Vital Signs: Deaths Among Persons with Diagnosed HIV Infection, United States, 2010–2018

Karin A. Bosh, PhD[1]; Anna Satcher Johnson, MPH[1]; Angela L. Hernandez, MD[1]; Joseph Prejean, PhD[1]; Jocelyn Taylor, MPH[1]; Rachel Wingard, MA[1]; Linda A. Valleroy, PhD[1]; H. Irene Hall, PhD[1]

Abstract

Background. Life expectancy for persons with human immunodeficiency virus (HIV) infection who receive recommended treatment can approach that of the general population, yet HIV remains among the 10 leading causes of death among certain populations. Using surveillance data, CDC assessed progress toward reducing deaths among persons with diagnosed HIV (PWDH).

Methods. CDC analyzed National HIV Surveillance System data for persons aged ≥13 years to determine age-adjusted death rates per 1,000 PWDH during 2010–2018. Using the *International Classification of Diseases, Tenth Revision*, deaths with a nonmissing underlying cause were classified as HIV-related or non–HIV-related. Temporal changes in total deaths during 2010–2018 and deaths by cause during 2010–2017 (2018 excluded because of delays in reporting), by demographic characteristics, transmission category, and U.S. Census region of residence at time of death were calculated.

Results. During 2010–2018, rates of death decreased by 36.6% overall (from 19.4 to 12.3 per 1,000 PWDH). During 2010–2017, HIV-related death rates decreased 48.4% (from 9.1 to 4.7), whereas non–HIV-related death rates decreased 8.6% (from 9.3 to 8.5). Rates of HIV-related deaths during 2017 were highest by race/ethnicity among persons of multiple races (7.0) and Black/African American persons (5.6), followed by White persons (3.9) and Hispanic/Latino persons (3.9). The HIV-related death rate was highest in the South (6.0) and lowest in the Northeast (3.2).

Conclusion. Early diagnosis, prompt treatment, and maintaining access to high-quality care and treatment have been successful in reducing HIV-related deaths and remain necessary for continuing reductions in HIV-related deaths.

Introduction

Persons with human immunodeficiency virus (HIV) infection require lifelong treatment to reduce HIV-related morbidity and mortality; advances in HIV treatment have resulted in a life expectancy that approaches that of the general population (*1,2*). Deaths attributable to HIV infection are preventable, yet during 2017, HIV was still among the 10 leading causes of death among certain population groups (*3*).

The National HIV Surveillance System (NHSS) is the primary source of population-based information about HIV in the

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

United States (*4*). A previous analysis demonstrated that, during 1990–2011, deaths among persons with stage 3 HIV infection (acquired immunodeficiency syndrome [AIDS]) decreased, with larger decreases in HIV-attributable deaths (–89%) than in non–HIV-attributable deaths (–57%) (*5*). On the basis of increasing evidence of the benefits of antiretroviral therapy both for persons with HIV and for preventing secondary transmission, treatment guidelines were updated in 2012 to recommend antiretroviral therapy for all persons with HIV (*6*). A national target for reducing the death rate among persons with diagnosed HIV (PWDH) by ≥33% during 2010–2020 was established to encourage progress toward improving health outcomes among PWDH (*7*). Using NHSS data, CDC assessed such progress, with an emphasis on HIV-related deaths, at the national and state levels.

Methods

CDC analyzed NHSS data reported through December 2019 regarding deaths during 2010–2018 among persons aged ≥13 years with diagnosed HIV infection. Using the *International Classification of Diseases, Tenth Revision* (ICD-10) codes associated with the underlying cause, deaths were classified as HIV-related or non–HIV-related.* Annual deaths (2010–2018) and

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* HIV-related: deaths with an ICD-10 code of B20–B24, 098.7, or R75 for the underlying cause; non–HIV-related: all other deaths with a nonmissing ICD-10 code for the underlying cause.

deaths by cause (2010–2017 because of delays in reporting) were assessed by demographic characteristics, transmission category, and U.S. region of residence at time of death. National-level results include persons with a residence at time of death in the 50 states or the District of Columbia; jurisdiction-level results also include persons with a residence at time of death in Puerto Rico.

Age-adjusted rates per 1,000 PWDH were calculated using the U.S. 2000 standard population. For HIV-related deaths, CDC calculated an absolute and a relative disparity measure for race/ethnicity and assessed change from 2010 to 2017.[†,§] For all measures, only stable rates (calculated on the basis of ≥12 deaths) and rates by cause of death for groups among whom ≥85% of deaths had a known cause (i.e., complete cause of death reporting) were assessed for temporal changes and for differences among groups.

[†] Absolute rate difference disparity measure: Difference between age-adjusted rate per 1,000 PWDH among selected race/ethnicity and White persons (population with lowest rate during 2010 among those with rates where ≥85% of deaths had a known cause). Change in the absolute rate difference disparity measure during 2010–2017 was calculated as ([absolute disparity measure in 2017 − absolute disparity measure in 2010]/absolute disparity measure in 2010) x 100.

[§] Relative rate ratio disparity measure: Ratio of age-adjusted rates per 1,000 PWDH for selected race/ethnicity, compared with White persons (population with lowest rate during 2010 among those with rates where ≥85% of deaths had a known cause). Change in the relative rate ratio disparity measure during 2010–2017 was calculated as ([relative disparity measure in 2017 − relative disparity measure in 2010]/relative disparity measure in 2010) x 100.

Results

During 2010–2018, the number of deaths among PWDH decreased by 7.5%, from 16,742 during 2010 to 15,483 during 2018; the rate of death decreased by 36.6% overall (Figure 1). The rate of HIV-related deaths decreased 48.4% from 9.1 per 1,000 PWDH during 2010 to 4.7 per 1,000 PWDH during 2017, whereas the rate of non–HIV-related deaths decreased 8.6% from 9.3 in 2010 to 8.5 in 2017 (Figure 1). The rate of HIV-related deaths during 2010–2017 decreased in all regions and for all gender, age, race/ethnicity, and transmission category groups. (Supplementary Table 1, https://stacks.cdc. gov/view/cdc/96933). The absolute rate difference disparity measure for HIV-related deaths between Hispanic/Latino persons and White persons decreased to zero (3.9 per 1,000 PWDH in both populations) in 2017. During 2010–2017, the absolute rate difference disparity measure between Black/ African American (Black) persons and White persons decreased by 66.0%, and between persons of multiple races and White persons decreased 36.7%. The relative rate ratio disparity measure between Black persons and White persons decreased 23.2%, between Hispanic/Latino persons and White persons decreased 17.7%, but between persons of multiple races and White persons increased 2.3%.

Rates of HIV-related deaths during 2017 were higher among females (5.4 per 1,000 PWDH) than males (4.5) and transgender females (females assigned male sex at birth) (4.3), and highest among persons of multiple races (7.0) and Black persons (5.6), followed by White persons (3.9) and Hispanic/ Latino persons (3.9) (Table 1). The rates of HIV-related deaths increased with age, from 1.6 among PWDH aged 13–24 years to 8.4 among persons aged ≥55 years. However, the proportion of deaths that were HIV-related decreased with increasing age from 48.6% among PWDH aged 13–24 years with a known cause of death to 30.0% among PWDH aged ≥55 years with a known cause of death because the rate of non–HIV-related death increased with age more than the rate of HIV-related death. Among males, the rate of HIV-related death was lower among those whose infection was attributed to male-to-male sexual contact (3.9) than among those whose infection was attributed to other transmission categories; among females, the rate was lower among those with infection attributed to heterosexual contact (4.6) than among those in other transmission categories. The rate of HIV-related deaths was highest in the South (6.0) and lowest in the Northeast (3.2).

In all areas with complete cause-of-death reporting and with stable rates, HIV-related deaths were lower during 2017 than in 2010 (Supplementary Table 2, https://stacks.cdc.gov/ view/cdc/96934). Rates of HIV-related deaths during 2017 varied by jurisdiction; rates were highest in Mississippi (10.3 per 1,000 PWDH), Puerto Rico (9.2), and South Carolina

FIGURE 1. Age-adjusted rates* of total deaths,[†] human immunodeficiency virus (HIV)–related deaths,[§] and non–HIV-related deaths among persons aged ≥13 years with diagnosed HIV infection — United States, 2010–2018[¶]
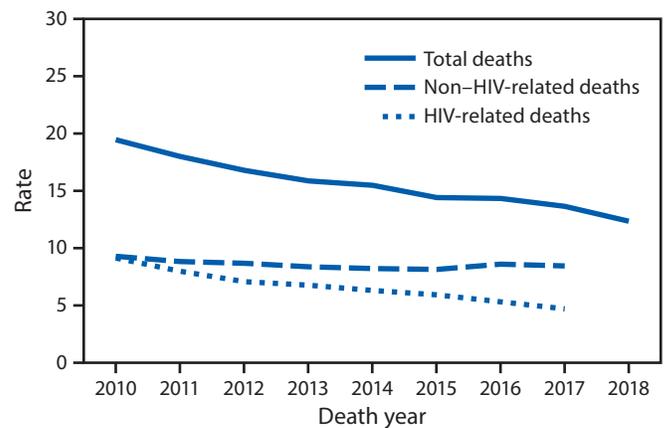
* Rates per 1,000 persons with diagnosed HIV infection. Rates age-adjusted using the U.S. 2000 standard population.
[†] Deaths among persons with diagnosed HIV infection regardless of cause of death (n = 16,742 in 2010; n = 15,483 in 2018).
[§] HIV-related deaths include deaths with an underlying cause with an *International Classification of Diseases, Tenth Revision*, code of B20-B24, O98.7, or R75. Non–HIV-related deaths include all other deaths with a known underlying cause.
[¶] Deaths by cause available through 2017 because of reporting delays.

(8.0), and lowest in New York (3.0), Massachusetts (3.1) and Delaware (3.2) (Figure 2). During 2017, rates of HIV-related deaths by race/ethnicity varied by jurisdiction (Table 2) (Supplementary Table 3, https://stacks.cdc.gov/view/ cdc/96934). Rates of HIV-related death were highest among White persons in South Carolina (10.1), Oklahoma (7.5), and Arkansas (6.5); highest among Black persons in Mississippi (11.5), Louisiana (8.8), South Carolina (8.2), and Nevada (8.2); and highest among Hispanic/Latino persons in Puerto Rico (9.2), Texas (6.5), and Arizona (6.2).

Discussion

By 2018, the rate of death among PWDH in the United States had decreased by 36.6% from what it was in 2010, surpassing the 2020 national target of ≥33% (7). This decrease, which was primarily attributable to reductions in HIV-related deaths, likely reflects the increase during 2010–2018 in the proportion of persons who knew their serostatus from 82.2% to 86.2% and the implementation of updated treatment guidelines resulting in increased viral suppression among PWDH from 46.0% to 64.7% (6,8). Absolute and relative differences in HIV-related deaths among Black persons and Hispanic/ Latino persons, compared with those among White persons, also decreased during 2010–2017. This reduction likely reflects a greater relative improvement during 2012–2017 in the time from diagnosis to viral suppression among Black persons,

TABLE 1. Total deaths, human immunodeficiency virus (HIV)–related deaths, and non–HIV-related deaths among persons aged ≥13 years with diagnosed HIV infection, by selected characteristics — United States, 2017

Characteristic	Total		HIV-related*				Non–HIV-related*	
	No.	Age-adjusted rate per 1,000 PWDH[†]	No.	% of deaths related to HIV	% of deaths with known cause related to HIV	Age-adjusted rate per 1,000 PWDH[†]	No.	Age-adjusted rate per 1,000 PWDH[†]
Gender								
Male	12,256	13.5	4,033	32.9	34.1	4.5	7,779	8.5
Female	3,994	14.1	1,466	36.7	37.7	5.4	2,425	8.3
Transgender male-to-female[§]	103	14.8	33	32.0	32.4	4.3	69	10.2
Transgender female-to-male[§]	4	18.0	2	50.0	50.0	10.7	2	7.3
Additional gender identity[¶]	1	13.8	0	0.0	0.0	0.0	1	13.8
Age at death, yrs								
13–24	151	3.5	70	46.4	48.6	1.6	74	1.7
25–34	1,048	6.5	492	46.9	48.8	3.0	516	3.2
35–44	1,838	9.4	826	44.9	46.4	4.2	954	4.9
45–54	4,470	14.4	1,584	35.4	36.6	5.1	2,740	8.9
≥55	8,851	28.9	2,562	28.9	30.0	8.4	5,992	19.5
Race/Ethnicity								
American Indian/ Alaska Native	44	13.5	8	18.2	21.1	3.3	30	8.3
Asian**	88	6.3	27	30.7	39.1	1.5	42	3.1
Black/African American	7,197	15.1	2,620	36.4	37.3	5.6	4,412	9.2
Hispanic/Latino[††]	2,694	11.1	955	35.4	37.2	3.9	1,609	6.6
Native Hawaiian/ Other Pacific Islander**	9	15.0	0	0.0	0.0	0.0	2	2.5
White	5,255	13.3	1,546	29.4	30.5	3.9	3,520	8.9
Multiple races	1,069	19.5	378	35.4	36.5	7.0	659	12.0
Transmission category[§§]								
Male adult or adolescent[¶¶]								
Male-to-male sexual contact	7,010	11.4	2,408	34.4	35.6	3.9	4,351	7.1
Injection drug use	2,168	22.7	590	27.2	28.1	6.2	1,506	15.8
Male-to-male sexual contact and injection drug use	1,373	19.1	444	32.4	33.3	6.1	889	12.6
Heterosexual contact***	1,705	16.1	579	34.0	35.6	5.8	1,046	9.5
Other[†††]	104	19.0	44	42.4	43.4	6.6	57	11.9
Subtotal	12,360	13.5	4,066	32.9	34.1	4.5	7,849	8.5
Female adult or adolescent[¶¶]								
Injection drug use	1,373	21.6	454	33.0	33.7	7.7	893	13.1
Heterosexual contact***	2,553	12.0	974	38.2	39.3	4.6	1,506	7.1
Other[†††]	72	16.2	40	56.2	59.6	7.0	27	8.9
Subtotal	3,998	14.1	1,468	36.7	37.7	5.4	2,427	8.3
U.S. Census region of residence at time of death								
Midwest	1,901	14.1	602	31.7	32.3	4.4	1,263	9.4
Northeast	3,689	12.0	941	25.5	26.8	3.2	2,576	8.2
South	8,040	15.5	3,092	38.5	39.1	6.0	4,822	9.2
West	2,728	11.4	899	33.0	35.8	3.9	1,615	6.6
Total	**16,358**	**13.6**	**5,534**	**33.8**	**35.0**	**4.7**	**10,276**	**8.5**

Abbreviation: PWDH = persons with diagnosed HIV infection.

* HIV-related deaths include deaths with an underlying cause with an *International Classification of Diseases, Tenth Revision* code of B20–B24, O98.7, or R75. Non–HIV-related deaths include all other deaths with a known underlying cause. Deaths with an unknown underlying cause are excluded.

[†] PWDH includes persons living with HIV infection at the end of the calendar year plus the number of diagnoses of HIV infection during the current calendar year. Rates age-adjusted using the U.S. 2000 standard population. Rates presented by age at time of death are not age-adjusted. Rates and percentage change calculated on the basis of <12 deaths are considered unstable and should be interpreted with caution.

[§] "Transgender male-to-female" includes persons who were assigned "male" sex at birth but have ever identified as "female." "Transgender female-to-male" includes persons who were assigned "female" sex at birth but have ever identified as "male."

[¶] Additional gender identity examples include "bigender," "gender queer," and "two-spirit."

** Data by cause of death should be interpreted with caution because <85% of reported deaths were reported with a known underlying cause of death.

[††] Hispanic/Latino persons can be of any race.

[§§] Data have been statistically adjusted to account for missing transmission category; therefore, values might not sum to column subtotals and total.

[¶¶] Data presented are based on sex at birth and include transgender persons.

*** Heterosexual contact with a person known to have, or to be at high risk for, HIV infection.

[†††] Includes hemophilia, blood transfusion, perinatal, and risk factor not reported or not identified.

TABLE 2. Total deaths and human immunodeficiency virus (HIV)–related deaths among persons aged ≥13 years with diagnosed HIV infection, by area of residence at time of death, and selected race/ethnicity categories — United States and Puerto Rico,* 2017

| | All races/ethnicities | | | Black/African American | | | | Hispanic/Latino | | | | White | | | |
| | Total | | | Total | | HIV-related[†] | | Total | | HIV-related[†] | | Total | | HIV-related[†] | |
Area of residence	No.	Age-adjusted rate per 1,000 PWDH[§]	% of deaths with a known cause	No.	Age-adjusted rate per 1,000 PWDH[§]	No.	Age-adjusted rate per 1,000 PWDH[§]	No.	Age-adjusted rate per 1,000 PWDH[§]	No.	Age-adjusted rate per 1,000 PWDH[§]	No.	Age-adjusted rate per 1,000 PWDH[§]	No.	Age-adjusted rate per 1,000 PWDH[§]
Alabama	257	17.8	98.4	150	17.5	60	6.5	5	11.4	2	5.2	83	19.5	29	6.1
Alaska	7	8.5	100.0	0	0	0	0	1	11.8	0	0	5	14.0	1	1.6
Arizona	247	13.5	99.6	29	14.9	10	6.1	56	12.3	26	6.2	145	14.7	48	4.6
Arkansas	107	17.0	99.1	33	12.3	16	6.2	6	15.7	3	7.9	61	19.2	21	6.5
California	1,717	11.0	89.7	327	12.1	118	4.4	509	10.2	195	3.9	724	10.4	193	2.8
Colorado	132	8.4	100.0	13	5.9	6	2.8	33	12.2	12	4.9	77	7.2	33	3.1
Connecticut	198	15.0	99.5	72	14.7	18	4.9	57	12.6	15	3.7	64	18.8	16	4.0
Delaware	67	13.8	100.0	50	18.0	13	4.6	4	13.6	1	3.8	11	6.5	1	0.5
District of Columbia	237	13.4	97.0	202	16.2	59	5.3	3	3.5	1	1.2	14	4.6	2	0.6
Florida	2,122	15.6	98.4	1,049	17.5	424	7.2	329	11.0	124	4.1	683	16.2	199	4.7
Georgia	823	14.5	97.7	559	15.3	244	6.5	43	12.5	18	4.2	158	12.0	38	2.9
Hawaii[¶]	37	15.2	35.1	1	5.6	0	0	1	3.3	1	3.3	12	7.0	2	0.8
Idaho	20	13.6	100.0	0	0	0	0	1	2.6	1	2.6	17	16.4	6	5.8
Illinois	498	12.8	99.2	289	16.6	76	4.4	48	7.3	14	1.8	124	11.2	30	2.1
Indiana	212	17.1	97.2	66	15.7	20	5.4	10	10.6	6	6.4	126	20.3	44	5.6
Iowa	44	13.1	100.0	11	16.9	6	9.7	3	7.0	1	2.3	26	11.3	10	4.4
Kansas	47	14.4	97.9	11	16.0	7	11.1	6	10.8	2	2.1	29	14.1	12	5.1
Kentucky	138	16.4	97.8	44	17.0	17	6.3	5	6.4	3	3.9	82	16.8	24	4.8
Louisiana	411	18.5	98.8	276	19.0	125	8.8	7	5.8	1	0.7	115	19.8	34	6.3
Maine	35	15.6	100.0	1	2.5	0	0	2	12.0	1	4.9	31	19.0	7	5.9
Maryland	597	14.7	98.3	412	14.0	132	4.4	26	9.5	9	3.0	84	18.9	19	3.8
Massachusetts	307	11.6	96.1	64	8.3	14	2.6	90	13.1	27	4.2	144	13.7	33	2.8
Michigan	273	15.6	99.3	160	17.2	49	5.1	13	14.9	4	3.2	88	12.5	27	3.8
Minnesota	91	9.3	98.9	27	8.3	15	4.0	6	6.9	3	2.1	52	10.2	19	4.2
Mississippi	220	21.2	98.6	158	22.1	85	11.5	9	36.7	6	21.3	44	19.3	12	5.5
Missouri	213	14.5	97.2	97	16.7	38	6.5	10	13.1	6	7.8	95	13.6	30	3.9
Montana	15	20.9	100.0	0	0	0	0	4	93.8	2	34.1	8	11.4	1	1.6
Nebraska	33	14.3	93.9	11	20.2	4	5.7	2	6.9	1	5.4	20	14.9	4	2.5
Nevada	174	16.1	97.7	50	20.5	19	8.2	23	9.6	9	3.4	90	15.9	26	4.6
New Hampshire	21	13.7	95.2	0	0	0	0	3	15.5	0	0	18	17.2	6	6.0
New Jersey	646	13.8	98.6	324	15.1	105	5.2	141	12.1	43	3.9	118	11.9	25	3.0
New Mexico	61	13.1	98.4	2	8.4	0	0	24	11.2	4	2.0	25	12.4	3	1.4
New York	1,787	10.7	98.3	661	10.7	164	3.0	635	11.0	170	3.0	247	7.2	59	1.9
North Carolina	547	15.1	98.9	338	15.3	137	6.1	19	7.9	8	3.5	152	15.1	48	4.6
North Dakota	3	8.9	100.0	0	0	0	0	1	131.2	1	131.2	2	8.7	1	4.4
Ohio	377	15.5	97.9	152	15.2	53	5.5	21	10.7	7	3.7	176	16.7	50	4.2
Oklahoma	109	16.8	95.4	22	13.5	11	7.1	6	8.9	1	1.0	65	20.3	22	7.5
Oregon	115	12.4	100.0	5	9.6	1	1.9	9	7.9	6	5.3	96	13.4	36	5.1
Pennsylvania[¶]	650	14.5	81.8	301	14.4	55	2.5	105	14.7	21	3.0	202	14.4	34	2.4
Puerto Rico	401	19.1	99.0	0	0	0	0	400	19.1	181	9.2	1	21.9	0	0
Rhode Island	33	9.6	97.0	7	8.6	3	3.5	6	8.6	2	3.2	17	9.5	4	2.2
South Carolina	337	17.2	97.9	236	17.7	110	8.2	5	6.4	2	2.3	83	19.3	34	10.1
South Dakota[¶]	9	12.4	33.3	2	9.1	1	3.9	0	0	0	0	4	10.0	0	0
Tennessee	332	18.2	99.4	189	19.9	81	7.7	6	9.2	2	3.2	128	17.3	48	5.8
Texas	1,413	15.1	98.9	557	17.3	245	7.4	359	12.8	182	6.5	409	14.6	157	5.8
Utah	22	8.4	95.5	1	4.2	1	4.2	3	9.8	0	0	16	7.0	8	3.4
Vermont	12	11.4	100.0	0	0	0	0	1	7.5	0	0	10	12.2	3	3.2
Virginia	292	10.5	98.3	180	11.8	60	4.1	9	3.3	6	2.1	79	9.0	27	3.2
Washington	175	10.4	97.1	24	10.8	9	4.2	19	9.3	6	2.8	112	10.8	35	3.8
West Virginia	31	13.8	100.0	4	7.5	1	2.1	1	11.9	0	0	24	15.8	6	4.6
Wisconsin	101	12.7	100.0	30	11.7	8	3.3	9	9.0	0	0	57	13.8	18	4.2
Wyoming[¶]	6	27.2	66.7	0	0	0	0	0	0	0	0	3	9.5	1	3.5

See table footnotes on the next page.

TABLE 2. (*Continued*) Total deaths and human immunodeficiency virus (HIV)–related deaths among persons aged ≥13 years with diagnosed HIV infection, by area of residence at time of death, and selected race/ethnicity categories — United States and Puerto Rico,* 2017

Abbreviation: PWDH = persons with diagnosed HIV infection.

* Other U.S. dependent areas are excluded because they do not report underlying cause of death information.

[†] HIV-related deaths include deaths with an underlying cause with an *International Classification of Diseases, Tenth Revision* code of B20–B24, O98.7, or R75. Non–HIV-related deaths include all other deaths with a known underlying cause. Deaths with an unknown underlying cause are excluded.

[§] PWDH includes persons living with HIV infection at the end of the calendar year plus the number of diagnoses of HIV infection during the current calendar year. Rates age-adjusted using the U.S. 2000 standard population. Rates calculated based on consideration that analyses of data with <12 deaths are considered unstable and should be interpreted with caution.

[¶] Proportion of deaths with a known underlying cause of death is <85%.

compared with White persons (*9*), and reduced disparities during 2010–2016 in viral suppression among Black persons and Hispanic/Latino persons, compared with White persons (*10*). These findings highlight how successes in identifying HIV infections, initiating treatment, and achieving viral suppression among PWDH improve health outcomes.

Despite success in reducing rates of HIV-related deaths among PWDH, differences still exist by gender, race/ethnicity, age, transmission category, and region. Variation in timely diagnosis and treatment initiation, along with ongoing treatment, likely contributes to differences in HIV-related deaths. During 2015, delays in HIV diagnosis were longer among non-White racial/ethnic groups and males with HIV infection attributed to heterosexual contact (*11*). Timely initiation of treatment, as measured by the proportion of persons with suppressed viral loads ≤6 months after diagnosis, and receipt of ongoing, recommended treatment, as measured by the proportion of PWDH with a suppressed viral load, varied during 2017 by gender, age, race/ethnicity, transmission category, and region (*8,12*); populations with higher rates of HIV-related deaths were less likely to have evidence of timely initiation of treatment and ongoing treatment as demonstrated through lower proportions of viral suppression in the population.

Prevalence of HIV infection and the number of HIV-related deaths were greatest by race/ethnicity among Black persons and by U.S. region in the South (*4*). Rates of HIV-related deaths were also high among these two populations. Higher levels of poverty, unemployment, and persons uninsured, challenges associated with accessing care, and HIV-related stigma likely affect timely diagnosis and access to treatment and contribute to higher rates of HIV-related deaths (*13,14*). Expanded efforts to address these and other structural barriers are critical to improving health outcomes, including reducing differences in HIV-related death rates, especially among Black persons and persons in the South.

Although rates of HIV-related deaths were lower among younger PWDH, the proportion of HIV-related deaths among younger PWDH (ages 13–44 years) was higher than that among older PWDH; this is concerning because HIV-related deaths are preventable. Higher proportions of undiagnosed HIV infections and lower levels of viral suppression are more common among younger persons (*8,15*). Additional efforts are needed to ensure younger persons are aware of their infection and able to access and adhere to recommended, ongoing HIV treatment to improve health outcomes.

CDC supports numerous activities for identifying HIV infections: initiating treatment as quickly as possible and ensuring ongoing treatment; addressing social barriers to HIV prevention and treatment efforts; and expanding opportunities for persons to test for HIV infection and receive the results on their own (i.e., self-testing), which allows persons who might not otherwise take a test to learn their HIV status (*16*). CDC's Integrated HIV Surveillance and Prevention Programs for Health Departments, initiated in 2018, includes critical activities to enable state and local health departments to improve identification of HIV infections and increase viral suppression among PWDH (*17*). CDC's national campaign, Let's Stop HIV Together, supports efforts to end HIV stigma and promote HIV testing, prevention, and treatment (*18*). Ending the HIV Epidemic: A Plan for America is an initiative for reducing HIV infections in the United States by ≥90% by 2030; it focuses on strategies regarding diagnosis, treatment, prevention, and response to HIV infection in communities most affected by HIV (*19*). In addition to decreasing the risk for ongoing HIV transmission, prompt diagnosis and improving timely and continuing access to HIV treatment should also improve health outcomes for PWDH and prevent HIV-related deaths.

The findings in this report are subject to at least two limitations. First, cause-of-death information on death certificates is typically completed by funeral directors, attending physicians, medical examiners, or coroners (*3*). HIV-related deaths might be underreported because of lack of knowledge about the correct documentation needed or reluctance to include HIV on the death certificate because of possible stigma (*5*). An assessment of Florida's HIV surveillance data for 2000–2011 indicated that HIV-related deaths were underestimated in the surveillance system by approximately 9% (*20*). Second, the proportion of deaths with a known cause was <100%. Overall, the proportion of deaths with a known cause was high for the United States (94.6% in 2010 and 96.7% in 2017); however, the proportion of deaths with a known cause was lower for

FIGURE 2. Age-adjusted rates* of human immunodeficiency virus (HIV)–related deaths among persons aged ≥13 years with diagnosed HIV infection, by area of residence at time of death — United States and Puerto Rico, 2017

DC
PR

6.0–10.3
4.7–5.9
3.7–4.6
1.9–3.6
Incomplete reporting
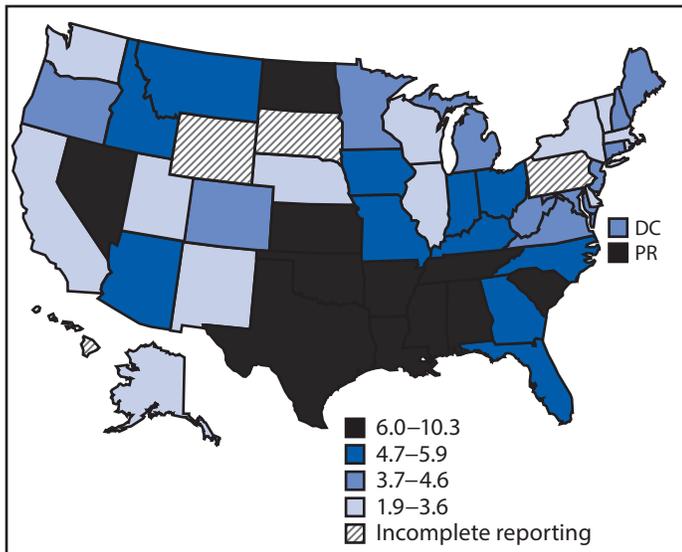
Abbreviations: DC = District of Columbia; PR = Puerto Rico.
* Rates per 1,000 persons with diagnosed HIV infection. Rates age-adjusted using the U.S. 2000 standard population. HIV-related deaths include deaths with an underlying cause with an *International Classification of Diseases, Tenth Revision* code of B20–B24, 098.7, or R75. Other U.S. dependent areas are excluded because they do not report underlying cause of death information. Jurisdictions with striped shading are those with <85% of deaths in 2017 with a known underlying cause of death. Rates from Alaska, Idaho, Maine, Montana, Nebraska, New Hampshire, New Mexico, North Dakota, Rhode Island, Utah, Vermont, and West Virginia are calculated based on <12 deaths and should be interpreted with caution.

certain demographic groups (e.g., Asian persons) and for certain jurisdictions (e.g., Hawaii during 2017).

Deaths among persons with HIV have decreased, and by 2018 had surpassed the 2020 national target, primarily because of a reduction in HIV-related deaths. Deaths caused by HIV infection have likely decreased because of improvements in diagnosing infections and in treatment and medical care. However, differences in HIV-related death rates still exist for multiple populations. Diagnosing HIV infection early, treating it promptly, and maintaining access to high-quality care and treatment over a lifetime can improve life expectancy and reduce differences in rates of deaths across all populations.

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Xueyuan (Bill) Dong, ICF Corporation, Atlanta, Georgia.

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.

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Summary

What is already known about this topic?

HIV remains among the 10 leading causes of death among certain populations, although deaths attributable to HIV infection are preventable.

What is added by this report?

Deaths among persons with diagnosed HIV (PWDH) decreased, primarily because of decreases in HIV-related deaths. The age-adjusted rate per 1,000 PWDH of HIV-related deaths decreased 48% and non–HIV-related deaths decreased 9% during 2010–2017. Differences in HIV-related deaths persist for certain populations.

What are the implications for public health practice?

Continued efforts in diagnosing HIV early, promptly initiating treatment, and maintaining access to high-quality care and treatment are necessary for continuing progress in reducing deaths and eliminating differences across populations.

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COVID-19 Outbreak — New York City, February 29–June 1, 2020

Corinne N. Thompson, PhD[1]; Jennifer Baumgartner, MSPH[1]; Carolina Pichardo[1]; Brian Toro[1]; Lan Li, MPH[1]; Robert Arciuolo, MPH[1]; Pui Ying Chan, MPH[1]; Judy Chen[1]; Gretchen Culp, PhD[1]; Alexander Davidson, MPH[1]; Katelynn Devinney, MPH[1]; Alan Dorsinville, MPH[1]; Meredith Eddy, MPH[1]; Michele English[1]; Ana Maria Fireteanu, MPH[1]; Laura Graf, MPH[1]; Anita Geevarughese, MD[1]; Sharon K. Greene, PhD[1]; Kevin Guerra, MPH[1]; Mary Huynh, PhD[1]; Christina Hwang, MPH[1]; Maryam Iqbal, MPH[1]; Jillian Jessup, MPH[1]; Jillian Knorr, MPH[1]; Julia Latash, MPH[1]; Ellen Lee, MD[1]; Kristen Lee, MPH[1]; Wenhui Li, PhD[1]; Robert Mathes, MPH[1]; Emily McGibbon, MPH[1]; Natasha McIntosh[1]; Matthew Montesano, MPH[1]; Miranda S. Moore, MPH[1]; Kenya Murray, MPH[1]; Stephanie Ngai, MPH[1]; Marc Paladini, MPH[1]; Rachel Paneth-Pollak, MD[1]; Hilary Parton, MPH[1]; Eric Peterson, MPH[1]; Renee Pouchet, MHA[1]; Jyotsna Ramachandran, MPH[1]; Kathleen Reilly, PhD[1]; Jennifer Sanderson Slutsker, MPH[1]; Gretchen Van Wye, PhD[1]; Amanda Wahnich, MPH[1]; Ann Winters, MD[1]; Marcelle Layton, MD[1]; Lucretia Jones, DrPH[1]; Vasudha Reddy, MPH[1]; Anne Fine MD[1]

New York City (NYC) was an epicenter of the coronavirus disease 2019 (COVID-19) outbreak in the United States during spring 2020 (*1*). During March–May 2020, approximately 203,000 laboratory-confirmed COVID-19 cases were reported to the NYC Department of Health and Mental Hygiene (DOHMH). To obtain more complete data, DOHMH used supplementary information sources and relied on direct data importation and matching of patient identifiers for data on hospitalization status, the occurrence of death, race/ethnicity, and presence of underlying medical conditions. The highest rates of cases, hospitalizations, and deaths were concentrated in communities of color, high-poverty areas, and among persons aged ≥75 years or with underlying conditions. The crude fatality rate was 9.2% overall and 32.1% among hospitalized patients. Using these data to prevent additional infections among NYC residents during subsequent waves of the pandemic, particularly among those at highest risk for hospitalization and death, is critical. Mitigating COVID-19 transmission among vulnerable groups at high risk for hospitalization and death is an urgent priority. Similar to NYC, other jurisdictions might find the use of supplementary information sources valuable in their efforts to prevent COVID-19 infections.

This report describes cases of laboratory-confirmed COVID-19 among NYC residents diagnosed during February 29–June 1, 2020, that were reported to DOHMH. DOHMH began COVID-19 surveillance in January 2020 when testing capacity for SARS-CoV-2 (the virus that causes COVID-19) using real-time reverse transcription–polymerase chain reaction (RT-PCR) was limited by strict testing criteria because of limited test availability only through CDC. The NYC and New York State public health laboratories began testing hospitalized patients at the end of February and early March. DOHMH encouraged patients with mild symptoms to remain at home rather than seek health care because of shortages of personal protective equipment and laboratory tests at hospitals and clinics. Commercial laboratories began testing for SARS-CoV-2 in mid- to late March. During February 29–March 15, patients with laboratory-confirmed COVID-19 were interviewed by DOHMH, and close contacts were identified for monitoring. The rapid rise in laboratory-confirmed cases (cases) quickly made interviewing all patients, as well as contact tracing, unsustainable. Subsequent case investigations

first included medical chart review for patients who were hospitalized or who had died, but then progressed to chart review only for patients who had died, and then finally only for deaths in patients aged <65 years. On April 14, DOHMH began to report probable COVID-19–associated deaths (i.e., no known positive SARS-CoV-2 test result and death certificate listing cause of death as COVID-19 or an equivalent term [e.g., COVID, SARS-CoV-2, or another term]).

DOHMH quickly recognized the need for supplementary information sources and relied on direct data importation and matching of patient identifiers for data on hospitalization status, the occurrence of death, race/ethnicity, and presence of underlying medical conditions, including diabetes, lung disease, cancer, immunodeficiency, heart disease, asthma, kidney disease, gastrointestinal/liver disease, and obesity. These supplementary data systems included emergency department syndromic surveillance, the New York State Hospital Emergency Response Data System, regional health information organizations, NYC public hospitals, DOHMH's electronic death registry system, and remote access to hospitals' electronic health record systems. Even with these supplementary data sources, many variables (e.g., race/ethnicity) were still incomplete, given variable data quality.

Descriptive statistics were calculated using SAS software (version 9.4; SAS Institute). Age-adjusted rates were calculated using direct standardization for age and weighting by the U.S. 2000 standard population (*2*). Crude rates of cumulative cases, deaths, and testing per 100,000 population were mapped by modified U.S. Census Bureau ZIP code tabulation area* using ArcGIS software (version 10.6.1; ESRI). Neighborhood-level poverty was defined as the percentage of residents within a ZIP code with household incomes <100% of the federal poverty level, per the American Community Survey 2013–2017 (low: <10%, medium: 10%–19.9%, high: 20%–29.9%, very high: ≥30%). Population estimates (for 2018) for age, sex, borough (county) of residence, racial/ethnic group, and neighborhood poverty were produced by DOHMH using U.S. Census Bureau Population Estimate Program files (unpublished data, NYC DOHMH, 2020).†

* https://www.census.gov/programs-surveys/geography/guidance/geo-areas/zctas.html.
† Population estimates were modified from U.S. Census Bureau interpolated intercensal population estimates, 2000–2018, updated August 2019.

During February 29–June 1, 2020, a total of 203,792 COVID-19 cases were diagnosed and reported[§] among residents of NYC, including 54,211 (26.6%) in persons known to have been hospitalized and 18,679 (9.2%) in persons who died. The age-adjusted cumulative citywide incidences were 2,263 cases,

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[§] As of July 27, 2020.

582 hospitalizations, and 198 deaths per 100,000 population. Case counts increased rapidly from a weekly mean of 274 diagnosed cases per day during the week of March 8 to a peak weekly mean of 5,132 cases per day by the week of March 29 (Figure 1). Hospital admissions also peaked the week of March 29 (weekly mean = 1,566 admissions per day). Deaths peaked during the week of April 5 (weekly mean = 566 per day). The median

FIGURE 1. Daily laboratory-confirmed COVID-19 cases, associated hospitalizations, and deaths — New York City, February 29–June 1, 2020
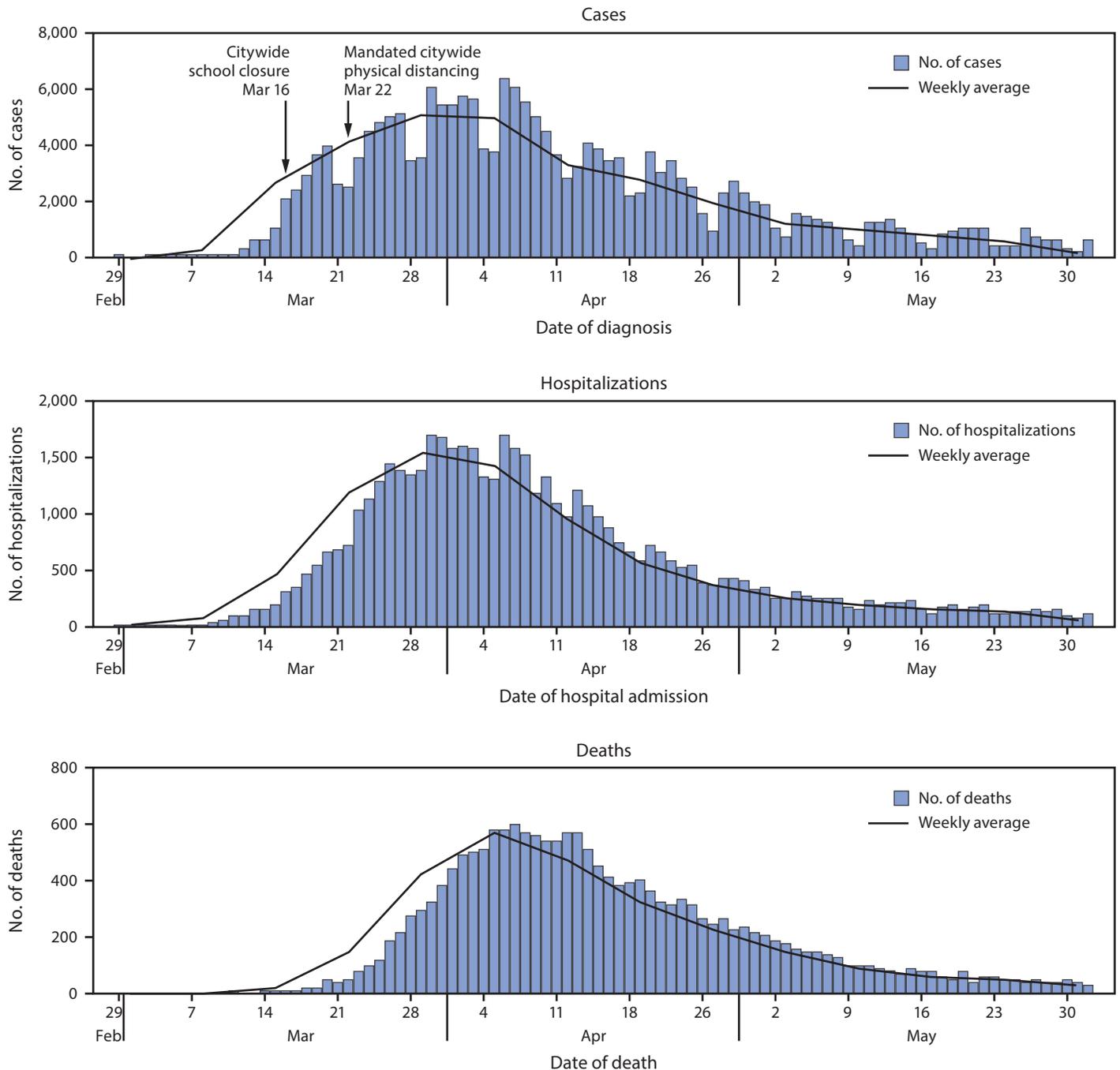
Abbreviation: COVID-19 = coronavirus disease 2019.

duration of hospitalization was 6 days (interquartile range [IQR] = 3–11 days). Among decedents with laboratory-confirmed COVID-19, the median interval from diagnosis to death was 8 days (IQR = 4–16 days). Among hospitalized patients, 32.1% were known to have died. The weekly proportion of hospitalized patients who died was highest among those admitted during March 22–April 5 (mean = 36.4%; range = 33.5%–38.2%).

Age-specific incidence was highest among adults aged 45–64 years (7,007 per 100,000) (Table). Hospitalization and death rates were highest among patients aged ≥75 years (2,146 and 1,311 per 100,000, respectively); among persons aged ≥75 years with confirmed cases, 38.3% were known to have died. Age-adjusted incidence, hospitalization rate, and death rate were higher among males than females, and all increased with increasing levels of neighborhood poverty. By borough, age-adjusted incidence, hospitalization rate, and death rate were consistently highest in the Bronx and lowest in Manhattan. Among the race/ethnicity groups with known identity, incidence was highest among Black/African American

(Black) persons (1,590 per 100,000). Age-adjusted rates of hospitalization and death were highest among Black (699 and 248 per 100,000, respectively) and Hispanic/Latino (Hispanic) persons (658 and 260 per 100,000, respectively).

Some neighborhoods with high case rates also had high testing rates (e.g., North Bronx and Northwest Queens) (Figure 2). However, other neighborhoods had low or medium testing rates and high percent positivity with medium to high case rates (Southeast Queens, East Brooklyn, West Bronx, and Northern Manhattan), suggesting possible underascertainment of cases. Citywide, the percentage of tests with positive results increased from 27% the week of March 8 to a peak of 65% during the week of March 22. The growth of testing rates lagged behind the growth of percent positivity but increased steadily from 86 per 100,000 during the week of March 8 to 1,634 per 100,000 by the week of May 24.

Among 85% of decedents with known underlying medical conditions, the majority (75%) of decedents with a confirmed laboratory test had two or more underlying conditions; heart

TABLE. Characteristics of cumulative laboratory-confirmed COVID-19 cases, hospitalizations, and deaths among New York City residents reported to the New York City Department of Health and Mental Hygiene — New York City, February 29–June 1, 2020*

Characteristic	Cases		Hospitalizations		Deaths	
	No.	Rate[†]	No. (row %)	Rate[†]	No. (row %)	Rate[†]
Total	203,792	2,263	54,211 (26.6)	582	18,679 (9.2)	198
Age group, yrs						
0–17	6,016	348	508 (8.4)	29	12 (0.2)	1
18–44	74,654	2,215	8,474 (11.4)	251	686 (0.9)	20
45–64	73,998	7,007	18,219 (24.6)	1,725	4,183 (5.7)	396
65–74	25,182	2,518	12,009 (47.7)	1,201	4,634 (18.4)	463
≥75	23,942	3,425	15,001 (62.7)	2,146	9,164 (38.3)	1,311
Sex						
Female	98,992	2,060	23,612 (23.9)	456	7,494 (7.6)	136
Male	104,675	2,511	30,589 (29.2)	744	11,183 (10.7)	283
Race/Ethnicity						
Hispanic/Latino	36,498	1,514	15,288 (41.9)	658	5,743 (15.7)	260
Black/African American	32,458	1,590	14,676 (45.2)	699	5,215 (16.1)	248
White	31,029	988	11,057 (35.6)	314	4,745 (15.3)	123
Asian/Pacific Islander	8,122	601	3,441 (42.4)	258	1,403 (17.3)	111
American Indian/Alaska Native	196	973	33 (16.8)	168	5 (2.6)	27
Other race/Missing	95,489	—[§]	9,716 (10.2)	—[§]	1,568 (1.6)	—[§]
Neighborhood poverty[¶]						
Low	33,114	1,787	7,498 (22.6)	358	2,756 (8.3)	125
Medium	79,327	2,169	20,907 (26.4)	551	7,404 (9.3)	193
High	48,998	2,315	15,034 (30.7)	700	5,184 (10.6)	241
Very high	36,642	2,706	10,341 (28.2)	796	3,305 (9)	268
Borough of residence						
Bronx	46,085	3,157	12,076 (26.2)	826	3,870 (8.4)	268
Brooklyn	56,548	2,104	15,125 (26.7)	556	5,563 (9.8)	205
Manhattan	25,315	1,369	7,867 (31.1)	408	2,476 (9.8)	123
Queens	62,260	2,507	16,806 (27)	637	5,882 (9.4)	217
Staten Island	13,577	2,701	2,337 (17.2)	423	888 (6.5)	158

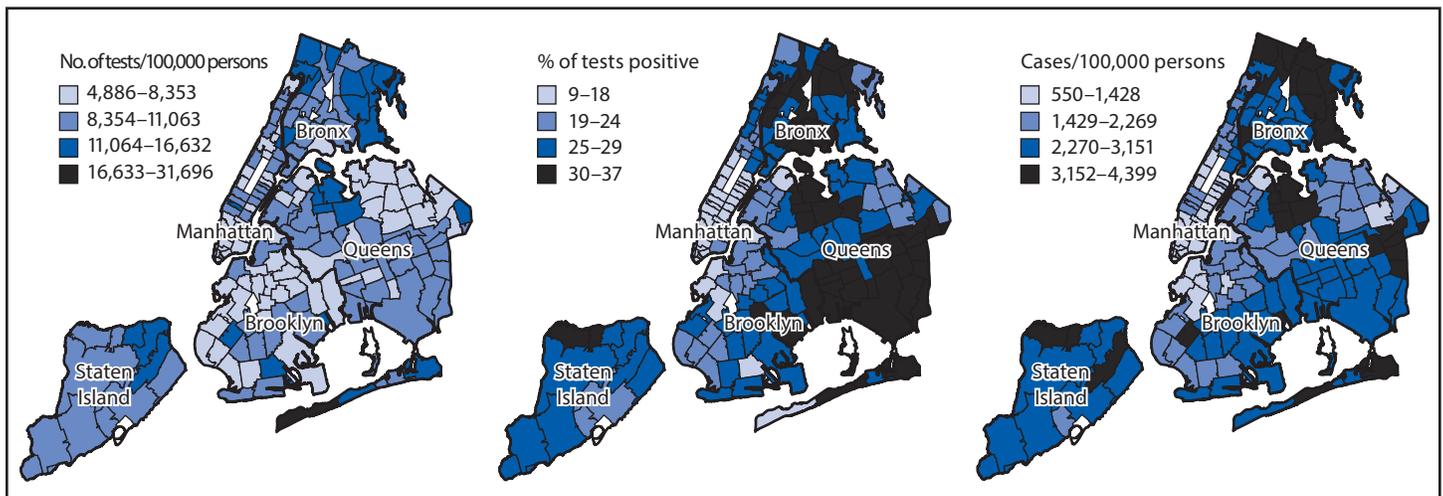**Abbreviation:** COVID-19 = coronavirus disease 2019.
* Data missing on sex for 138 persons, on borough for nine persons, and on neighborhood poverty for 6,660 persons.
[†] Per 100,000 population; rates for sex, race/ethnicity, neighborhood poverty, and borough of residence were age-adjusted.
[§] Rates not calculated because no population denominator.
[¶] Neighborhood-level poverty was defined as the percentage of residents in a ZIP code with household incomes <100% of the federal poverty level, per the American Community Survey 2013–2017. Low poverty: <10%; medium poverty: 10%–19.9%; high poverty: 20%–29.9%; very high poverty: ≥30%.

FIGURE 2. Cumulative crude rates of COVID-19 testing per 100,000 population, percentage of tests positive for SARS-CoV-2, and cumulative crude rates of COVID-19 cases per 100,000 population,* by modified ZIP code tabulation areas — New York City, February 29–June 1, 2020

Abbreviation: COVID-19 = coronavirus disease 2019.
* All data are displayed by four levels of natural breaks.

disease (73%), diabetes (58%), and chronic kidney disease (23%) were the most commonly reported conditions (NYC DOHMH, unpublished data; 2020). During March 11–June 1, 4,516 probable COVID-19–associated deaths were known to have occurred among NYC residents. These deaths occurred more commonly at home (30%) or in a nursing home (26%), compared with confirmed COVID-19 deaths (4% at home and 8% in a nursing home). Deaths occurring in a hospital were frequently laboratory-confirmed as COVID-19–associated (86%). Among 23,195 probable and confirmed deaths, 22.5% (5,226) were known to have occurred among residents of a nursing home.

Discussion

Phylogenetic analysis and sentinel surveillance suggest that the introduction of COVID-19 into NYC from travelers started during early to mid-February 2020 (*3,4*), although the first case of laboratory-confirmed COVID-19 in NYC was diagnosed on February 29. The subsequent 3-month period was characterized by a rapid acceleration in the epidemic, resulting in approximately 203,000 cases and 18,600 deaths among persons with laboratory-confirmed COVID-19. Reported diagnoses of cases peaked 1 week after physical distancing orders were enacted (March 22). The overall crude case fatality rate of 9.2% is an overestimate because of underascertainment of cases, given the restrictive testing guidance and limited availability of tests for the first 2 months of the epidemic.¶ Similar to findings from the United Kingdom,** approximately 30% of hospitalized patients with laboratory-confirmed COVID-19 were known to

have died. The increased case fatality rate among hospitalized patients during the peak period of reported cases suggests that health care system capacity constraints might have influenced patient outcomes.

As has been previously reported (*5*), COVID-19 incidence and related hospitalization and mortality were elevated among Black and Hispanic persons and among residents of high-poverty neighborhoods. The finding of neighborhoods with low testing rates and a high percentage of positive test results suggests barriers to accessing testing in areas with considerable community transmission.

The rapid spread of COVID-19, combined with a lack of testing availability early in 2020, led to considerable surveillance challenges. DOHMH quickly ceased labor-intensive individual case investigations for all patients and sought supplementary sources of information. In addition, publishing NYC DOHMH data online in real-time†† allowed the public to access basic and important information on COVID-19 in NYC.

The findings in this report are subject to at least four limitations. First, these data are based primarily on laboratory-confirmed disease, which is more likely to represent severe illness, especially early in the epidemic when COVID-19 testing was mostly limited to hospitalized patients. Second, hospitalizations were underestimated because of incomplete ascertainment from external sources. Third, race and ethnicity information was missing for a large proportion of nonhospitalized, nonfatal cases. Finally, rates are likely underestimated for more affluent neighborhoods because denominators do not reflect the differential exodus of wealthy NYC residents (*6*).

¶ https://www.medrxiv.org/content/10.1101/2020.06.27.20141689v1.full.pdf.
** https://www.medrxiv.org/content/10.1101/2020.04.23.20076042v1.full.pdf.

†† https://www1.nyc.gov/site/doh/covid/covid-19-data.page.

Summary

What is already known about this topic?

New York City (NYC) was an early epicenter of the COVID-19 pandemic in the United States.

What is added by this report?

Approximately 203,000 cases of laboratory-confirmed COVID-19 were reported in NYC during the first 3 months of the pandemic. The crude fatality rate among confirmed cases was 9.2% overall and 32.1% among hospitalized patients. Incidence, hospitalization rates, and mortality were highest among Black/African American and Hispanic/Latino persons, as well as those who were living in neighborhoods with high poverty, aged ≥75 years, and with underlying medical conditions.

What are the implications for public health practice?

Mitigating COVID-19 transmission among vulnerable groups at high risk for hospitalization and death is an urgent priority.

The initial wave of COVID-19 in NYC demonstrated that persons who were older, had underlying medical conditions, or resided in poorer neighborhoods, and racial and ethnic minority populations suffered disproportionately from SARS-Cov-2 infection and death. These trends represent the downstream effect of long-term policies, practices, attitudes, and cultural messages that promote, reinforce, and fail to eliminate inequities (7). In addition, Black and Hispanic persons are disproportionately employed in lower-paid, often frontline industries and occupations, work with limited ability to social distance, and are more likely to lack employer-based health insurance (8). Mitigating future morbidity and mortality from COVID-19 across NYC in the absence of a vaccine,§§ particularly among persons who are at increased risk, is an urgent priority.

§§ https://www.cdc.gov/coronavirus/2019-ncov/community/health-equity/index.html.

Corresponding author: Corinne N. Thompson, cthompson2@health.nyc.gov.

[1]New York City Department of Health and Mental Hygiene, Long Island City, New York.

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Characterization of COVID-19 in Assisted Living Facilities — 39 States, October 2020

Sarah H. Yi, PhD[1]; Isaac See, MD[1]; Alyssa G. Kent, PhD[1]; Nicholas Vlachos, MS[1]; J. Carrie Whitworth, PhD[1]; Kerui Xu, PhD[1]; Katryna A. Gouin, MPH[1]; Shirley Zhang, MS[1]; Kara Jacobs Slifka, MD[1]; Ann Goding Sauer, MSPH[1]; Preeta K. Kutty, MD[1]; Joseph F. Perz, DrPH[1]; Nimalie D. Stone, MD[1]; Matthew J. Stuckey, PhD[1]

The coronavirus disease 2019 (COVID-19) pandemic has highlighted the vulnerability of residents and staff members in long-term care facilities (LTCFs) (*1*). Although skilled nursing facilities (SNFs) certified by the Centers for Medicare & Medicaid Services (CMS) have federal COVID-19 reporting requirements, national surveillance data are less readily available for other types of LTCFs, such as assisted living facilities (ALFs) and those providing similar residential care. However, many state and territorial health departments publicly report COVID-19 surveillance data across various types of LTCFs. These data were systematically retrieved from health department websites to characterize COVID-19 cases and deaths in ALF residents and staff members. Limited ALF COVID-19 data were available for 39 states, although reporting varied. By October 15, 2020, among 28,623 ALFs, 6,440 (22%) had at least one COVID-19 case among residents or staff members. Among the states with available data, the proportion of COVID-19 cases that were fatal was 21.2% for ALF residents, 0.3% for ALF staff members, and 2.5% overall for the general population of these states. To prevent the introduction and spread of SARS-CoV-2, the virus that causes COVID-19, in their facilities, ALFs should 1) identify a point of contact at the local health department; 2) educate residents, families, and staff members about COVID-19; 3) have a plan for visitor and staff member restrictions; 4) encourage social (physical) distancing and the use of masks, as appropriate; 5) implement recommended infection prevention and control practices and provide access to supplies; 6) rapidly identify and properly respond to suspected or confirmed COVID-19 cases in residents and staff members; and 7) conduct surveillance of COVID-19 cases and deaths, facility staffing, and supply information (*2*).

LTCFs comprise a broad range of nursing and residential care facilities that provide varying degrees of health and social services. LTCFs include ALFs and similar residential care facilities, SNFs and other nursing homes, and residential facilities for persons with intellectual and developmental disabilities. As of 2016, the 28,900 U.S. ALFs accounted for approximately 44% of the nation's LTCFs and had 811,500 residents and 298,800 full-time equivalent care staff members (*3*). Resident care in ALFs is focused on activities of daily living, such as bathing and toileting, and assisting with skills needed for independent living, such as medication management and housekeeping (*3*). As of 2016, 52% of ALF residents were aged ≥85 years, 30%

were aged 75–84 years, 71% were female, 81% were non-Hispanic White, and 17% had Medicaid as payer for services.

By November 6, 2020, approximately 569,000–616,000 COVID-19 cases and 91,500 deaths were reported among LTCF residents and staff members in the United States, accounting for 6% of total state COVID-19 cases and 39% of deaths (*4,5*). Although U.S. LTCF outbreaks have been extensively described, they have primarily focused on SNFs. Less has been published on the occurrence of COVID-19 in ALFs (*6*). National characterization of COVID-19 in ALFs is challenging because these facilities do not have a federal COVID-19 reporting requirement, unlike CMS-certified SNFs. However, many state and territorial health departments collect and publicly report COVID-19 data across various types of LTCFs as part of their surveillance activities.

Starting April 30, 2020, health department websites were systematically searched for LTCF COVID-19 surveillance data at least weekly so that ALFs with one or more COVID-19 cases, and cases or deaths among residents and staff members could be counted. Data availability and presentation varied widely by state. Some reporting states aggregated surveillance data for all ALFs. Others provided COVID-19 case or death counts for individual LTCFs by name. For states providing LTCF names but not facility type, ALFs were identified by linking the facility name and available address information to general public listings of ALFs and similar residential care facilities* from state regulatory authorities. Some reporting states provided the number of affected facilities, number of cases, or number of deaths among ALF residents and staff members. Other states reported cases associated with active COVID-19 outbreaks, only representing cases or deaths occurring within a recent time frame, as indicated by the state. For these latter states,

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* "Assisted living facility" also refers to long-term care facilities defined as adult care facility (ACF), adult care home (ACH), adult home (AH), adult residential facility (ARF), assisted care living facility (ACLF), assisted care living home (ACLH), assisted living community (ALC), assisted living facility special care (ALF SC), assisted living program (ALP), assisted living residence (ALR), community residential care facility (CRCF), home for the aged (HFTA), personal care home (PCH), residential care facility (RCF), residential care facility for the elderly (RCFE), supportive living program (SLP), and supported residential care facility (sRCF). The following states report COVID-19 in assisted living facilities using one or more of those terms: California (ARF, RCFE), Illinois (ALF, SLP), Indiana (RCF), Iowa (ALF, RCF), Louisiana (ARF), Maryland, (ALP), Massachusetts (ALR), New Hampshire (sRCF, ALF, RCF), New Jersey (ALR, ALP, PCH), New York (AH, ALP, EHP), North Carolina (ACH), Oklahoma (ALC), Pennsylvania (ALF, ALF-SC, PCH), South Carolina (CRCF), and Tennessee (ACLF, HFTA).

when possible, cumulative counts were approximated by using maximum active numbers from outbreaks among available reports, or by combining numbers from active and inactive outbreaks. Statewide COVID-19 case counts in the general population were obtained from USAFacts.[†] The proportions of deaths among cases were calculated for the statewide general population, ALF residents, ALF staff members, and ALF residents and staff members, where possible. The overall number of U.S. ALFs was obtained using public listings from state regulatory authorities. SAS (version 9.4; SAS Institute) and Python (version 3.6.8; Python Software Foundation) were used for data analysis and to perform facility-level linkages.

As of October 15, 2020, 39 states had publicly available data reporting one or more COVID-19 cases in an ALF. The start of reporting varied by state, and when provided, ranged from February 27 to April 30, 2020. Among the 39 states, 38 reported the total number of ALFs in their state, 23 reported the number of cases among ALF residents, 22 reported the number of cases among ALF staff members, and 33 reported the number of cases among ALF residents and staff members. COVID-19–associated death data were available from 28 states for ALF residents and staff members combined, but available from only 20 states for ALF residents alone, and from nine states for ALF staff members alone.

A total of 33,167 licensed ALFs and similar residential care facilities from 50 states and the District of Columbia were identified through state government regulatory websites. Among the 39 states with available data, 6,440 (22%) of 28,623 ALFs had one or more COVID-19 cases as of October 15, 2020, ranging from 1.3% of ALFs in Iowa to 92.8% of ALFs in Connecticut (Table 1). Ten states (Connecticut, Georgia, Indiana, Kentucky, Massachusetts, Mississippi, New Jersey, North Dakota, Utah, and Washington) reported one or more cases in ≥50% of ALFs. Overall, 27,965 cases of COVID-19 were reported in ALF residents and 17,799 in ALF staff members (Table 1); 5,469 associated deaths were reported in residents and 46 in staff members (Table 2). ALF residents and staff members accounted for 4.1% and 0.1%, respectively, of COVID-19-associated deaths in the general population (Table 2). Among the states with available data, 21.4% of ALF residents and 0.6% of ALF staff members with COVID-19 died, compared with 2.5% of persons with COVID-19 who died in these states overall (Table 3).

Discussion

As of October 15, 2020, an average of one death occurred among every five ALF residents with COVID-19, compared with one death among every 40 persons in the general

[†] https://usafacts.org/.

Summary

What is already known about this topic?

Although the spread of SARS-CoV-2 in nursing homes is well documented, relatively little has been reported on COVID-19 among residents and staff members in U.S. assisted living facilities (ALFs).

What is added by this report?

By October 15, 2020, in 39 states with available data, 22% of ALFs reported one or more cases of COVID-19 among residents and staff members. Among ALF residents with COVID-19, 21% died, compared with 3% who died among the general population with COVID-19.

What are the implications for public health practice?

With ongoing community transmission, ALFs should take actions to prevent the spread of SARS-CoV-2 in their facilities, including rapid identification and response to residents and staff members with suspected or confirmed COVID-19.

population with COVID-19 in states with available data. Wide variability was observed across states in the proportion of ALFs with one or more residents and staff members with COVID-19, ranging from 1% to 93%. Statewide COVID-19 incidence and reporting practices might in part explain this variability. Such findings indicate the need to continue monitoring the effect of COVID-19 in ALFs and for infection prevention and control recommendations to be recognized and followed (2).

SARS-CoV-2 transmission can occur within LTCFs, among and between residents and staff members. ALFs are at risk for several reasons, including the congregate nature of the setting and need for close contact between staff members and residents as part of care (7). Community-acquired infections among staff members can also contribute to the introduction of SARS-CoV-2 into LTCFs (8). On average, residents are at increased risk for severe COVID-19–related outcomes because of their age and higher prevalence of chronic conditions (9). As of August 6, 2020, a similar resident proportion of deaths among COVID-19 patients (22%) was observed in nine states reporting cumulative numbers of cases and deaths among ALFs and similar residential care facilities (10).

The findings in this report are subject to at least five limitations. First, because data on COVID-19 in ALFs from 11 states, the District of Columbia, and six territories could not be ascertained, the findings in this report might not be representative of all U.S. ALFs, residents, and staff members. Second, for the states reporting facility-level LTCF counts, linkage to names and address information from regulatory records was required to identify ALFs; those records might have been incomplete or the process might have misclassified facilities. Third, comparisons between states were limited by variation in

TABLE 1. COVID-19 cases among residents and staff members in assisted living facilities (ALFs) and the general population — 39 states, October 15, 2020*

	ALFs[†,§,¶]		COVID-19 cases**			
	Total ALFs (38 states)	ALFs with ≥1 case (39 states)	General population (33 states)	ALF residents (23 states)	ALF staff members (22 states)	ALF residents and staff members (33 states)
Location	No.	No. (%)	No.	No. (%)	No. (%)	No. (%)
National[††]						
Total	**28,623**[§§]	**6,440 (22.5)**	**6,033,180**	**27,965 (0.6)**	**17,799 (0.4)**	**60,751 (1.0)**
Median (IQR)	275 (211–640)	115 (65–216)	108,139 (70,520–175,922)	891 (324–1,939)	521 (227–1,106)	1,234 (526–2,774)
State						
Arizona	2,122	376 (17.7)	—[§§]	—[§§]	—[§§]	—[§§]
Arkansas	172	51 (29.7)	96,523	112 (0.1)	111 (0.1)	223 (0.2)
California[¶¶]	7,364	388 (5.3)	861,887	3,600 (0.4)	2,295 (0.3)	5,895 (0.7)
Colorado	656	80 (12.2)	80,776	891 (1.1)	615 (0.8)	1,506 (1.9)
Connecticut	111	103 (92.8)	59,748	1,100 (1.8)	134 (0.2)	1,234 (2.1)
Delaware	33	8 (24.2)	—[§§]	—[§§]	—[§§]	—[§§]
Florida	3,113	450 (14.5)	741,631	1,502 (0.2)	754 (0.1)	2,256 (0.3)
Georgia	252	213 (84.5)	336,227	1,098 (0.3)	958 (0.3)	2,056 (0.6)
Hawaii	18	6 (33)	5,349	1 (—)	1 (—)	2 (—)
Idaho	280	115 (41.1)	50,610	—[§§]	—[§§]	1,347 (2.7)
Illinois	663	254 (38.3)	331,613	—[§§]	—[§§]	3,977 (1.2)
Indiana	211	134 (63.5)	143,911	626 (0.4)	302 (0.2)	928 (0.6)
Iowa	455	6 (1.3)	103,222	—[§§]	—[§§]	106 (0.1)
Kansas	220	12 (5.5)	70,520	—[§§]	—[§§]	163 (0.2)
Kentucky	131	67 (51.1)	84,195	107 (0.1)	151 (0.2)	258 (0.3)
Louisiana	—***	185 (—***)	173,088	—[§§]	—[§§]	1,245 (0.7)
Maryland	1,626	201 (12.4)	133,547	2,253 (1.7)	1,952 (1.5)	4,205 (3.1)
Massachusetts	269	215 (79.9)	148,756	—[§§]	—[§§]	1,855 (1.2)
Minnesota	1,744	303 (17.4)	—[§§]	—[§§]	—[§§]	—[§§]
Mississippi	113	58 (51.3)	108,139	362 (0.3)	289 (0.3)	651 (0.6)
Montana	211	71 (33.6)	20,210	—[§§]	—[§§]	526 (2.6)
Nevada	381	94 (24.7)	87,968	481 (0.5)	274 (0.3)	755 (0.9)
New Hampshire	139	12 (8.6)	8,878	285 (3.2)	211 (2.4)	496 (5.6)
New Jersey	263	216 (82.1)	216,994	4,367 (2.0)	2,783 (1.3)	7,150 (3.3)
New Mexico	267	70 (26.2)	—[§§]	—[§§]	—[§§]	—[§§]
New York	337	65 (19.3)	—[§§]	—[§§]	—[§§]	—[§§]
North Carolina	591	174 (29.4)	240,105	2,274 (0.9)	976 (0.4)	3,250 (1.4)
North Dakota	139	70 (50.4)	28,947	117 (0.4)	90 (0.3)	207 (0.7)
Ohio	787	329 (41.8)	173,665	1,625 (0.9)	1,149 (0.7)	2,774 (1.6)
Oklahoma	211	99 (46.9)	103,836	—[§§]	—[§§]	713 (0.7)
Oregon	241	65 (27.0)	38,522	—[§§]	—[§§]	1,003 (2.6)
Pennsylvania	1,203	448 (37.2)	175,922	2,456 (1.4)	1,264 (0.7)	3,720 (2.1)
Rhode Island	65	15 (23.1)	25,698	266 (1.0)	—[§§]	266 (1.0)
South Carolina	501	190 (37.9)	158,883	1,152 (0.7)	620 (0.4)	1,772 (1.1)
Tennessee	378	47 (12.4)	211,001	138 (0.1)	127 (0.1)	265 (0.1)
Texas	2,016	629 (31.2)	759,395	2,739 (0.4)	2,317 (0.3)	5,056 (0.7)
Utah	236	156 (66.1)	90,491	413 (0.5)	426 (0.5)	839 (0.9)
Virginia	565	191 (33.8)	162,923	—[§§]	—[§§]	4,052 (2.5)
Washington	539	274 (50.8)	—[§§]	—[§§]	—[§§]	—[§§]

Abbreviations: COVID-19 = coronavirus disease 2019; IQR = interquartile range.

* Data were accessed on October 15, 2020. The most recent data available varied across states from September 24, to October 15, 2020.

[†] The following states reported COVID-19 in individual long-term care facilities, but did not specify facility type: Arkansas, Delaware, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Maryland, Minnesota, Mississippi, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Oklahoma, and Oregon. For these states, facilities were linked with state regulatory listings to identify assisted living and similar residential care facilities.

[§] "Assisted living facility" also refers to long-term care facilities defined as adult care facility (ACF), adult care home (ACH), adult home (AH), adult residential facility (ARF), assisted care living facility (ACLF), assisted care living home (ACLH), assisted living community (ALC), assisted living facility special care (ALF SC), assisted living program (ALP), assisted living residence (ALR), basic care facility (BCF), community residential care facility (CRCF), enriched housing program (EHP), home for the aged (HFTA), personal care home (PCH), residential care facility (RCF), residential care facility for the elderly (RCFE), supportive living program (SLP), and supported residential care facility (sRCF). The following states report COVID-19 in assisted living facilities using one or more of those terms: California (ARF, RCFE), Illinois (ALF, SLP), Indiana (RCF), Iowa (ALF, RCF), Louisiana (ARF), Maryland, (ALP), Massachusetts (ALR), New Hampshire (sRCF, ALF, RCF), New Jersey (ALR, ALP, PCH), New York (AH, ALP, EHP), North Carolina (ACH), North Dakota (ALF, BCF), Oklahoma (ALC, RCF), Pennsylvania (ALF, ALF-SC, PCH), South Carolina (CRCF), and Tennessee (ACLF, HFTA).

[¶] Numbers reflect cumulative counts where available. The following states report cases associated with active COVID-19 outbreaks, which represent those occurring in a recent timeframe, as defined by the state: Delaware, Florida, Mississippi, New Jersey, North Carolina, North Dakota, Tennessee, and Utah. When possible, cumulative counts were approximated by using maximum active numbers from outbreaks among available reports retrieved over time (Delaware, Mississippi, New Jersey, North Carolina, and North Dakota) or by combining numbers from active and inactive outbreaks (Colorado).

** ALF COVID-19 case data come from state health department websites; general population COVID-19 case data come from https://usafacts.org/visualizations/coronavirus-covid-19-spread-map/.

[††] Each state-level measure was summed to the national level and summarized across reporting states using median and IQR.

[§§] No data presented.

[¶¶] When ranges were used instead of actual numbers, the minimum non-zero number within the range was used (e.g., a value of "<5" was treated as a count of 1); applicable states included: California and Massachusetts.

*** A reliable estimate was not ascertainable for the total number of facilities corresponding to those reported on by the state health department for Louisiana and therefore does not contribute to the total number of ALFs.

TABLE 2. COVID-19-associated deaths*,† among residents and staff members in assisted living facilities (ALFs) and the general population — 28 states, October 15, 2020§,¶

Location	General population (28 states) No.	ALF residents (20 states) No. (%)	ALF staff members (9 states) No. (%)	ALF residents and staff members (28 states) No. (%)
Nationwide**				
Total	**153,348**	**5,469 (4.1)**	**46 (0.1)**	**7,433 (4.8)**
Median (IQR)	3,269 (1,136–5,993)	215 (61–397)	1 (0–5)	156 (67–403)
State				
Arkansas	1,636	15 (0.9)	0 (—)	15 (0.9)
California	16,677	444 (2.7)	24 (0.1)	468 (2.8)
Colorado	2,159	229 (10.6)	0 (—)	229 (10.6)
Connecticut	4,527	381 (8.4)	0 (—)	381 (8.4)
Delaware	651	37 (5.7)	—††	37 (5.7)
Georgia	7,486	230 (3.1)	—††	230 (3.1)
Idaho	517	—††	—††	151 (29.2)
Illinois	9,127	—††	—††	692 (7.6)
Indiana	3,862	160 (4.1)	—††	160 (4.1)
Kentucky	1,296	18 (1.4)	0 (—)	18 (1.4)
Louisiana	5,495	—††	—††	146 (2.7)
Maryland	4,086	587 (14.4)	12 (0.3)	599 (14.7)
Mississippi	3,152	72 (2.3)	—††	72 (2.3)
Montana	227	—††	—††	38 (16.7)
Nevada	1,691	98 (5.8)	1 (0.1)	99 (5.9)
New Hampshire	448	—††	—††	82 (18.3)
New Jersey	16,197	1,326 (8.2)	—††	1,354 (8.4)
New York	33,041	200 (0.6)	—††	200 (0.6)
North Carolina	3,874	303 (7.8)	5 (0.1)	308 (8.0)
Oklahoma	1,143	—††	—††	65 (5.7)
Oregon	610	—††	—††	121 (19.8)
Pennsylvania	8,410	483 (5.7)	—††	483 (5.7)
Rhode Island	1,116	42 (3.8)	—††	42 (3.8)
South Carolina	3,575	253 (7.1)	4 (0.1)	257 (7.2)
Tennessee	2,726	20 (0.7)	—††	20 (0.7)
Texas	15,702	504 (3.2)	—††	504 (3.2)
Utah	531	67 (12.6)	—††	67 (12.6)
Virginia	3,386	—††	—††	595 (17.6)

Abbreviations: COVID-19 = coronavirus disease 2019; IQR = interquartile range.
  * The following states reported COVID-19 deaths in individual long-term care facilities, but did not specify facility type: Arkansas, Delaware, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Maryland, Minnesota, Mississippi, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Oklahoma, and Oregon. For these states, facilities were linked with state regulatory listings to identify assisted living and similar residential care facilities.
  † Numbers reflect cumulative counts where available. The following states only report COVID-19–related deaths in active outbreaks, which represent those occurring in a recent timeframe, as defined by the state: Delaware, Mississippi, New Jersey, North Carolina, Tennessee, and Utah. When possible, cumulative counts were approximated by using maximum active numbers from outbreaks among available reports retrieved over time (Delaware, Mississippi, New Jersey, North Carolina, and North Dakota).
  § Data were accessed on October 15, 2020. The most recent data available varied across states from September 24, to October 15, 2020.
  ¶ ALF COVID-19-associated death data come from state health department websites; general population COVID-19-associated death data come from https://usafacts.org/visualizations/coronavirus-covid-19-spread-map/.
  ** Each state-level measure was summed to the national level and summarized across reporting states using median and IQR.
  †† No data presented.

publicly reported count types on health department websites (e.g., cumulative versus active), level of aggregation (e.g., state, county, or facility level), population (e.g., residents, staff members, or both), and a lack of standardization in ALF definitions. Fourth, delays in testing residents and staff members early in the pandemic, differences in when states began requiring and publicly posting LTCF data, and changes in surveillance methods during the pandemic might have resulted in underestimations of the numbers of affected facilities, cases, and deaths among ALF residents and staff members. Finally, with only a small number of states publicly reporting deaths among ALF

staff members, these data should be interpreted with caution and might not be generalizable to the national level.

State and territorial health department websites are important sources of publicly available COVID-19 surveillance data from ALFs. National surveillance data are less readily available for ALFs. Increased standardization in public reporting format across states could improve the characterization of COVID-19 in these LTCFs across the United States. Although ALFs do not have the same federal reporting requirements as do CMS-certified SNFs, ALFs can voluntarily report COVID-19 cases, facility staffing, and supply information to the CDC National

TABLE 3. Proportion of deaths among COVID-19 cases*,† among residents and staff members in assisted living facilities (ALFs) and general population — 26 states, October 15, 2020§

Location	General population (25 states) % (No. deaths/cases)	ALF residents (17 states) % (No. deaths/cases)	ALF staff members (9 states) % (No. deaths/cases)	ALF residents and staff members (25 states) % (No. deaths/cases)
Nationwide¶				
Total	**2.5 (119,656/4,761,090)**	**21.4 (5,232/24,435)**	**0.6 (46/7,128)**	**13.5 (7,196/53,388)**
Median (IQR)	2.2 (1.6–3.0)	19.8 (15.9–24.7)	0.4 (0–0.6)	11.9 (9.2–15.1)
State				
Arkansas	1.7 (1,636/96,523)	13.4 (15/112)	0.0 (0/111)	6.7 (15/223)
California	1.9 (16,677/861,887)	12.3 (444/3,600)	1.0 (24/2,295)	7.9 (468/5,895)
Colorado	2.7 (2,159/80,776)	25.7 (229/891)	0.0 (0/615)	15.2 (229/1,506)
Connecticut	7.6 (4,527/59,748)	34.6 (381/1,100)	0.0 (0/134)	30.9 (381/1,234)
Georgia	2.2 (7,486/336,227)	20.9 (230/1,098)	—**	11.2 (230/2,056)
Idaho	1.0 (517/50,610)	—**	—**	11.2 (151/1,347)
Illinois	2.8 (9,127/331,613)	—**	—**	17.4 (692/3,977)
Indiana	2.7 (3,862/143,911)	25.6 (160/626)	—**	17.2 (160/928)
Kentucky	1.5 (1,296/84,195)	16.8 (18/107)	0.0 (0/151)	7.0 (18/258)
Louisiana	3.2 (5,495/173,088)	—**	—**	11.7 (146/1,245)
Maryland	3.1 (4,086/133,547)	26.1 (587/2,253)	0.6 (12/1,952)	14.2 (599/4,205)
Mississippi	2.9 (3,152/108,139)	19.9 (72/362)	—**	11.1 (72/651)
Montana	1.1 (227/20,210)	—**	—**	7.2 (38/526)
Nevada	1.9 (1,691/87,968)	20.4 (98/481)	0.4 (1/274)	13.1 (99/755)
New Hampshire	5.0 (448/8,878)	—**	—**	16.5 (82/496)
New Jersey	7.5 (16,197/216,994)	30.4 (1,326/4,367)	—**	18.9 (1,354/7,150)
North Carolina	1.6 (3,874/240,105)	13.3 (303/2,274)	0.5 (5/976)	9.5 (308/3,250)
Oklahoma	1.1 (1,143/103,836)	—**	—**	9.1 (65/713)
Oregon	1.6 (610/38,522)	—**	—**	12.1 (121/1,003)
Pennsylvania	4.8 (8,410/175,922)	19.7 (483/2,456)	—**	13.0 (483/3,720)
Rhode Island	4.3 (1,116/25,698)	15.8 (42/266)	—**	15.8 (42/266)
South Carolina	2.3 (3,575/158,883)	22.0 (253/1,152)	0.6 (4/620)	14.5 (257/1,772)
Tennessee	1.3 (2,726/211,001)	14.5 (20/138)	—**	7.5 (20/265)
Texas	2.1 (15,702/759,395)	18.4 (504/2,739)	—**	10.0 (504/5,056)
Utah	0.6 (531/90,491)	16.1 (67/413)	—**	8.0 (67/839)
Virginia	2.1 (3,386/162,923)	—**	—**	14.7 (595/4,052)

Abbreviations: COVID-19 = coronavirus disease 2019; IQR = interquartile range.
 * ALF COVID-19–associated case and death data come from state health department websites; general population COVID-19–associated case and death data come from https://usafacts.org/visualizations/coronavirus-covid-19-spread-map/.
 † Proportion of deaths among COVID-19 cases was calculated by dividing deaths by cases.
 § Data were accessed on October 15, 2020. The most recent data available varied across states from September 24, to October 15, 2020.
 ¶ Each state-level measure was summed to the national level and summarized across reporting states using median and IQR.
 ** No data presented.

Healthcare Safety Network LTCF COVID-19 module.§ Innovative uses of COVID-19 surveillance data from ALFs can focus resources and inform prevention and response activities and might have implications for vaccine programs. The disproportionate share of deaths among ALF residents underscores the need for ongoing surveillance of nationwide COVID-19 data and more robust infection prevention and control activities to protect this population.

ALFs, like all LTCFs, should remain vigilant to prevent the introduction and spread of SARS-CoV-2 in their facilities. Preventive steps should include 1) identifying a point of contact at the local health department to aid prompt notification; 2) educating residents, family members, and staff members about COVID-19; 3) having a plan for visitor and staff member restrictions; 4) encouraging social (physical) distancing and the use of masks, as appropriate; 5) implementing recommended infection prevention and control practices and providing access to supplies; 6) rapidly identifying and properly responding to residents and staff members with suspected or confirmed COVID-19; and 7) conducting surveillance of COVID-19 cases and deaths, facility staffing, and supply information (2).

Corresponding author: Sarah H. Yi, sarahyi@cdc.gov, 404-639-4068.

[1]CDC COVID-19 Response Team.

§ https://www.cdc.gov/nhsn/ltc/covid19/index.html.

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Tobacco Product Use Among Adults — United States, 2019

Monica E. Cornelius, PhD[1]; Teresa W. Wang, PhD[1]; Ahmed Jamal, MBBS[1]; Caitlin G. Loretan, MPH[1]; Linda J. Neff, PhD[1]

Cigarette smoking remains the leading cause of preventable disease and death in the United States (*1*). The prevalence of current cigarette smoking among U.S. adults has declined over the past several decades, with a prevalence of 13.7% in 2018 (*2*). However, a variety of combustible, noncombustible, and electronic tobacco products are available in the United States (*1,3*). To assess recent national estimates of tobacco product use among U.S. adults aged ≥18 years, CDC analyzed data from the 2019 National Health Interview Survey (NHIS). In 2019, an estimated 50.6 million U.S. adults (20.8%) reported currently using any tobacco product, including cigarettes (14.0%), e-cigarettes (4.5%), cigars (3.6%), smokeless tobacco (2.4%), and pipes* (1.0%).† Most current tobacco product users (80.5%) reported using combustible products (cigarettes, cigars, or pipes), and 18.6% reported using two or more tobacco products.§ The prevalence of any current tobacco product use was higher among males; adults aged ≤65 years; non-Hispanic American Indian/Alaska Native (AI/AN) adults; those whose highest level of educational attainment was a General Educational Development (GED) certificate; those with an annual household income <$35,000; lesbian, gay, or bisexual (LGB) adults; uninsured adults and those with Medicaid; those with a disability; or those with mild, moderate, or severe generalized anxiety disorder. E-cigarette use was highest among adults aged 18–24 years (9.3%), with over half (56.0%) of these young adults reporting that they had never smoked cigarettes. Implementing comprehensive, evidence-based, population level interventions (e.g., tobacco price increases, comprehensive smoke-free policies, high-impact antitobacco media campaigns, and barrier-free cessation coverage), in coordination with regulation of the manufacturing, marketing, and sale of all tobacco products, can reduce tobacco-related disease and death in the United States (*1,4*). As part of a comprehensive approach, targeted interventions are also warranted to reach subpopulations with the highest prevalence of use, which might vary by tobacco product type.

NHIS is an annual, nationally representative, household survey of the noninstitutionalized U.S. civilian population.¶ The 2019 NHIS Sample Adult component included 31,997 adults aged ≥18 years; the response rate was 59.1% (*5*). Data were weighted to account for complex survey design and provide nationally representative estimates. Use of five tobacco product types was assessed: cigarettes, cigars (cigars, cigarillos, or filtered little cigars), pipes (regular pipes, water pipes, or hookahs), e-cigarettes, and smokeless tobacco (chewing tobacco, snuff, dip, snus, or dissolvable tobacco). Current cigarette smokers reported having smoked ≥100 cigarettes during their lifetime and reported that they smoked "every day" or "some days" at the time of survey. Current users of all other tobacco products reported using these products "every day" or "some days" at the time of survey. Prevalence estimates for current use of each tobacco product type, any tobacco product, any combustible tobacco product, and two or more tobacco products were calculated. Estimates were calculated overall and by sex, age, race/ethnicity, U.S. Census region,** education (adults aged ≥25 years), marital status, annual household income,†† sexual orientation,§§ health insurance coverage,¶¶ disability status,*** and indication of generalized anxiety disorder (GAD-7).††† The distribution of age groups was assessed among current users of each tobacco product, any tobacco product,

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* The use of regular pipe, water pipe, or hookah was assessed together using a single question. Interviewers could read the following sentences, if necessary: "A hookah is a type of water pipe. It is sometimes called a narghile pipe. Do not include electronic hookahs or e-hookahs." "Do not include electronic pipes or e-pipes. Do not include pipes filled with substances other than tobacco."

† Categories are not mutually exclusive.

§ Current use of two or more tobacco products was defined as "every day" or "some day" use of two or more of the following tobacco products: cigarettes (≥100 cigarettes during lifetime); cigars, cigarillos, or filtered little cigars; pipes, water pipes, or hookahs; electronic cigarettes; or smokeless tobacco products.

¶ https://www.cdc.gov/nchs/nhis/data-questionnaires-documentation.htm.

** *Northeast:* Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont. *Midwest:* Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin. *South:* Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia. *West:* Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

†† Based on the imputed sample adult family income (grouped) variable (n = 31,997). ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2019/srvydesc-508.pdf.

§§ Sexual orientation was determined using the question "Which of the following best represents how you think of yourself?" Response options included "gay," "straight, that is, not gay," "bisexual," "something else," and "I don't know the answer" among male respondents, and "lesbian or gay," "straight, that is, not lesbian or gay," "bisexual, "something else," and "I don't know the answer" among female respondents. Respondents were considered to be lesbian, gay, or bisexual if they responded "gay," "lesbian or gay," or "bisexual."

¶¶ Private coverage: includes adults who had any comprehensive private insurance plan (including health maintenance organizations and preferred provider organizations). Medicaid: for adults aged <65 years, includes those who did not have private coverage, but who had Medicaid or other state-sponsored health plans, including Children's Health Insurance Program (CHIP). For adults aged ≥65 years, includes adults aged ≥65 years who did not have any private coverage but had Medicare and Medicaid or other state-sponsored health plans; Medicare only: includes adults aged ≥65 years who only had Medicare coverage; Other coverage: includes adults who did not have private insurance, Medicaid, or other public coverage, but who had any type of military coverage, coverage from other government programs, or Medicare. Uninsured: includes adults who did not indicate that they were covered at the time of the interview under private health insurance, Medicare, Medicaid, CHIP, a state-sponsored health plan, other government programs, or military coverage.

combustible products, and two or more tobacco products. Among e-cigarette users, the percentage of current,[§§§] former,[¶¶¶] and never[****] cigarette smokers was assessed by age group. SAS-callable SUDAAN software (version 11.0.3; RTI International) was used to conduct all analyses.

Among U.S. adults in 2019, 20.8% (estimated 50.6 million) currently used any tobacco product, 16.7% (40.8 million) used any combustible tobacco product, and 3.9% (9.4 million) used two or more tobacco products (Table). Cigarettes were the most commonly used tobacco product (14.0%; 34.1 million). Prevalence of use of other tobacco products was as follows: e-cigarettes (4.5%; 10.9 million); cigars (3.6%; 8.7 million); smokeless tobacco (2.4%; 5.9 million); and pipes (1.0%; 2.4 million). Combustible tobacco products were used by 80.5% of current tobacco product users. Use of two or more tobacco products was reported by 18.6% of current tobacco product users.

The tobacco product with the highest percentage of users aged 18–24 (24.5%) and 25–44 years (49.3%) was e-cigarettes (Figure 1). The tobacco product with the highest percentage of users aged 45–64 (40.2%) and ≥65 years (12.3%) was cigarettes. Among current e-cigarette users, 36.9% were current cigarette smokers, 39.5% were former cigarette smokers, and 23.6% were never cigarette smokers (Figure 2). The percentage of e-cigarette users who were never smokers was highest

(56.0%) among the 18–24 age group and decreased with increasing age. The percentage of e-cigarette users who were former smokers was lowest (20.5%) among the 18–24 age group and increased with increasing age. Many adults in all age groups were dual users of e-cigarettes and cigarettes.

The prevalence of any current tobacco product use was higher among males (26.2%) than among females (15.7%) and among those aged 25–44 years (25.3%), 45–64 years (23.0%), or 18–24 years (18.2%) than among those aged ≥65 years (11.4%) (Table). Current tobacco product use was also higher among non-Hispanic AI/AN adults (29.3%), non-Hispanic adults of other[††††] races (28.1%), non-Hispanic White adults (23.3%), non-Hispanic Black adults (20.7%), and Hispanic or Latino adults (13.2%) than among non-Hispanic Asian adults (11.0%); and among those living in the Midwest (23.7%) or South (22.9%) than among those in the Northeast (18.5%) or West (16.4%). The prevalence of current tobacco product use was higher among those whose highest educational attainment was a GED (43.7%) than among those with other levels of education; among those who were divorced/separated/widowed (23.5%) or single/never married/not living with a partner (23.0%) than among those married/living with a partner (19.2%); among those who had annual household income of <$35,000 (27.0%) than among those with higher income; and among LGB adults (29.9%) than among those who were heterosexual/straight (20.5%). Prevalence was also higher among adults who were uninsured (30.2%), insured by Medicaid (30.0%), or had some other public insurance (25.6%) than among those with private insurance (18.0%) or Medicare only (11.4%); among those who had a disability (26.9%) compared with those without (20.1%); and among those who had GAD-7 scores indicating mild (30.4%), moderate (34.2%) or severe (45.3%) anxiety than among those indicating no or minimal (18.4%) anxiety.

Discussion

In 2019, approximately one in five U.S. adults (50.6 million) reported currently using any tobacco product. Cigarettes were the most commonly used tobacco product among adults, and combustible tobacco products (cigarettes, cigars, or pipes) were used by most (80.5%) adult tobacco product users. Most of the death and disease from tobacco use in the United States is

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*** Disability was defined based on self-reported presence of selected limitations including vision, hearing, mobility, remembering, self-care, communication. Respondents had to answer "A lot of difficulty" or "Cannot do at all/unable to do" to one of the following questions: "Do you have difficulty seeing, even when wearing glasses?," Do you have difficulty hearing, even when using a hearing aid?," "Do you have any difficulty walking or climbing steps?," "Using your usual language, do you have difficulty communicating, for example, understanding or being understood?," "Do you have difficulty remembering or concentrating?," "Do you have difficulty with self-care, such as washing all over or dressing?" to be coded as having a disability; those who responded "no difficulty" or "some difficulty" to all six questions were coded as not having a disability. These six questions are based on the short set of questions recommended by the Washington Group on Disability Statistics (https://www.cdc.gov/nchs/washington_group/index.htm).

††† Based on the 7-item Generalized Anxiety Disorder scale (GAD-7) recode of none/minimal (values 0–4), mild (values 5–9), moderate (values 10–14) and severe (values 15–21). Adults were asked how often they have been bothered by the following symptoms in the past 2 weeks: "Feeling nervous, anxious, or on edge"; "Not being able to stop or control worrying"; "Worrying too much about different things"; "Trouble relaxing"; "Being so restless that it's hard to sit still"; "Becoming easily annoyed or irritable"; and "Feeling afraid as if something awful might happen." Response options were "not at all," "several days," "more than half the days," and "nearly every day," scored as 0 to 3 points, respectively, and then summed into a total score.

§§§ Current cigarette smokers were defined as adults who reported smoking ≥100 cigarettes during their lifetime and smoked cigarettes "every day" or "some days" at the time of the interview (only other response options were "not at all, refused, and don't know").

¶¶¶ Former cigarette smokers were defined as adults who had smoked ≥100 cigarettes in their lifetime but reported smoking "not at all" at the time of the interview.

**** Never cigarette smokers were defined as adults who had not smoked ≥100 cigarettes in their lifetime.

†††† The following four non-Hispanic single race categories were available for sample adults in the 2019 NHIS public use files: 1) White; 2) Black or African American; 3) Asian; and 4) American Indian or Alaska Native (AI/AN). Exclusive from these groups, the "non-Hispanic, Other" category in this report includes those adults who were categorized as "non-Hispanic AI/AN and any other group" or "other single and multiple races." The only multiracial category available was "non-Hispanic AI/AN and any other group." ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2019/srvydesc-508.pdf.

TABLE. Percentage of adults aged ≥18 years who reported tobacco product use "every day" or "some days," by tobacco product and selected characteristics — National Health Interview Survey, United States, 2019

Characteristic	Any tobacco product*	Any combustible product†	Cigarettes§	Cigars/Cigarillos/ Filtered little cigars¶	Regular pipe/ Water pipe/ Hookah**	E-cigarettes††	Smokeless tobacco§§	≥2 Tobacco products¶¶
				% (95% CI)				
Overall	**20.8 (20.2–21.4)**	**16.7 (16.1–17.3)**	**14.0 (13.5–14.5)**	**3.6 (3.3–3.9)**	**1.0 (0.9–1.1)**	**4.5 (4.2–4.8)**	**2.4 (2.2–2.6)**	**3.9 (3.6–4.2)**
Sex								
Male	26.2 (25.3–27.1)	20.1 (19.3–20.9)	15.3 (14.5–16.1)	6.3 (5.8–6.8)	1.5 (1.3–1.7)	5.5 (5.0–6.0)	4.7 (4.2–5.2)	5.7 (5.2–6.2)
Female	15.7 (14.9–16.5)	13.6 (12.9–14.3)	12.7 (12.0–13.4)	1.1 (0.9–1.3)	0.5 (0.4–0.6)	3.5 (3.1–3.9)	0.3 (0.2–0.4)	2.2 (1.9–2.5)
Age group (yrs)								
18–24	18.2 (16.2–20.2)	11.2 (9.7–12.7)	8.0 (6.7–9.3)	3.8 (2.8–4.8)	1.7 (1.1–2.3)	9.3 (7.9–10.7)	2.2 (1.4–3.0)	5.2 (4.1–6.3)
25–44	25.3 (24.2–26.4)	20.1 (19.1–21.1)	16.7 (15.8–17.6)	4.4 (3.9–4.9)	1.3 (1.0–1.6)	6.4 (5.8–7.0)	3.2 (2.8–3.6)	5.5 (4.9–6.1)
45–64	23.0 (21.9–24.1)	19.5 (18.5–20.5)	17.0 (16.0–18.0)	3.7 (3.3–4.1)	0.6 (0.4–0.8)	3.0 (2.6–3.4)	2.5 (2.1–2.9)	3.4 (3.0–3.8)
≥65	11.4 (10.6–12.2)	9.9 (9.2–10.6)	8.2 (7.5–8.9)	2.0 (1.6–2.4)	0.5 (0.3–0.7)	0.8 (0.6–1.0)	1.2 (0.9–1.5)	1.3 (1.0–1.6)
Race/Ethnicity*								
White, non–Hispanic	23.3 (22.5–24.1)	18.3 (17.6–19.0)	15.5 (14.8–16.2)	3.8 (3.5–4.1)	1.0 (0.8–1.2)	5.1 (4.7–5.5)	3.4 (3.1–3.7)	4.5 (4.1–4.9)
Black, non–Hispanic	20.7 (19.0–22.4)	18.6 (17.0–20.2)	14.9 (13.4–16.4)	4.4 (3.5–5.3)	1.1 (0.7–1.5)	3.4 (2.6–4.2)	0.5 (0.3–0.7)	3.3 (2.5–4.1)
Asian, non–Hispanic	11.0 (9.0–13.0)	8.6 (6.7–10.5)	7.2 (5.4–9.0)	1.2 (0.6–1.8)	—†††	2.7 (1.7–3.7)	—	1.4 (0.8–2.0)
American Indian/Alaska Native, non–Hispanic	29.3 (16.4–42.2)	22.3 (10.5–34.1)	20.9 (9.9–31.9)	—	—	—	—	—
Hispanic	13.2 (11.9–14.5)	11.2 (10.0–12.4)	8.8 (7.8–9.8)	3.0 (2.3–3.7)	0.8 (0.5–1.1)	2.8 (2.2–3.4)	0.5 (0.3–0.7)	2.2 (1.7–2.7)
Other, non–Hispanic	28.1 (23.4–32.8)	22.0 (17.7–26.3)	19.7 (15.7–23.7)	3.1 (1.6–4.6)	—	9.3 (6.0–12.6)	—	7.5 (4.7–10.3)
U.S. Census region§§§								
Northeast	18.5 (17.1–19.9)	16.0 (14.7–17.3)	12.8 (11.5–14.1)	3.8 (3.1–4.5)	0.8 (0.5–1.1)	3.3 (2.7–3.9)	1.1 (0.7–1.5)	2.9 (2.4–3.4)
Midwest	23.7 (22.2–25.2)	19.1 (17.8–20.4)	16.4 (15.2–17.6)	3.9 (3.2–4.6)	1.0 (0.7–1.3)	4.5 (3.9–5.1)	3.1 (2.5–3.7)	4.1 (3.5–4.7)
South	22.9 (21.8–24.0)	18.2 (17.2–19.2)	15.4 (14.5–16.3)	3.9 (3.4–4.4)	1.0 (0.8–1.2)	4.9 (4.3–5.5)	3.0 (2.6–3.4)	4.5 (4.0–5.0)
West	16.4 (15.3–17.5)	12.6 (11.6–13.6)	10.4 (9.4–11.4)	2.6 (2.2–3.0)	1.0 (0.7–1.3)	4.4 (3.8–5.0)	1.9 (1.4–2.4)	3.4 (2.9–3.9)
Education (adults aged ≥25 years)								
0–12 years (no diploma)	26.4 (24.2–28.6)	23.5 (21.4–25.6)	21.6 (19.5–23.7)	3.0 (2.1–3.9)	1.2 (0.6–1.8)	3.0 (2.2–3.8)	2.9 (2.1–3.7)	4.0 (3.1–4.9)
General Educational Development	43.7 (39.1–48.3)	37.1 (32.8–41.4)	35.3 (31.1–39.5)	5.2 (3.2–7.2)	—	7.8 (5.5–10.1)	4.9 (2.6–7.2)	8.9 (6.4–11.4)
High school diploma	26.4 (25.0–27.8)	21.9 (20.6–23.2)	19.6 (18.3–20.9)	3.7 (3.1–4.3)	0.8 (0.6–1.0)	4.3 (3.7–4.9)	3.5 (2.9–4.1)	4.8 (4.1–5.5)
Some college, no diploma	24.8 (23.2–26.4)	20.6 (19.1–22.1)	17.7 (16.3–19.1)	3.7 (2.9–4.5)	0.9 (0.6–1.2)	5.0 (4.2–5.8)	2.0 (1.5–2.5)	3.9 (3.2–4.6)
Associate degree (academic or technical/ vocational)	21.2 (19.6–22.8)	16.8 (15.4–18.2)	14.0 (12.7–15.3)	3.8 (3.1–4.5)	0.7 (0.3–1.1)	4.5 (3.7–5.3)	2.8 (2.2–3.4)	4.0 (3.3–4.7)
Undergraduate degree (bachelor's)	13.1 (12.2–14.0)	10.0 (9.1–10.9)	6.9 (6.2–7.6)	3.4 (2.8–4.0)	0.9 (0.6–1.2)	3.2 (2.7–3.7)	1.5 (1.2–1.8)	2.4 (2.0–2.8)
Graduate degree (master's, professional, or doctoral)	8.7 (7.8–9.6)	7.1 (6.2–8.0)	4.0 (3.3–4.7)	3.2 (2.6–3.8)	0.7 (0.4–1.0)	1.5 (1.1–1.9)	1.0 (0.7–1.3)	1.5 (1.1–1.9)
Marital status								
Married/Living with partner	19.2 (18.5–19.9)	15.3 (14.6–16.0)	12.4 (11.8–13.0)	3.5 (3.1–3.9)	0.8 (0.6–1.0)	3.9 (3.5–4.3)	2.5 (2.2–2.8)	3.2 (2.9–3.5)
Divorced/Separated/ Widowed	23.5 (22.2–24.8)	20.6 (19.4–21.8)	19.0 (17.9–20.1)	3.0 (2.5–3.5)	0.8 (0.5–1.1)	3.3 (2.8–3.8)	2.1 (1.7–2.5)	4.2 (3.6–4.8)
Single/Never married/ Not living with a partner	23.0 (21.6–24.4)	17.8 (16.5–19.1)	14.6 (13.4–15.8)	4.1 (3.5–4.7)	1.7 (1.3–2.1)	6.9 (6.1–7.7)	2.5 (1.9–3.1)	5.3 (4.6–6.0)
Annual household income ($)¶¶¶								
<35,000	27.0 (25.7–28.3)	23.2 (22.0–24.4)	21.4 (20.2–22.6)	3.2 (2.8–3.6)	1.2 (0.9–1.5)	5.0 (4.4–5.6)	2.0 (1.6–2.4)	4.8 (4.2–5.4)
35,000–74,999	22.0 (20.9–23.1)	18.1 (17.1–19.1)	15.7 (14.7–16.7)	3.2 (2.7–3.7)	1.1 (0.8–1.4)	4.5 (4.0–5.0)	2.5 (2.1–2.9)	4.3 (3.8–4.8)
75,000–99,999	18.8 (17.3–20.3)	14.5 (13.1–15.9)	11.4 (10.1–12.7)	3.9 (3.1–4.7)	1.1 (0.6–1.6)	4.6 (3.7–5.5)	2.4 (1.8–3.0)	3.5 (2.7–4.3)
≥100,000	15.1 (14.1–16.1)	10.8 (10.0–11.6)	7.1 (6.4–7.8)	4.1 (3.6–4.6)	0.7 (0.5–0.9)	3.8 (3.3–4.3)	2.7 (2.2–3.2)	2.8 (2.4–3.2)
Sexual orientation								
Heterosexual/Straight	20.5 (19.9–21.1)	16.5 (15.9–17.1)	13.8 (13.2–14.4)	3.6 (3.3–3.9)	0.9 (0.8–1.0)	4.2 (3.9–4.5)	2.5 (2.3–2.7)	3.8 (3.5–4.1)
Lesbian, Gay, or Bisexual	29.9 (25.9–33.9)	22.7 (19.2–26.2)	19.2 (16.1–22.3)	4.7 (2.9–6.5)	2.3 (1.1–3.5)	11.5 (8.7–14.3)	—	6.9 (5.0–8.8)
Health insurance coverage**								
Private insurance	18.0 (17.3–18.7)	13.7 (13.1–14.3)	10.7 (10.1–11.3)	3.6 (3.3–3.9)	0.9 (0.7–1.1)	4.3 (3.9–4.7)	2.5 (2.2–2.8)	3.3 (3.0–3.6)
Medicaid	30.0 (27.9–32.1)	26.8 (24.8–28.8)	24.9 (22.9–26.9)	3.3 (2.6–4.0)	1.1 (0.7–1.5)	5.0 (4.0–6.0)	1.8 (1.3–2.3)	5.3 (4.3–6.3)
Medicare only (aged ≥65 yrs)	11.4 (9.9–12.9)	10.1 (8.7–11.5)	8.6 (7.3–9.9)	1.8 (1.2–2.4)	—	1.0 (0.6–1.4)	—	1.2 (0.7–1.7)
Other public insurance	25.6 (23.2–28.0)	20.8 (18.7–22.9)	17.8 (15.9–19.7)	5.4 (3.9–6.9)	1.1 (0.6–1.6)	4.4 (3.2–5.6)	3.4 (2.2–4.6)	5.2 (4.0–6.4)
Uninsured	30.2 (28.0–32.4)	24.9 (22.9–26.9)	22.5 (20.6–24.4)	4.1 (3.1–5.1)	1.3 (0.8–1.8)	7.2 (6.1–8.3)	2.9 (2.1–3.7)	6.5 (5.4–7.6)
Disability††††								
Yes	26.9 (24.9–28.9)	23.1 (21.2–25.0)	21.1 (19.3–22.9)	3.7 (2.8–4.6)	1.4 (0.9–1.9)	4.2 (3.3–5.1)	2.8 (2.1–3.5)	5.0 (4.1–5.9)
No	20.1 (19.5–20.7)	16.1 (15.5–16.7)	13.3 (12.8–13.8)	3.6 (3.3–3.9)	0.9 (0.8–1.0)	4.5 (4.2–4.8)	2.4 (2.1–2.7)	3.8 (3.5–4.1)

See table footnotes on the next page.

TABLE. (*Continued*) Percentage of adults aged ≥18 years who reported tobacco product use "every day" or "some days," by tobacco product and selected characteristics — National Health Interview Survey, United States, 2019

Characteristic	% (95% CI)							
	Any tobacco product*	Any combustible product†	Cigarettes§	Cigars/Cigarillos/ Filtered little cigars¶	Regular pipe/ Water pipe/ Hookah**	E-cigarettes††	Smokeless tobacco§§	≥2 Tobacco products¶¶
Generalized anxiety disorder§§§§								
None/Minimal	18.4 (17.8–19.0)	14.7 (14.1–15.3)	12.0 (11.5–12.5)	3.4 (3.1–3.7)	0.8 (0.7–0.9)	3.6 (3.3–3.9)	2.4 (2.1–2.7)	3.2 (2.9–3.5)
Mild	30.4 (28.3–32.5)	24.3 (22.3–26.3)	21.5 (19.5–23.5)	4.0 (3.0–5.0)	1.6 (1.1–2.1)	8.9 (7.5–10.3)	2.3 (1.6–3.0)	6.6 (5.4–7.8)
Moderate	34.2 (30.7–37.7)	29.2 (25.9–32.5)	27.0 (23.8–30.2)	3.9 (2.4–5.4)	2.6 (1.2–4.0)	9.6 (7.3–11.9)	2.2 (1.1–3.3)	8.2 (6.1–10.3)
Severe	45.3 (41.1–49.5)	38.7 (34.5–42.9)	34.5 (30.5–38.5)	6.7 (4.5–8.9)	2.1 (1.0–3.2)	10.1 (7.5–12.7)	3.5 (1.9–5.1)	9.4 (6.9–11.9)

Abbreviation: CI = confidence interval.

  * Any tobacco use was defined as use either "every day" or "some days" of at least one tobacco product. (For cigarettes, users were defined as adults who reported use either "every day" or "some days" and had smoked ≥100 cigarettes during their lifetime).

  † Any combustible tobacco use was defined as use either "every day" or "some days" of at least one combustible tobacco product: cigarettes; cigars, cigarillos, filtered little cigars; pipes, water pipes, or hookah. (For cigarettes, users were defined as adults who reported use either "every day" or "some days" and had smoked ≥100 times during their lifetime).

  § Current cigarette smokers were defined as adults who reported smoking ≥100 cigarettes during their lifetime and now smoked cigarettes "every day" or "some days."

  ¶ Current cigar smokers were defined as adults who reported smoking cigars, cigarillos, or little filtered cigars at least once during their lifetime and now smoked at least one of these products "every day" or "some days."

  ** Current pipe smokers were defined as adults who reported smoking tobacco in a regular pipe, water pipe, or hookah at least once during their lifetime and now smoked at least one of these products "every day" or "some days."

  †† Current electronic cigarette (e-cigarette) users were reported as adults who reported using e-cigarettes at least once during their lifetime and now used e-cigarettes "every day" or "some days."

  §§ Current smokeless tobacco product users were defined as adults who reported using chewing tobacco, snuff, dip, snus, or dissolvable tobacco at least once during their lifetime and now used at least one of these products "every day" or "some days."

  ¶¶ Current multiple tobacco product users were defined as adults who reported use "every day" or "some days" for at least two or more of the following tobacco products: cigarettes (≥100 cigarettes during lifetime); cigars, cigarillos, filtered little cigars; pipes, water pipes, or hookah; e-cigarettes; or smokeless tobacco products.

  *** Hispanic adults could be of any race. All other groups were non-Hispanic. The following four non-Hispanic single-race categories were available for sample adults in the 2019 NHIS public use files: 1) White; 2) Black or African American; 3) Asian; and 4) American Indian or Alaska Native (AI/AN). Exclusive from these groups, the "Non-Hispanic, Other" category includes those adults who were categorized as "Non-Hispanic AI/AN and any other group" or "other single and multiple races." The only multiracial category available was "Non-Hispanic AI/AN and any other group." ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2019/srvydesc-508.pdf.

  ††† Estimates with a relative standard error >30% or unweighted denominator <50 are suppressed.

  §§§ *Northeast*: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont; *Midwest*: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin; *South*: Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia; *West*: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

  ¶¶¶ Based on the imputed sample adult family income (grouped) variable (n = 31,997). ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2019/srvydesc-508.pdf.

  **** Private insurance: includes adults who had any comprehensive private insurance plan (including health maintenance organizations and preferred provider organizations). Medicaid: For adults aged <65 years, includes adults who do not have private coverage, but who have Medicaid or other state-sponsored health plans including Children's Health Insurance Program (CHIP); for adults aged ≥65 years, includes adults aged ≥65 years who do not have any private coverage but have Medicare and Medicaid or other state-sponsored health plans. Medicare only: includes adults aged ≥65 years who only have Medicare coverage. Other public insurance: includes adults who do not have private insurance, Medicaid, or other public coverage, but who have any type of military coverage, coverage from other government programs, or Medicare (adults <65 years). Uninsured: includes adults who have not indicated that they are covered at the time of the interview under private health insurance, Medicare, Medicaid, a state-sponsored health plan, other government programs, or military coverage. Insurance coverage is "as of time of survey."

  †††† Disability was defined based on self-reported presence of selected limitations including vision, hearing, mobility, remembering or concentrating, self-care, and communication. Respondents had to answer "A lot of difficulty" or "Cannot do at all/unable to do" to one of the following questions: "Do you have difficulty seeing, even when wearing glasses?," "Do you have difficulty hearing, even when using a hearing aid?," "Do you have any difficulty walking or climbing steps?," "Using your usual language, do you have difficulty communicating, for example, understanding or being understood?," "Do you have difficulty remembering or concentrating?," "Do you have difficulty with self-care, such as washing all over or dressing?" to be coded as having a disability; those who responded "no difficulty" or "some difficulty" to all six questions were coded to not have a disability. Classifications are based on the 2019 NHIS Washington Group Short Set Composite Disability Indicator recode, as based on the short set of questions recommended by the Washington Group on Disability Statistics (https://www.cdc.gov/nchs/washington_group/index.htm).

  §§§§ Based on the 7-item Generalized Anxiety Disorder Scale (GAD-7) recode of none/minimal (values 0–4), mild (values 5–9), moderate (values 10–14) and severe (values 15–21). Adults were asked how often they have been bothered by the following symptoms in the past 2 weeks: "Feeling nervous, anxious, or on edge"; "Not being able to stop or control worrying"; "Worrying too much about different things"; "Trouble relaxing"; "Being so restless that it's hard to sit still"; "Becoming easily annoyed or irritable"; and "Feeling afraid as if something awful might happen." Response options were "not at all," "several days," "more than half the days," and "nearly every day," scored as 0 to 3 points, respectively, and then summed into a total score.

primarily caused by cigarettes and other combustible products (*1*); therefore, continued efforts to reduce all forms of combustible tobacco smoking among U.S. adults are warranted. Moreover, approximately one in five current tobacco product users (18.6%) reported using two or more tobacco products, and differences in prevalence of tobacco use were also seen across population groups, with higher prevalence among those with a GED, American Indian/Alaska Natives, uninsured adults and adults with Medicaid, and LGB adults. Each of these groups has experienced social, economic, and environmental stressors that might contribute to higher tobacco use prevalence (*6*). Comprehensive strategies at the national, state, and local levels, including targeted interventions and tailored community

engagement, can reduce tobacco-related disease and death and help to mitigate tobacco-related disparities (*1,4,6*).

U.S. adults also reported using various noncigarette tobacco products, with e-cigarettes being the most commonly used noncigarette tobacco product (4.5%). E-cigarette use was highest among adults aged 18–24 years (9.3%), with over half (56.0%) of these young adults reporting that they had never smoked cigarettes. In addition, the tobacco product with the highest percentage of users aged 18–24 years (24.5%) was e-cigarettes. E-cigarettes contain nicotine, which is highly addictive, can prime the brain for addiction to other drugs, and can harm brain development, which continues until about age 25 years (*3*). Although e-cigarette use was lower among

FIGURE 1. Age distribution of adults aged ≥18 years who reported current tobacco product use* — National Health Interview Survey, United States, 2019
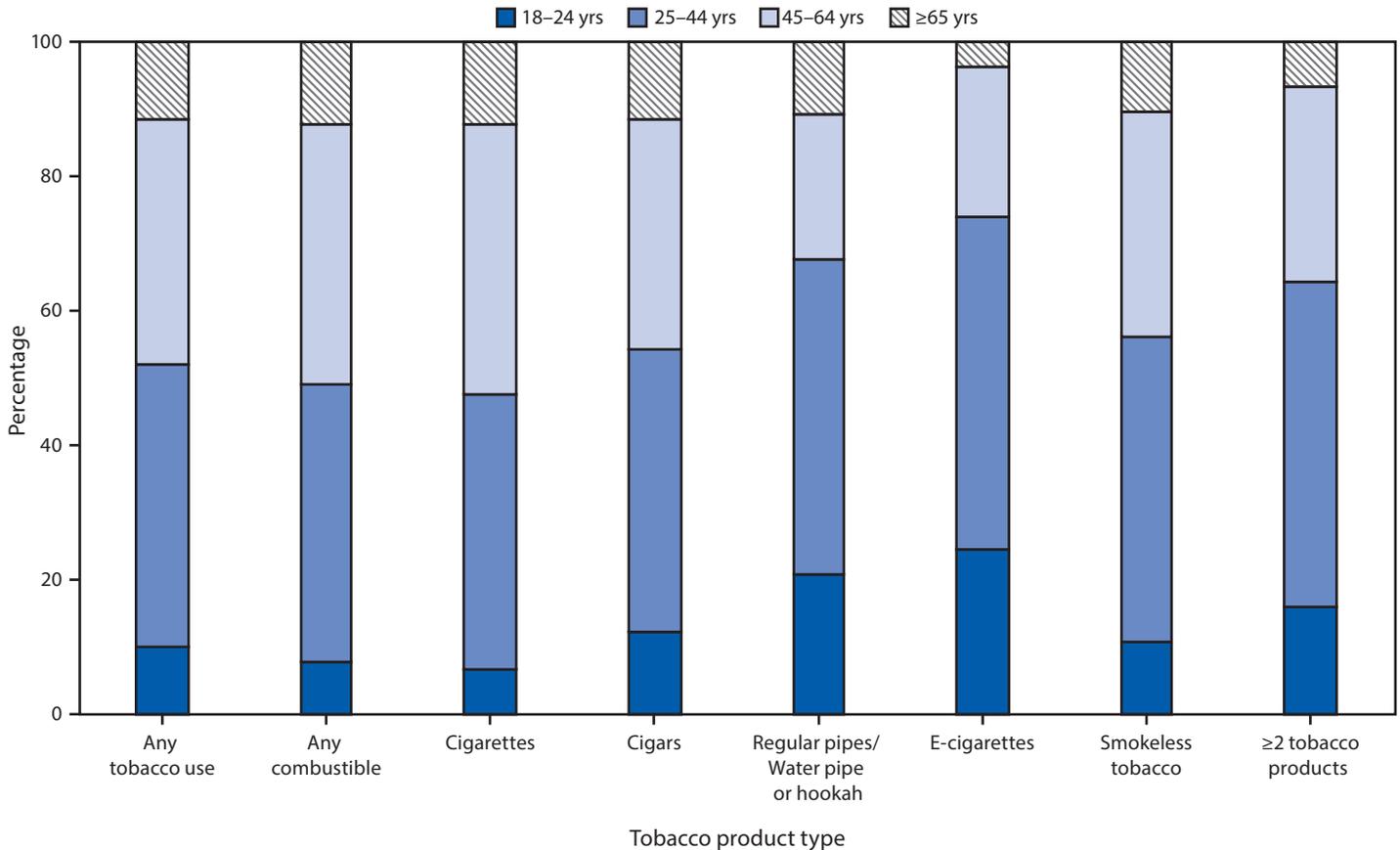

* Any tobacco use was defined as use either "every day" or "some days" of at least one tobacco product among individuals. For cigarettes, users were defined as adults who reported smoking ≥100 cigarettes during their lifetime, and smoked "every day" or "some days" at the time of interview. Any combustible tobacco use was defined as use either "every day" or "some days" of at least one combustible tobacco product: cigarettes; cigars, cigarillos, filtered little cigars; pipes, water pipes, or hookah. Use of two or more tobacco products was defined as adults who reported use "every day" or "some days" of at least two or more of the following tobacco products: cigarettes; cigars, cigarillos, filtered little cigars; pipes, water pipes, or hookah; e-cigarettes; or smokeless tobacco products.

the older age groups, more than 40% of e-cigarette users in the 25–44, 45–64 and ≥65 years age groups reported being former smokers. Although some evidence suggests that the use of e-cigarettes containing nicotine and more frequent use of e-cigarettes are associated with increased smoking cessation, smokers need to completely stop smoking cigarettes and stop using any other tobacco product to achieve meaningful health benefits (6,7). The U.S. Surgeon General concluded that there is presently inadequate evidence to conclude that e-cigarettes, in general, increase smoking cessation, and further research is needed on the effects that e-cigarettes have on cessation (7). Therefore, continued efforts to reduce use of all tobacco products, combustible and noncombustible, are needed.

The findings in this report are subject to at least four limitations. First, the 59.1% response rate might have resulted in nonresponse bias, although sample weighting is designed to account for this. Second, self-reported responses were not validated by biochemical testing for cotinine (a biomarker

indicating nicotine exposure); however, there is high correlation between self-reported smoking and smokeless use and cotinine levels (8,9). Third, because NHIS is limited to the noninstitutionalized U.S. civilian population, these results might not be generalizable to institutionalized populations and persons in the military. Finally, this analysis does not provide comparisons of prevalence estimates with previous surveys because changes in weighting and design methodology for the 2019 NHIS have the potential to affect comparisons of weighted survey estimates over time.§§§§

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§§§§ 2019 NHIS documentation indicates that changes to the nonresponse adjustment approach and the calibration methods for the 2019 NHIS have the potential to affect comparisons of the weighted survey estimates over time. Because of the changes in weighting and design methodology, direct comparisons between estimates for 2019 and earlier years should be made with caution because the effect of these changes has not been fully evaluated at this time. ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2019/srvydesc-508.pdf; https://www.cdc.gov/nchs/data/nhis/earlyrelease/EarlyRelease202009-508.pdf.

FIGURE 2. Cigarette smoking status* among current adult e-cigarette users,[†] by age group[§] — National Health Interview Survey, United States, 2019
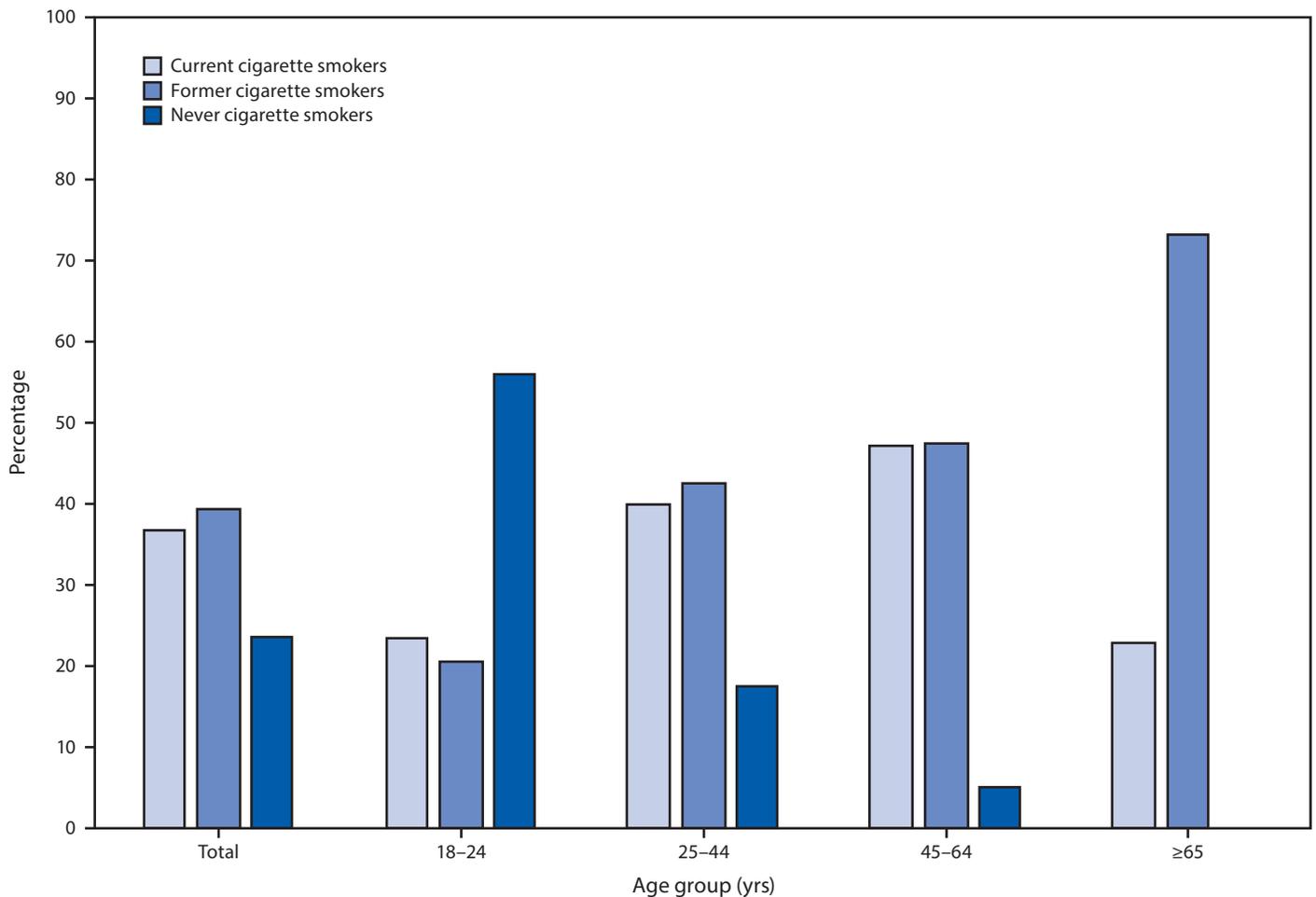
* Adults were asked if they had smoked ≥100 cigarettes in their lifetime and, if yes, whether they currently smoked cigarettes "every day," "some days," or "not at all." Those who smoked "every day" or "some days" were classified as current cigarette smokers. Adults who had not smoked ≥100 cigarettes in their lifetime were classified as never cigarette smokers. Adults who had smoked ≥100 cigarettes in their lifetime but responded to smoking "not at all" at the time of the interview were classified as former cigarette smokers.

[†] Current e-cigarette users were defined as adults who reported e-cigarette use at least once during their lifetime and use "every day" or "some days" at the time of the interview.

[§] The prevalence of never cigarette smokers among e-cigarette users aged 65 years and older is not presented because of relative standard error >30% or unweighted denominator <50.

The implementation of comprehensive, evidence-based, population-level interventions in coordination with regulation of tobacco products, can reduce tobacco-related disease, disparities, and death in the United States (*1,4*). These evidence-based, population-level strategies include implementation of tobacco price increases, comprehensive smoke-free policies, high-impact antitobacco media campaigns, and barrier-free cessation coverage (*1*). As part of a comprehensive approach, targeted interventions are also warranted to reach subpopulations with the highest prevalence of use, which might vary by tobacco product type.

Summary

What is already known about this topic?

Cigarette smoking remains the leading cause of preventable disease and death in the United States; however, a variety of new combustible, noncombustible, and electronic tobacco products are available in the United States.

What is added by this report?

In 2019, approximately 20.8% of U.S. adults (50.6 million) currently used any tobacco product. Cigarettes were the most commonly used tobacco product among adults, and e-cigarettes were the most commonly used noncigarette tobacco product (4.5%). The highest prevalence of e-cigarette use was among smokers aged 18–24 years (9.3%), with over half (56.0%) of these young adults reporting that they had never smoked cigarettes.

What are the implications for public health practice?

The implementation of comprehensive, evidence-based, population-level interventions, combined with targeted strategies, in coordination with regulation of tobacco products, can reduce tobacco-related disease and death in the United States. As part of a comprehensive approach, targeted interventions are also warranted to reach subpopulations with the greatest use, which might vary by tobacco product type.

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Implementation of a Pooled Surveillance Testing Program for Asymptomatic SARS-CoV-2 Infections on a College Campus — Duke University, Durham, North Carolina, August 2–October 11, 2020

Thomas N. Denny, MSci, MPhil[1]; Laura Andrews, MS[2]; Mattia Bonsignori, MD[3]; Kyle Cavanaugh, MBA[4]; Michael B. Datto, MD, PhD[5];
Anastasia Deckard, PhD[6]; C. Todd DeMarco[1]; Nicole DeNaeyer[1]; Carol A. Epling, MD[4]; Thaddeus Gurley[1]; Steven B. Haase, PhD[3];
Chloe Hallberg[7]; John Harer, PhD[8]; Charles L. Kneifel, PhD[6]; Mark J. Lee, PhD[5]; Raul Louzao[1]; M. Anthony Moody, MD[9]; Zack Moore, MD[10];
Christopher R. Polage, MD[5]; Jamie Puglin, PhD[11]; P. Hunter Spotts, MD[4]; John A. Vaughn, MD[4]; Cameron R. Wolfe, MBBS[3]

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On university campuses and in similar congregate environments, surveillance testing of asymptomatic persons is a critical strategy (*1,2*) for preventing transmission of SARS-CoV-2, the virus that causes coronavirus disease 2019 (COVID-19). All students at Duke University, a private research university in Durham, North Carolina, signed the Duke Compact (*3*), agreeing to observe mandatory masking, social distancing, and participation in entry and surveillance testing. The university implemented a five-to-one pooled testing program for SARS-CoV-2 using a quantitative, in-house, laboratory-developed, real-time reverse transcription–polymerase chain reaction (RT-PCR) test (*4,5*). Pooling of specimens to enable large-scale testing while minimizing use of reagents was pioneered during the human immunodeficiency virus pandemic (*6*). A similar methodology was adapted for Duke University's asymptomatic testing program. The baseline SARS-CoV-2 testing plan was to distribute tests geospatially and temporally across on- and off-campus student populations. By September 20, 2020, asymptomatic testing was scaled up to testing targets, which include testing for residential undergraduates twice weekly, off-campus undergraduates one to two times per week, and graduate students approximately once weekly. In addition, in response to newly identified positive test results, testing was focused in locations or within cohorts where data suggested an increased risk for transmission. Scale-up over 4 weeks entailed redeploying staff members to prepare 15 campus testing sites for specimen collection, developing information management tools, and repurposing laboratory automation to establish an asymptomatic surveillance system. During August 2–October 11, 68,913 specimens from 10,265 graduate and undergraduate students were tested. Eighty-four specimens were positive for SARS-CoV-2, and 51% were among persons with no symptoms. Testing as a result of contact tracing identified 27.4% of infections. A combination of risk-reduction strategies and frequent surveillance testing likely contributed to a prolonged period of low transmission on campus. These findings highlight the importance of combined testing and contact tracing

strategies beyond symptomatic testing, in association with other preventive measures. Pooled testing balances resource availability with supply-chain disruptions, high throughput with high sensitivity, and rapid turnaround with an acceptable workload.

Duke's SARS-CoV-2 surveillance program commenced when the campus reopened for fall 2020 classes. As advised by the Atlantic Coast Conference Medical Advisory Group, a total of 781 student-athletes and student athletic assistants have been participating in a separate surveillance program, in which teams are categorized as high-, medium-, or low-risk. Results described here focus on testing of students who are not student-athletes. The pooled testing program was aimed at students, but was also available to faculty and staff members. Not included are the results of specimens tested from 8,012 faculty and staff members (including pooled tests of specimens from asymptomatic persons and individual testing of specimens from symptomatic persons) by mid-September.

Students self-quarantined at home for 14 days before arriving at the reopened campus in scheduled windows during August 11–15. The surveillance program includes entry testing for all incoming students, surveillance of asymptomatic persons using pooled testing, and individual testing for symptomatic persons. Upon arrival, all students underwent entry SARS-CoV-2 screening that included collection of nasopharyngeal swabs that were tested using standard protocols in a CAP/CLIA-certified* laboratory; students were sequestered in prearranged housing (dormitories or off-campus housing) pending results (*7*). The students who were already in residence on campus or in the local community did not participate in entry testing. Mitigation strategies included converting all dormitory rooms to single-occupancy, modifying classrooms and common areas to accommodate social distancing, and distributing packaged meals. All students signed the Duke Compact (*3*), agreeing to observe mandatory masking, social distancing, and participation in entry and surveillance testing. Students who missed scheduled surveillance tests lost access to campus facilities and services. Compliance for testing among

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* College of American Pathologists (https://www.cap.org/); Clinical Laboratory Improvement Amendments (https://www.cdc.gov/clia/about.html).

students on the date requested was approximately 95% (*8*). In addition, contact tracing was performed for all positive cases. Exposed contacts were quarantined for 14 days, and students, whether asymptomatic or symptomatic, submitted specimens for testing upon initiating quarantine and again if they became symptomatic during quarantine.

Students also installed the custom-built SymMon (symptom monitoring) smartphone app,[†] which administers a daily symptom survey (*7*). The app facilitates testing for symptomatic users and for asymptomatic persons undergoing pooled testing. The app's barcode scanner enables linking of specimens to persons and creation of labels for electronic health record system orders. In addition to students, all faculty and staff members were required to complete the same SymMon symptom survey before arrival on each day they entered the campus.

Duke's SARS-CoV-2 surveillance program is ongoing. Testing of nasal swabs collected from symptomatic persons is conducted in a CAP/CLIA–certified laboratory using a platform approved under the Food and Drug Administration (FDA) Emergency Use Authorization (EUA). Testing sites for asymptomatic persons receive prelabeled tubes, swabs, and specimen bags. Supervised self-collected nasal swabs are obtained,[§] and unique barcodes are scanned using the SymMon app to record date and time and establish the link between person and specimen. Specimens are placed in secondary containers and driven to the processing laboratory. Testing of asymptomatic persons reached full capacity on September 20; since then, residential undergraduates are tested twice weekly, off-campus undergraduates one to two times per week, and graduate students approximately once weekly. At full capacity during weeks 6–9, an average of 11,390 samples were pooled per week (2,278 samples per day, 5 days per week).

Laboratory automation was rapidly repurposed to provide a high-throughput, rapid platform for pooling specimens for RT-PCR testing. An automated five-to-one pooling run transfers 120 primary samples into 24 2-mL tubes in 13 minutes, 9 seconds (33 seconds per pool). After pooling, specimens are held at 39.2°F (4°C) pending final disposition. Pooled samples are tested using an automated QIAsymphony (Qiagen LLC) laboratory-developed two-step RT-PCR and the World Health Organization E_Sarbeco primer-probe set (Charité/Berlin).[¶] For pooled assays, viral load calibration standards are run on each plate, and positive pool viral loads are extrapolated from the calibration curve (Table 1). Clinical viral loads are reported from a similar calibration process.

[†] SymMon app developed by Mike Revoir, Matt Gardner, Shellene Walker, and Scott Barkie, Office of Information Technology and Institute for Health Innovation, Duke University.

[§] https://www.fda.gov/news-events/press-announcements/coronavirus-covid-19-update-fda-authorizes-first-test-patient-home-sample-collection.

[¶] https://www.who.int/docs/default-source/coronaviruse/protocol-v2-1.pdf.

TABLE 1. Validation data* for the SARS-CoV-2 quantitative viral load assay indicating 100% target detection at 62 copies/mL and 74% at 15 copies/mL — Duke University, Durham, North Carolina, August–October 2020

Sample ID[†]	Target viral load (RNA copies/mL)	% Detection (95% CI)	
		Both replicates detected	Single replicate detected
Validation panel A	5,000,000	100 (94.9–NE)	100 (94.9–NE)
Validation panel B	500,000	100 (94.9–NE)	100 (94.9–NE)
Validation panel C	50,000	100 (94.9–NE)	100 (94.9–NE)
Validation panel D	5,000	100 (94.9–NE)	100 (94.9–NE)
Validation panel E	500	100 (94.9–NE)	100 (94.9–NE)
Validation panel F	250	100 (94.9–NE)	100 (94.9–NE)
Validation panel G	125	99 (92.3–99.9)	100 (94.9–NE)
Validation panel H	62	83 (72.0–91.0)	100 (94.9–NE)
Validation panel I	31	56 (43.3–68.6)	94 (86.0–98.4)
Validation panel J	15	27 (17.2–39.1)	74 (62.0–84.0)

Abbreviations: CI = confidence interval; NE = not able to estimate.
* Validation panels were tested 70 times to determine limit of detection with 95% CIs.
[†] Genomic viral RNA was used to establish the validation panels.

Positive pools are flagged for follow-up by deconvolution (individual testing of specimens in positive pools). For each pool, the five component specimens are retrieved, aliquoted, and labeled with unique barcodes. SymMon data are used to generate clinical orders, and specimens are tested in the CLIA-certified Duke Clinical Microbiology Laboratory using standard protocols. Results are entered into electronic health records and reported to the University's Student Health. Clinical assays (Xpert-Xpress SARS-COV-2 [Cepheid], Abbott Alinity mSARS-COv-2 [Abbott Diagnostics] or Roche cobas SARS-COV-2 [Roche Diagnostics]) were authorized for emergency use by the FDA. The two-stage testing strategy described here was designed so that the first stage used a sensitive test in a low-prevalence population, and the second stage used EUA clinical tests in the identified subset of samples where the pretest probability was higher. Additional details regarding clinical assays, sample pooling, and testing are available online.**

During August 2–October 11, a total of 10,265 undergraduate and graduate students, representing all students residing on campus or in the Durham community, but excluding athletes (781) and students attending class remotely outside of Durham (4,452), participated in pooled testing. Overall, 68,913 tests were performed for students, including 8,873 entry tests (1,392 students were already in residence on campus or in the Durham community), 59,476 pooled tests, 379 contact-traced tests, and 185 tests for symptomatic students (Table 2).

Duke's comprehensive strategy includes multiple categories of tests to identify COVID-19 infections (Table 2). During August 2–October 11, a total of 84 cases among students were identified. Across testing categories, 17 cases (20.2%)

** https://iqa.center.duke.edu/sites/iqa.center.duke.edu/files/Online%20 Methods%20Supplement%20%2800000002%29.docx.

TABLE 2. Number of tests* positive for SARS-CoV-2 among students, by test category — Duke University, Durham, North Carolina, August 2–October 11, 2020

Test category	No. of tests performed	No. of positive tests	No. (%) of persons[†] asymptomatic at testing
Entry testing	8,873	17	9 (53)
Pooled testing[§]	59,476	29	29 (100)
Contact tracing[¶]	379	23	5 (22)
Symptom monitoring[¶]	185	15	0 (0)
Total	**68,913**	**84**	**43 (51)**

* Testing was performed on specimens from a total population of 10,265 undergraduate and graduate students residing on Duke University campus or in the surrounding Durham community.
[†] Who received positive test results.
[§] Total number of positive pools = 158, which upon deconvolution yielded 29 individual positive specimens among students.
[¶] Because numbers for total tests in contact tracing and symptom monitoring were encoded together, classifications of tests as resulting from contact tracing or symptom monitoring in this table represent an estimate.

were detected by entry testing (nine asymptomatic and eight symptomatic), 29 cases (34.5%) by pooled testing (all asymptomatic), 23 cases (27.4%) by contact tracing (five asymptomatic and 18 symptomatic at time of testing), and 15 (17.9%) by symptom monitoring. Overall, among 84 total students who received positive test results, 43 (51%) did not report symptoms at the time of testing (Table 2).

Contact tracing was activated for each case detected. Among 379 students quarantined as a result of contact tracing, 23 (6.1%) received positive test results while in quarantine. Thus, the combined number of cases in asymptomatic students identified by testing (entry and pooled) and cases in all students identified by contact tracing accounted for 61 (73%) of the 84 COVID-19 cases that might not have been detected as rapidly or completely through symptomatic testing alone. Because of high testing frequency, an accurate weekly per-capita infection incidence was calculated, averaging 0.08% during the measurement period. Pooled testing for asymptomatic students comprises two steps: pooled screening and deconvolution. The pooled screening resulted in 158 positive pools that, upon deconvolution, identified 29 (18.4%) confirmed cases.

Estimated viral load was reported for pooled tests and clinical deconvolution tests. Specimens that tested positive upon deconvolution indicated good concordance with viral load estimates for positive pools (Figure). Viral load estimates for multiple asymptomatic students reached levels >10,000,000 copies/mL (geometric mean = 2,590 copies/mL [range = 3–32,360,000 copies/mL]). For pooled testing, the time between sampling, return of a positive pool, subsequent deconvolution, and return of clinical results was 18–30 hours. In addition, pooled testing permitted a nearly 80% savings in use of reagents and laboratory resources compared with testing each individual specimen.

Discussion

For the fall 2020 semester at Duke University, COVID-19 mitigation strategies included mandatory mask wearing, social distancing, emphasis of hand hygiene, daily symptom self-monitoring/reporting, and a multipronged testing strategy that comprised entry testing of all students, frequent testing of pooled student specimens, contact tracing with quarantine, and testing for symptomatic and exposed students. The cross-sectional strategy for collecting surveillance/pooled testing specimens involved distributing tests weekly across off- and on-campus student populations. In addition, the frequency of surveillance/pooled testing enabled real-time adaptive sampling, wherein additional individual specimens were focused either geospatially or within identified cohorts of the persons with positive test results. Case identification activated contact tracing for quarantine and testing for exposed asymptomatic contacts. This plan allowed campus to remain open for 10 weeks of classes without substantial outbreaks among residential or off-campus populations. Importantly, no evidence from contact tracing linked transmission with in-person classes.

Multiple universities began fall 2020 classes using only symptomatic testing. Among colleges with in-person classes and approximately 5,000 undergraduates, only 6% routinely tested all of their students in the fall semester.[††] The finding that 51% of SARS-CoV-2 infections in this analysis were asymptomatic suggests that a substantial proportion of infections would be missed with only symptomatic testing. Entry and pooled testing of asymptomatic students combined with contact tracing allowed identification and isolation of nearly three quarters of students with diagnosed infections. Importantly, despite constrained testing resources, pooled surveillance enabled the data-driven deployment of testing to areas or groups potentially at risk for an outbreak before substantial spread. Frequent testing in addition to asymptomatic entry testing, facilitated isolation of infected students before transmission could occur, keeping baseline incidence low; average weekly per-capita incidence among students was estimated to be 0.08% (8). By comparison, during October 12–18, weekly per-capita positivity for Durham County was 0.1% (9). Several asymptomatic students had high viral loads, suggesting substantial potential for transmission (1). These findings highlight the importance of combined testing and tracing strategies beyond symptomatic testing.

Recently, a COVID-19 cluster involving multiple students was identified in off-campus housing. Pooled testing identified the asymptomatic index patient. After contact tracing identified students with potential exposure, eight students linked to

FIGURE. Cumulative number of nasal swab specimens processed for pooled SARS-CoV-2 real-time reverse transcription–polymerase chain reaction testing, August 18–October 11, 2020 (A) and viral load estimates for pooled (n = 158) and confirmatory specimens (n = 30), August–October 2020 (B)* — Duke University, Durham, North Carolina
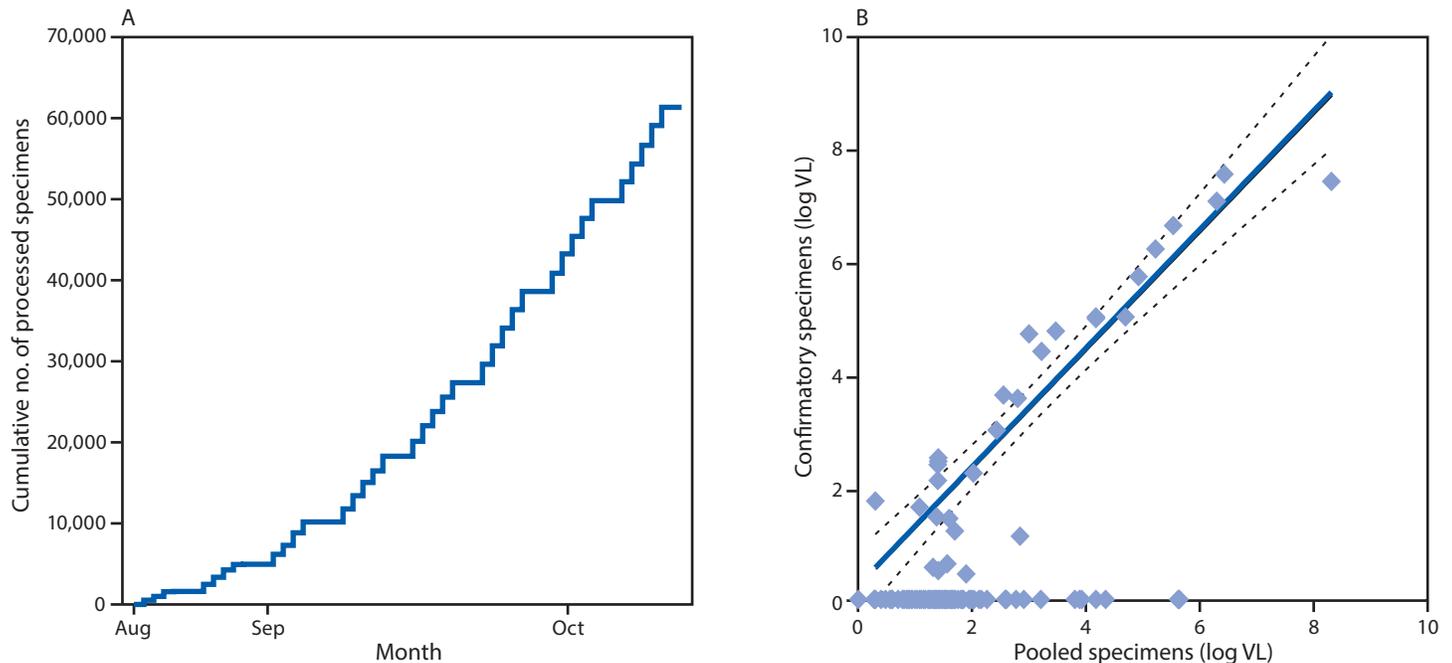
Abbreviation: VL = viral load.
* In addition to data for students, plot includes data for one faculty member with a positive test result.

Summary

What is already known about this topic?

SARS-CoV-2 can rapidly spread through university settings. Pooling specimens can enable large-scale testing while minimizing needed resources.

What is added by this report?

In fall 2020, Duke University's COVID-19 prevention strategy included risk reduction behaviors, frequent testing using pooled SARS-CoV-2 polymerase chain reaction testing, and contact tracing. Among 10,265 students who received testing 68,913 times, 84 had positive results. One half of infections were asymptomatic, and some had high viral loads.

What are the implications for public health practice?

SARS-CoV-2 transmission was limited in this congregate setting by integration of prevention strategies that included identification of asymptomatic infections through frequent testing. Pooled testing reduced the need for resources while allowing high throughput with high sensitivity and rapid turnaround of results.

the index patient received positive test results. Pooled testing and contact tracing rapidly isolated the cluster, preventing further transmission. In addition, rapid identification of cases among contacts in off-campus locations might have prevented community outbreaks.

The high sensitivity of RT-PCR testing could support use of larger pools or more complex two-stage testing strategies than those used in this study. However, deconvolution would also increase turnaround time, reducing capacity for rapid identification and isolation of infections. Using five-to-one pooling balances resource availability with supply-chain disruptions, high throughput with high sensitivity, and rapid turnaround with an acceptable workload for the laboratory conducting confirmatory testing. Further, surveillance testing at this scale in a relatively low-prevalence population will identify more false positives than true positives; thus, the current two-stage approach and pooling size allows rapid identification and confirmation of asymptomatic cases for contact tracing.

The findings of this report are subject to at least four limitations. First, the determination of whether students were asymptomatic or symptomatic at the time of testing relied on self-reporting of symptoms, which was unlikely to be fully accurate. Second, some reported positive cases might have included students who were not residing on campus or within the Durham, North Carolina, community at the time of the report. Third, positive pools were deconvoluted in a CLIA-certified clinical laboratory using multiple EUA-certified platforms with different metrics and thresholds for determining positives. Finally, the impact of Duke's testing program was assessed within the context of an incidence rate specific to the local Durham community and in the context of multiple strategies for mitigations on campus. The precise findings were

likely influenced by multiple factors, such as maintaining students in single rooms on campus and by the level of adherence to campus policies on face coverings, social distancing, and symptom monitoring by Duke's student populations.

Before fall 2020, many universities made decisions based on epidemiologic models with scant data for estimating critical parameters (*2,10*). Among the Duke student body and faculty and staff members, weekly or more frequent mandatory testing led to low infection rates when combined with preventive mitigation strategies such as frequent handwashing, masking, and social distancing. In addition to limiting transmission on campus and within the local community, Duke's comprehensive COVID-19 mitigation will provide critical data to inform parameters in epidemiologic models and support data-driven approaches on college campuses and in other settings.

Corresponding author: Thomas N. Denny, thomas.denny@duke.edu.

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[1]Duke Human Vaccine Institute, Duke University School of Medicine, Durham, North Carolina; [2]Student Affairs, Duke University, Durham, North Carolina; [3]Department of Medicine, Duke University School of Medicine, Durham, North Carolina; [4]Department of Family Medicine, Duke University School of Medicine, Durham, North Carolina; [5]Department of Pathology, Duke University of Medicine, Durham, North Carolina; [6]Office of Information Technology, Duke University, Durham, North Carolina; [7]Emergency Management and Emergency Services, Duke University, Durham, North Carolina; [8]Department of Mathematics, Duke University, Durham, North Carolina; [9]Department of Pediatrics, Duke University School of Medicine, Durham, North Carolina; [10]North Carolina Department of Health and Human Services; [11]Office of Assessment, Duke University, Durham, North Carolina.

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Progress Toward Poliomyelitis Eradication — Pakistan, January 2019–September 2020

Christopher H. Hsu, MD, PhD[1]; Muhammad Shafiq-ur-Rehman, MPH[2]; Kelley Bullard, MS[3]; Jaume Jorba, PhD[4]; Milhia Kader, MD[5]; Hamish Young[5]; Muhammad Safdar, MD[6]; Hamid S. Jafari, MD[7]; Derek Ehrhardt, MPH, MSN[1]

Pakistan and Afghanistan are the only countries where wild poliovirus type 1 (WPV1) is endemic (*1,2*). In 2019, Pakistan reported 147 WPV1 cases, approximately 12 times the number reported in 2018. As of September 15, 72 cases had been reported in 2020. Since 2019, WPV1 transmission has also spread from Pakistan's core poliovirus reservoirs (Karachi, Peshawar, and Quetta block) to southern districts of Khyber Pakhtunkhwa (KP), Punjab, and Sindh provinces. Further, an outbreak of circulating vaccine-derived poliovirus type 2 (cVDPV2), first detected in July 2019, has caused 22 paralytic cases in 2019 and 59 as of September 15, 2020, throughout the country. The coronavirus disease 2019 (COVID-19) pandemic has substantially reduced delivery of polio vaccines through essential immunization (formerly routine immunization) and prevented implementation of polio supplementary immunization activities (SIAs)* during March–July 2020. This report describes Pakistan's progress in polio eradication during January 2019–September 2020 and updates previous reports (*1,3,4*). The Pakistan polio program has reinitiated SIAs and will need large, intensive, high-quality campaigns with strategic use of available oral poliovirus vaccines (OPVs)† to control the surge and widespread transmission of WPV1 and cVDPV2.

Immunization Activities

Essential immunization. Based on a national survey of 12,815 households in 2017–2018, essential immunization coverage with 3 doses of bivalent OPV (bOPV, containing vaccine virus types 1 and 3) by age 1 year was 86% and with 1 dose of inactivated poliovirus vaccine (IPV), which contains all three serotypes, was 64% (*5*). Coverage in 2019 was highest in Azad Jammu and Kashmir (92%) and Islamabad (95%) and lowest in Balochistan (66%) and Gilgit-Baltistan (67%). Provincial essential immunization coverage with bacillus Calmette–Guérin, OPV3, pentavalent (diphtheria, tetanus, pertussis, hepatitis B, and *Haemophilus influenzae* type b), and measles vaccines decreased 22%–49% from 2019 to 2020 (*6*).

Vaccination histories of children aged 6–23 months with acute flaccid paralysis (AFP) who tested negative for wild poliovirus and vaccine-derived poliovirus (VDPV) (nonpolio AFP [NPAFP]§) are a surrogate estimate of population polio vaccination coverage. In 2019, the highest proportion of children with NPAFP who had not received any polio vaccination (zero-dose children) were in Balochistan (3.9%) and KP (1.1%).

Supplementary immunization activities. In 2019, three national and four subnational SIAs were conducted using bOPV. Because of COVID-19 outbreaks during January–September 2020, only two national campaigns (February and September using bOPV) and two subnational campaigns (March and August) using monovalent OPV type 2 (mOPV2) were conducted. In addition, multiple small-scale vaccination campaigns were implemented in response to isolation of poliovirus from environmental surveillance (sewage sampling) or persons with AFP, using bOPV for WPV1 or mOPV2 for cVDPV2. SIA quality was assessed through intracampaign monitoring surveys and lot quality assurance sample (LQAS) surveys.¶ During the national immunization days (NIDs) conducted in January 2019 (i.e., before the COVID-19 pandemic), one province (Gilgit-Baltistan) did not meet LQAS targets (≥80%), compared with three (Azad Jammu and Kashmir, Gilgit-Baltistan, and Sindh) during the September 2020 NID (i.e., during the COVID-19 pandemic).

Community-based vaccination. Since 2015, locally recruited community-based vaccinators have engaged with communities in core poliovirus reservoirs to increase vaccination during and between SIAs. Community-based vaccinators, recruited from the local population, are mostly (85%) female, which facilitates entry in homes in religiously conservative areas, and are perceived as possessing a vested interest in reaching all children in their communities. As of August 2020, a total of 10,318 community-based vaccinators, approximately

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* Mass campaigns conducted for a brief period (days to weeks) in which 1 dose of oral poliovirus vaccine is administered to all children aged <5 years, regardless of vaccination history. Campaigns can be conducted nationally or subnationally.
† Three types of oral poliovirus vaccine are currently in use in Pakistan: monovalent OPV to type 2 (mOPV2), bivalent OPV (bOPV) to types 1 and 3, and trivalent OPV (tOPV) to types 1, 2, and 3.

§ Vaccination histories of children aged 6–23 months with acute flaccid paralysis who do not receive positive test results for WPV/VDPV are used to estimate OPV coverage of the overall target population and to corroborate national reported routine vaccination coverage estimates.
¶ Lot quality assurance sample survey is a two-stage post-campaign assessment: stratified random sampling and one-sided hypothesis testing during analysis. Lots are union councils (the tier of government below districts) within a vaccination catchment area. If the number of vaccinated children identified by finger marking within a lot has met the predetermined threshold, the lot has passed.

one half the community-based vaccinator workforce of August 2019, have been deployed in areas at high risk.

Surveillance Activities

AFP surveillance. In 2019 and 2020, all provinces exceeded the target NPAFP case rate of six per 100,000 persons aged <15 years and the 80% target proportion of AFP cases with collection of adequate specimens** (Table). During January–September 2020, the national NPAFP rate was 14.2 (range = 10.2–18.9 among provinces), lower than that during the same period in 2019 (20.5; range = 16.3–31.0) (*1*). The national percentages of AFP cases with adequate stool specimens were 88% in 2019 and 89% in 2020.

Environmental surveillance. AFP surveillance is supplemented through systematic sewage sampling (currently at 60 regular sampling sites and eight ad hoc sites) and testing for poliovirus. During January 2019–September 2020, WPV1 has been detected in all provinces, including core reservoirs (Karachi, Peshawar, and Quetta block) and multiple sites in


** AFP surveillance quality is monitored by performance indicators that include 1) the detection rate of nonpolio acute flaccid paralysis (NPAFP) cases and 2) the percentage of AFP cases with adequate stool specimens. World Health Organization (WHO) operational targets for countries with endemic-poliovirus transmission are NPAFP detection rates of two or more cases per 100,000 population aged <15 years and adequate stool specimen collected from ≥80% of AFP cases. For Pakistan, an endemic country, the minimum detection rate is six per 100,000 population aged <15 years. Adequate stool specimen is defined as two stool specimens collected ≥24 hours apart, both within 14 days of paralysis onset, and shipped on ice or frozen packs to a WHO-accredited laboratory, arriving in good condition (i.e., without leaks or desiccation) within 3 days.

Balochistan, KP, Punjab, and central and northern Sindh. Among the 68 sampling sites, the proportion of positive samples detected in 2020 (55%) increased compared with that during the same period in 2019 (43%). VDPV2 was first detected through environmental surveillance in August 2019 in Gilgit-Baltistan and northern KP. Over the next 12 months VDPV2 was detected in Balochistan, Punjab, and Sindh; by February 2020, VDPV2 was detected at 12 (18%) of the 68 sampling sites in all provinces.

Epidemiology of WPV1 and cVDPV2 cases. During 2019, 147 WPV1 cases were reported in Pakistan, more than 12 times the 12 reported cases during 2018 (Figure 1). During January–September 2020, 72 WPV1 cases had been reported among 33 districts in four provinces, compared with 72 from 22 districts in four provinces during the same period in 2019. Among the 219 WPV1 cases with paralysis onset during January 2019–September 2020, 115 (53%) were from KP, 30 (14%) from Balochistan, 52 (24%) from Sindh, and 22 (10%) from Punjab (Table) (Figure 2). Ages of the 219 WPV1 patients ranged from 1 to 168 months (median 18 months). Thirty-three (15%) patients were zero-dose children, and 153 (70%) had received ≥4 doses.

Several WPV1 genetic lineages persisted through the 2019–20 low season (November–April). Among the 10 genetic clusters (groups of polioviruses sharing ≥95% sequence identity in the viral capsid protein [VP1]) associated with AFP cases during the reporting period, seven were detected during the low season, mostly in KP and Sindh provinces.

TABLE. Acute flaccid paralysis (AFP) surveillance indicators, number of reported cases of wild poliovirus (WPV), and number of reported cases of circulating vaccine derived poliovirus type 2 (cVDPV2), by region and period — Pakistan, January 2019–September 2020

Indicator	Pakistan Total	Region						
		Azad Jammu Kashmir	Gilgit-Baltistan	Islamabad	Khyber Pakhtunkhwa	Punjab	Balochistan	Sindh
AFP surveillance indicators (2019–2020)								
No. of AFP cases (2019)	**15,216**	388	156	188	3,366	7,287	658	3,173
No. of AFP cases (2020)	**7,698**	147	78	80	1,797	3,609	352	1,635
Nonpolio AFP rate (2019)*	**20.5**	18.2	22.4	31.0	21.8	16.9	16.3	16.9
Nonpolio AFP rate (2020)*	**14.2**	10.2	16.5	18.9	17.2	12.0	12.4	12.0
% with adequate specimens (2019)†	**88**	91	86	87	83	87	89	90
% with adequate specimens (2020)†	**89**	90	88	87	85	89	91	91
Reported WPV cases								
Jan–Jun 2019	**44**	0	0	0	34	5	2	3
Jul–Dec 2019	**103**	0	0	0	59	7	10	27
Jan–Sep 2020	**72**	0	0	0	22	10	18	22
Total	**219**	**0**	**0**	**0**	**115**	**22**	**30**	**52**
Reported cVDPV2 cases								
Jul–Dec 2019	**22**	0	4	1	16	1	0	0
Jan–Sep 2020	**59**	0	0	0	42	11	1	5
Total	**81**	**0**	**4**	**1**	**58**	**12**	**1**	**5**

* Per 100,000 children aged <15 years.
† Two stool specimens collected at an interval of at least 24 hours within 14 days of paralysis onset and arriving in a World Health Organization–accredited laboratory with reverse cold chain maintained and without leakage or desiccation.

FIGURE 1. Wild poliovirus type 1 (WPV1) and circulating vaccine-derived poliovirus type 2 (cVDPV2) cases, by month — Pakistan, January 2016–September 2020
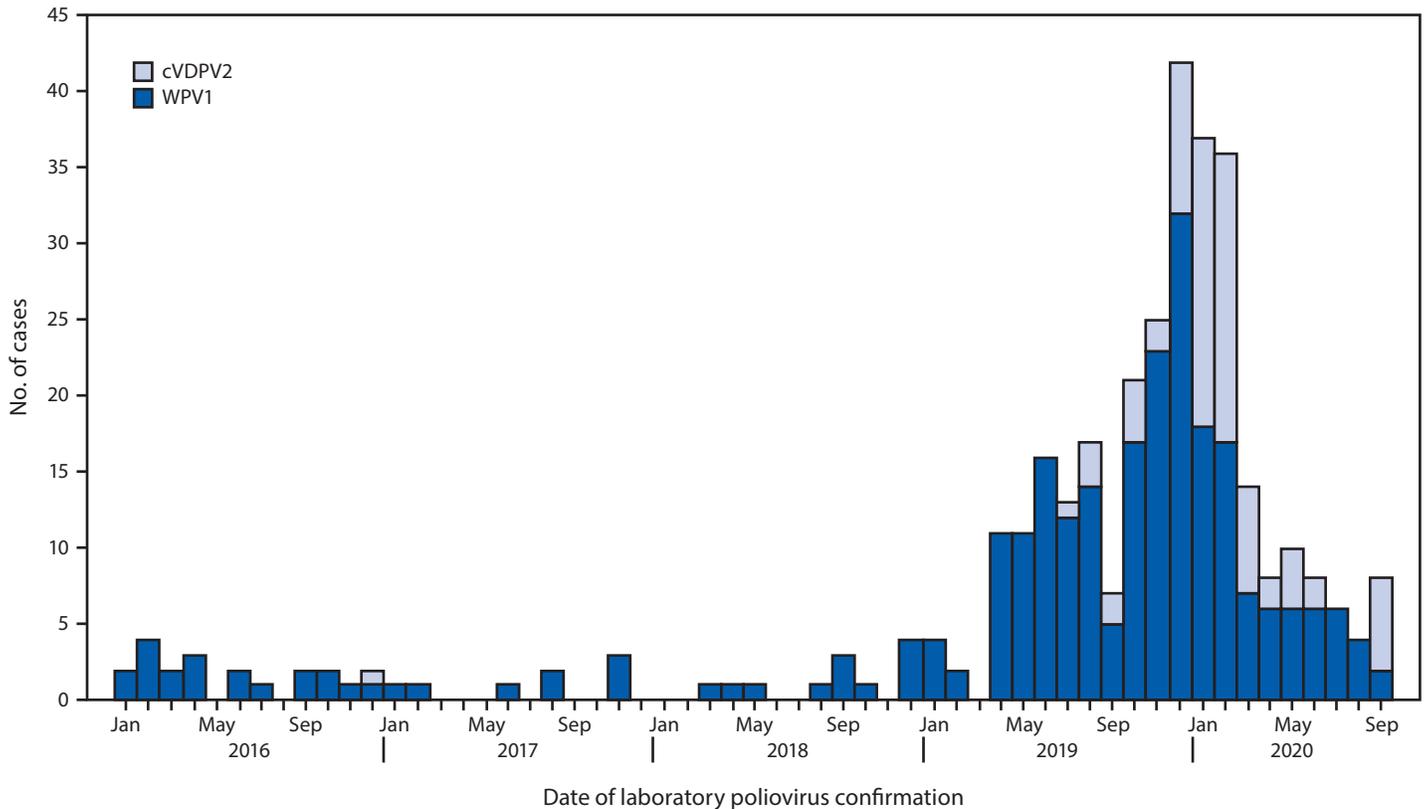
Since the detection in July 2019 of the first cVDPV2 case in Diamer district (Gilgit-Baltistan province) through September 15, 2020, a total of 81 cases affecting 30 districts in six provinces had been reported (Table) (Figure 1). The 2019 cVDPV2 outbreaks occurred as five independent emergences (7); in 2020, the cVDPV2 cases were genetically linked to two of the five original cVDPV2 emergences. Fifty-eight (72%) cases were from KP, one (1%) from Balochistan, five (6%) from Sindh, 13 (16%) from Punjab, and four (5%) from Gilgit-Baltistan. Ages of cVDPV2 patients ranged from 6 to 102 months (median 16 months). Ten (12%) were zero-dose children, 41 (51%) had never received essential immunization, 13 (16%) had received mOPV2, and 17 (21%) had received IPV. Three breakthrough cVDPV2 transmissions have been detected after response vaccination campaigns: one each in Nowshera and Torghar districts in KP and Rawalpindi district in Punjab; all occurred before March 2020.

Discussion

Significant setbacks in Pakistan's polio eradication began during 2018, with a sharp increase in WPV1 cases and positive environmental samples for WPV1 and cVDPV2 in 2019. The WPV1 resurgence resulted from ongoing challenges

reaching children in districts with endemic transmission and deterioration in overall SIA quality. Efforts to halt transmission of WPV1 failed in 2019, and with emergence of cVDPV2, spread of both poliovirus types was exacerbated in 2020 by the COVID-19 pandemic, which placed significant demands on the health care system and disrupted surveillance and vaccination activities. The COVID-19 response required leadership, laboratory personnel, and frontline workers from polio surveillance and vaccination activities to combat rising COVID-19 cases, resulting in reduction of essential immunization and suspension by the National Emergency Operations Center of all polio SIAs during March–July 2020.

SIAs need to be implemented with great urgency to close immunity gaps created during the first half of 2020. The full range of polio vaccines available (mOPV2, bOPV, and trivalent OPV [tOPV, containing vaccine types 1, 2 and 3]) can be strategically distributed to reduce transmission, depending on the type-specific serotype circulating and population immunity. In June 2020, the Pakistan Technical Advisory Group[††] recommended using tOPV in SIAs, to immunize against types 1

[††] The Technical Advisory Group includes international polio experts who meet biannually to assess Pakistan's eradication activities and progress and to provide recommendations toward the goal of eradication.

FIGURE 2. Location of cases of wild poliovirus type 1 (WPV1) and circulating vaccine-derived poliovirus type 2 (cVDPV2), by province and period — Pakistan, January 2019–September 2020
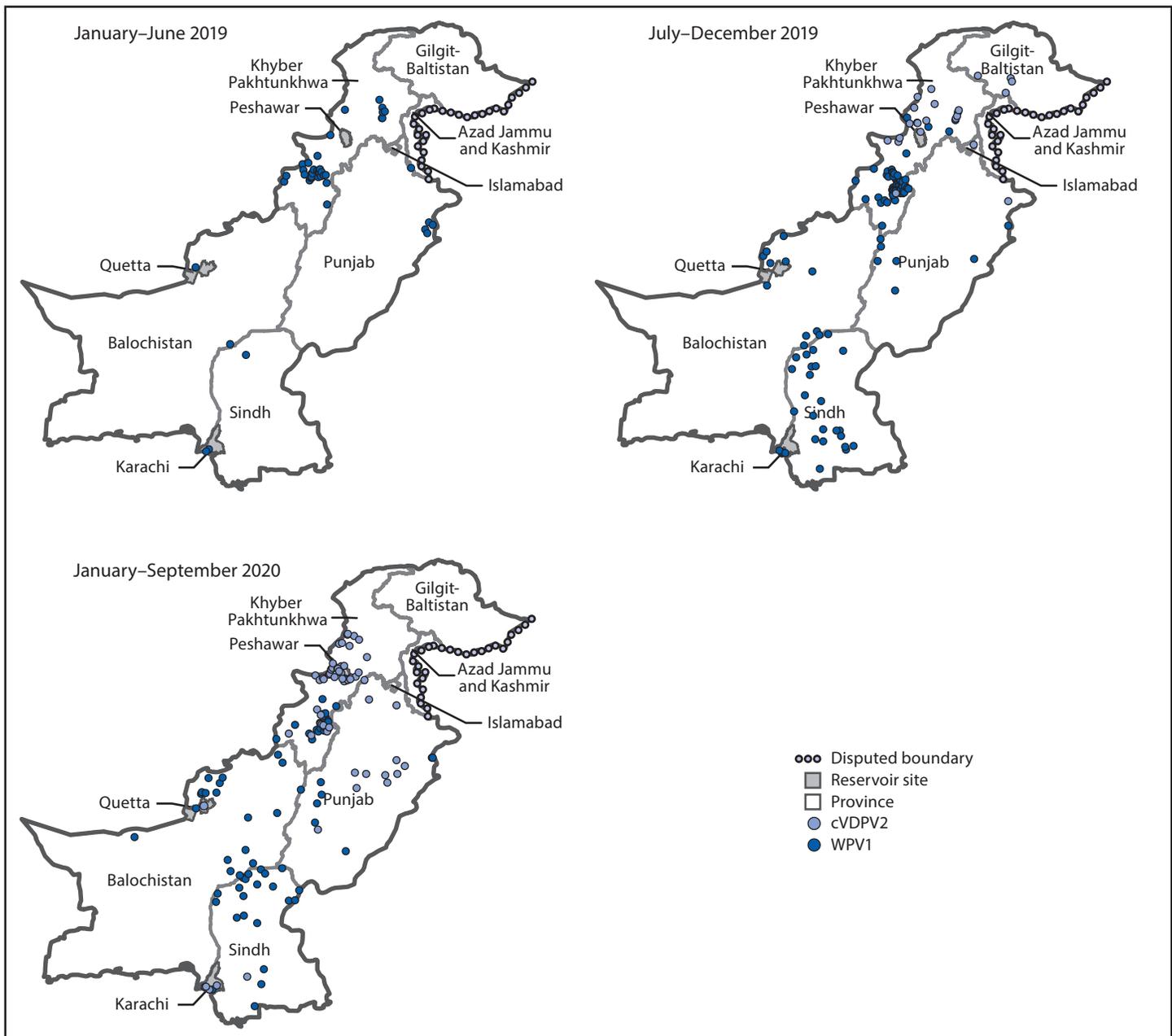
and 2 simultaneously. The National Emergency Operations Center resumed SIAs with a small-scale mOPV2 campaign in July, followed by a larger-scale mOPV2 campaign in August and a bOPV NID in September. NIDs are planned for every 5 weeks from September to December using tOPV, if available, or bOPV.

Pakistan's polio program would also benefit from gaining community trust through effective messaging to counter false information and vaccine refusals. Vulnerable, high-risk areas include Quetta, Sindh province, districts of Khyber

and Peshawar, and southern districts of KP province. Efforts to improve community engagement and relevant social data collection are necessary to understand challenges hindering vaccine acceptance in these high-risk areas. Community-based vaccinators have improved vaccination coverage by improving trust in some communities at high risk, and by downsizing its workforce in 2020 to place the most skilled community-based vaccinators where they might have the greatest impacts. Community-based vaccinators will continue to play a crucial role in vaccinating hard-to-reach children.

Summary

What is already known about this topic?

Since 2016, Pakistan and Afghanistan are the only countries to report ongoing transmission of indigenous wild poliovirus type 1 (WPV1) and remain the last countries where polio is endemic.

What is added by this report?

WPV1 transmission continued in Pakistan during January 2019–September 2020, and circulating vaccine-derived poliovirus type 2 (cVDPV2) outbreak cases have spread throughout the country since July 2019. In 2020, the coronavirus disease 2019 pandemic has substantially reduced delivery of polio vaccines.

What are the implications for public health practice?

Stopping WPV1 and cVDPV2 transmission in Pakistan will require resumption of high-quality national vaccination campaigns with strategic use of oral poliovirus vaccines, continuing cross-border coordination with Afghanistan, national coordination among the partnerships, and gaining the trust of high-risk communities.

Mistrust of vaccines and vaccinators is also responsible for poor vaccination coverage among certain migrant and displaced communities. Some of these groups move back and forth between Pakistan and Afghanistan or settle along the border in KP and Balochistan. Culturally sensitive efforts with direct engagement of these communities, including adequate representation within the local vaccination workforce, will be needed to improve vaccine acceptance. In addition, coordination between Pakistan and Afghanistan through data sharing, SIA coordination, and cooperative border health efforts, will be essential to eradicating WPV1 from the border (2).

The national program and the Global Polio Eradication Initiative[§§] partners in Pakistan have undergone significant transformation since late 2019 to overcome challenges in oversight, data burden, and efficiency. Transformation goals included improving accountability of field activities; restructuring and defining government and partnership roles; and streamlining data flow from the union council and district levels to provincial and national levels. The new program

structure needs to be finalized and commence functioning immediately to reverse the trend of nationwide WPV1 and cVDPV2 expansion and ultimately to achieve regional and global polio eradication.

Acknowledgment

Corresponding author: Christopher H. Hsu, chsu@cdc.gov, 404-639-4526.

[1]Global Immunization Division, Center for Global Health, CDC; [2]World Health Organization, Islamabad, Pakistan; [3]IHRC, Inc., Atlanta, Georgia; [4]Division of Viral Diseases, National Center for Immunization and Respiratory Diseases, CDC; [5]United Nations Children's Fund, Islamabad, Pakistan; [6]National Emergency Operation Center, Islamabad, Pakistan; [7]World Health Organization, Amman, Jordan.

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[§§] The Global Polio Eradication Initiative is a partnership of CDC, the Bill and Melinda Gates Foundation, WHO, United Nations Children's Fund, and Rotary International.

COVID-19 Stats

COVID-19 Incidence,* by Urban-Rural Classification[†] — United States, January 22–October 31, 2020[§]
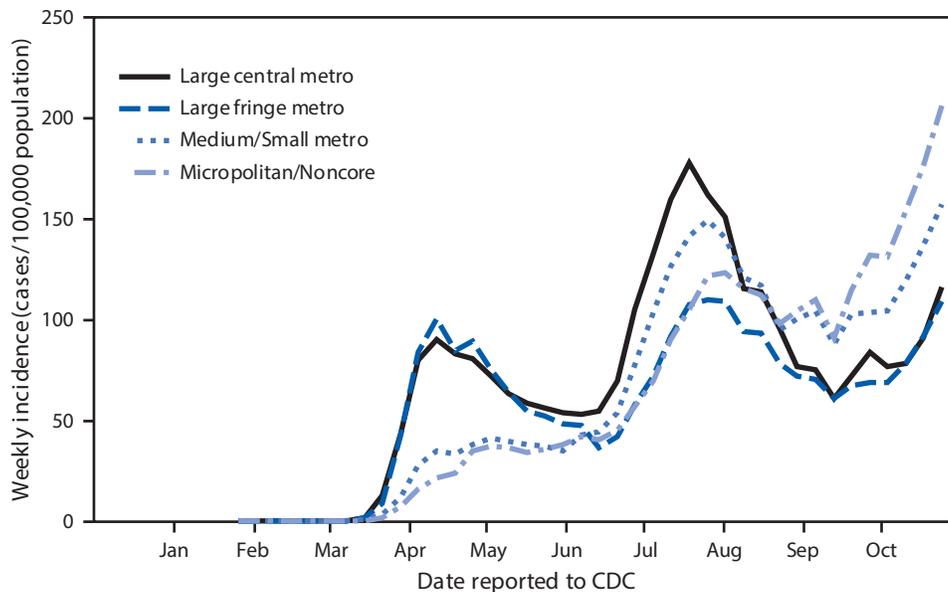
Abbreviation: COVID-19 = coronavirus disease 2019.

* Incidence = cases per 100,000 population calculated using 2019 U.S. census population.

[†] *Large central metro*: counties in metropolitan statistical areas (MSAs) of ≥1 million population that 1) contain the entire population of the largest principal city of the MSA, 2) have the entire population contained in the largest principal city of the MSA, or 3) contain ≥250,000 inhabitants of any principal city of the MSA; *Large fringe metro*: counties in MSAs of ≥1 million population that did not qualify as large central metro counties; *Medium metro*: counties in MSAs of 250,000–999,999 population; *Small metro*: counties in MSAs of 50,000–249,999 population; *Micropolitan*: counties centered on an urban cluster with 10,000–49,999 population; *Noncore*: nonmetropolitan counties that did not qualify as micropolitan. https://www.cdc.gov/nchs/data_access/urban_rural.htm#2013_Urban-Rural_Classification_Scheme_for_Counties.

[§] Data are provisional and subject to change.

Early in the pandemic, from mid-March to mid-May, COVID-19 incidence was highest among residents of large central and large fringe metropolitan areas. Beginning in mid-April, incidence in large metropolitan (central and fringe) areas declined and then increased similarly among all urban-rural areas. In September 2020, COVID-19 incidence sharply increased, and it remains highest among residents of medium/small metropolitan areas and micropolitan/noncore areas, indicating increased spread into rural communities. In October, weekly incidence was increasing steadily among all urban-rural areas.

Source: Protect USAFacts. https://usafacts.org/visualizations/coronavirus-covid-19-spread-map/.

Reported by: Lindsey M. Duca, PhD, pgz5@cdc.gov; Jayme Coyle, PhD; Carter McCabe, MPH; Catherine A. McLean, MD.

QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Death Rates* from Septicemia† Among Persons Aged ≥65 Years, by Age Group — National Vital Statistics System, United States, 2000–2018
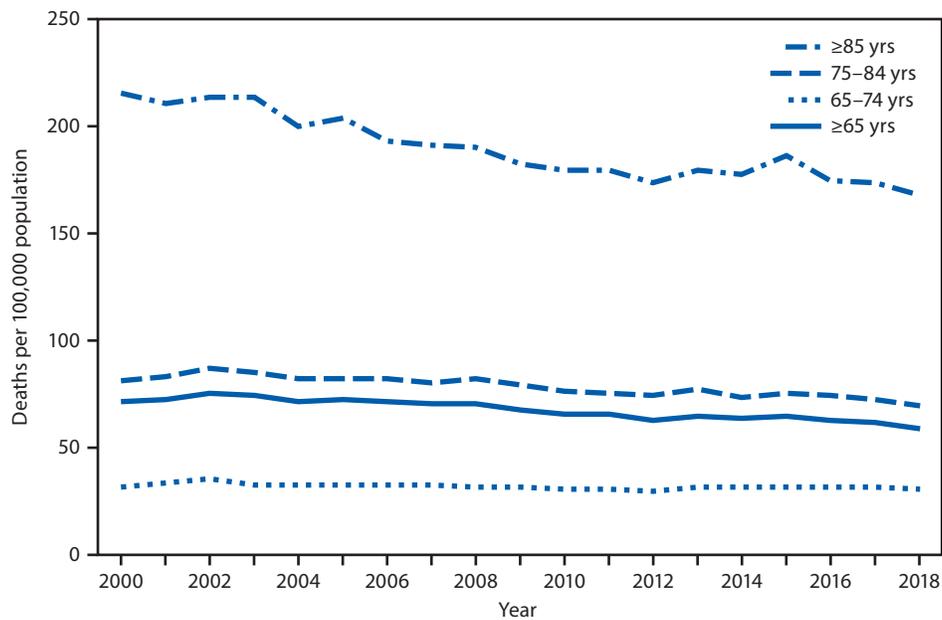
* Deaths per 100,000 population in each age group.
† Deaths attributed to septicemia were identified using *International Classification of Diseases, Tenth Revision* underlying cause of death codes A40–A41.

During 2000–2018, the death rate from septicemia among persons aged ≥65 years generally decreased from 70.8 to 58.7 deaths per 100,000 population. The death rate was lower in 2018 than in 2000 among persons aged 75–84 years (80.4 compared with 69.4) and among persons aged ≥85 years (215.7 compared with 167.4). The death rate for persons aged 65–74 was similar in 2000 (31.0) and 2018 (30.0). In each year during 2000–2018, the death rate was highest among persons aged ≥85 years and lowest among persons aged 65–74 years.

Source: National Vital Statistics System mortality data. https://www.cdc.gov/nchs/nvss/deaths.htm.

Reported by: Ellen A. Kramarow, PhD, ekramarow@cdc.gov, 301-458-4325; Julie D. Weeks, PhD; Cynthia Reuben, MA.

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