs) were calculated to evaluate differences between groups. Differences in coverage by SVI were also evaluated for three separate periods to assess variation in inequities over time.[§§] All analyses were conducted using SAS (version 9.4; SAS Institute). This activity was reviewed by CDC and was conducted consistent with applicable federal law and CDC policy.[¶¶]

During December 14, 2020–May 1, 2021, 54% of adults living in the 3,129 assessed U.S. counties received ≥1 dose of COVID-19 vaccine. Disparities in vaccination coverage by SVI increased over time, especially in large fringe metropolitan and nonmetropolitan counties, where coverage differences between SVI Q4 and Q1 counties were most prominent (Figure) (Supplementary Table, https://stacks.cdc.gov/view/cdc/106461).

By May 1, 2021, after states opened eligibility to all adults, vaccination coverage was lower among adults living in counties with the highest overall SVI (Q4 coverage = 49.0% versus Q1 coverage = 59.3%) (Table 1). Coverage differences between adults living in counties with the highest versus lowest SVI were –11.0% (95% CI = –13.2% to –8.9%) in large central metropolitan counties, –16.7% (95% CI = –20.7% to –12.7%) in large fringe metropolitan counties, –8.2% (95% CI = –13.1% to –3.4%) in medium and small metropolitan counties, and –12.3% (95% CI = –16.4% to –8.2%) in nonmetropolitan counties. Coverage differed by three SVI themes: coverage was lower in counties with higher SVI pertaining to socioeconomic status (Q4 = 44.3% versus Q1 = 61.0%) and household composition and disability (Q4 = 42.0% versus Q1 = 60.1%), but higher in counties with higher SVI related to racial and ethnic minority residents and English proficiency (Q4 = 56.5% versus Q1 = 45.3%).

Individual components of SVI themes related to socioeconomic status and housing composition and disability highlighted factors contributing to disparities. Vaccination coverage was lower among adults living in counties with per capita income less than the median (42.7%) compared with those in counties at or above the median (56.7%) and other social determinants of poor health, including poverty and less education, especially in large fringe metropolitan and nonmetropolitan counties (Table 2). Vaccination coverage was also lower among adults living in counties where the percentages of children, persons with disabilities, or single-parent households were at or above the median (51.3%, 43.9%, and 51.5%, respectively) compared with those in counties where the percentages of these groups were below the median (56.8%, 56.3%, and 58.0%, respectively), especially in large fringe metropolitan counties. Although coverage did not vary by the SVI theme related to housing type and transportation, one component of this theme suggested disparities in coverage. Specifically, vaccination coverage was lower in counties where the percentage of mobile homes was at or above the median (42.1%) compared with those where this percentage was below the median (58.8%).

Summary

What is already known about this topic?

Counties with higher levels of social vulnerability have been disproportionately affected by COVID-19.

What is added by this report?

Disparities in county-level vaccination coverage by social vulnerability have increased as vaccine eligibility has expanded, especially in large fringe metropolitan (areas surrounding large cities, e.g., suburban) and nonmetropolitan counties. By May 1, 2021, vaccination coverage among adults was lower among those living in counties with lower socioeconomic status and with higher percentages of households with children, single parents, and persons with disabilities.

What are the implications for public health practice?

Outreach efforts, including expanding public health messaging tailored to local populations and increasing vaccination access, could help increase vaccination coverage in counties with high social vulnerability.

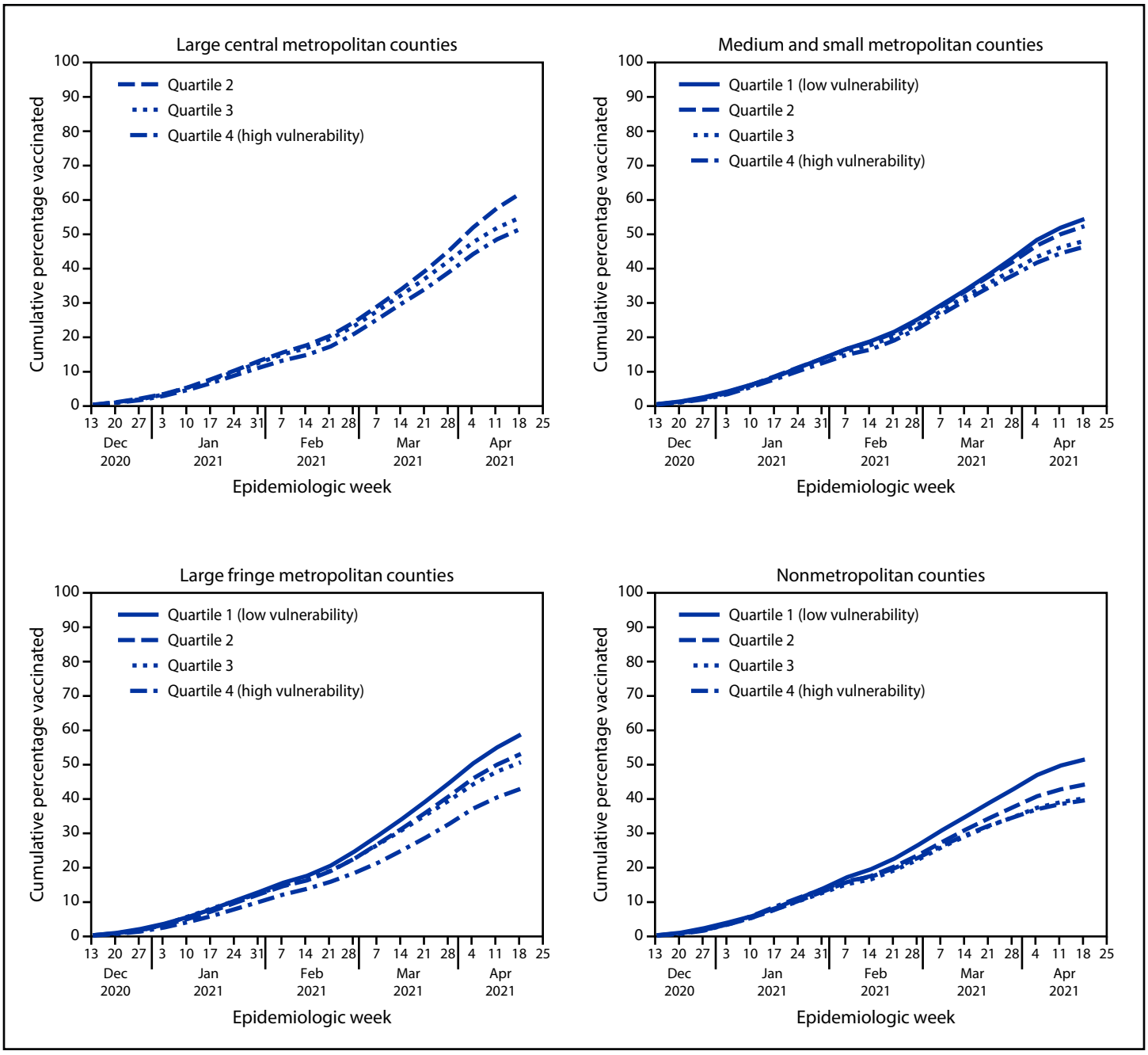
** The 15 population-based social factors incorporated into the SVI measures included 1) percentage of persons with incomes below poverty threshold, 2) percentage of civilian population (aged ≥16 years) that is unemployed, 3) per capita income, 4) percentage of persons aged ≥25 years with no high school diploma, 5) percentage of persons aged ≥65 years, 6) percentage of persons aged ≤17 years, 7) percentage of civilian noninstitutionalized population aged >5 years with a disability, 8) percentage of single-parent households with children aged <18 years, 9) percentage of persons who are racial/ethnic minorities (i.e., all persons except those who are non-Hispanic White), 10) percentage of persons aged ≥5 years who speak English "less than well," 11) percentage of housing in structures with ≥10 units (multiunit housing), 12) percentage of housing structures that are mobile homes, 13) percentage of households with more persons than rooms (crowding), 14) percentage of households with no vehicle available, and 15) percentage of persons living in institutionalized group quarters. Estimates were created using 2014–2018 (5-year) data from the American Community Survey (https://www.atsdr.cdc.gov/placeandhealth/svi/documentation/pdf/SVI2018Documentation-H.pdf). The 15 indicators are categorized into four themes: 1) socioeconomic status (indicators 1–4), 2) household composition and disability (indicators 5–8), 3) racial/ethnic minority status and language (indicators 9 and 10), and 4) housing type and transportation (indicators 11–15). Overall SVI includes all 15 indicators as a composite measure. https://www.atsdr.cdc.gov/placeandhealth/svi/fact_sheet/fact_sheet.html

†† 95% CIs for the vaccination coverage differences used robust standard errors to account for state variability.

§§ Periods used in the Supplementary Table were December 14, 2020–January 23, 2021; January 24–March 20, 2021; and March 21–May 1, 2021.

¶¶ 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. COVID-19 vaccination coverage among U.S. adults, by county social vulnerability index quartile* and urbanicity† (N = 3,129 counties§) — United States, December 14, 2020–May 1, 2021¶,**



Abbreviation: SVI = social vulnerability index.

* Scores for all SVI measures represented percentile rankings by county, ranging from 0–1, with higher scores indicating higher vulnerability. Scores were categorized into quartiles based on distribution among all 3,142 U.S. counties and then applied to the 3,129 assessed counties.

† Urbanicity categories were based on the 2013 National Center for Health Statistics urban-rural classification scheme (https://www.cdc.gov/nchs/data/series/sr_02/sr02_166.pdf). Categories were collapsed into large metropolitan, large fringe metropolitan, medium and small metropolitan, and nonmetropolitan (micropolitan and noncore) counties.

§ California counties with populations <20,000 (n = 8) and all Hawaii counties (n = 5) were excluded because of lack of available county-level vaccination data.

¶ Only 6 days of data were available for week December 13, 2020 (analysis used data from December 14, 2020, and on).

** Results were suppressed for SVI and urbanicity categories with four or fewer counties (quartile 1, large central metropolitan counties).

TABLE 1. Associations between social vulnerability index* and vaccination coverage† among U.S. adults, overall and by county urbanicity§ (N = 3,129 counties¶) — United States, December 14, 2020–May 1, 2021

	All counties		Large central metropolitan		Large fringe metropolitan		Medium and small metropolitan		Nonmetropolitan	
	(N = 3,129)		(n = 68)		(n = 368)		(n = 727)		(n = 1,966)	
SVI quartile	VC estimate	VC differences (95% CI)	VC estimate	VC differences (95% CI)	VC estimate	VC differences (95% CI)	VC estimate	VC differences (95% CI)	VC estimate	VC differences (95% CI)
Overall SVI										
Q1 (lowest)	**59.3**	**Ref**	—**	—	61.7	Ref	56.2	Ref	52.9	Ref
Q2	**56.0**	**−3.2 (−7.2 to 0.8)**	65.1	Ref	55.6	−6.1 (−10.2 to −2.0)	54.1	−2.1 (−5.9 to 1.7)	45.4	−7.5 (−10.6 to −4.5)
Q3	**52.5**	**−6.8 (−10.3 to −3.3)**	57.4	−7.7 (−11.9 to −3.5)	53.1	−8.6 (−11.7 to −5.5)	49.5	−6.7 (−10.5 to −2.9)	41.3	−11.6 (−15.4 to −7.9)
Q4 (highest)	**49.0**	**−10.3 (−14.1 to −6.4)**	54.0	−11.0 (−13.2 to −8.9)	45.0	−16.7 (−20.7 to −12.7)	47.9	−8.2 (−13.1 to −3.4)	40.6	−12.3 (−16.4 to −8.2)
SVI related to socioeconomic status										
Q1 (lowest)	**61.0**	**Ref**	—	—	62.2	Ref	57.1	Ref	54.7	Ref
Q2	**54.2**	**−6.8 (−9.6 to −4.0)**	59.2	Ref	51.7	−10.5 (−13.5 to −7.4)	52.9	−4.2 (−7.0 to −1.5)	46.8	−7.9 (−11.1 to −4.6)
Q3	**50.0**	**−11.0 (−13.4 to −8.6)**	55.2	−4.0 (−10.6 to 2.6)	45.0	−17.1 (−21.0 to −13.3)	46.4	−10.7 (−14.1 to −7.4)	40.9	−13.8 (−17.7 to −9.9)
Q4 (highest)	**44.3**	**−16.7 (−20.9 to −12.5)**	50.8	−8.5 (−17.3 to 0.4)	41.4	−20.8 (−26.9 to −14.6)	48.4	−8.7 (−16.2 to −1.1)	39.2	−15.5 (−19.7 to −11.3)
SVI related to household composition and disability										
Q1 (lowest)	**60.1**	**Ref**	—	—	61.5	Ref	56.5	Ref	50.0	Ref
Q2	**50.1**	**−10.0 (−12.6 to −7.3)**	51.7	Ref	48.6	−12.8 (−15.7 to −10.0)	51.5	−4.9 (−7.8 to −2.0)	45.3	−4.7 (−7.9 to −1.6)
Q3	**47.5**	**−12.6 (−15.2 to −9.9)**	52.8	1.1 (−1.8 to 4.1)	44.5	−17.0 (−22.7 to −11.3)	48.6	−7.9 (−10.8 to −5.0)	42.9	−7.1 (−10.5 to −3.7)
Q4 (highest)	**42.0**	**−18.1 (−21.1 to −15)**	47.7	−4.0 (−6.0 to −2.1)	37.3	−24.2 (−27.9 to −20.5)	42.2	−14.2 (−17.1 to −11.3)	41.0	−9.0 (−12.8 to −5.2)
SVI related to racial and ethnic minority residents and English proficiency										
Q1 (lowest)	**45.3**	**Ref**	—	—	48.7	Ref	46.5	Ref	43.9	Ref
Q2	**47.4**	**2.1 (−1.2 to 5.3)**	—	—	52.9	4.3 (−2.2 to 10.7)	46.2	−0.3 (−5.1 to 4.6)	45.3	1.4 (−1.9 to 4.6)
Q3	**51.6**	**6.3 (2.0 to 10.5)**	61.0	Ref	55.4	6.7 (2.5 to 10.9)	51.5	5.1 (−1.8 to 11.9)	43.4	−0.5 (−4.9 to 3.8)
Q4 (highest)	**56.5**	**11.2 (6.4 to 15.9)**	57.9	−3.2 (−9.9 to 3.5)	59.1	10.4 (4.1 to 16.7)	53.3	6.8 (−0.3 to 14.0)	43.6	−0.4 (−5.7 to 5.0)
SVI related to housing type and transportation										
Q1 (lowest)	**53.2**	**Ref**	—	—	55.7	Ref	47.8	Ref	47.2	Ref
Q2	**52.7**	**−0.5 (−3.9 to 2.9)**	54.4	Ref	58.4	2.8 (−2.0 to 7.5)	50.0	2.2 (−2.8 to 7.2)	44.5	−2.7 (−5.5 to 0.2)
Q3	**53.4**	**0.2 (−3.4 to 3.9)**	54.9	0.4 (−5.8 to 6.7)	58.2	2.5 (−1.8 to 6.9)	52.6	4.8 (0.0 to 9.6)	43.5	−3.7 (−6.2 to −1.1)
Q4 (highest)	**55.1**	**1.9 (−2.2 to 5.9)**	60.2	5.8 (−1.0 to 12.6)	56.1	0.4 (−7.4 to 8.2)	51.6	3.8 (−1.2 to 8.8)	43.0	−4.2 (−7.7 to −0.7)

Abbreviations: CI = confidence interval; Ref = referent group; SVI = social vulnerability index; VC = vaccination coverage.

* Scores for all SVI measures represent percentile ranks by county ranging from 0–1 with higher scores indicating higher vulnerability. Scores were categorized into quartiles based on distribution among all 3,142 U.S. counties and then applied to the 3,129 assessed counties.

† Vaccination coverage (≥1 dose) was calculated by summing the number of vaccinated adults in each SVI category and dividing by the total adult population in the specified SVI category. 95% CIs for the vaccination coverage differences were calculated using generalized estimating equation models with robust standard errors to account for state variability.

§ Urbanicity categories were based on the 2013 National Center for Health Statistics urban-rural classification scheme (https://www.cdc.gov/nchs/data/series/sr_02/sr02_166.pdf). Categories were collapsed into large metropolitan, large fringe metropolitan, medium and small metropolitan, and nonmetropolitan (micropolitan and noncore) counties.

¶ California counties with populations <20,000 (n = 8) and all Hawaii counties (n = 5) were excluded because of lack of available county-level vaccination data.

** Results were suppressed for SVI and urbanicity categories with four or fewer counties; reference group was the lowest vulnerability quartile with more than four counties.

Discussion

Counties with higher SVIs have been disproportionately affected by the COVID-19 pandemic (*4*); therefore, ensuring equitable access to COVID-19 vaccination is a priority for the U.S. COVID-19 vaccination program (*5*). In addition, disparities in vaccination coverage by SVI have increased over time, especially in large fringe metropolitan and nonmetropolitan counties. Disparities were associated with county-level differences in socioeconomic status and household composition and disability. Although disparities were not associated with

TABLE 2. Associations between individual components of the social vulnerability index* and vaccination coverage† among U.S. adults, overall and by urbanicity§ (N = 3,129 counties¶) — United States, December 14, 2020–May 1, 2021

SVI indicator	All counties (N = 3,129)		Large central metropolitan (n = 68)		Large fringe metropolitan (n = 368)		Medium and small metropolitan (n = 727)		Nonmetropolitan (n = 1,966)	
	VC estimate	VC differences (95% CI)	VC estimate	VC differences (95% CI)	VC estimate	VC differences (95% CI)	VC estimate	VC differences (95% CI)	VC estimate	VC differences (95% CI)
SVI related to socioeconomic status										
Percentage of persons living below poverty (median = 14.7%)										
Below median	**57.4**	**Ref**	63.9	Ref	58.5	Ref	54.4	Ref	49.1	Ref
At or above median	**49.8**	**−7.7 (−10.0 to −5.3)**	54.8	−9.1 (−15.3 to −2.9)	45.9	−12.7 (−15.6 to −9.7)	48.6	−5.8 (−8.9 to −2.7)	40.8	−8.3 (−11.2 to −5.5)
Percentage of persons unemployed (median = 5.4%)										
Below median	**56.6**	**Ref**	61.4	Ref	60.0	Ref	53.3	Ref	47.0	Ref
At or above median	**51.9**	**−4.7 (−6.7 to −2.7)**	56.5	−4.9 (−8.6 to −1.1)	52.9	−7.1 (−9.8 to −4.4)	50.4	−3.0 (−5.9 to 0.0)	42.0	−5.0 (−7.8 to −2.3)
Income per capita (median = $26,245)										
At or above median	**56.7**	**Ref**	—**	—	58.6	Ref	53.9	Ref	50.9	Ref
Below median	**42.7**	**−14 (−16.5 to −11.5)**	—	—	41.6	−16.9 (−20.7 to −13.2)	45.1	−8.8 (−12.4 to −5.2)	40.2	−10.7 (−13.3 to −8.2)
Percentage of persons aged ≥25 years with no high school diploma (median = 12.1%)										
Below median	**56.5**	**Ref**	60.1	Ref	59.4	Ref	53.7	Ref	49.9	Ref
At or above median	**50.4**	**−6.2 (−9.2 to −3.1)**	56.8	−3.3 (−7.5 to 1.0)	47.6	−11.8 (−15.4 to −8.3)	47.1	−6.5 (−10.8 to −2.3)	39.8	−10.2 (−12.7 to −7.6)
SVI related to household composition and disability										
Percentage of persons aged ≥65 years (median = 18%)										
Below median	**54.9**	**Ref**	57.9	Ref	57.5	Ref	51.7	Ref	42.8	Ref
At or above median	**49.4**	**−5.5 (−8.1 to −3.0)**	61.0	3.1 (−5.3 to 11.5)	54.9	−2.5 (−6.7 to 1.7)	50.6	−1.1 (−4.1 to 1.9)	45.2	2.4 (−0.1 to 4.9)
Percentage of persons aged <18 years (median = 22.3%)										
Below median	**56.8**	**Ref**	63.1	Ref	60.7	Ref	53.6	Ref	45.8	Ref
At or above median	**51.3**	**−5.5 (−7.8 to −3.3)**	53.3	−9.7 (−11.4 to −8.1)	54.8	−6.0 (−11.0 to −0.9)	49.6	−4 (−6.4 to −1.7)	42.1	−3.7 (−6.2 to −1.3)
Percentage of persons living with a disability (median = 15.4%)										
Below median	**56.3**	**Ref**	58.2	Ref	58.1	Ref	53.8	Ref	47.7	Ref
At or above median	**43.9**	**−12.4 (−15.1 to −9.7)**	51.7	−6.5 (−12.3 to −0.8)	43.7	−14.4 (−19.2 to −9.6)	44.7	−9.1 (−12.3 to −5.8)	42.0	−5.7 (−8.4 to −3.0)
Percentage of households with single parents and children (median = 8.1%)										
Below median	**58.0**	**Ref**	65.3	Ref	62.4	Ref	54.7	Ref	45.5	Ref
At or above median	**51.5**	**−6.5 (−8.3 to −4.6)**	55.7	−9.6 (−11.6 to −7.6)	51.5	−10.9 (−13.8 to −8.0)	49.9	−4.8 (−7.3 to −2.3)	43.0	−2.4 (−4.7 to −0.1)
SVI related to racial and ethnic minority residents and English proficiency										
Percentage of racial and ethnic minority residents (median = 16.1%)										
Below median	**48.5**	**Ref**	—	—	53.7	Ref	49.2	Ref	45.1	Ref
At or above median	**55.1**	**6.6 (3.2 to 10.1)**	—	—	57.9	4.2 (0.5 to 7.9)	52.1	2.9 (−1.1 to 6.9)	42.9	−2.2 (−5.9 to 1.4)
Percentage of persons who speak English less than well (median = 0.7%)										
Below median	**45.8**	**Ref**	—	—	50.3	Ref	45.7	Ref	43.9	Ref
At or above median	**55.2**	**9.5 (6.4 to 12.5)**	—	—	58.1	7.7 (4.4 to 11.1)	52.5	6.8 (3.4 to 10.2)	44.3	0.4 (−2.5 to 3.3)
SVI related to housing type and transportation										
Percentage of housing structures with ≥10 units (median = 2.9%)										
Below median	**40.9**	**Ref**	—	—	40.7	Ref	42.3	Ref	40.4	Ref
At or above median	**55.4**	**14.5 (11.9 to 17.1)**	—	—	58.3	17.7 (14.8 to 20.6)	52.2	9.9 (5.9 to 13.9)	47.4	7.0 (5.0 to 8.9)
Percentage of housing units that are mobile home units (median = 10.9%)										
Below median	**56.4**	**Ref**	—	—	58.8	Ref	53.6	Ref	49.7	Ref
At or above median	**42.0**	**−14.4 (−17.2 to −11.5)**	—	—	42.1	−16.7 (−20.6 to −12.8)	44.3	−9.3 (−12.5 to −6.1)	40.0	−9.7 (−12.5 to −6.8)
Percentage of households with more persons than rooms (median = 1.9%)										
Below median	**53.4**	**Ref**	57.6	Ref	58.4	Ref	51.9	Ref	45.8	Ref
At or above median	**54.1**	**0.7 (−2.7 to 4.2)**	58.0	0.4 (−5.4 to 6.2)	56.3	−2.1 (−5.6 to 1.4)	51.2	−0.7 (−3.9 to 2.4)	42.7	−3.1 (−5.8 to −0.5)

See table footnotes on the next page.

TABLE 2. (*Continued*) Associations between individual components of the social vulnerability index* and vaccination coverage† among U.S. adults, overall and by urbanicity§ (N = 3,129 counties¶) — United States, December 14, 2020–May 1, 2021

	All counties (N = 3,129)		Large central metropolitan (n = 68)		Large fringe metropolitan (n = 368)		Medium and small metropolitan (n = 727)		Nonmetropolitan (n = 1,966)	
SVI indicator	VC estimate	VC differences (95% CI)	VC estimate	VC differences (95% CI)	VC estimate	VC differences (95% CI)	VC estimate	VC differences (95% CI)	VC estimate	VC differences (95% CI)
Percentage of households with no vehicle access (median = 5.7%)										
Below median	**53.7**	**Ref**	63.9	Ref	55.9	Ref	50.3	Ref	44.6	Ref
At or above median	**54.0**	**0.3**	56.7	−7.2	59.3	3.4	52.1	1.8	43.8	−0.8
		(−3.0 to 3.5)		(−12.5 to −1.9)		(0.0 to 6.8)		(−2.2 to 5.8)		(−3.4 to 1.7)
Percentage of persons living in institutionalized group quarters (median = 2.0%)										
Below median	**53.5**	**Ref**	56.0	Ref	56.3	Ref	50.5	Ref	43.5	Ref
At or above median	**54.3**	**0.9**	61.4	5.4	58.9	2.6	52.0	1.6	44.6	1.1
		(−1.2 to 2.9)		(0.4 to 10.5)		(−2.6 to 7.8)		(−1.5 to 4.7)		(−0.9 to 3.0)

Abbreviation: CI = confidence interval; Ref = referent group; SVI = social vulnerability index; VC = vaccination coverage.

* Scores for all SVI measures represent percentile ranks by county ranging from 0–1 with higher scores indicating higher vulnerability. Scores were categorized into quartiles based on distribution among all 3,142 U.S. counties and then applied to the 3,129 assessed counties.

† Vaccination coverage (≥1 dose) was calculated by summing the number of vaccinated adults in each SVI category and dividing by the total adult population in the specified SVI category. 95% CIs for the vaccination coverage differences were calculated using generalized estimating equation models with robust standard errors to account for state variability.

§ Urbanicity categories were based on the 2013 National Center for Health Statistics urban-rural classification scheme (https://www.cdc.gov/nchs/data/series/sr_02/sr02_166.pdf). Categories were collapsed into large metropolitan, large fringe metropolitan, medium and small metropolitan, and nonmetropolitan (micropolitan and noncore) counties.

¶ California counties with populations <20,000 (n = 8) and all Hawaii counties (n = 5) were excluded because of lack of available county-level vaccination data.

** Results were suppressed for SVI and urbanicity categories with four or fewer counties; reference group was the lowest vulnerability quartile with more than four counties.

county-level differences related to racial and ethnic minority residents and housing types, individual SVI components suggested disparities among adults living in counties with particular housing characteristics (e.g., lower coverage in counties with higher percentages of mobile homes). These results underscore the importance of timely strategies to ensure that all communities can equitably benefit from COVID-19 vaccination.

Although differences in coverage by SVI were observed in counties of all urbanicity levels, large fringe metropolitan and nonmetropolitan counties were most affected. Persons living in these counties might experience unique challenges in accessing vaccination. For example, residents of large fringe metropolitan counties might face socioeconomic challenges, including substantial barriers to accessing health care services (*6*,*7*). COVID-19 vaccination coverage has been lower in rural than in urban areas, and persons in rural areas are more likely to travel outside their county of residence for vaccination (*8*). Efforts to improve vaccination coverage could focus on areas that are more vulnerable with respect to socioeconomics and household composition, while tailoring interventions by urbanicity.

Focused efforts to increase access to vaccination could help ensure high and equitable vaccination coverage. Opportunities to increase access by enrolling providers who are known and trusted in the community and partnering with community- and faith-based organizations to organize pop-up clinics*** should be considered. Mobile and walk-in vaccination clinics with flexible evening and weekend hours could also increase access in such communities.††† Home visits, although resource-intensive, have proven effective at increasing non–COVID-19 vaccination coverage among adults (*9*). Establishing COVID-19 vaccination clinics near child care facilities and schools, with hours communicated to parents through school channels, could increase vaccination coverage among adults in single-parent households. Vaccination locations should be accessible to persons with disabilities and offer special hours for persons who require extra assistance.

Because U.S. adults with less education and income and without health insurance were more likely to report vaccine hesitancy before the start of the COVID-19 vaccination program (*10*), strategies to improve vaccination coverage in counties with high SVI should also address vaccine confidence. This might include involving trusted messengers from the community who can communicate vaccine concerns, such as vaccine side effects or risk, and promote the benefit of immunization using local communication platforms.§§§ For example, expanded public health messaging campaigns in a variety of accessible formats could raise awareness that the vaccine is free, safe, effective, and necessary to decrease COVID-19 incidence in local communities.

The findings in this report are subject to at least four limitations. First, because SVI and vaccination coverage might have

*** Pop-up clinics can operate from any publicly accessible space, and be staffed by physicians, nurses, and volunteers. https://www.cdc.gov/vaccines/covid-19/downloads/Key-Op-Considerations-COVID-Mass-Vax.pdf

††† https://www.cdc.gov/vaccines/covid-19/planning/mobile.html

§§§ https://www.cdc.gov/vaccines/covid-19/vaccinate-with-confidence.html

varied within counties, additional analyses could account for a finer geographic scale. Second, disparities in coverage by SVI might have differed if vaccination series completion had been assessed. Third, sparse data for certain SVI and urbanicity categories limited interpretation of results. Finally, the findings provide only a national picture of COVID-19 vaccination coverage by SVI, and state-specific patterns should be explored to direct efforts to local areas.

COVID-19 vaccination coverage disparities by SVI have persisted and increased over time, even as vaccination eligibility and access have expanded. Disparities are associated with socioeconomic status and household composition and disability, particularly in large fringe metropolitan areas. Ensuring equitable COVID-19 vaccine access will require focused efforts on increasing coverage in counties with high SVI and tailoring efforts to local population needs. Efforts could include walk-in vaccination clinics and public health messaging about the importance of getting vaccinated.

Acknowledgments

Immunization program managers; immunization information system managers; other staff members of the immunization programs in the jurisdictions and federal entities; Kevin Delaney, CDC; Eli S. Rosenberg, University of Albany; CDC COVID-19 Vaccine Task Force.

Corresponding author: Vaughn Barry, vbarry@cdc.gov.

[1]Epidemic Intelligence Service, CDC; [2]CDC COVID-19 Response Team; [3]Geospatial Research, Analysis, and Services Program, Agency for Toxic Substances and Disease Registry, Atlanta, Georgia; [4]Division of Population Health, National Center for Chronic Disease Prevention and Health Promotion, CDC.

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

References

1. Hughes MM, Wang A, Grossman MK, et al. County-level COVID-19 vaccination coverage and social vulnerability—United States, December 14, 2020–March 1, 2021. MMWR Morb Mortal Wkly Rep 2021;70:431–6. PMID:33764963 https://doi.org/10.15585/mmwr.mm7012e1
2. Agency for Toxic Substances and Disease Registry. CDC/ATSDR social vulnerability index. Atlanta, GA: US Department of Health and Human Services, CDC and Agency for Toxic Substances and Disease Registry; 2021. https://www.atsdr.cdc.gov/placeandhealth/svi/index.html
3. Flanagan BE, Hallisey EJ, Adams E, Lavery A. Measuring community vulnerability to natural and anthropogenic hazards: the Centers for Disease Control and Prevention's social vulnerability index. J Environ Health 2018;80:34–6. PMID:32327766
4. Dasgupta S, Bowen VB, Leidner A, et al. Association between social vulnerability and a county's risk for becoming a COVID-19 hotspot—United States, June 1–July 25, 2021. MMWR Morb Mortal Wkly Rep 2020;69:1535–41. PMID:33090977 https://doi.org/10.15585/mmwr.mm6942a3
5. Office of the President of the United States. National strategy for the COVID-19 response and pandemic preparedness. Washington, DC: White House; 2021. https://www.whitehouse.gov/wp-content/uploads/2021/01/National-Strategy-for-the-COVID-19-Response-and-Pandemic-Preparedness.pdf
6. Ingram DD, Franco SJ; National Center for Health Statistics. 2013 NCHS urban-rural classification scheme for counties. Vital Health Stat 2 2014;166:1–73. PMID:24776070
7. Schnake-Mahl AS, Sommers BD. Health care in the suburbs: an analysis of suburban poverty and health care access. Health Aff (Millwood) 2017;36:1777–85. PMID:28971923 https://doi.org/10.1377/hlthaff.2017.0545
8. Murthy BP, Sterrett N, Weller D, et al. Disparities in COVID-19 vaccinations in urban versus rural counties—United States, December 14, 2020–April 10, 2021. MMWR Morb Mortal Wkly Rep 2021;70:759–64. PMID:34014911 https://doi.org/10.15585/mmwr.mm7020e3
9. Community Preventive Services Task Force. The guide to community preventive services: what works to promote health? Atlanta, GA: US Department of Health and Human Services, CDC; 2018. https://www.thecommunityguide.org/
10. Nguyen KH, Srivastav A, Razzaghi H, et al. COVID-19 vaccination intent, perceptions, and reasons for not vaccinating among groups prioritized for early vaccination—United States, September and December 2020. MMWR Morb Mortal Wkly Rep 2021;70:217–22. PMID:33571174 https://doi.org/10.15585/mmwr.mm7006e3

Excess Death Estimates in Patients with End-Stage Renal Disease — United States, February–August 2020

Robert Ziemba, PhD[1]; Kyle N. Campbell, PharmD[1]; Tsu-Hsuan Yang, PharmD[1]; Sara Eve Schaeffer, MBA, MA[1]; Kelly M. Mayo, MS[1]; Paul McGann, MD[2]; Shalon Quinn, PhD[3]; Jesse Roach, MD[4]; Edwin D. Huff, PhD[3]

On June 1, 2021, this report was posted as an MMWR *Early Release on the* MMWR *website (https://www.cdc.gov/mmwr).*

End-stage renal disease (ESRD) is a condition in which kidney function has permanently declined such that renal replacement therapy* is required to sustain life (*1*). The mortality rate for patients with ESRD in the United States has been declining since 2001 (*2*). However, during the COVID-19 pandemic, ESRD patients are at high risk for COVID-19–associated morbidity and mortality, which is due, in part, to weakened immune systems and presence of multiple comorbidities (*3*–*5*). The ESRD National Coordinating Center (ESRD NCC) supports the Centers for Medicare & Medicaid Services (CMS) and the ESRD Networks†,§ through analysis of data, dissemination of best practices, and creation of educational materials. ESRD NCC analyzed deaths reported to the Consolidated Renal Operations in a Web-Enabled Network (CROWNWeb), a system that facilitates the collection of data and maintenance of information about ESRD patients on chronic dialysis or receiving a kidney transplant who are treated in Medicare-certified dialysis facilities and kidney transplant centers in the United States. Excess death estimates were obtained by comparing observed and predicted monthly numbers of deaths during February 1–August 31, 2020; predicted deaths were modeled based on data from January 1, 2016, through December 31, 2019. The analysis estimated 8.7–12.9 excess deaths per 1,000 ESRD patients, or a total of 6,953–10,316 excess deaths in a population of 798,611 ESRD patients during February 1–August 31, 2020. These findings suggest that deaths among ESRD patients during the early phase of the pandemic exceeded those that would have been expected based on previous years' data. Geographic and temporal patterns of excess mortality, including those among persons with ESRD, should be considered during planning and implementation of interventions, such as COVID-19 vaccination, infection control guidance, and patient education. These findings underscore the importance of data-driven technical assistance and further analyses of the causes and patterns of excess deaths in ESRD patients.

CROWNWeb¶ is the national ESRD patient registry and contains administrative and clinical data submitted by dialysis facilities in the United States (*6*). Dialysis facility admission and discharge records in CROWNWeb for transplant and dialysis patients were accessed to identify decedents. Estimates of excess deaths during the early months of the COVID-19 pandemic (February–August 2020) were expressed as a range based on methodology established by CDC (*7*). The upper limit of excess deaths was defined as the difference between the observed and the predicted number of deaths; the lower limit was defined as the difference between the observed number of deaths and the upper end of a one-sided 95% prediction interval from the model. The predicted number of deaths was calculated using a Poisson model with five variables: year, month, age group, age-group-by-year interaction term, and ESRD Network service area. The month and year variables were added to model the seasonal and secular trends in mortality, which were observed in the data. The model was fit with observations from 2016 to 2019; predictions for 2020 assume that seasonal and secular trends in death rates observed during 2016–2019 were replicated in 2020.** All analyses were

* Renal replacement therapy is the broad name for any of the treatment choices available when kidney function has declined below an estimated glomerular filtration rate (eGFR) of 15 mL/min/1.73 m^2. These therapies include conservative management, peritoneal dialysis, hemodialysis, and transplant. https://www.niddk.nih.gov/health-information/professionals/clinical-tools-patient-management/kidney-disease/identify-manage-patients/manage-ckd/prepare-kidney-replacement-therapy

† The ESRD Network Program (https://www.cms.gov/Medicare/End-Stage-Renal-Disease/ESRDNetworkOrganizations), which is directed by CMS, was established to improve cost-effectiveness, ensure quality of care, encourage kidney transplant and home dialysis, and support patients returning to work. To coordinate these efforts, CMS contracts with ESRD Network organizations, arranged into 18 service areas. During the COVID-19 pandemic, ESRD Networks have been charged with implementing COVID-19 mitigation strategies for dialysis facilities, kidney transplant hospitals, and ESRD patients, with technical support from ESRD NCC.

§ *Network 1*: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont; *Network 2*: New York; *Network 3*: New Jersey, Puerto Rico, and U.S. Virgin Islands; *Network 4*: Delaware and Pennsylvania; *Network 5*: District of Columbia, Maryland, Virginia, and West Virginia; *Network 6*: Georgia, North Carolina, and South Carolina; *Network 7*: Florida; *Network 8*: Alabama, Mississippi, and Tennessee; *Network 9*: Indiana, Kentucky, and Ohio; *Network 10*: Illinois; *Network 11*: Michigan, Minnesota, North Dakota, South Dakota, and Wisconsin; *Network 12*: Iowa, Kansas, Missouri, and Nebraska; *Network 13*: Arkansas, Louisiana, and Oklahoma; *Network 14*: Texas; *Network 15*: Arizona, Colorado, Nevada, New Mexico, Utah, and Wyoming; *Network 16*: Alaska, Idaho, Montana, Oregon, and Washington; *Network 17*: American Samoa, Guam, Hawaii, Northern Mariana Islands, and Northern California; *Network 18*: Southern California.

¶ On November 9, 2020, CMS launched the ESRD Quality Reporting System, which merged three legacy systems, including CROWNWeb, into one ESRD program.

** Bootstrapping was used to generate the 95% prediction interval for the predicted mean number of deaths. One hundred replicate samples of the original data were obtained by sampling with replacement. Model coefficients were then estimated, and the predicted mean number of deaths was obtained. For each bootstrap replicate, 100 predictions were randomly generated from a Poisson distribution, with the mean equal to the predicted mean number of deaths for that bootstrap replicate. The 95th percentile of the resulting 10,000 simulated observations was then taken as the upper end of the one-sided 95% prediction interval.

conducted using SAS (version 9.4; SAS Institute). This activity was reviewed by CMS and was conducted consistent with applicable federal law and CMS policy.[††]

Excess death estimates during February 1–August 31, 2020, at the ESRD Network service area and national levels were compared with the total ESRD patient population size from February 2020 to allow comparisons between populations. Excess mortality for all ESRD patients was compared using analyses that included dialysis or kidney transplant patients, defined by the last treatment type for each patient before death.[§§] For each subgroup analysis, a new prediction model was estimated, and the numbers of patients who had a most recent dialysis treatment or kidney transplant before death or before February 1, 2020, were used to calculate the total dialysis or kidney transplant patient population sizes, respectively.

A total of 410,297 decedents were identified in the CROWNWeb data set during January 1, 2016–August 31, 2020, including 60,317 (14.7%) deaths that occurred during February 1–August 31, 2020. Based on the 798,611 patients who were on dialysis or had a kidney transplant as of February 2020, an estimated 8.7–12.9 excess deaths per 1,000 patients occurred among this ESRD population during the early phase of the COVID-19 pandemic, representing 6,953–10,316 excess deaths (Figure 1). Excess deaths at the national level peaked in the early months of the pandemic with a smaller peak in late summer.

For the subgroup analyses of dialysis and transplant patients, as of February 2020, a total of 541,932 dialysis patients and 256,671 transplant patients were identified in CROWNWeb; eight patients were excluded because of missing data. Nationwide, among dialysis patients, an estimated 10.8–16.6 excess deaths per 1,000 patients (5,860–9,019 excess deaths) occurred, and among kidney transplant patients, an estimated 2.6–5.5 excess deaths per 1,000 patients (663–1,403 excess deaths) occurred.

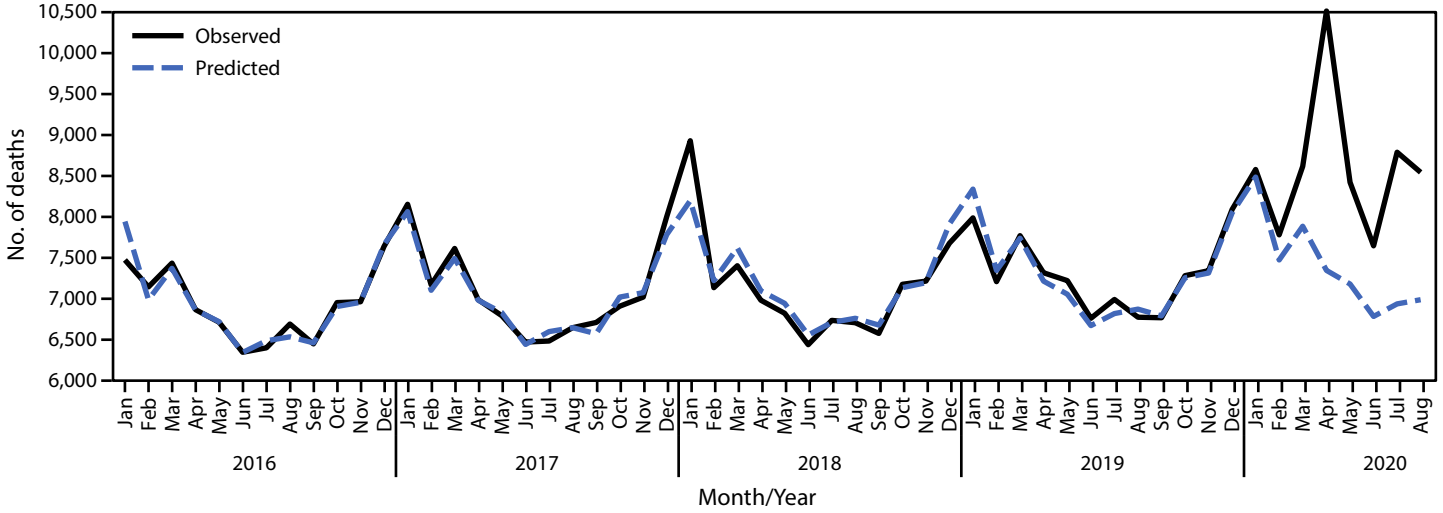
The three ESRD Network service areas with the highest estimated number of excess deaths per 1,000 patients were Network 2 (New York), Network 3 (New Jersey, Puerto Rico, and U.S. Virgin Islands), and Network 14 (Texas) (Figure 2). This is consistent with CDC data indicating that during late January–October 2020, the largest number of COVID-19–associated deaths occurred in California, New Jersey, New York, and Texas[¶¶] (*8*). Substantial variation among ESRD Network service areas in the temporal pattern of excess death was observed. For example, in the Network 2 service area, an increase in excess deaths was observed during March–May; however, very few or none occurred in later months, depending on the estimate (Figure 3). In contrast, in the Network 14 service area, where the initial peak of COVID-19 cases occurred later, excess deaths increased more gradually until July. In some Network service areas, such as Network 16 (Alaska, Idaho,

[††] 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.

[§§] In this study, patients receiving dialysis and patients with a previous failed kidney transplant who subsequently required chronic dialysis treatment are categorized as "dialysis patients." Patients with a successful kidney transplant, even if temporary dialysis is required after transplantation, are categorized as "kidney transplant patients."

[¶¶] California is divided into two ESRD Network service areas (17 and 18); therefore, the impact on that entire state is not apparent in this analysis.

FIGURE 1. Observed* and predicted† monthly deaths among patients with end-stage renal disease — United States, January 1, 2016–August 31, 2020



Abbreviation: CROWNWeb = Consolidated Renal Operations in a Web-Enabled Network.
* Based on CROWNWeb data from January 1, 2016, through August 31, 2020.
† Based on a model fit with monthly data from January 1, 2016, through December 31, 2019.

Montana, Oregon, and Washington), few excess deaths were identified over the entire observation period. The observation of fewer excess deaths per 1,000 ESRD patients in regions affected later in the pandemic is consistent with studies of excess deaths in the overall U.S. population (*9*).

Discussion

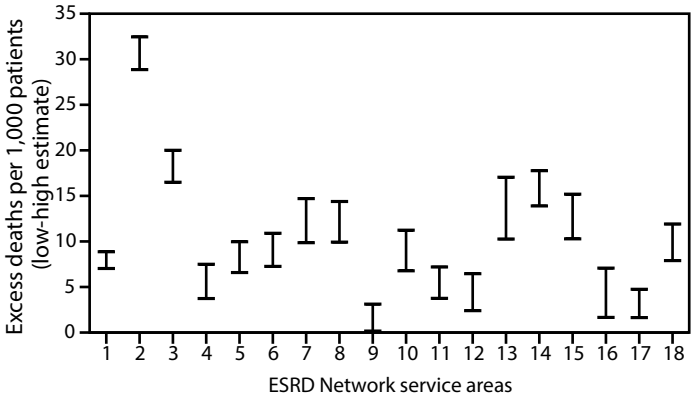
Over a 7-month period during the early months of the COVID-19 pandemic (February–August 2020), an estimated 6,953–10,316 excess deaths occurred among ESRD patients. The estimated number of excess deaths per 1,000 patients and total excess deaths were two to three times higher among dialysis patients than among kidney transplant patients. The reasons for excess deaths in the ESRD population might include the unmet need for in-person health services or SARS-CoV-2 transmission from other patients, staff members, or the wider community during the COVID-19 pandemic. Further research into the difference in excess deaths between dialysis and kidney transplant patients is needed.

Since March 2020, all 18 ESRD Networks have implemented interventions to slow transmission of SARS-CoV-2, the virus that causes COVID-19 (*10*). Prevention messages were distributed by the ESRD Networks and ESRD NCC to facilities and patients, highlighting CDC recommendations and addressing factors that might increase patient risk, such as living in multigenerational housing.*** Using the COVID-19 dashboard created by ESRD NCC, the ESRD Networks identified facilities in regions with the most rapid growth in new cases for targeted interventions, and the ESRD Networks provided more than 4,800 instances of one-on-one technical assistance to those facilities during August–November 2020. Data-driven technical assistance has guided the implementation of processes and education initiatives to mitigate the spread of COVID-19 in dialysis facilities. Further research will be required to determine the impact of the technical assistance on excess deaths in the larger context of patient risk factors and regional variations in the progression of the pandemic.

Analyses in this report provide a rapid means for assessing the impact of the pandemic while the documentation methods, such as *International Classification of Diseases, Tenth Revision, Clinical Modification* codes (e.g., U07.1, 2019-nCoV acute respiratory disease) and clinical data workflow, for COVID-19–associated morbidity and mortality were emerging. With additional infection waves occurring in different parts of the United States during summer 2020, the reduction in COVID-19–associated excess deaths among ESRD patients during this period is worth noting. Excess deaths varied widely by ESRD Network service area and over time. The highest numbers of excess deaths per 1,000 patients were observed in regions affected early in the pandemic, with most excess deaths occurring during the first 4 months of the observation period. These patterns were generally consistent with known areas of high COVID-19 transmission in the early phase of the pandemic. Some regions had very few excess deaths, possibly because of less exposure of ESRD patients or effectiveness of early responses to the pandemic. Data on these patterns and an understanding of the mechanisms driving them could guide the planning and implementation of interventions.

The findings in this report are subject to at least four limitations. First, the CROWNWeb admission and discharge records were used as the sole data source for mortality events in this analysis. Although CROWNWeb is representative of the U.S. ESRD population, inferences from this study are limited to data included in this registry. Second, studies of excess death often correct for the lag in reporting in later periods (*7*). This

FIGURE 2. Range of high* and low† estimates of excess deaths per 1,000 ESRD patients,§ by ESRD Network service area¶ — United States, February 1–August 31, 2020



Abbreviation: ESRD = end-stage renal disease.

* High estimates were calculated as the difference between the observed number of deaths and the predicted number of deaths from the model, divided by the number of prevalent ESRD patients as of February 1, 2020.

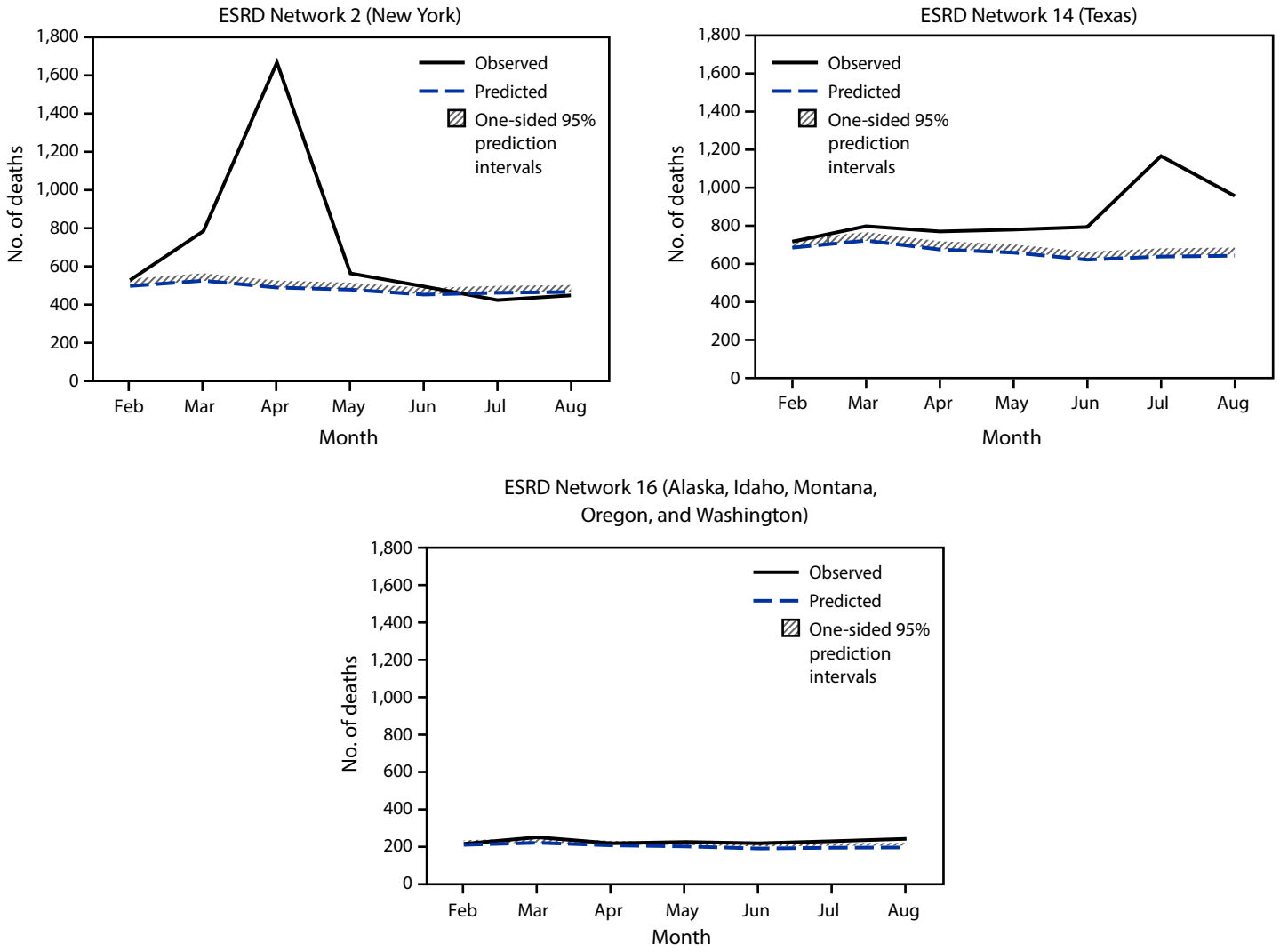
† Low estimates were calculated in a similar manner but used the upper end of the one-sided 95% prediction interval from the model in place of the mean model prediction.

§ Networks 2, 3, and 14 had the highest estimated number of excess deaths per 1,000 patients.

¶ *Network 1*: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont; *Network 2*: New York; *Network 3*: New Jersey, Puerto Rico, and U.S. Virgin Islands; *Network 4*: Delaware and Pennsylvania; *Network 5*: District of Columbia, Maryland, Virginia, and West Virginia; *Network 6*: Georgia, North Carolina, and South Carolina; *Network 7*: Florida; *Network 8*: Alabama, Mississippi, and Tennessee; *Network 9*: Indiana, Kentucky, and Ohio; *Network 10*: Illinois; *Network 11*: Michigan, Minnesota, North Dakota, South Dakota, and Wisconsin; *Network 12*: Iowa, Kansas, Missouri, and Nebraska; *Network 13*: Arkansas, Louisiana, and Oklahoma; *Network 14*: Texas; *Network 15*: Arizona, Colorado, Nevada, New Mexico, Utah, and Wyoming; *Network 16*: Alaska, Idaho, Montana, Oregon, and Washington; *Network 17*: American Samoa, Guam, Hawaii, Northern Mariana Islands, and Northern California; *Network 18*: Southern California.

*** The ESRD Networks and ESRD NCC distributed information highlighting CDC recommendations regarding mask use, physical distancing, and handwashing. Resources were also distributed to address factors that might increase patient risk. ESRD NCC developed materials including reminders for dialysis patients, a guide to using telemedicine, and tips for mental health care.

FIGURE 3. Patterns in observed* and predicted† monthly deaths in the ESRD population from selected ESRD Network service areas — United States, February 1, 2020–August 31, 2020



Abbreviations: CROWNWeb = Consolidated Renal Operations in a Web-Enabled Network; ESRD = end-stage renal disease.
* Observed number of monthly deaths was based on CROWNWeb discharge records.
† Predicted number of monthly deaths was based on a model fit with data from 2016–2019. One-sided 95% prediction intervals for the model were also calculated.

correction was not possible with data available for the present study, and lags in the reporting of deaths might have resulted in undercounting of deaths in the last months of the observation period. Third, this study does not examine the effect of race and ethnicity on excess deaths, which might confound comparisons between excess death estimates in the ESRD population and the general population. Finally, the analysis presented here estimates the number of excess deaths during February 1–August 31, 2020, compared with expectations based on previous years. This observation period coincides with the early months of the COVID-19 pandemic, but the actual cause of death and the relationship to COVID-19 was not determined.

The findings of this report suggest that deaths among ESRD patients during the early phase of the pandemic exceeded those that would have been expected based on previous years' data. Geographic and temporal patterns of excess mortality should be considered during planning and implementation of interventions, such as COVID-19 vaccination, infection control guidance, and patient education. These findings underscore the importance of data-driven technical assistance and further analyses on the causes and patterns of excess deaths in ESRD patients.

Acknowledgments

Lisa Rees, Division of Kidney Health, Center for Clinical Standards and Quality, Centers for Medicare & Medicaid Services; Janet Lea Hutchinson, Kristen Turner, Dianna Christensen, Health Services Advisory Group, Inc.

Summary

What is already known about this topic?

Patients with end-stage renal disease (ESRD) are at increased risk for COVID-19–associated morbidity and mortality.

What is added by this report?

Based on the national trend in ESRD deaths during the first 7 months of the U.S. COVID-19 pandemic (February 1–August 31, 2020), an estimated 8.7–12.9 excess deaths per 1,000 patients or 6,953–10,316 excess deaths in a population of 798,611 U.S. ESRD patients occurred.

What are the implications for public health practice?

Geographic and temporal patterns of excess mortality, including those among persons with ESRD, should be considered during planning and implementation of interventions, such as COVID-19 vaccination, patient education, and rollout of infection control guidance and technical assistance.

Corresponding author: Robert Ziemba, rziemba@hsag.com.

[1]Health Services Advisory Group, Inc., Tampa, Florida; [2]iQuality Improvement and Innovation Group, Center for Clinical Standards and Quality, Centers for Medicare & Medicaid Services, Baltimore, Maryland; [3]Division of Kidney Health, Center for Clinical Standards and Quality, Centers for Medicare & Medicaid Services, Baltimore, Maryland; [4]Quality Measurement and Value-Based Incentives Group, Center for Clinical Standards and Quality, Centers for Medicare & Medicaid Services, Baltimore, Maryland.

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. Kelly M. Mayo is a current member of the National Forum of ESRD Networks Board of Directors. No other potential conflicts of interest were disclosed.

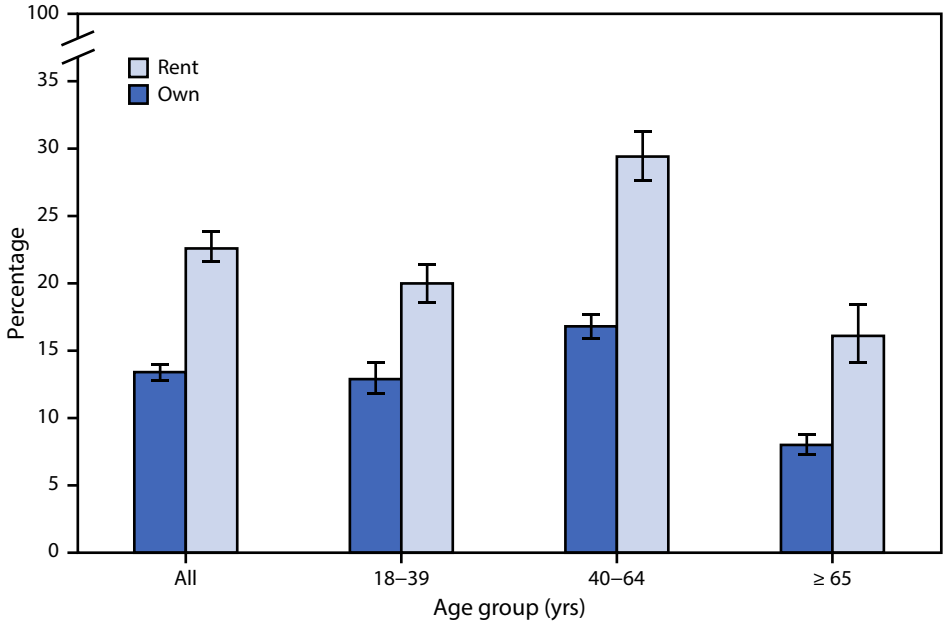
References

1. Centers for Medicare & Medicaid Services. End-stage renal disease (ESRD). Baltimore, MD: US Department of Health and Human Services, Centers for Medicare & Medicaid Services; 2020. https://www.cms.gov/Medicare/Coordination-of-Benefits-and-Recovery/Coordination-of-Benefits-and-Recovery-Overview/End-Stage-Renal-Disease-ESRD/ESRD
2. United States Renal Data System. USRDS annual data report: epidemiology of kidney disease in the United States. Bethesda, MD: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, United States Renal Data System; 2019. https://usrds.org/media/2371/2019-executive-summary.pdf
3. Division of Viral Diseases. Coronavirus diseases 2019 (COVID-19): interim SARS-CoV-2 testing guidelines for patients in outpatient hemodialysis facilities. Atlanta, GA: US Department of Health and Human Services, CDC; 2020. https://www.cdc.gov/coronavirus/2019-ncov/hcp/dialysis/testing-patients.html
4. National Kidney Foundation. Kidney disease & COVID-19. New York, NY: National Kidney Foundation, Inc.; 2021. https://www.kidney.org/coronavirus/kidney-disease-covid-19
5. Jager KJ, Kramer A, Chesnaye NC, et al. Results from the ERA-EDTA registry indicate a high mortality due to COVID-19 in dialysis patients and kidney transplant recipients across Europe. Kidney Int 2020;98:1540–8. PMID:32979369 https://doi.org/10.1016/j.kint.2020.09.006
6. Centers for Medicare & Medicaid Services. Learn about EQRS. Baltimore, MD: US Department of Health and Human Services, Centers for Medicare & Medicaid Services; 2020. https://mycrownweb.org/
7. National Center for Health Statistics. Excess deaths associated with COVID-19: provisional death counts for coronavirus disease (COVID-19). Atlanta, GA: US Department of Health and Human Services, CDC, National Center for Health Statistics; 2020. https://www.cdc.gov/nchs/nvss/vsrr/covid19/excess_deaths.htm
8. CDC. Coronavirus disease 2019 (COVID-19): CDC COVID data tracker. Atlanta, GA: US Department of Health and Human Services, CDC; 2020. https://covid.cdc.gov/covid-data-tracker/#cases_totaldeaths
9. Woolf SH, Chapman DA, Sabo RT, Weinberger DM, Hill L. Excess deaths from COVID-19 and other causes, March–April 2020. JAMA 2020;324:510–3. PMID:32609307 https://doi.org/10.1001/jama.2020.11787
10. Corbett RW, Blakey S, Nitsch D, et al.; West London Renal and Transplant Centre. Epidemiology of COVID-19 in an urban dialysis center. J Am Soc Nephrol 2020;31:1815–23. PMID:32561681 https://doi.org/10.1681/ASN.2020040534

QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Percentage* of Adults Who Are Very Worried About Ability to Pay Medical Bills if They Get Sick or Have an Accident,† by Home Ownership§ and Age Group — National Health Interview Survey, United States, 2019¶



* With 95% confidence intervals indicated with error bars.
† Based on a response of "very worried" to the question, "If you get sick or have an accident, how worried are you that you will be able to pay your medical bills?" Other categories included "Somewhat worried" and "Not worried at all." Unknowns were included in the denominators when calculating percentages.
§ Defined by response to the question, "Is this house/apartment owned or rented by you [you or someone in your family]?"
¶ Estimates are based on household interviews of a sample of the civilian, noninstitutionalized U.S. population.

In 2019, 22.6% of renters were very worried about their ability to pay their medical bills if they get sick or have an accident, compared with 13.4% of homeowners. For each age group, renters were more likely than homeowners to be very worried about paying their medical bills: 20.0% compared with 12.9% among those aged 18–39 years, 29.4% compared with 16.8% among those aged 40-64 years, and 16.1% compared with 8.0% among those aged ≥65 years.

Source: National Health Interview Survey, 2019. https://www.cdc.gov/nchs/nhis.htm

Reported by: Cordell Golden, cdg4@cdc.gov, 301-458-4237; Yu Sun, PhD.

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

Readers who have difficulty accessing this PDF file may access the HTML file at https://www.cdc.gov/mmwr/index2021.html. Address all inquiries about the *MMWR* Series to Editor-in-Chief, *MMWR* Series, Mailstop V25-5, CDC, 1600 Clifton Rd., N.E., Atlanta, GA 30329-4027 or to mmwrq@cdc.gov.

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

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

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

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

ISSN: 0149-2195 (Print)