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Vital Signs: Trends in State Suicide Rates — United States, 1999–2016 and Circumstances Contributing to Suicide — 27 States, 2015

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Abstract

Introduction: Suicide rates in the United States have risen nearly 30% since 1999, and mental health conditions are one of several factors contributing to suicide. Examining state-level trends in suicide and the multiple circumstances contributing to it can inform comprehensive state suicide prevention planning.

Methods: Trends in age-adjusted suicide rates among persons aged ≥10 years, by state and sex, across six consecutive 3-year periods (1999–2016), were assessed using data from the National Vital Statistics System for 50 states and the District of Columbia. Data from the National Violent Death Reporting System, covering 27 states in 2015, were used to examine contributing circumstances among decedents with and without known mental health conditions.

Results: During 1999–2016, suicide rates increased significantly in 44 states, with 25 states experiencing increases >30%. Rates increased significantly among males and females in 34 and 43 states, respectively. Fifty-four percent of decedents in 27 states in 2015 did not have a known mental health condition. Among decedents with available information, several circumstances were significantly more likely among those without known mental health conditions than among those with mental health conditions, including relationship problems/loss (45.1% versus 39.6%), life stressors (50.5% versus 47.2%), and recent/impending crises (32.9% versus 26.0%), but these circumstances were common across groups.

Conclusions: Suicide rates increased significantly across most states during 1999–2016. Various circumstances contributed to suicides among persons with and without known mental health conditions.

Implications for Public Health Practice: States can use a comprehensive evidence-based public health approach to prevent suicide risk before it occurs, identify and support persons at risk, prevent reattempts, and help friends and family members in the aftermath of a suicide.

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Introduction

In 2016, nearly 45,000 suicides (15.6/100,000 population [age-adjusted]) occurred in the United States among persons aged ≥10 years (*1*). From 1999 to 2015, suicide rates increased among both sexes, all racial/ethnic groups, and all urbanization levels (*2*,*3*). Suicide rates have also increased among persons in all age groups <75 years, with adults aged 45–64 having the largest absolute rate increase (from 13.2 per 100,000 persons [1999] to 19.2 per 100,000 [2016]) and the greatest number of suicides (232,108) during the same period (*1*,*3*). Suicide is the tenth leading cause of death and is one of just three leading causes that are increasing (*1*,*4*). In addition, rates of emergency department visits for nonfatal self-harm, a main risk factor for suicide, increased 42% from 2001 to 2016 (*1*). Together, suicides and self-harm injuries cost the nation approximately $70 billion per year in direct medical and work loss costs (*1*).

The National Strategy for Suicide Prevention (*5*) calls for a public health approach to suicide prevention with efforts spanning multiple levels (individual, family/relationship, community, and societal). Such a comprehensive approach underscores that suicide is rarely caused by any single factor, but rather, is determined by multiple factors. Despite this call to action, suicide prevention largely focuses on identifying and referring suicidal persons to mental health treatment and preventing reattempts (*6*). In addition to mental health conditions and prior suicide attempts, other contributing circumstances include social and economic problems, access to lethal means (e.g., substances, firearms) among persons at risk, and poor coping and problem-solving skills (*5*). Expanded awareness of these additional circumstances contributing to suicide risk and action to address them can help reach the national goal, established by the National Action Alliance of Suicide Prevention and the American Foundation for Suicide Prevention, of reducing the annual suicide rate 20% by 2025 (*7*). To assist states in achieving this goal, CDC analyzed state-specific trends in suicide rates and assessed the multiple contributing factors to suicide; this report presents options for strategies to include in comprehensive suicide prevention efforts that are based on the best available evidence.

Methods

Suicide rates were analyzed for persons aged ≥10 years because determining suicidal intent in younger children can be difficult (*8*). Age-specific suicide counts were tabulated based on National Vital Statistics System coded death certificate records (*International Classification of Diseases, Tenth Revision,* underlying-cause-of death codes X60–X84, Y87.0, U03). Age-specific population estimates were obtained from U.S. Census Bureau/National Center for Health Statistics bridged-race population data releases.

National and state-level suicide rate estimates were calculated for six consecutive 3-year aggregate periods spanning 1999–2016 (1999–2001; 2002–2004; 2005–2007; 2008–2010; 2011–2013; and 2014–2016). Rate estimates were age-adjusted to the U.S. 2000 standard population and expressed

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per 100,000 persons per year. Age-adjusted suicide rate trends were modeled using the same 3-year data aggregates, employing weighted least-squares regression with inverse-variance weighting. Modeled rate trends are reported in terms of average annual percentage changes.

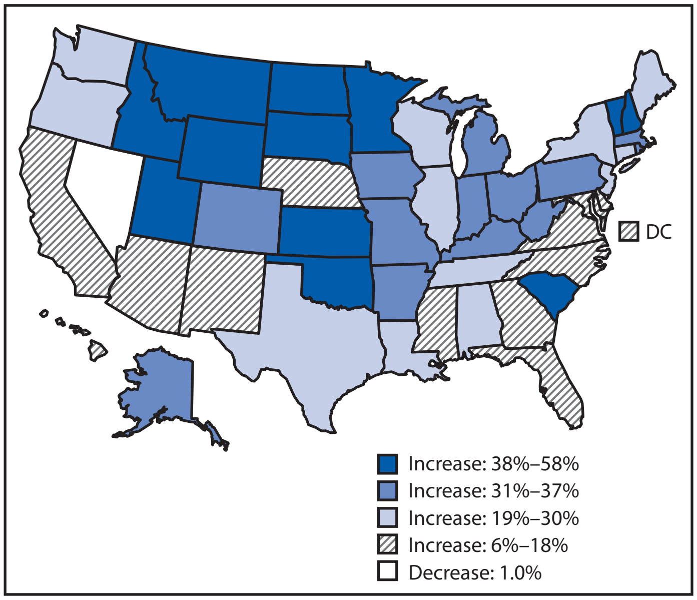
Characteristics of persons aged ≥10 years who died by suicide, with and without known mental health conditions, and the circumstances surrounding the suicides were compared in the 27 states* with complete data participating in CDC's National Violent Death Reporting System (NVDRS) in 2015. NVDRS defines mental health conditions as disorders and syndromes listed in the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (*9*), with the exception of problematic alcohol use and other substance use that are captured separately in NVDRS. NVDRS aggregates data from three primary data sources: death certificates, coroner/medical examiner reports (including toxicology), and law enforcement reports. A range of circumstances (relationship problems, life stressors, and recent or impending crises) have been identified as potential risk factors for suicide in NVDRS. Circumstances captured are those identified as contributing to suicide in coroner/medical examiner or law enforcement reports, which reflect information provided by family and friends at the time of death. Decedents could have experienced multiple circumstances. Decedents with and without known mental health conditions were compared using chi-square tests. Logistic regression analyses were used to estimate adjusted odds ratios (aORs) with 95% confidence intervals (CIs), controlling for sex, age group, and race/ethnicity.

Results

The most recent overall suicide rates (representing 2014–2016) varied fourfold, from 6.9 (District of Columbia) to 29.2 (Montana) per 100,000 persons per year (Supplementary Table; https://stacks.cdc.gov/view/cdc/53785). Across the study period, rates increased in all states except Nevada (where the rate was consistently high throughout the study period), with absolute increases ranging from 0.8 per 100,000 (Delaware) to 8.1 (Wyoming). Percentage increases in rates ranged from 5.9% (Delaware) to 57.6% (North Dakota), with increases >30% observed in 25 states (Supplementary Table; https://stacks.cdc.gov/view/cdc/53785) (Figure).

Modeled suicide rate trends indicated significant increases in 44 states, among males (34 states) and females (43 states), as well as for the United States overall (Supplementary Table; https://stacks.cdc.gov/view/cdc/53785). Nationally, the model-estimated average annual percentage change for the overall suicide rate was an increase of 1.5%. By sex, estimated national rate trends further indicated significant average annual percentage change increases for males (1.1%) and females (2.6%) (Supplementary Table; https://stacks.cdc.gov/view/cdc/53785).

FIGURE. Percent change in annual suicide rate,* by state — United States, from 1999–2001 to 2014–2016



* Per 100,000 population, age-adjusted to the 2000 U.S. standard population.

Suicide decedents without known mental health conditions (11,039; 54.0%) were compared with those with known mental health conditions (9,407; 46.0%) for 27 states. Whereas decedents were predominantly male (76.8%) (Table 1) and non-Hispanic white (83.6%), those without known mental health conditions, relative to those with mental health conditions, were more likely to be male (83.6% versus 68.8%; odds ratio [OR] = 2.3, 95% CI = 2.2–2.5) and belong to a racial/ethnic minority (OR range = 1.2–2.0). Suicide decedents without known mental health conditions also had significantly higher odds of perpetrating homicide followed by suicide (aOR = 2.9, 95% CI = 2.2–3.8). Among decedents aged ≥18 years, 20.1% of those without known mental health conditions and 15.3% of those with mental health conditions had previously served in the U.S. military or were serving at the time of death.

Whereas firearms were the most common method of suicide overall (48.5%), decedents without known mental health conditions were more likely to die by firearm (55.3%) and less likely to die by hanging/strangulation/suffocation (26.9%) or poisoning (10.4%) than were those with known mental health conditions (40.6%, 31.3%, and 19.8%, respectively). These differences remained significant in the adjusted models.

Toxicology testing was less likely to be performed for decedents without known mental health conditions. Among those with toxicology results, decedents without known mental health

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* Alaska, Arizona, Colorado, Connecticut, Georgia, Hawaii, Kansas, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, Rhode Island, South Carolina, Utah, Vermont, Virginia, and Wisconsin.

TABLE 1. Selected demographic and descriptive characteristics of suicides among persons aged ≥10 years with and without known mental health conditions — National Violent Death Reporting System, 27 states,[*] 2015

Characteristic	Total (N = 20,446) No. (%)	Known mental health condition[†] (n = 9,407) No. (%)	No known mental health condition (n = 11,039) No. (%)	Chi-square p-value	OR[§] (95% CI)	Adjusted OR[¶] (95% CI)
Sex						
Male	**15,702 (76.8)**	6,469 (68.8)	9,233 (83.6)	<0.01	2.3 (2.2–2.5)	NA
Female	**4,744 (23.2)**	2,938 (31.2)	1,806 (16.4)	<0.01	0.4 (0.4–0.5)	NA
Age group (yrs)[**]						
10–24	**2,804 (13.7)**	1,211 (12.9)	1,593 (14.4)	<0.01	1.1 (1.1–1.2)	NA
25–44	**6,456 (31.6)**	3,036 (32.3)	3,420 (31.0)	<0.05	0.9 (0.9–1.0)	NA
45–64	**7,718 (37.7)**	3,820 (40.6)	3,898 (35.3)	<0.01	0.8 (0.8–0.8)	NA
≥65	**3,468 (17.0)**	1,340 (14.2)	2,128 (19.3)	<0.01	1.4 (1.3–1.5)	NA
Race/Ethnicity						
White, non-Hispanic	**17,102 (83.6)**	8,165 (86.8)	8,937 (81.0)	<0.01	0.6 (0.6–0.7)	NA
Black, non-Hispanic	**1,228 (6.0)**	411 (4.4)	817 (7.4)	<0.01	1.7 (1.5–2.0)	NA
American Indian/Alaska Native, non-Hispanic	**378 (1.8)**	112 (1.2)	266 (2.4)	<0.01	2.0 (1.6–2.6)	NA
Asian, non-Hispanic	**576 (2.8)**	235 (2.5)	341 (3.1)	<0.05	1.2 (1.1–1.5)	NA
Hispanic	**1,096 (5.4)**	463 (4.9)	633 (5.7)	<0.05	1.2 (1.0–1.3)	NA
Other	**66 (0.3)**	21 (0.2)	45 (0.4)	<0.05	1.8 (1.1–3.1)	NA
Extended demographics						
Ever served in military[††]	**3,429 (17.8)**	1,354 (15.3)	2,075 (20.1)	<0.01	1.4 (1.3–1.5)	1.1 (1.0–1.1)
Homeless	**240 (1.2)**	104 (1.1)	136 (1.3)	NS	1.1 (0.9–1.5)	1.2 (0.9–1.5)
Incident type						
Single suicide	**20,063 (98.2)**	9,318 (99.1)	10,745 (97.4)	<0.01	0.3 (0.3–0.4)	0.4 (0.3–0.5)
Homicide followed by suicide	**319 (1.6)**	64 (0.7)	255 (2.3)	<0.01	3.5 (2.6–4.5)	2.9 (2.2–3.8)
Multiple suicides	**64 (0.3)**	25 (0.3)	39 (0.4)	NS	1.3 (0.8–2.2)	1.6 (0.9–2.6)
Method						
Firearm	**9,909 (48.5)**	3,821 (40.6)	6,088 (55.3)	<0.01	1.8 (1.7–1.9)	1.6 (1.5–1.7)
Hanging/Strangulation/Suffocation	**5,907 (28.9)**	2,940 (31.3)	2,967 (26.9)	<0.01	0.8 (0.8–0.9)	0.8 (0.7–0.8)
Poisoning	**3,003 (14.7)**	1,861 (19.8)	1,142 (10.4)	<0.01	0.5 (0.4–0.5)	0.6 (0.6–0.7)
Substance class causing death[§§]						
Other (e.g., over-the-counter)	**1,021 (34.0)**	666 (35.8)	355 (31.1)	<0.01	0.8 (0.7–0.9)	0.9 (0.7–1.0)
Opioids	**944 (31.4)**	608 (32.7)	336 (29.4)	NS	0.9 (0.7–1.0)	0.9 (0.8–1.1)
Antidepressants	**800 (26.6)**	644 (34.6)	156 (13.7)	<0.01	0.3 (0.2–0.4)	0.3 (0.3–0.4)
Benzodiazepines	**624 (20.8)**	468 (25.1)	156 (13.7)	<0.01	0.5 (0.4–0.6)	0.5 (0.4–0.6)
Antipsychotics	**219 (7.3)**	195 (10.5)	24 (2.1)	<0.01	0.2 (0.1–0.3)	0.2 (0.1–0.3)
Other	**1,595 (7.8)**	780 (8.3)	815 (7.4)	<0.05	0.9 (0.8–1.0)	0.9 (0.8–1.0)

See table footnotes on next page.

conditions were less likely to test positive for any substance overall (aOR = 0.8, 95% CI = 0.7–0.8), including opioids (aOR = 0.90, 95% CI = 0.81–0.99), but were more likely to test positive for alcohol (aOR = 1.2, 95%, CI = 1.1–1.3).

Information on circumstances surrounding suicide were available for all decedents with mental health conditions (9,407) and approximately 85% of those without known mental health conditions (9,357) in 27 states (Table 2). Persons without known mental health conditions were less likely to have any problematic substance use (aOR = 0.7, 95% CI = 0.7–0.8) than were persons with known mental health conditions. Whereas two thirds of decedents with known mental health conditions had a history of mental health or substance use treatment (67.2%), just over half (54.0%) were in treatment at the time of death.

Decedents without known mental health conditions had a significantly higher likelihood of any relationship problem/loss (45.1%) than did those with known mental health conditions (39.6%), specifically intimate partner problems (30.2% versus 24.1%), arguments/conflicts (17.5% versus 13.6%), and perpetrating interpersonal violence in the past month (3.0% versus 1.4%). Decedents without known mental health conditions were also more likely than were those with known mental health conditions to have experienced any life stressors (50.5% versus 47.2%) such as recent criminal legal problems (10.7% versus 6.2%) or eviction/loss of home (4.3% versus 3.4%) and were more likely to have had a recent or impending (within the preceding or upcoming 2 weeks, respectively) crisis (a current or acute event thought to contribute to the suicide) (32.9% versus 26.0%). All of these differences remained significant in the adjusted models. Physical health problems and job/financial problems were commonly contributing stressors among both persons without mental health conditions (23.2% and 15.6%, respectively) and those with mental health conditions (21.4%

TABLE 1. (*Continued*) **Selected demographic and descriptive characteristics of suicides among persons aged ≥10 years with and without known mental health conditions — National Violent Death Reporting System, 27 states,[*] 2015**

Characteristic	Total (N = 20,446) No. (%)	Known mental health condition[†] (n = 9,407) No. (%)	No known mental health condition (n = 11,039) No. (%)	Chi-square p-value	OR[§] (95% CI)	Adjusted OR[¶] (95% CI)
Toxicology results						
Any toxicology testing	**13,317 (65.1)**	6,658 (70.8)	6,659 (60.3)	<0.01	0.6 (0.6–0.7)	0.7 (0.6–0.7)
Positive for ≥1 substance[¶¶]	**9,913 (74.4)**	5,192 (78.0)	4,721 (70.9)	<0.01	0.7 (0.6–0.7)	0.8 (0.7–0.8)
Substance detected[***]						
Alcohol						
Tested	**10,950 (53.6)**	5,409 (57.5)	5,541 (50.2)	<0.01	0.7 (0.7–0.8)	0.8 (0.7–0.8)
Positive	**4,442 (40.6)**	2,115 (39.1)	2,327 (42.0)	<0.01	1.1 (1.0–1.2)	1.2 (1.1–1.3)
Opioids						
Tested	**8,554 (41.8)**	4,258 (45.3)	4,296 (38.9)	<0.01	0.8 (0.7–0.8)	0.8 (0.8–0.9)
Positive	**2,279 (26.6)**	1,238 (29.1)	1,041 (24.2)	<0.01	0.8 (0.7–0.9)	0.9 (0.8–1.0)
Benzodiazepines						
Tested	**8,124 (39.7)**	4,226 (44.9)	3,898 (35.3)	<0.01	0.7 (0.6–0.7)	0.7 (0.7–0.8)
Positive	**2,464 (30.3)**	1,639 (38.8)	825 (21.2)	<0.01	0.4 (0.4–0.5)	0.5 (0.5–0.6)
Cocaine						
Tested	**7,978 (39.0)**	3,866 (41.1)	4,112 (37.2)	<0.01	0.9 (0.8–0.9)	0.9 (0.9–1.0)
Positive	**499 (6.3)**	216 (5.6)	283 (6.9)	<0.05	1.2 (1.0–1.5)	1.2 (1.0–1.5)
Amphetamines						
Tested	**7,615 (37.2)**	3,696 (39.3)	3,919 (35.5)	<0.01	0.9 (0.8–0.9)	0.9 (0.8–0.9)
Positive	**736 (9.7)**	376 (10.2)	360 (9.2)	NS	0.9 (0.8–1.0)	1.0 (0.8–1.1)
Marijuana						
Tested	**6,569 (32.1)**	3,127 (33.2)	3,442 (31.2)	<0.01	0.9 (0.9–1.0)	0.9 (0.9–1.0)
Positive	**1,471 (22.4)**	710 (22.7)	761 (22.1)	NS	1.0 (0.9–1.1)	0.9 (0.8–1.0)
Antidepressants						
Tested	**5,425 (26.5)**	3,103 (33.0)	2,322 (21.0)	<0.01	0.5 (0.5–0.6)	0.6 (0.6–0.7)
Positive	**2,214 (40.8)**	1,735 (55.9)	479 (20.6)	<0.01	0.2 (0.2–0.2)	0.2 (0.2–0.3)

Abbreviations: CI = confidence interval; NA = not adjusted; NS = not significant; OR = odds ratio.

[*] Alaska, Arizona, Colorado, Connecticut, Georgia, Hawaii, Kansas, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, Rhode Island, South Carolina, Utah, Vermont, Virginia, and Wisconsin.

[†] Decedent had been identified as having a current diagnosis of mental health condition in coroner/medical examiner or law enforcement reports.

[§] OR reflects the risk among those without known mental health condition relative to those with known mental health condition.

[¶] Logistic regression was used to estimate adjusted OR with 95% CIs after controlling for sex, age group, and race/ethnicity. Known mental health condition was used as the reference group.

[**] Decedents were aged ≥10 years, as per standard in the suicide prevention literature.

[††] Denominator is decedents aged ≥18 years with reported military service status.

[§§] Denominator is decedents who died by poisoning, including overdose.

[¶¶] Denominator is decedents with any toxicology testing.

[***] Denominator for each positive group is the number tested for the substance in that group.

and 16.8%, respectively). Similarly, among all persons with recent crises, intimate partner problems were the most common types and did not differ by group.

Decedents without known mental health conditions had significantly lower odds of recent release from any institution (aOR = 0.5, 95% CI = 0.4–0.5). Among those recently released, decedents without known mental health conditions were significantly more likely than decedents with mental health conditions to have been released from a correctional facility (25.7% versus 8.7%), hospital (43.7% versus 33.0%), or other facility, such as an alcohol/substance use treatment facility (24.2% versus 11.6%). Among decedents with known mental health conditions who were recently released from an institution, 46.7% were released from psychiatric facilities.

Decedents without known mental health conditions were significantly less likely to have a history of suicidal ideation (23.0%) or prior suicide attempts (10.3%) compared with those with known mental health conditions (40.8% and 29.4%, respectively). Suicide intent was disclosed by 22.4% and 24.5% of persons without and with known mental health conditions, respectively.

Conclusions and Comments

During 1999–2016, suicide rates increased significantly in 44 states, and 25 states experienced increases >30%. Rates increased significantly among males in 34 states, and females in 43 states. Additional research into the specific causes of these trends is needed. Data from the 27 states participating in NVDRS provide important insight into circumstances surrounding suicide and can help states identify prevention priorities.

TABLE 2. Circumstances preceding suicide among decedents aged ≥10 years with and without known mental health conditions — National Violent Death Reporting System, 27 states,[*] 2015

Characteristic	Total No. (%)	Known mental health condition[†] No. (%)	No known mental health condition No. (%)	Chi-square p-value	OR[§] (95% CI)	Adjusted OR[¶] (95% CI)
Suicide with known circumstances	**18,764 (91.8)**	9,407 (100)	9,357 (84.8)	<0.01	N/A	N/A
Mental health						
Any current diagnosed mental health condition[**]						
Depression/Dysthymia	—[††]	7,076 (75.2)	N/A	N/A	N/A	N/A
Anxiety disorder	—[††]	1,579 (16.8)	N/A	N/A	N/A	N/A
Bipolar disorder	—[††]	1,431 (15.2)	N/A	N/A	N/A	N/A
Schizophrenia	—[††]	509 (5.4)	N/A	N/A	N/A	N/A
PTSD	—[††]	424 (4.5)	N/A	N/A	N/A	N/A
ADD/ADHD	—[††]	226 (2.4)	N/A	N/A	N/A	N/A
Not specified	—[††]	760 (8.1)	N/A	N/A	N/A	N/A
Current depressed mood[§§]	**7,038 (37.5)**	3,962 (42.1)	3,076 (32.9)	<0.01	0.7 (0.6–0.7)	0.7 (0.6–0.7)
Problematic substance use						
Any	**5,319 (28.3)**	2,976 (31.6)	2,343 (25.0)	<0.01	0.7 (0.7–0.8)	0.7 (0.7–0.8)
Alcohol	**3,268 (17.4)**	1,862 (19.8)	1,406 (15.0)	<0.01	0.7 (0.7–0.8)	0.7 (0.7–0.8)
Other	**3,084 (16.4)**	1,768 (18.8)	1,316 (14.1)	<0.01	0.7 (0.7–0.8)	0.7 (0.7–0.8)
Treatment						
Current mental health/substance use treatment	**5,141 (27.4)**	5,077 (54.0)	64 (0.7)	<0.01	0.01 (0.01–0.01)	0.01 (0.01–0.01)
Ever treated for mental health/substance disorder	**6,717 (35.8)**	6,323 (67.2)	394 (4.2)	<0.01	0.02 (0.02–0.02)	0.02 (0.02–0.03)
Relationship problems/loss						
Any relationship problem/loss	**7,948 (42.4)**	3,726 (39.6)	4,222 (45.1)	<0.01	1.3 (1.2–1.3)	1.3 (1.2–1.4)
Intimate partner problem	**5,098 (27.2)**	2,270 (24.1)	2,828 (30.2)	<0.01	1.4 (1.3–1.5)	1.4 (1.3–1.5)
Perpetrator of interpersonal violence in past month	**414 (2.2)**	131 (1.4)	283 (3.0)	<0.01	2.2 (1.8–2.7)	2.0 (1.6–2.4)
Victim of interpersonal violence in past month	**84 (0.4)**	53 (0.6)	31 (0.3)	<0.05	0.6 (0.4–0.9)	0.8 (0.5–1.2)
Family relationship problem	**1,671 (8.9)**	873 (9.3)	798 (8.5)	NS	0.9 (0.8–1.0)	1.0 (0.9–1.1)
Other relationship problem (nonintimate)	**403 (2.1)**	202 (2.1)	201 (2.1)	NS	1.0 (0.8–1.2)	1.1 (0.9–1.3)
Argument or conflict (not specified)	**2,914 (15.5)**	1,278 (13.6)	1,636 (17.5)	<0.01	1.3 (1.2–1.5)	1.4 (1.3–1.5)
Death of a loved one (any)	**1,497 (8.0)**	826 (8.8)	671 (7.2)	<0.01	0.8 (0.7–0.9)	0.9 (0.8–0.9)
Nonsuicide death	**1,181 (6.3)**	647 (6.9)	534 (5.7)	<0.01	0.8 (0.7–0.9)	0.9 (0.8–1.0)
Suicide of family or friend	**379 (2.0)**	217 (2.3)	162 (1.7)	<0.01	0.7 (0.6–0.9)	0.8 (0.7–1.0)
Other life stressors						
Any life stressor	**9,171 (48.9)**	4,442 (47.2)	4,729 (50.5)	<0.01	1.1 (1.1–1.2)	1.1 (1.0–1.2)
Recent criminal legal problem	**1,588 (8.5)**	586 (6.2)	1,002 (10.7)	<0.01	1.8 (1.6–2.0)	1.7 (1.5–1.9)
Other legal problem	**748 (4.0)**	378 (4.0)	370 (4.0)	NS	1.0 (0.8–1.1)	1.0 (0.9–1.2)
Physical health problem	**4,179 (22.3)**	2,012 (21.4)	2,167 (23.2)	<0.01	1.1 (1.0–1.2)	1.0 (1.0–1.1)
Job/Financial problem[¶¶]	**2,941 (16.2)**	1,530 (16.8)	1,411 (15.6)	<0.05	0.9 (0.8–1.0)	0.9 (0.8–1.0)
Eviction or loss of home	**722 (3.8)**	317 (3.4)	405 (4.3)	<0.01	1.3 (1.1–1.5)	1.4 (1.2–1.6)
School problem[***]	**162 (19.9)**	70 (17.8)	92 (21.9)	NS	1.3 (0.9–1.8)	1.3 (0.9–1.9)
Recent release from an institution[†††]	**1,412 (7.6)**	941 (10.2)	471 (5.1)	<0.01	0.5 (0.4–0.5)	0.5 (0.4–0.5)
Jail/Prison/Detention facility	**203 (14.4)**	82 (8.7)	121 (25.7)	<0.01	3.6 (2.7–4.9)	4.5 (3.2–6.4)
Hospital	**517 (36.6)**	311 (33.0)	206 (43.7)	<0.01	1.6 (1.3–2.0)	1.3 (1.0–1.7)
Psychiatric hospital/institution	**469 (33.2)**	439 (46.7)	30 (6.4)	<0.01	0.1 (0.1–0.1)	0.1 (0.1–0.1)
Other (includes alcohol/SU treatment facilities)	**223 (15.8)**	109 (11.6)	114 (24.2)	<0.01	2.4 (1.8–3.3)	2.5 (1.8–3.3)

See table footnotes on next page.

Suicidologists regularly state that suicide is not caused by a single factor (*5*); however, suicide prevention is often oriented toward mental health conditions alone with regard to downstream identification of suicidal persons, treatment of mental health conditions, and prevention of reattempts. This study found that approximately half of suicide decedents in NVDRS did not have a known mental health condition, indicating that additional focus on nonmental health factors further upstream could provide important information for a public health approach (*10*). Those without a known mental health condition suffered more from relationship problems and other life stressors such as criminal/legal matters, eviction/loss of home, and recent or impending crises.

Similarly, persons with mental health conditions also often experienced other circumstances such as relationship problems and job/financial or physical health problems that contributed to their suicide. These findings point to the need to both prevent the circumstances associated with the onset of mental health conditions and support persons with known mental health conditions to decrease their risk for poor outcomes (*11*). Two thirds of suicide decedents with mental health conditions had a history of treatment for mental health or substance use disorders,

TABLE 2. (*Continued*) **Circumstances preceding suicide among decedents aged ≥10 years with and without known mental health conditions — National Violent Death Reporting System, 27 states,* 2015**

Characteristic	Total No. (%)	Known mental health condition† No. (%)	No known mental health condition No. (%)	Chi-square p-value	OR§ (95% CI)	Adjusted OR¶ (95% CI)
Crisis within past or upcoming 2 weeks§§§	**5,525 (29.4)**	2,444 (26.0)	3,081 (32.9)	<0.01	1.4 (1.3–1.5)	1.4 (1.3–1.5)
Intimate partner problem	**1,968 (35.6)**	854 (34.9)	1,114 (36.2)	NS	1.1 (0.9–1.2)	1.1 (0.9–1.2)
Physical health problem	**739 (13.4)**	315 (12.9)	424 (13.8)	NS	1.1 (0.9–1.3)	1.0 (0.8–1.2)
Criminal legal problem	**621 (11.2)**	203 (8.3)	418 (13.6)	<0.01	1.7 (1.5–2.1)	1.6 (1.3–1.9)
Family relationship problem	**430 (7.8)**	212 (8.7)	218 (7.1)	<0.05	0.8 (0.7–1.0)	0.9 (0.7–1.1)
Job problem	**354 (6.4)**	191 (7.8)	163 (5.3)	<0.01	0.7 (0.5–0.8)	0.7 (0.5–0.8)
Suicide event/history						
Left a note	**6,468 (34.5)**	3,182 (33.8)	3,286 (35.1)	NS	1.1 (1.0–1.1)	1.2 (1.1–1.2)
Disclosed suicide intent	**4,405 (23.5)**	2,306 (24.5)	2,099 (22.4)	<0.01	0.9 (0.8–1.0)	0.9 (0.8–0.9)
History of ideation	**5,990 (31.9)**	3,838 (40.8)	2,152 (23.0)	<0.01	0.4 (0.4–0.5)	0.4 (0.4–0.5)
History of attempts	**3,732 (19.9)**	2,770 (29.4)	962 (10.3)	<0.01	0.3 (0.3–0.3)	0.3 (0.3–0.3)

Abbreviations: ADD/ADHD = attention deficit disorder/attention deficit hyperactivity disorder; CI = confidence interval; N/A = not applicable; NS = not significant; OR = odds ratio; PTSD = posttraumatic stress disorder; SU = substance use.

* Alaska, Arizona, Colorado, Connecticut, Georgia, Hawaii, Kansas, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, Rhode Island, South Carolina, Utah, Vermont, Virginia, and Wisconsin.

† Decedent had been identified as having a current diagnosis of mental health condition in coroner/medical examiner or law enforcement reports.

§ OR reflects the risk among those without known mental health condition relative to those with known mental health condition.

¶ Logistic regression was used to estimate adjusted OR with 95% CIs after controlling for sex, age group, and race/ethnicity. Known mental health condition was the reference group.

** Includes decedents with one or more diagnosed current mental health conditions, which are not mutually exclusive. Therefore, sums of percentages for the diagnosed conditions exceed 100%. Denominator includes the number of decedents with one or more current diagnosed mental health conditions.

†† The specific type of mental health condition was calculated only among those with one or more known diagnosed mental health conditions.

§§ Not a diagnosis.

¶¶ Denominator is decedents aged ≥18 years.

*** Denominator is decedents aged 10–18 years.

††† Denominator of institution subgroup is decedents with recent release from an institution. Recent release from an institution is defined as having occurred within the past month.

§§§ Denominator of crisis subgroup is decedents with any crisis within past or upcoming 2 weeks. Crises depicted here represent the most commonly occurring categories.

with approximately half in treatment when they died. This finding suggests the need for additional safety supports, including broader implementation of affordable and effective treatment modalities, such as doctor-patient collaborative care models and proven cognitive-behavioral therapies. In addition, increased access to behavioral health providers in underserved areas is needed, as is expansion of health care systems that integrate physical and behavioral health, with a priority on suicide prevention and patient safety, especially through care transitions (*12*).

Comprehensive statewide suicide prevention activities are needed to address the full range of factors contributing to suicide. Prevention strategies include strengthening economic supports (e.g., housing stabilization policies, household financial support); teaching coping and problem-solving skills to manage everyday stressors and prevent future relationship problems, especially early in life; promoting social connectedness to increase a sense of belonging and access to informational, tangible, emotional, and social support; and identifying and better supporting persons at risk (e.g., military veterans, persons with physical/mental health conditions) (*12*). Other strategies include creating protective environments (e.g., reducing access to lethal means among persons at risk for suicide, creating organizational and workplace policies to promote help-seeking, easing transitions into and out of work for persons with mental health conditions and other life challenges), strengthening access to and delivery of care, supporting family and friends after a suicide, and encouraging the media to follow safe reporting recommendations (*12*). Some states, such as Colorado, are planning to implement such a comprehensive approach to suicide prevention (*10*).

The findings in this report are subject to at least three limitations. First, in the state-level analysis, rankings for four states (Maryland, Massachusetts, Rhode Island, and Utah) might have been affected by large proportions of injury deaths of undetermined intent (potentially biasing reported suicide rates downward) or decreased percentages of such deaths over time (potentially biasing estimated rate trends upward). Second, NVDRS is not yet nationally representative; the 27 states included represent 49.6% of the population (https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml). Finally, abstractors of NVDRS data are limited to information contained in investigative reports. Therefore, the extent of informant knowledge can affect data completeness and accuracy. Studies that include more in-depth interviews with next-of-kin often identify greater attributions to mental health disorders

Summary

What is already known about this topic?

In 2016, nearly 45,000 persons died by suicide in the United States. Mental health conditions are one of several contributors to suicide.

What is added by this report?

During 1999–2016, suicide rates increased in nearly every state, including >30% increases in 25 states. 2015 data from 27 states indicate 54% of suicide decedents were not known to have mental health conditions. Relationship, substance use, health, and job or financial problems are among the other circumstances contributing to suicide.

What are the implications for public health practice?

A comprehensive approach using proven prevention strategies, such as those in CDC's *Preventing Suicide: A Technical Package of Policy, Programs, and Practices*, can help reach the national goal of reducing the annual suicide rate 20% by 2025.

(*13*); however, many methodological variations across studies exist (*14*). It is likely that some persons without known mental health conditions in the current study were experiencing mental health challenges that were unknown, undiagnosed, or not reported by key informants. Nonetheless, the high prevalence of diverse contributing circumstances among those with and without known mental health conditions suggests the importance of addressing the broad range of factors that contribute to suicide.

Suicide is a growing public health problem. Effective approaches to prevent the many suicide risk factors are available. States and communities can use data from NVDRS and resources such as CDC's *Preventing Suicide: A Technical Package of Policy, Programs, and Practices* (*12*) to better understand suicide in their populations, prioritize evidence-based comprehensive suicide prevention, and save lives.

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Conflict of Interest

No conflicts of interest were reported.

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Invasive Methicillin-Resistant *Staphylococcus aureus* Infections Among Persons Who Inject Drugs — Six Sites, 2005–2016

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In the United States, age-adjusted opioid overdose death rates increased by >200% during 1999–2015, and heroin overdose death rates increased nearly 300% during 2011–2015 (*1*). During 2011–2013, the rate of heroin use within the past year among U.S. residents aged ≥12 years increased 62.5% overall and 114.3% among non-Hispanic whites, compared with 2002–2004 (*2*). Increases in human immunodeficiency virus (HIV) and hepatitis C virus (HCV) infections related to increases in injection drug use have been recently highlighted (*3*,*4*); likewise, invasive bacterial infections, including endocarditis, osteomyelitis, and skin and soft tissue infections, have increased in areas where the opioid epidemic is expanding (*5*–*7*). To assess the effects of the opioid epidemic on invasive methicillin-resistant *Staphylococcus aureus* (MRSA) infections during 2005–2016, surveillance data from CDC's Emerging Infections Program (EIP) were analyzed (*8*). Persons who inject drugs were estimated to be 16.3 times more likely to develop invasive MRSA infections than others. The proportion of invasive MRSA cases that occurred among persons who inject drugs increased from 4.1% in 2011 to 9.2% in 2016. Infection types were frequently those associated with nonsterile injection drug use. Continued increases in nonsterile injection drug use are likely to result in increases in invasive MRSA infections, underscoring the importance of public health measures to curb the opioid epidemic.

Active, population-, and laboratory-based surveillance data collected through the Healthcare-Associated Infections/Community Interface (HAIC) component of CDC's EIP during 2005–2016 were analyzed to assess the effects of the opioid epidemic on invasive MRSA infection. A case was defined as the isolation of MRSA from a normally sterile site (e.g., blood, cerebrospinal fluid, or bone) from a surveillance area resident. National invasive MRSA disease prevalence (adjusted for age, race, sex, and dialysis) among persons aged ≥13 years who inject drugs and among persons aged ≥13 years who do not inject drugs were estimated for 2011 from EIP/HAIC data using a previously described method (*8*); invasive MRSA rates per 100,000 persons in both groups (and the corresponding rate ratio) were calculated in conjunction with a published population point estimate of the U.S. population aged ≥13 years who injected drugs in the previous year for 2011 (*9*). The six-site surveillance area used for the remainder of this report included California (three counties); Connecticut (statewide); Georgia (eight counties); and Minnesota, New York, and Tennessee (one county each). Demographic characteristics and clinical diagnoses of invasive MRSA cases among persons who inject drugs were compared with those among persons who do not inject drugs. The proportion of invasive MRSA cases that occurred among persons who injected drugs (among all invasive MRSA cases) was calculated overall and by site for each year; significance of trends was analyzed using linear regression. P values <0.05 were considered statistically significant.

Among invasive MRSA cases occurring in persons who inject drugs, demographics and health care–associated risk factors for cases ascertained during 2005–2010 were compared with those that occurred during 2011–2016 to describe changes over time. Health care–associated risk factors include specimen collection for culture >3 days after hospital admission; dialysis, hospitalization, surgery, or long-term care residency in the 12 months preceding culture; and/or presence of a central venous catheter ≤2 days before invasive MRSA culture collection. Cases among persons with none of these risk factors were considered community-associated. Trends in the proportion of invasive MRSA cases that occurred among persons who inject drugs also were assessed in three sites that reported data from 2005–2014 only (Colorado and Maryland [one county each]; Oregon [three counties]).

Among 39,050 invasive MRSA cases reported from six sites during 2005–2016, a total of 2,093 (5.4%) occurred in persons who injected drugs. The estimated rate of invasive MRSA among persons aged ≥13 years who injected drugs in the previous year was 472.2 per 100,000 in 2011, and the estimated rate among persons aged ≥13 who did not inject drugs in the previous year was 29.0 per 100,000 (rate ratio [RR] = 16.3; 95% confidence interval [CI] = 15.7–16.8). Overall, cases of invasive MRSA among persons who inject drugs were more likely than cases among persons who did not inject drugs to occur in persons who were younger (median age = 45 versus 63 years; $p<0.05$) and to be community-associated infections (odds ratio [OR] = 4.4, 95% CI = 4.0–4.8). Clinical diagnoses frequently associated with injection drug use were more common among patients with invasive MRSA who injected drugs than among those who did not (Table), including septic embolism, endocarditis, abscess (skin and internal), cellulitis, and osteomyelitis.

The proportion of invasive MRSA cases that occurred among persons who inject drugs approximately doubled in some sites (counties in Connecticut, Georgia, Minnesota, and Tennessee) after 2011. In the six-site catchment area, the percentage of invasive MRSA cases among persons who inject drugs declined from 6.4% in 2005 to 3.5% in 2010 ($p<0.05$), but subsequently increased steadily to 9.2% in 2016 ($p<0.05$) (Figure). Among invasive MRSA cases that occurred among persons who inject drugs, cases during 2011–2016 were more likely to occur in persons who were white (OR = 1.7; 95% CI = 1.4–2.0) and be community-associated (OR = 1.3; 95% CI = 1.1–1.6) than were cases during 2005–2010. In two of three sites (Colorado and Oregon) that reported data from 2005–2014 only, similar increases in the proportion of invasive MRSA cases that occurred among persons who inject drugs after an initial decrease (2005: 11.1% of cases; 2011: 10.6%; 2014: 15.2%) were observed.

Discussion

In six sites, invasive MRSA infections disproportionately affected persons who inject drugs. In this analysis, invasive MRSA infections that occurred among persons who inject drugs were those frequently associated with nonsterile injection drug use; demographic shifts in the population of invasive MRSA infections among injection drug users mirror those observed in the ongoing opioid epidemic, such as the increased proportion of cases among whites. A decline and subsequent rise in the proportion of invasive MRSA cases among persons who inject drugs was observed in the six-site catchment area during 2005–2016 and in two additional sites for which data were available through 2014; similar patterns were seen in the incidence of acute HCV[*] and in the rate of drug overdose deaths involving heroin (*1*), with notable increases in both beginning around 2010.

The findings in this report are subject to at least five limitations. First, injection drug use status in medical records is possibly misclassified, which could result in an under- or

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[*] https://www.cdc.gov/hepatitis/statistics/2015surveillance/commentary.htm.

TABLE. Clinical diagnoses of cases of invasive methicillin-resistant *Staphylococcus aureus* (MRSA) infection, by injection drug use status — Emerging Infections Program, six surveillance sites,[*] 2005–2016

Infection type[†]	Cases among persons who inject drugs (n = 2,093), no. (%)	Cases among persons who do not inject drugs (n = 36,957), no. (%)	OR (95% CI)
Septic emboli[§]	208 (14.9%)	340 (1.4%)	12.7 (10.6–15.2)
Endocarditis	426 (20.4%)	1,601 (4.3%)	5.6 (5.0–6.3)
Abscess (not skin)	350 (16.7%)	1,920 (5.2%)	3.7 (3.2–4.1)
Skin abscess[¶]	204 (12.8%)	1,361 (4.7%)	3.0 (2.5–3.5)
Meningitis	243 (11.6%)	169 (0.5%)	2.5 (1.6–3.9)
Septic arthritis	240 (11.4%)	2,186 (5.9%)	2.1 (1.8–2.4)
Cellulitis	367 (17.5%)	3,459 (9.4%)	2.1 (1.8–2.3)
Traumatic wound infection	25 (1.2%)	254 (0.7%)	1.7 (1.2–2.6)
Empyema	60 (2.9%)	650 (1.8%)	1.6 (1.3–2.2)
Osteomyelitis	337 (16.0%)	4,073 (11.0%)	1.5 (1.4–1.7)
Pneumonia	282 (13.5%)	4,655 (12.6%)	1.1 (0.9–1.2)
Bacteremia	1,541 (73.6%)	28,073 (76.0%)	0.9 (0.8–0.98)
Septic shock	132 (6.3%)	2,799 (7.6%)	0.8 (0.7–1.0)
Bursitis	23 (1.1%)	717 (1.9%)	0.6 (0.4–0.9)
Decubitus/Pressure ulcer infection	28 (1.3%)	974 (2.6%)	0.5 (0.3–0.7)
Internal surgical site infection	22 (1.1%)	821 (2.2%)	0.5 (0.3–0.7)
Urinary tract infection	55 (2.6%)	2,348 (6.4%)	0.4 (0.3–0.5)
Surgical incision infection	22 (1.1%)	1,124 (3.0%)	0.3 (0.2–0.5)
Peritonitis	8 (0.4%)	538 (1.5%)	0.3 (0.1–0.5)
Arteriovenous fistula/Graft infection[**]	7 (0.6%)	447 (2.1%)	0.3 (0.1–0.6)
Catheter site infection[**]	12 (1.0%)	686 (3.2%)	0.3 (0.2–0.5)
Chronic ulcer/Wound infection[††]	14 (1.4%)	709 (4.0%)	0.3 (0.2–0.6)

Abbreviations: CI = confidence interval; OR = odds ratio.

[*] California (three counties), Connecticut (statewide), Georgia (eight counties), Minnesota (one county), New York (one county), and Tennessee (one county).

[†] Cases can have more than one infection type.

[§] Variable added to surveillance in 2008. For persons who inject drugs n = 1,395; for persons who do not inject drugs n = 24,987.

[¶] Variable added to surveillance in 2007. For persons who inject drugs n = 1,589; for persons who do not inject drugs n = 28,860.

[**] Variable added to surveillance in 2009. For persons who inject drugs n = 1,201; for persons who do not inject drugs n = 21,334.

[††] Variable added to surveillance in 2010. For persons who inject drugs n = 1,039; for persons who do not inject drugs n = 17,668.

overestimation of the percentage of MRSA infections in injection drug users. Second, rates were based on national estimates of both invasive MRSA case counts and the population of persons who inject drugs that might not be accurate. Third, the rates are based on 2011 data because this is the only year for which population estimates for the number of persons who inject drugs is available. This might be an underestimate if current injection drug use practices are higher risk. Fourth, site-specific counts of persons who inject drugs were not available, precluding the calculation of site-specific rates. Finally, invasive methicillin-sensitive *Staphylococcus aureus* surveillance began in 2016 and could not be included in this report to describe the impact of the opioid epidemic on these infections.

Although much attention has focused on the transmission of blood-borne pathogens such as HIV and hepatitis B and C viruses related to injection drug use, infections from skin flora such as *Staphylococcus aureus* are also important and might not be prevented solely by programs focused on preventing blood-borne pathogen transmission. Increases in nonsterile injection drug use are likely to result in increases in the occurrence of invasive MRSA infections among persons who inject drugs, underscoring the importance of public health measures to curb the opioid epidemic. Effective interventions include primary prevention of opioid misuse through guideline-concordant opioid prescribing; treatment of opioid use disorder with medication-assisted therapies; community-based comprehensive syringe services programs that provide access to sterile equipment used to inject drugs and its safe disposal; and education on safer injection practices, wound care, and early warning signs of serious infections associated with injection drug use.

Summary

What is already known about this topic?

The ongoing opioid epidemic is associated with increases in human immunodeficiency virus and hepatitis C infections and infection syndromes such as endocarditis.

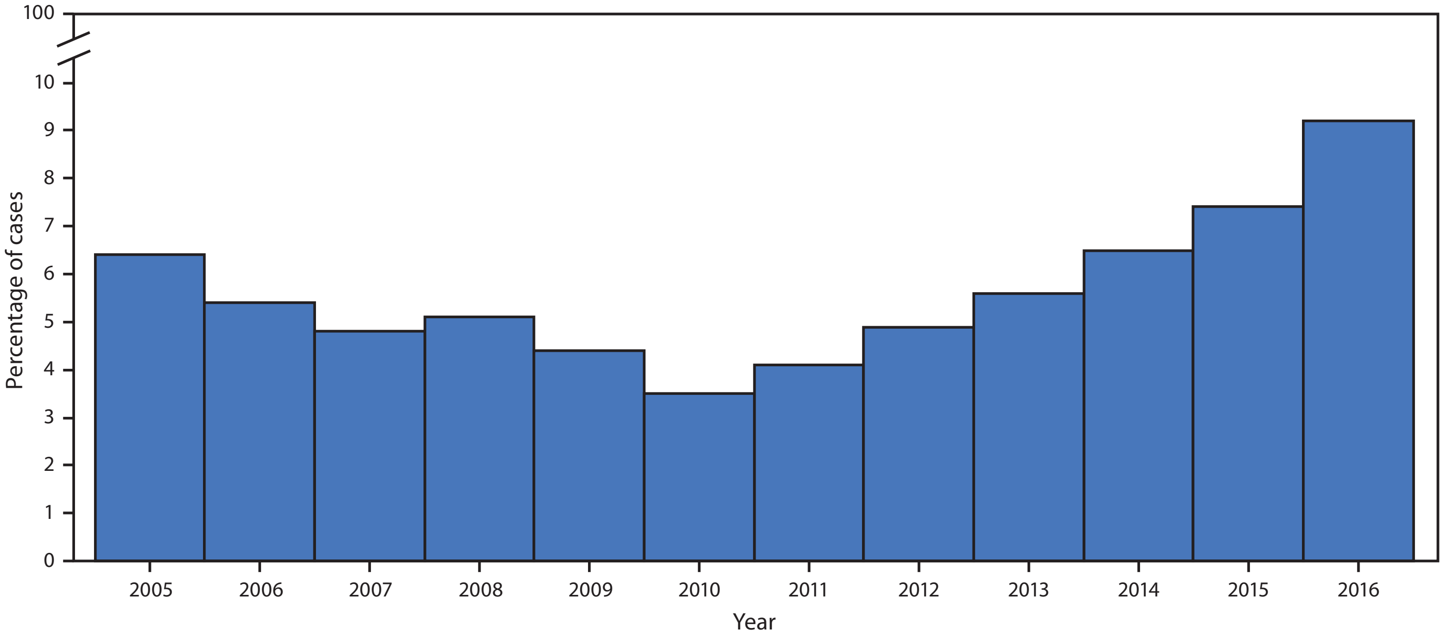
What is added by this report?

Persons who inject drugs were an estimated 16.3 times more likely to develop invasive methicillin-resistant *Staphylococcus aureus* (MRSA) infections than others. Invasive MRSA from injecting drugs increased from 4.1% of invasive MRSA cases to 9.2% (2011–2016).

What are the implications for public health practice?

Increases in nonsterile injection drug use can cause increases in MRSA infections, underscoring the importance of public health interventions, including prevention of opioid misuse, providing medication-assisted treatment, syringe services programs, and education on safer injection practices to prevent infections from skin flora.

FIGURE. Percentage of invasive methicillin-resistant *Staphylococcus aureus* cases among persons who inject drugs, by year — Emerging Infections Program, six surveillance sites,* 2005–2016



* California (three counties), Connecticut (statewide), Georgia (eight counties), Minnesota (one county), New York (one county), and Tennessee (one county).

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Conflict of Interest

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Tobacco Product Use Among Middle and High School Students — United States, 2011–2017

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Tobacco use is the leading cause of preventable disease and death in the United States, and nearly all tobacco use begins during youth and young adulthood (*1*,*2*). CDC and the Food and Drug Administration (FDA) analyzed data from the 2011–2017 National Youth Tobacco Surveys (NYTS)* to determine patterns of current (past 30-day) use of seven tobacco product types among U.S. middle school (grades 6–8) and high school (grades 9–12) students and estimate use nationwide. Among high school students, current use of any tobacco product decreased from 24.2% (estimated 3.69 million users) in 2011 to 19.6% (2.95 million) in 2017. Among middle school students, current use of any tobacco product decreased from 7.5% (0.87 million) in 2011 to 5.6% (0.67 million) in 2017. In 2017, electronic cigarettes (e-cigarettes) were the most commonly used tobacco product among high (11.7%; 1.73 million) and middle (3.3%; 0.39 million) school students. During 2016–2017, decreases in current use of hookah and pipe tobacco occurred among high school students, while decreases in current use of any tobacco product, e-cigarettes, and hookah occurred among middle school students. Current use of any combustible tobacco product, ≥2 tobacco products, cigarettes, cigars, smokeless tobacco, and bidis did not change among middle or high school students during 2016–2017. Comprehensive and sustained strategies can help prevent and reduce the use of all forms of tobacco products among U.S. youths (*1*,*2*).

NYTS is a cross-sectional, voluntary, school-based, self-administered, pencil-and-paper questionnaire survey of U.S. middle and high school students. A three-stage cluster sampling procedure is used to generate a nationally representative sample of U.S. students attending public and private schools in grades 6–12. Briefly, primary sampling units are selected at the first stage, schools are selected at the second stage, and students are selected from intact classrooms at each grade level at the third stage. This report used data from seven NYTS waves (2011–2017). Sample sizes and response rates were 18,766, 72.7% (2011); 24,658, 73.6% (2012); 18,406, 67.8% (2013); 22,007, 73.3% (2014); 17,711, 63.4% (2015); 20,675, 71.6% (2016); and 17,872, 68.1% (2017).

Participants were asked about current (past 30-day) use of cigarettes, cigars, smokeless tobacco,† e-cigarettes,§ hookah,¶ pipe tobacco,** and bidis (small imported cigarettes wrapped in a leaf). Current use for each product was defined as use on ≥1 day during the past 30 days. "Any tobacco product use" was defined as use of one or more tobacco products in the past 30 days, and "≥2 tobacco product use" was defined as use of two or more tobacco products in the past 30 days. "Any combustible tobacco product use" was defined as use of cigarettes, cigars, hookah, pipe tobacco, and/or bidis in the past 30 days.

Data were weighted to account for the complex survey design and adjusted for nonresponse. National prevalence estimates with 95% confidence intervals and population estimates rounded down to the nearest 10,000 were computed. Current use estimates for 2017 were determined for any tobacco product, ≥2 tobacco products, any combustible tobacco product, and each tobacco product individually, overall and by selected demographics for each school level (high and middle). The presence of linear and quadratic trends during 2011–2017 were assessed, adjusting for race/ethnicity, sex, and grade.[††] T-tests were performed to examine differences between 2016 and 2017. For all analyses, p-values <0.05 were considered statistically significant.

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* https://www.cdc.gov/tobacco/data_statistics/surveys/nyts/index.htm.

† Beginning in 2015, the definition of smokeless tobacco included chewing tobacco/snuff/dip, snus, and dissolvable tobacco to better reflect this class of tobacco products. Thus, estimates for individual smokeless tobacco products (chewing tobacco/snuff/dip, snus, and dissolvable tobacco) are not reported.

§ During 2011–2013, e-cigarette use was assessed by the question "In the past 30 days, which of the following products have you used on at least one day?" and the response option, "Electronic cigarettes or e-cigarettes such as Ruyan or NJOY." In 2014, current use of e-cigarettes was assessed by the question "During the past 30 days, on how many days did you use e-cigarettes such as Blu, 21st Century Smoke, or NJOY?" During 2015–2017, e-cigarette questions were preceded by an introductory paragraph defining the product. In 2015, current use of e-cigarettes was assessed by the question "During the past 30 days, on how many days did you use electronic cigarettes or e-cigarettes?" In 2016 and 2017, current use of e-cigarettes was assessed by the question "During the past 30 days, on how many days did you use e-cigarettes?"

¶ During 2011–2015, current hookah smoking was assessed by the question "In the past 30 days, which of the following products have you used on at least one day?" Hookah was the fourth or fifth response option during 2011–2013, the first option in 2014, and the fourth option in 2015. During 2016–2017, hookah questions were preceded by an introductory paragraph defining the product; current hookah smoking was assessed by the question "In the past 30 days, on how many days did you smoke tobacco in a hookah or waterpipe?"

** During 2011–2013, pipe tobacco use was assessed by the question "During the past 30 days, on how many days did you smoke tobacco in a pipe?" During 2014–2017, current use of pipe tobacco was assessed by the question "In the past 30 days, which of the following products have you used on at least one day?" and the response option "Pipes filled with tobacco (not waterpipe)." Pipe tobacco was the second response option available in 2014, the fifth option in 2015, and the second option during 2016–2017.

In 2017, 19.6% of high school students (estimated 2.95 million users) reported current use of any tobacco product, including 9.2% (1.38 million; 46.8% of current tobacco product users) who currently used ≥2 tobacco products, and 12.9% (1.94 million; 65.8% of current tobacco product users) who currently used any combustible tobacco product (Table). E-cigarettes were the most commonly used tobacco product among high school students (11.7%), followed by cigars (7.7%), cigarettes (7.6%), smokeless tobacco (5.5%), hookah (3.3%), pipe tobacco (0.8%), and bidis (0.7%). Smokeless

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[††] A test for linear trend was significant if an overall statistically significant decrease or increase occurred during the study period. Data also were assessed for the presence of quadratic trends. A significant quadratic trend indicated that the rate of change accelerated or decelerated across the study period.

TABLE. Estimated prevalence of tobacco use among high school and middle school students in the past 30 days, by product,[*] school level, sex, and race/ethnicity[†] — National Youth Tobacco Survey, United States, 2017

	Sex		Race/Ethnicity				Total	
Tobacco product	Female % (95% CI)	Male % (95% CI)	White[†] % (95% CI)	Black[†] % (95% CI)	Hispanic % (95% CI)	Other[†] % (95% CI)	% (95% CI)	Estimated no. users[§]
High school students								
E-cigarettes	9.9 (8.0–12.1)	13.3 (11.1–15.9)	14.2 (12.2–16.5)	4.9 (3.5–6.8)	10.1 (7.0–14.4)	5.5 (3.1–9.5)	**11.7 (9.7–13.9)**	**1,730,000**
Cigarettes	7.5 (6.1–9.2)	7.6 (6.4–9.0)	9.5 (8.0–11.3)	2.8 (1.7–4.4)	6.2 (4.6–8.3)	3.8 (2.2–6.2)	**7.6 (6.5–8.9)**	**1,120,000**
Cigars	6.3 (5.0–7.8)	9.0 (7.6–10.7)	8.4 (6.9–10.0)	7.8 (5.8–10.4)	6.7 (5.1–8.6)	4.1 (2.6–6.3)	**7.7 (6.5–9.0)**	**1,130,000**
Smokeless tobacco	3.0 (2.3–4.0)	7.7 (5.9–10.0)	7.2 (5.6–9.4)	1.8 (1.2–2.8)	3.7 (2.6–5.3)	—[¶]	**5.5 (4.2–7.0)**	**810,000**
Hookah	3.2 (2.5–4.1)	3.3 (2.5–4.3)	2.8 (2.1–3.7)	3.1 (2.3–4.3)	4.6 (3.4–6.3)	3.3 (2.1–5.1)	**3.3 (2.7–4.0)**	**480,000**
Pipe tobacco	0.5 (0.4–0.8)	1.0 (0.8–1.4)	0.7 (0.5–1.1)	—	1.3 (0.8–2.0)	—	**0.8 (0.6–1.0)**	**120,000**
Bidis	0.6 (0.4–0.9)	0.7 (0.4–1.1)	0.5 (0.3–0.8)	—	1.1 (0.7–1.7)	—	**0.7 (0.5–1.0)**	**100,000**
Any tobacco product[**]	17.5 (15.2–20.1)	21.5 (18.7–24.6)	22.7 (20.3–25.4)	14.2 (11.6–17.3)	16.7 (12.9–21.4)	10.7 (7.0–16.2)	**19.6 (17.2–22.3)**	**2,950,000**
≥2 tobacco products[††]	7.6 (6.2–9.4)	10.7 (9.0–12.6)	11.3 (9.6–13.2)	4.4 (3.1–6.2)	8.2 (5.9–11.3)	4.0 (2.6–6.2)	**9.2 (7.8–10.9)**	**1,380,000**
Any combustible tobacco product[§§]	12.2 (10.4–14.2)	13.5 (11.6–15.6)	14.4 (12.4–16.5)	10.9 (8.7–13.6)	11.8 (9.2–15.1)	6.8 (4.4–10.3)	**12.9 (11.2–14.8)**	**1,940,000**
Middle school students								
E-cigarettes	2.9 (2.3–3.7)	3.7 (3.0–4.5)	3.4 (2.6–4.5)	2.2 (1.3–3.6)	4.0 (2.9–5.5)	—	**3.3 (2.8–3.9)**	**390,000**
Cigarettes	2.2 (1.7–2.9)	2.0 (1.5–2.8)	1.7 (1.3–2.4)	2.1 (1.2–3.6)	3.5 (2.6–4.7)	—	**2.1 (1.8–2.6)**	**250,000**
Cigars	1.4 (1.0–2.0)	1.6 (1.1–2.2)	1.1 (0.7–1.7)	1.9 (1.1–3.1)	2.4 (1.6–3.4)	—	**1.5 (1.2–2.0)**	**170,000**
Smokeless tobacco	1.2 (0.9–1.7)	2.4 (1.8–3.2)	1.6 (1.0–2.3)	—	3.2 (2.4–4.2)	—	**1.9 (1.5–2.4)**	**210,000**
Hookah	1.1 (0.7–1.5)	1.6 (1.1–2.4)	0.6 (0.3–1.1)	1.8 (1.1–3.1)	2.7 (1.9–3.9)	—	**1.4 (1.0–1.8)**	**150,000**
Pipe tobacco	—	—	—	—	—	—	**0.4 (0.3–0.7)**	**40,000**
Bidis	—	—	—	—	—	—	**0.3 (0.2–0.5)**	**30,000**
Any tobacco product[**]	4.8 (4.0–5.8)	6.4 (5.4–7.4)	5.1 (4.0–6.4)	4.9 (3.6–6.5)	7.7 (6.3–9.4)	—	**5.6 (5.0–6.4)**	**670,000**
≥2 tobacco products[††]	2.0 (1.6–2.6)	2.7 (2.0–3.7)	1.9 (1.4–2.7)	2.5 (1.6–3.8)	3.7 (2.7–5.0)	—	**2.4 (2.0–2.9)**	**280,000**
Any combustible tobacco product[§§]	3.2 (2.5–4.0)	3.5 (2.7–4.4)	2.4 (1.8–3.1)	3.9 (2.7–5.7)	5.3 (4.2–6.6)	—	**3.4 (2.8–4.0)**	**390,000**

Abbreviation: CI = confidence interval; E-cigarettes = electronic cigarettes.

[*] Past 30-day use of e-cigarettes was determined by asking, "During the past 30 days, on how many days did you use e-cigarettes?" Past 30-day use of cigarettes was determined by asking, "During the past 30 days, on how many days did you smoke cigarettes?" Past 30-day use of cigars was determined by asking, "During the past 30 days, on how many days did you smoke cigars, cigarillos, or little cigars?" Past 30-day use of hookah was determined by asking, "During the past 30 days, on how many days did you smoke tobacco in a hookah or waterpipe?" Smokeless tobacco was defined as use of chewing tobacco, snuff, dip, snus, and/or dissolvable tobacco products. Past 30-day use of smokeless tobacco was determined by asking the following question for use of chewing tobacco, snuff, and dip: "During the past 30-days, on how many days did you use chewing tobacco, snuff, or dip?," and the following question for use of snus and dissolvable tobacco products: "In the past 30 days, which of the following products did you use on at least one day?" Responses from these questions were combined to derive overall smokeless tobacco use. Past 30-day use of pipe tobacco (not hookah) and bidis were determined by asking, "In the past 30 days, which of the following products have you used on at least one day?"

[†] Blacks, whites, and others are non-Hispanic; Hispanic persons could be of any race.

[§] Estimated total number of users was rounded down to the nearest 10,000 persons.

[¶] Data are statistically unreliable because samples size was <50 or relative standard error was >0.3.

[**] Any tobacco product use was defined as use of any tobacco product (e-cigarettes, cigarettes, cigars, smokeless tobacco, hookah, pipe tobacco, and/or bidis) on at least one day in the past 30 days.

[††] ≥2 tobacco products use was defined as use of two or more tobacco products (e-cigarettes, cigarettes, cigars, smokeless tobacco, hookah, pipe tobacco, and/or bidis) on at least one day in the past 30 days.

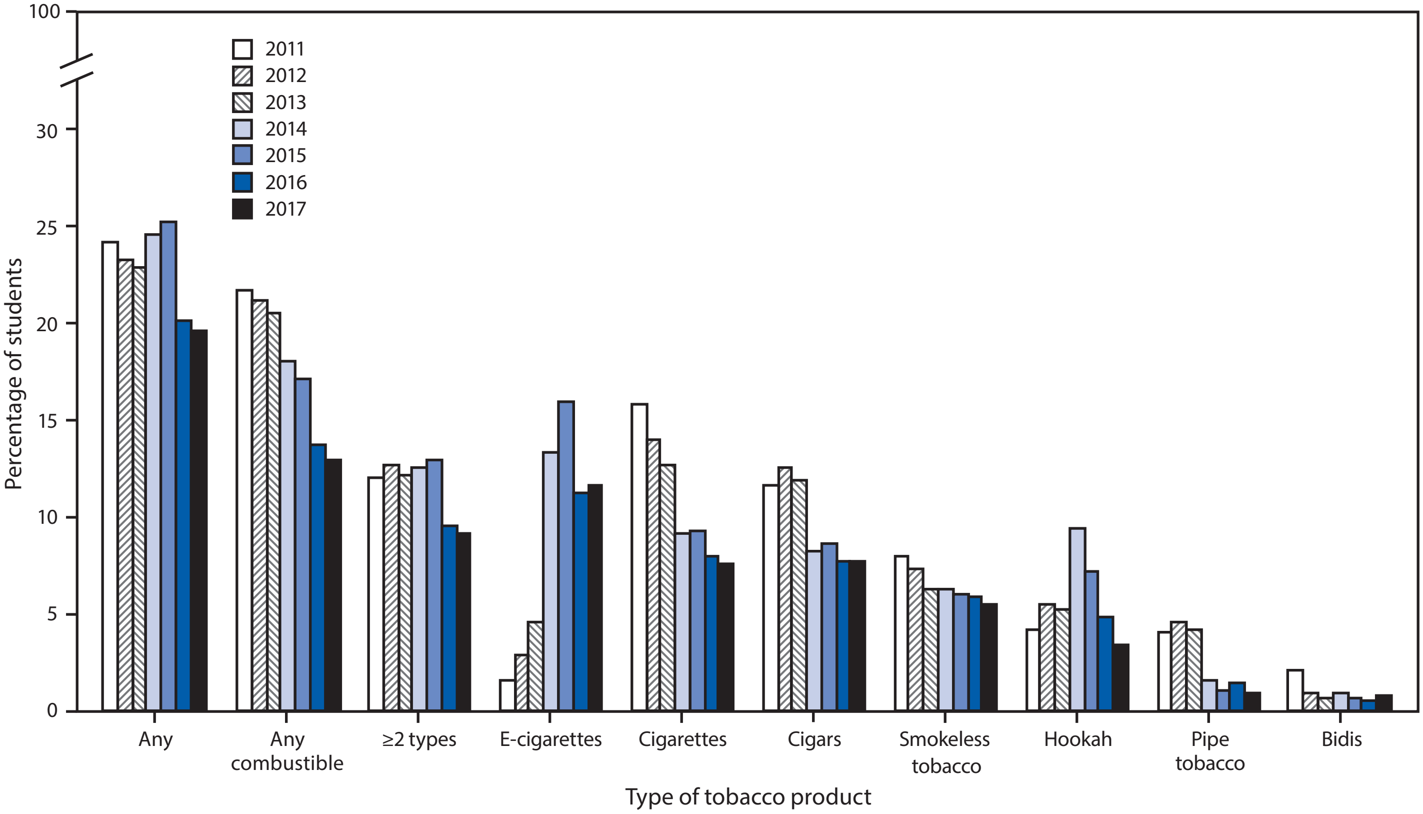
[§§] Any combustible tobacco product use was defined as use of cigarettes, cigars, hookah, pipe tobacco, and/or bidis on at least one day in the past 30 days.

tobacco use was higher among males than among females. E-cigarettes were the most commonly used tobacco product among non-Hispanic white (white) (14.2%) and Hispanic (10.1%) high school students, whereas cigars were the most commonly used tobacco product among non-Hispanic black (black) high school students (7.8%).

Among middle school students, 5.6% (0.67 million) currently used any tobacco product, including 2.4% (0.28 million; 41.8% of current tobacco product users) who currently used ≥2 tobacco products, and 3.4% (0.39 million; 58.2% of current tobacco product users) who currently used any combustible tobacco product (Table). The most commonly used tobacco product among middle school students was e-cigarettes (3.3%), followed by cigarettes (2.1%), smokeless tobacco (1.9%), cigars (1.5%), hookah (1.4%), pipe tobacco (0.4%), and bidis (0.3%). Any tobacco product use was 6.4% among males and 4.8% among females. E-cigarettes were the most commonly used product among Hispanic (4.0%), white (3.4%), and black (2.2%) middle school students.

Among high school students, a nonlinear decrease occurred in the current use of any tobacco product from 2011 (24.2%) to 2017 (19.6%). Nonlinear decreases also occurred in the current use of ≥2 tobacco products (12.0% to 9.2%) and any combustible tobacco product (21.8% to 12.9%). By product, linear decreases occurred for cigarettes (15.8% to 7.6%), cigars (11.6% to 7.7%), and smokeless tobacco (7.9% to 5.5%); nonlinear decreases occurred for pipe tobacco (4.0% to 0.8%) and bidis (2.0% to 0.7%) (Figure 1). E-cigarette use among

FIGURE 1. Estimated percentage of high school students who currently use any tobacco product,* any combustible tobacco product,† ≥2 tobacco products,§ and selected tobacco products — National Youth Tobacco Survey, United States, 2011–2017¶,,††**



* Use of any tobacco product was defined as use of electronic cigarettes (e-cigarettes), cigarettes, cigars, smokeless tobacco, hookah, pipe tobacco, and/or bidis on at least one day in the past 30 days.

† Use of any combustible tobacco product was defined as use of cigarettes, cigars, hookah, pipe tobacco, and/or bidis on at least one day in the past 30 days.

§ Use of ≥2 tobacco products was defined as use of two or more of the following tobacco products: e-cigarettes, cigarettes, cigars, smokeless tobacco, hookah, pipe tobacco, and/or bidis on at least one day in the past 30 days.

¶ During 2016–2017, current use of hookah and pipe tobacco decreased significantly ($p<0.05$).

** During 2011–2017, current use of cigarettes, cigars, and smokeless tobacco exhibited linear decreases ($p<0.05$). Current use of any tobacco product, any combustible tobacco product, ≥2 types of tobacco products, pipe tobacco, and bidis exhibited nonlinear decreases ($p<0.05$). Current use of e-cigarettes exhibited a nonlinear increase ($p<0.05$). Current use of hookah exhibited a nonlinear change ($p<0.05$).

†† Beginning in 2015, the definition of smokeless tobacco included chewing tobacco/snuff/dip, snus, and dissolvable tobacco to better reflect this class of tobacco products. Thus, estimates for individual smokeless tobacco products (chewing tobacco/snuff/dip, snus, and dissolvable tobacco) are not reported. This definition was applied across all years (2011–2017) for comparability purposes.

high school students increased nonlinearly during 2011–2017 (1.5% to 11.7%).

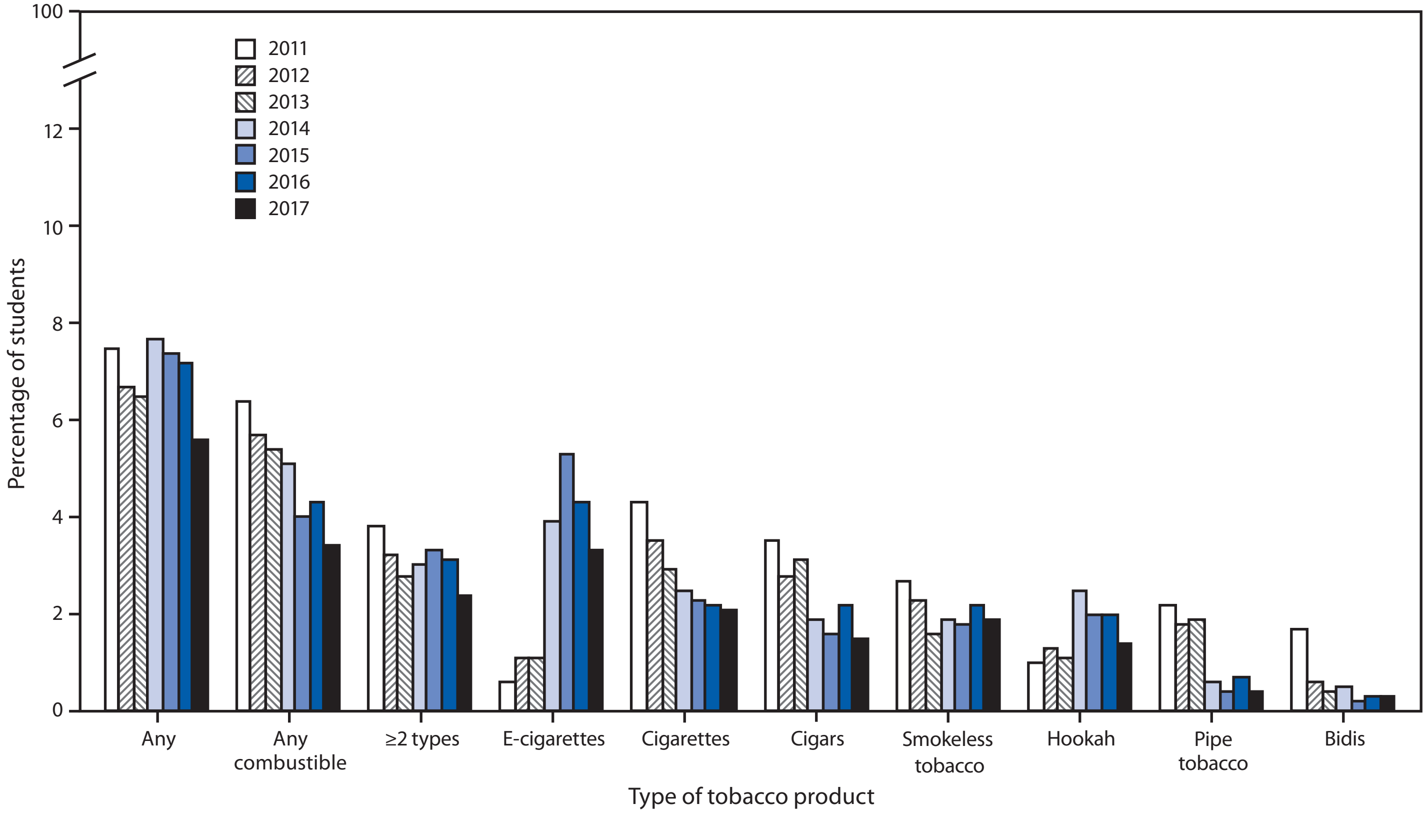
Among middle school students, linear decreases occurred in current use of any tobacco product (7.5% to 5.6%), ≥2 tobacco products (3.8% to 2.4%), and any combustible tobacco product (6.4% to 3.4%). By product, linear decreases occurred for cigars (3.5% to 1.5%), smokeless tobacco (2.7% to 1.9%), and pipe tobacco (2.2% to 0.4%); nonlinear decreases occurred for cigarettes (4.3% to 2.1%) and bidis (1.7% to 0.3%). Nonlinear increases occurred in use of e-cigarettes (0.6% in 2011 to 3.3% in 2017) and hookah (1.0% to 1.4%) among middle school students (Figure 2).

During 2016–2017, among high school students, decreases occurred in current use of hookah (4.8% to 3.3%) and pipe tobacco (1.4% to 0.8%). Among middle school students, decreases occurred in current use of any tobacco product (7.2% to 5.6%), e-cigarettes (4.3% to 3.3%), and hookah (2.0% to 1.4%).

Discussion

Among U.S. middle and high school students, the current use of any tobacco product decreased during 2011–2017. However, in 2017, approximately one in five high school students (2.95 million) and one in 18 middle school students (0.67 million) currently used a tobacco product. Since 2014, e-cigarettes have been the most commonly used tobacco product among both middle and high school students. Furthermore, approximately one in two high school students who used a

FIGURE 2. Estimated percentage of middle school students who currently use any tobacco product,* any combustible tobacco product,† ≥2 tobacco products,§ and selected tobacco products — National Youth Tobacco Survey, United States, 2011–2017¶,,††**



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* Use of any tobacco product was defined as use of electronic cigarettes (e-cigarettes), cigarettes, cigars, smokeless tobacco, hookah, pipe tobacco, and/or bidis on at least one day in the past 30 days.

† Use of any combustible tobacco product was defined as use of cigarettes, cigars, hookah, pipe tobacco, and/or bidis on at least one day in the past 30 days.

§ Use of ≥2 tobacco products was defined as use of two or more of the following tobacco products: e-cigarettes, cigarettes, cigars, smokeless tobacco, hookah, pipe tobacco, and/or bidis on at least one day in the past 30 days.

¶ During 2016–2017, current use of any tobacco product, e-cigarettes, and hookah decreased significantly ($p<0.05$).

** During 2011–2017, current use of any tobacco product, any combustible tobacco product, ≥2 tobacco products, cigars, smokeless tobacco, and pipe tobacco exhibited significant linear decreases ($p<0.05$). Cigarettes and bidis exhibited significant nonlinear decreases ($p<0.05$). E-cigarettes and hookah exhibited significant nonlinear increases ($p<0.05$).

†† Beginning in 2015, the definition of smokeless tobacco included chewing tobacco/snuff/dip, snus, and dissolvable tobacco to better reflect this class of tobacco products. Thus, estimates for individual smokeless tobacco products (chewing tobacco/snuff/dip, snus, and dissolvable tobacco) are not reported. This definition was applied across all years (2011–2017) for comparability purposes.

Summary

What is already known about this topic?

Tobacco use is the leading cause of preventable disease and death in the United States; nearly all tobacco use begins during youth and young adulthood.

What is added by this report?

During 2011–2017, prevalence of current use of any tobacco product decreased from 24.2% to 19.6% among high school students and from 7.5% to 5.6% among middle school students. Electronic cigarettes were the most commonly used tobacco product among high school (11.7%) and middle school students (3.3%) in 2017.

What are the implications for public health practice?

Sustained implementation of population-based strategies, in coordination with Food and Drug Administration regulation of tobacco products, are critical to reducing tobacco product use and initiation among U.S. youths.

tobacco product and two in five middle school students who used a tobacco product reported using ≥2 tobacco products. Among youths, symptoms of nicotine dependence are increased in multiple tobacco product–users compared with those in single product–users (*3*).

Tobacco prevention and control strategies at the national, state, and local levels might have contributed to the reduction in any tobacco product use in recent years, including tobacco product price increases, comprehensive smoke-free policies, media campaigns warning about the risks for youth tobacco product use, and youth access restrictions (*1*,*2*,*4*). However, several factors continue to promote and influence tobacco product use among youths, including exposure to tobacco product advertising and imagery through various media, as well as the availability of flavored tobacco products (*2*,*5*,*6*). Sustained and targeted interventions to address these factors could help prevent and reduce all forms of tobacco use among U.S. youths (*1*,*2*,*4*). In March 2018, the Food and Drug Administration issued an advance notice of proposed rulemaking to obtain information related to the role that flavors play in tobacco product use (*7*).

The findings in this report are subject to at least four limitations. First, findings might not be generalizable to all youths; those who are home-schooled, have dropped out of school, or are in detention centers are not included in this survey. Second, data were self-reported and might be subject to recall and response bias. Third, changes in the wording and placement of survey questions for certain tobacco products during 2011–2017 might limit comparability of responses between years. Finally, data on some tobacco products were unavailable for certain years (e.g., roll-your-own cigarettes), which might result in underestimation of overall tobacco product use.

The sustained implementation of population-based strategies, in coordination with the regulation of tobacco products by FDA (*8*), are critical to reducing all forms of tobacco product use and initiation among U.S. youths (*1*,*2*,*4*). Strategies to reduce youth tobacco product use include increasing the price of tobacco products, implementing comprehensive smoke-free policies, implementing advertising and promotion restrictions and national public education media campaigns, and raising the minimum age of purchase for tobacco products to 21 years (*1*,*4*,*9*).

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Morbidity and Mortality Weekly Report

Update: Influenza Activity in the United States During the 2017–18 Season and Composition of the 2018–19 Influenza Vaccine

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The United States 2017–18 influenza season (October 1, 2017–May 19, 2018) was a high severity season with high levels of outpatient clinic and emergency department visits for influenza-like illness (ILI), high influenza-related hospitalization rates, and elevated and geographically widespread influenza activity across the country for an extended period. Nationally, ILI activity began increasing in November, reaching an extended period of high activity during January–February, and remaining elevated through March. Influenza A(H3N2) viruses predominated through February and were predominant overall for the season; influenza B viruses predominated from March onward. This report summarizes U.S. influenza activity* during October 1, 2017–May 19, 2018.†

Virus Surveillance

CDC receives influenza test results from public health and clinical laboratories located in all 50 states, Puerto Rico, and the District of Columbia through U.S. World Health Organization (WHO) Collaborating Laboratories and the National Respiratory and Enteric Virus Surveillance System (NREVSS). During October 1, 2017–May 19, 2018, clinical laboratories tested 1,210,053 specimens for influenza virus; 224,113 (18.5%) tested positive (Supplementary Figure 1, https://stacks.cdc.gov/view/cdc/54973), including 151,413 (67.6%) for influenza A and 72,700 (32.4%) for influenza B. Nationally, the percentage of clinical laboratory–tested specimens positive for influenza virus peaked for 5 consecutive weeks during January 13–February 10 (surveillance weeks 2–6) (range = 26.1%–26.9%). Regionally,§ the week of peak clinical laboratory influenza positivity varied, ranging from the week ending December 30 (week 52) to the week ending February 17 (week 7).

Public health laboratories tested 98,446 specimens during October 1, 2017–May 19, 2018; 53,790 (54.6%) were positive for influenza viruses, including 38,303 (71.2%) positive for influenza A and 15,487 (28.8%) for influenza B (Supplementary Figure 2, https://stacks.cdc.gov/view/cdc/54974). Among the 37,681 seasonal influenza A viruses subtyped, 31,977 (84.9%) were influenza A(H3N2), and 5,704 (15.1%) were influenza A(H1N1)pdm09. Influenza B lineage information was available for 11,950 (77.2%) influenza B viruses; 10,612 (88.8%) were B/Yamagata lineage, and 1,338 (11.2%) were B/Victoria lineage. Whereas influenza A(H3N2) viruses accounted for the majority of circulating viruses, the proportion of influenza A viruses subtyped as A(H1N1)pdm09 ranged regionally from 9.0% in the central United States to approximately 24% in the northwestern and southeastern United States. Influenza B viruses were more commonly reported than were influenza A viruses from early March to late May (weeks 9–20). The proportion of influenza B viruses reported regionally ranged from 23.0% in the Midwest to 40.6% in the northwestern United States.

Among 47,121 (87.6%) patients who tested positive for seasonal influenza virus by public health laboratories and for whom age data were available, 3,802 (8.1%) were aged 0–4 years; 11,550 (24.5%), 5–24 years; 15,597 (33.1%), 25–64 years; and 16,172 (34.3%), ≥65 years. Influenza A(H3N2) viruses predominated among all age groups, ranging from 51.2% of viruses among persons aged 5–24 years to 70.0% among persons aged ≥65 years. The largest proportion of reported influenza B viruses (36.5%) occurred in persons aged 5–24 years.

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* The CDC influenza surveillance system collects five categories of information from eight data sources: 1) virus surveillance (U.S. World Health Organization collaborating laboratories, the National Respiratory and Enteric Virus Surveillance System (NREVSS), and novel influenza A virus case reporting); 2) outpatient illness surveillance (U.S. Outpatient Influenza-Like Illness Surveillance Network [ILI-Net]); 3) mortality (the National Center for Health Statistics Mortality Surveillance System and influenza-associated pediatric mortality reports); 4) hospitalizations (FluSurv-NET, which includes the Emerging Infections Program and surveillance in three additional states); and 5) summary of the geographic spread of influenza (state and territorial epidemiologist reports). https://www.cdc.gov/flu/weekly/fluactivitysurv.htm.

† Data as of June 1, 2018.

§ The 10 regions include the following jurisdictions: *Region 1*: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont; *Region 2*: New Jersey, New York, Puerto Rico, and the U.S. Virgin Islands; *Region 3*: Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia; *Region 4*: Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee; *Region 5*: Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin; *Region 6*: Arkansas, Louisiana, New Mexico, Oklahoma, and Texas; *Region 7*: Iowa, Kansas, Missouri, and Nebraska; *Region 8*: Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming; *Region 9*: Arizona, California, Hawaii, Nevada, American Samoa, Commonwealth of the Northern Mariana Islands, Federated States of Micronesia, Guam, Marshall Islands, and Republic of Palau; *Region 10*: Alaska, Idaho, Oregon, and Washington.

Antigenic and Genetic Characterization of Influenza Viruses

Public health laboratories participating as U.S. WHO collaborating laboratories submit a subset of influenza-positive respiratory specimens to CDC for virus characterization through three National Influenza Reference Centers in the California, New York, and Wisconsin state public health laboratories. CDC characterizes influenza viruses through genomic sequencing and antigenic characterization (using hemagglutination inhibition [HI] or neutralization assays). This process evaluates whether genetic changes in circulating viruses have led to antigenic drift away from the vaccine reference virus.

Influenza-positive specimens are sequenced using next-generation sequencing (NGS)¶ on the MiSeq System platform (Illumina), using genomic enrichment practices (*1*,*2*) adapted by CDC. Genomic data are analyzed to determine the genetic identity of circulating viruses and submitted to public databases (GenBank or GISAID EpiFlu).

CDC evaluates the antigenic similarity** between ferret antisera raised against reference viruses representing the recommended vaccine components of the Northern Hemisphere 2017–18 vaccine and circulating viruses isolated and propagated in mammalian cell culture. Since the 2014–15 season, many influenza A(H3N2) viruses propagated in mammalian cell culture have lacked sufficient hemagglutination titers for antigenic characterization using HI assays. Therefore, in addition to the use of the HI assay, a subset of influenza A(H3N2) viruses are antigenically characterized using a focus reduction assay (FRA) to assess the ability of various antisera to neutralize infectivity of the test viruses.

CDC has genetically characterized 3,329 influenza viruses collected since October 1, 2017, including 832 influenza A(H1N1)pdm09 viruses, 1,313 influenza A(H3N2) viruses, and 1,184 influenza B viruses. A subset of these viruses was also antigenically characterized.

Phylogenetic analysis of the hemagglutinin (HA) gene segments from 832 A(H1N1)pdm09 viruses collected since October 1, 2017, showed that all viruses belonged to subclade 6B.1 (Supplementary Figure 3, https://stacks.cdc.gov/view/cdc/54975). This has been the predominant HA clade in the United States since the 2015–16 season (*3*). Of the 736 A(H1N1)pdm09 viruses analyzed using HI assays, 735 (99.9%) were well inhibited (i.e., reacted at titers that were within fourfold of the homologous virus titer) by ferret antisera raised against cell culture–propagated 6B.1 virus A/Michigan/45/2015, the reference virus representing the A(H1N1)pdm09 vaccine virus for the 2017–18 Northern Hemisphere influenza season.

A total of 1,313 influenza A(H3N2) viruses were sequenced, and phylogenetic analysis of the HA gene segments indicated that multiple clades/subclades were cocirculating (Supplementary Figure 3, https://stacks.cdc.gov/view/cdc/54975), with 3C.2a predominating. Viruses with the 3C.2a HA emerged at the end of the 2013–14 season and have remained the predominant clade since the 2014–15 season (*4*), undergoing continued genetic diversification each season. Among 655 representative A(H3N2) viruses antigenically characterized by HI or FRA, 612 (93.4%) were well inhibited by ferret antisera raised against A/Michigan/15/2014 (3C.2a), a cell-propagated reference virus representing A/Hong Kong/4801/2014 (the A(H3N2) component of the 2017–18 Northern Hemisphere influenza vaccines). Only 6.6% of A(H3N2) viruses, the majority of which belonged to genetic clade 3C.3a, showed evidence of antigenic drift (i.e., had eightfold or greater reductions in HI or FRA titers compared with reference virus titers). In contrast to the 93.4% of A(H3N2) viruses that were well inhibited by ferret antisera raised against cell-propagated A/Michigan/15/2014, only 48.2% of viruses tested were well inhibited by ferret antiserum raised against the egg-propagated A/Hong Kong/4801/2014 reference virus representing the A(H3N2) vaccine component. A higher proportion (77.3%) of viruses tested were well inhibited by ferret antisera raised against egg-propagated A/Singapore/INFIMH-16–0019/2016 reference virus, representing the A(H3N2) component recommended for the 2018 Southern Hemisphere and the 2018–19 Northern Hemisphere influenza vaccines.

Phylogenetic analysis of 896 influenza B/Yamagata-lineage viruses showed that all HA gene segments belonged to clade Y3 (Supplementary Figure 3, https://stacks.cdc.gov/view/cdc/54975), which also predominated in the 2016–17 season (*5*). All 824 B/Yamagata lineage viruses that were antigenically characterized were antigenically similar to cell culture–propagated B/Phuket/3073/2013, the reference virus representing the B/Yamagata-lineage component of quadrivalent vaccines for the 2017–18 Northern Hemisphere influenza season.

¶ Next generation sequencing uses advanced molecular detection to identify gene sequences from each virus in a specimen and thus reveals the genetic variations among many different influenza virus particles in a single specimen; these methods also reveal the entire coding region of the genomes. https://www.cdc.gov/amd/project-summaries/influenza-vaccines.html.

** A virus is considered "reference virus-like" if its hemagglutination inhibition (HI) or neutralization focus reduction assay (FRA) titer is within fourfold of the homologous HI/FRA titer of the reference strain. A virus is considered as low to the reference virus if there is an eightfold or more reduction in the HI or FRA titer when compared with the homologous HI or FRA titer of the reference strain.

The HA gene segment of 288 influenza B/Victoria-lineage viruses sequenced and phylogenetically analyzed belonged to genetic clade V1A, the same genetic clade as the vaccine reference virus, B/Brisbane/60/2008. However, 234 (81.3%) viruses had a six-nucleotide deletion in the HA gene segment (encoding amino acids 162 and 163). Viruses like these, previously abbreviated as V1A-2Del and now designated as V1A.1, were first reported during the 2016–17 season (*5*). Among 270 antigenically characterized influenza B/Victoria viruses, only 53 (19.6%) were antigenically similar to cell culture–propagated B/Brisbane/60/2008, the reference virus representing the B/Victoria lineage component of 2017–18 Northern Hemisphere vaccines. All 217 B/Victoria viruses that were poorly inhibited by antisera raised to B/Brisbane/60/2008 (i.e., had eightfold or greater reductions in HI titers compared with reference virus titers) had the V1A.1 HA segment. Circulating B/Victoria lineage V1A.1 viruses were well inhibited by ferret antisera raised against B/Colorado/06/2017, a V1A.1 reference virus representing the influenza B component recommended for the 2018–19 Northern Hemisphere influenza vaccine.

Antiviral Susceptibility of Influenza Viruses

CDC tested 4,619 influenza viruses from the United States collected since October 1, 2017, for resistance to the influenza neuraminidase inhibitor antiviral medications recommended for use against seasonal influenza (oseltamivir, peramivir, and zanamivir). Among 1,147 influenza A(H1N1)pdm09 viruses tested for oseltamivir and peramivir susceptibility, 11 (1.0%) were resistant to both drugs and contain a known marker of resistance in the neuraminidase gene segment (H275Y). Among 786 influenza A(H1N1)pdm09 viruses also tested for zanamivir susceptibility, no resistant viruses were detected. All 2,354 influenza A(H3N2) viruses tested for oseltamivir and zanamivir susceptibility were susceptible to both medications. No peramivir-resistant viruses were detected among 1,248 A(H3N2) viruses tested. All 1,118 influenza B viruses tested were susceptible to all three medications. High levels of resistance to the adamantanes (amantadine and rimantadine) persist among influenza A viruses. Adamantane drugs are not recommended for use against influenza at this time.

Composition of the 2018–19 Influenza Vaccine

The Food and Drug Administration's Vaccines and Related Biologic Products Advisory Committee recommended that the 2018–19 trivalent vaccine to be used in the United States contain an A/Michigan/45/2015 A(H1N1)pdm09-like virus, an A/Singapore/INFIMH-16–0019/2016 A(H3N2)-like virus, and a B/Colorado/06/2017-like (B/Victoria lineage) virus (*6*). The quadrivalent vaccine recommendation included the trivalent vaccine viruses as well as a B/Phuket/3073/2013-like (B/Yamagata lineage) virus. The B component recommendation represents a change in the influenza B/Victoria lineage component recommended for the 2017–2018 Northern Hemisphere and 2018 Southern Hemisphere influenza vaccines. The B component change was made because of the increasing global circulation of an antigenically drifted B/Victoria lineage virus (V1A.1) (*7*). The A(H3N2) recommendation represents an update to the 2017–2018 Northern Hemisphere vaccines but is the same A(H3N2) virus recommended for the 2018 Southern Hemisphere vaccine. The decision to update the A(H3N2) component was not made to address antigenic drift, but rather because the egg-propagated A/Singapore vaccine virus is antigenically more similar to circulating viruses than the egg-propagated A/Hong Kong vaccine virus recommended for the Northern Hemisphere 2017–2018 vaccine. Vaccine recommendations were based on factors including global influenza virologic and epidemiologic surveillance, genetic characterization, antigenic characterization, and the candidate vaccine viruses that are available for production.

Outpatient Illness Surveillance

Nationally, the weekly percentage of outpatient visits for ILI[††] to health care providers participating in the United States Outpatient Influenza-like Illness Surveillance Network (ILINet) was at or above the national baseline[§§] level of 2.2% for 19 consecutive weeks (weeks 47–13) during the 2017–18 season (Figure 1). The percentage of outpatient ILI visits exceeded 7.0% for three consecutive weeks, peaking at 7.5% during the week ending February 3, 2018 (week 5). During the 2012–13 through 2016–17 seasons, peak weekly percentages of outpatient ILI visits ranged from 3.6%–6.1% and remained at or above baseline levels for an average of 16 weeks (range = 11–20 weeks).

ILINet data are used to produce a weekly jurisdiction-level measure of ILI activity,[¶¶] ranging from minimal to high. For the weeks ending December 30, 2017–February 24, 2018, approximately half of the 53 jurisdictions experienced high ILI activity each week, with the highest number (46; 87%) during the weeks ending January 27–February 10, 2018 (weeks 4–6). During the past 5 seasons, the highest number of jurisdictions experiencing high ILI activity in a single week ranged from 16 (30%) during the 2015–16 season to 31 (58%) during the 2012–13 season.

[††] Defined as a fever (temperature ≥100°F [≥37.8°C], oral or equivalent) and cough or sore throat, without a known cause other than influenza.

[§§] The national and regional baselines are the mean percentages of visits for influenza-like illness (ILI) during noninfluenza weeks for the previous 3 seasons plus two standard deviations. Noninfluenza weeks are defined as periods of ≥2 consecutive weeks during which each week accounted for <2% of the season's total number of specimens that tested positive for influenza. National and regional percentages of patient visits for ILI are weighted based on state population. Use of the national baseline for regional data is not appropriate.

[¶¶] Activity levels are based on the percentage of outpatient visits in a jurisdiction attributed to ILI and are compared with the average percentage of ILI visits that occur during weeks with little or no influenza virus circulation. Activity levels range from minimal, corresponding to ILI activity from outpatient clinics at or below the average, to high, corresponding to ILI activity from outpatient clinics much higher than the average. Because the clinical definition of ILI is nonspecific, not all ILI is caused by influenza; however, when combined with laboratory data, the information on ILI activity provides a clearer picture of influenza activity in the United States.

Geographic Spread of Influenza Activity

State and territorial epidemiologists report the geographic distribution of influenza in their jurisdictions[***] through a weekly influenza activity code.[†††] During the 2017–18 season, the peak number of jurisdictions reporting widespread activity in a single week was 50 (93%); this occurred for 3 consecutive weeks (weeks ending January 6, 13, and 20, 2018). During the previous 5 influenza seasons, the peak number of jurisdictions reporting widespread activity in a single week during each season has ranged from 41 (76%) (2015–16 season) to 48 (89%) (2012–13 season).

Influenza-Associated Hospitalizations

CDC monitors hospitalizations associated with laboratory-confirmed influenza infections through the Influenza Hospitalization Surveillance Network (FluSurv-NET),[§§§] which covers approximately 27 million persons (9% of the U.S. population). During October 1, 2017–April 30, 2018, a total of 30,453 laboratory-confirmed influenza-related hospitalizations were reported (cumulative incidence for all age groups = 106.6 per 100,000 population) (Figure 2). The overall peak occurred during the week ending January 6, 2018 (week 1). The hospitalization rate was highest among persons aged ≥65 years, who accounted for approximately 58% of reported influenza-associated hospitalizations. By age group, the cumulative hospitalization rate was 74.3 per 100,000 population among children aged 0–4 years, 20.2 among children and adolescents aged 5–17 years, 32.6 among adults aged 18–49 years, 115.7 among adults aged 50–64 years, and 460.9 among adults aged ≥65 years. Among all influenza-associated hospitalizations, 22,023 (72.3%) were for influenza A virus infections, 8,226 (27.0%) for influenza B virus infections, 116 (0.4%) for influenza A virus and influenza B virus coinfections, and 88 (0.3%) for an influenza virus for which no type testing was done. Among 7,352 patients for whom influenza A subtype information was available, 6,163 (83.8%) were infected with influenza A(H3N2) viruses, and 1,189 (16.2%) were infected with influenza A(H1N1)pdm09 viruses.

Complete medical chart abstraction data in FluSurv-NET will not be finalized until later in 2018; however, as of June 1, 2018, data were available for 7,584 (24.9%) hospitalized adults and children with laboratory-confirmed influenza. Among 6,910 hospitalized adults with information on underlying medical conditions, 6,385 (92.4%) had at least one reported underlying medical condition that placed them at high risk[¶¶¶] for influenza-associated complications. The most commonly reported underlying medical conditions among adults were cardiovascular disease (46.3%), metabolic disorders (43.3%), obesity (36.5%), and chronic lung disease (29.6%). Among 674 hospitalized children with such information, 382 (56.7%) had at least one underlying medical condition; the most commonly reported were asthma (23.4%), neurologic disorder (15.4%), and obesity (10.7%). Among 609 hospitalized

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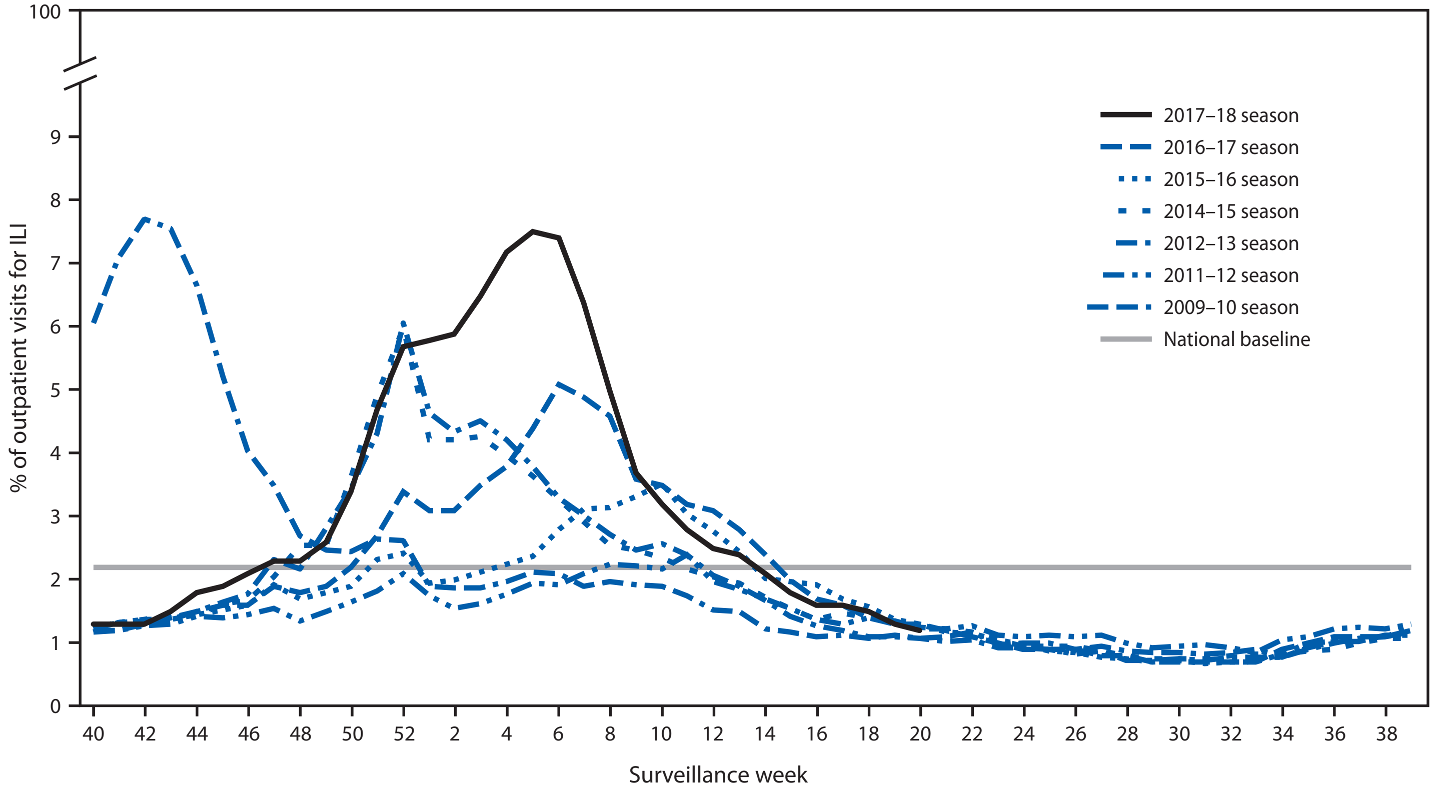
[***] For this surveillance component, 54 jurisdictions participate: the 50 states, the District of Columbia, Guam, Puerto Rico, and U.S. Virgin Islands.

[†††] Levels of activity are 1) no activity; 2) sporadic: isolated laboratory-confirmed influenza cases or a laboratory-confirmed outbreak in one institution, with no increase in activity; 3) local: increased ILI, or two or more institutional outbreaks (ILI or laboratory-confirmed influenza) in one region of the state, with recent laboratory evidence of influenza in that region; virus activity no greater than sporadic in other regions; 4) regional: increased ILI activity or institutional outbreaks (ILI or laboratory-confirmed influenza) in two or more outbreaks, but less than half of the regions in the state with recent laboratory evidence of influenza in those regions; and 5) widespread: increased ILI activity or institutional outbreaks (ILI or laboratory-confirmed influenza) in at least half of the regions in the state, with recent laboratory evidence of influenza in the state.

[§§§] FluSurv-NET conducts population-based surveillance for laboratory-confirmed, influenza-associated hospitalizations in children and adolescents aged <18 years (since the 2003–04 influenza season) and adults aged ≥18 years (since the 2005–06 influenza season). FluSurv-NET covers approximately 70 counties in the 10 Emerging Infections Program states (California, Colorado, Connecticut, Georgia, Maryland, Minnesota, New Mexico, New York, Oregon, and Tennessee) and additional Influenza Hospitalization Surveillance Project (IHSP) states. IHSP began during the 2009–10 season to enhance surveillance during the 2009 H1N1 pandemic. IHSP sites included Idaho, Iowa, Michigan, Oklahoma, and South Dakota during the 2009–10 season; Idaho, Michigan, Ohio, Oklahoma, Rhode Island, and Utah during the 2010–11 season; Michigan, Ohio, Rhode Island, and Utah during the 2011–12 season; Iowa, Michigan, Ohio, Rhode Island, and Utah during the 2012–13 season; and Michigan, Ohio, and Utah during the 2013–14, 2014–15, 2015–16, and 2016–17 seasons. Cumulative unadjusted incidence rates are calculated using CDC's National Center for Health Statistics population estimates for the counties included in the surveillance catchment area. Laboratory confirmation is dependent on clinician-ordered influenza testing, and testing for influenza often is underutilized because of the poor reliability of rapid test results and greater reliance on clinical diagnosis for influenza. Therefore, cases identified as part of influenza hospitalization surveillance likely are an underestimation of the actual number of persons hospitalized with influenza.

[¶¶¶] Persons at higher risk include 1) children aged <2 years; 2) adults aged ≥65 years; 3) persons with chronic pulmonary conditions (including asthma), cardiovascular disease (except hypertension alone), renal, hepatic, hematologic (including sickle cell) disease, metabolic disorders (including diabetes mellitus), or neurologic and neurodevelopmental conditions (including disorders of the brain, spinal cord, peripheral nerves, and muscles, such as cerebral palsy, epilepsy [seizure disorders], stroke, intellectual disability [mental retardation], moderate to severe developmental delay, muscular dystrophy, or spinal cord injury); 4) persons with immunosuppression, including that caused by medications or by human immunodeficiency virus infection; 5) women who are pregnant or postpartum (within 2 weeks after delivery); 6) persons aged ≤18 years who are receiving long-term aspirin therapy; 7) American Indians/Alaska Natives; 8) persons with extreme obesity (i.e., body mass index ≥40); and 9) residents of nursing homes and other chronic care facilities.

FIGURE 1. Percentage of outpatient visits for influenza-like illness (ILI)* reported to CDC, by surveillance week — U.S. Outpatient Influenza-Like Illness Surveillance Network (ILINET), national summary, United States, 2017–18† influenza season and selected previous influenza seasons



* Defined as fever (temperature of ≥100°F [≥37.8°C], oral or equivalent) and cough or sore throat, without a known cause other than influenza.
† As of June 1, 2018.

women aged 15–44 years with information on pregnancy status, 187 (30.7%) were pregnant.

Pneumonia and Influenza-Associated Mortality

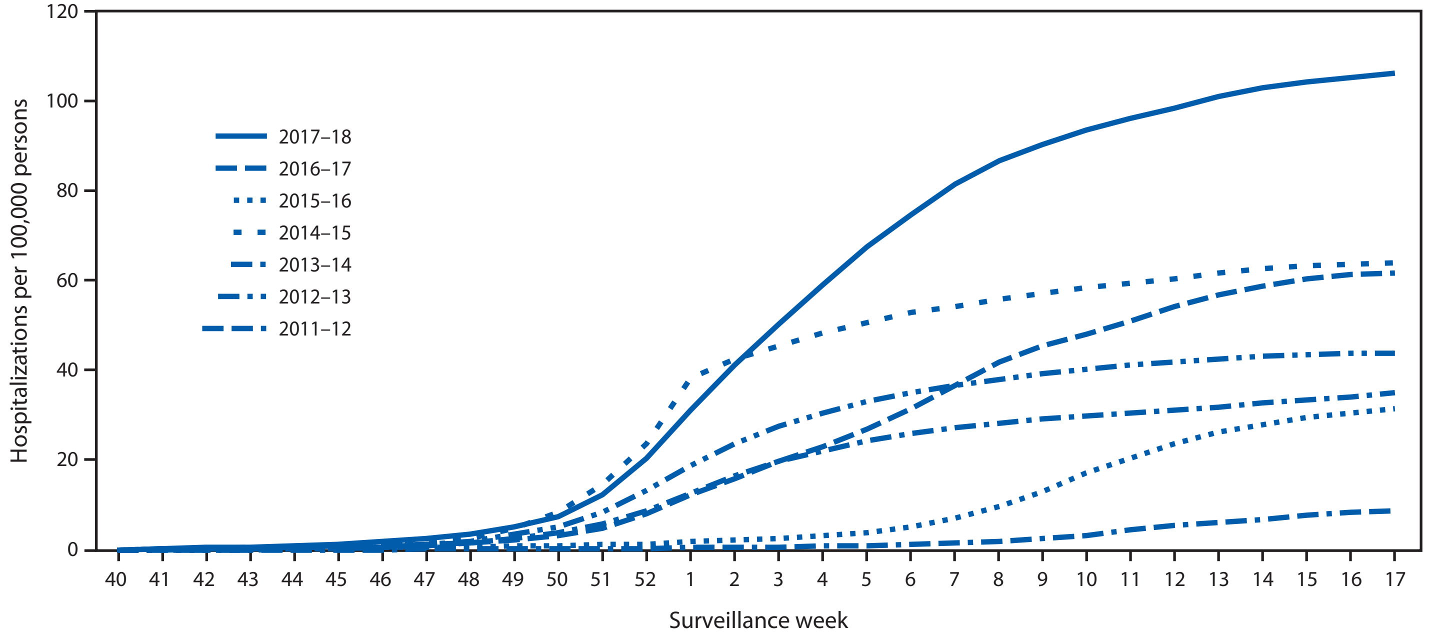
CDC tracks pneumonia and influenza (P&I)–attributed deaths through CDC's National Center for Health Statistics (NCHS) Mortality Reporting System. The percentages of deaths attributed to P&I are released 2 weeks after the week of death to allow for collection of sufficient data to produce a stable P&I mortality percentage. During the 2017–18 season, based on data from NCHS, the proportion of deaths attributed to P&I was at or above the epidemic threshold**** for 16 consecutive weeks during the weeks ending December 23, 2017–April 7, 2018 (weeks 51–14). Nationally, mortality attributed to P&I exceeded 10.0% for 4 consecutive weeks, peaking at 10.8% during the week ending January 20, 2018 (week 3).

Severity Assessment

In 2017, CDC began using a new methodology to classify influenza season severity using three indicators: 1) the percentage of visits to outpatient clinics for ILI from ILINet, 2) the rates of influenza-associated hospitalizations from FluSurv-Net, and 3) the percentage of deaths resulting from pneumonia or influenza from NCHS (*8*). This approach uses data from past influenza season indicators to calculate three intensity thresholds (ITs) (additional information is available at https://www.cdc.gov/flu/professionals/classifies-flu-severity.htm). These ITs help assess the historic chance that surveillance system data will exceed a certain threshold. CDC then classifies the severity of the current influenza season by determining which IT was crossed by at least two of the peak values from the above indicators. Based on this method, the severity of the 2017–18 season was classified as high severity overall and high severity for each age group (children and adolescents, adults, and older adults). This is the first time that each age group was classified as high in the same season, in a retrospective analysis going back to the 2003–04 season (Figure 3).

**** The seasonal baseline proportion of pneumonia and influenza (P&I) deaths is projected using a robust regression procedure, in which a periodic regression model is applied to the observed percentage of deaths from P&I that were reported by the National Center for Health Statistics Mortality Surveillance System during the preceding 5 years. The epidemic threshold is set at 1.645 standard deviations above the seasonal baseline.

FIGURE 2. Cumulative rates of hospitalizations for laboratory-confirmed influenza by season and surveillance week — FluSurv-NET,* United States, 2011–12 through 2017–18 influenza seasons†



* FluSurv-NET conducts population-based surveillance for laboratory-confirmed influenza-associated hospitalizations in children aged <18 years (since the 2003–04 season) and adults aged ≥18 years (since the 2005–06 season). FluSurv-NET covers >70 counties in the 10 Emerging Infections Program states (California, Colorado, Connecticut, Georgia, Maryland, Minnesota, New Mexico, New York, Oregon, and Tennessee) and three additional Influenza Hospitalization Surveillance Project states (Michigan, Ohio, and Utah).

† As of June 1, 2018.

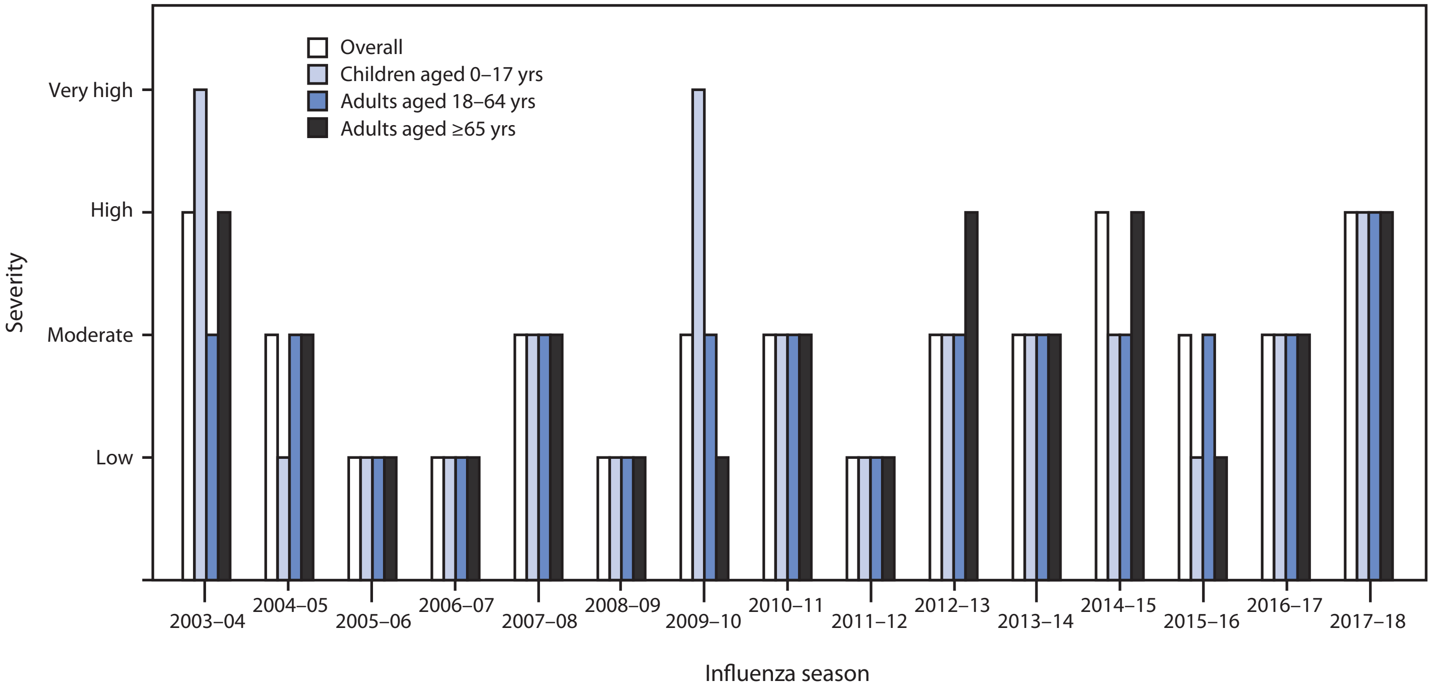
Influenza-Associated Pediatric Mortality

CDC monitors pediatric influenza-associated deaths through the Influenza-Associated Pediatric Mortality Surveillance System. As of June 1, 2018, a total of 171 laboratory-confirmed influenza-associated pediatric deaths during the 2017–18 season had been reported to CDC from Chicago, New York City, and 41 states. Of these deaths, 36 (21%) were associated with infection with an influenza A(H3N2) virus, 31 (18%) with an influenza A(H1N1)pdm09 virus, 36 (21%) with an influenza A virus for which no subtyping was performed, 64 (37%) with an influenza B virus, two (1%) with an influenza A and B coinfection, and two (1%) with an influenza virus for which the type was not determined. The mean age of the pediatric deaths reported this season was 7.1 years (range = 8 weeks–17 years); 97 (57%) children died after admission to the hospital. Among the 154 children with a known medical history, 79 (51%) had at least one underlying medical condition recognized by the Advisory Committee on Immunization Practices (ACIP) as placing them at high risk for influenza-related complications. Among the 138 children who were eligible for influenza vaccination (age ≥6 months at date of onset) and for whom vaccination status was known, 30 (22%) had received at least 1 dose of influenza vaccine before illness onset (28 were fully vaccinated according to 2017 ACIP recommendations, and two had received 1 of 2 recommended doses). Since influenza-associated pediatric mortality became a nationally notifiable condition in 2004, the total number of influenza-associated pediatric deaths per season has ranged from 37 during the 2011–12 season to 171 during the 2012–13 season, excluding the 2009 pandemic, during which 358 pediatric deaths were reported to CDC during April 15, 2009–October 2, 2010.

Discussion

The 2017–18 influenza season was a high severity, A(H3N2)-predominant season. In 2017, CDC began using a new methodology to classify seasonal severity and applied the methodology to the 2003–04 through 2016–17 seasons. The 2017–18 season is the third overall high severity season since 2003–04 and the first classified as high severity for all age groups (*8*). The peak percentage of outpatient visits for ILI was the third highest recorded since 1997–98, when ILINet was implemented. Mortality attributed to P&I remained above epidemic threshold for 16 consecutive weeks, peaking at 10.8%, the highest percentage reported since the 2014–15 season, when NCHS mortality data were first presented for routine influenza surveillance purposes. The cumulative hospitalization rate for laboratory-confirmed influenza for all ages combined and for the three adult age groups was the highest documented since the system expanded to include adults

FIGURE 3. Influenza season severity classification,* by age group and season — United States, 2003–04 through 2017–18 seasons†



* CDC began using a new method in 2017 to classify influenza season severity using three indicators: the percentage of visits to outpatient clinics for influenza-like illness (ILI) from ILINet, the rates of influenza-associated hospitalizations from FluSurv-Net, and the percentage of deaths resulting from pneumonia or influenza from the National Center for Health Statistics. This method was applied retrospectively, going back to the 2003–04 influenza season. https://www.cdc.gov/flu/professionals/classifies-flu-severity.htm.

† As of June 1, 2018.

during the 2005–06 season. Although the hospitalization rates for children this season did not exceed the rates reported during the 2009 pandemic, they surpassed rates reported in previous high severity A(H3N2)-predominant seasons. These hospitalization rates are not adjusted for testing practices, which can vary from season to season; therefore, caution should be used when comparing hospitalization rates across seasons.

Influenza-associated pediatric mortality became a nationally notifiable condition in 2004. Excluding the 2009 pandemic, the previous highest number of pediatric deaths was reported during the 2012–13 season. The 171 pediatric deaths reported so far this season, approximately half in otherwise healthy children, equal the numbers reported during 2012–13 season. Although A(H3N2) was the predominant subtype circulating, there was substantial diversity in type and subtype of influenza infections leading to death in children. Less than one fourth (22%) of vaccine-eligible children who died from influenza this season had received influenza vaccine before illness onset.

Analysis of the influenza A(H3N2), A(H1N1)pdm09, and B/Yamagata lineage viruses showed that circulating viruses were antigenically similar to the cell-grown reference viruses representing the 2017–18 Northern Hemisphere influenza vaccine viruses. The majority of U.S.-produced influenza vaccines use egg-based manufacturing and viruses adapted for growth in eggs. Amino acid changes in these egg-adapted viruses might contribute to differences in antigenicity from circulating viruses. Although this can occur in all types/subtypes, it was most evident in circulating A(H3N2) viruses, where half showed reduced inhibition by antisera to the egg-adapted vaccine reference virus. Whereas the overall number of circulating B/Victoria viruses was low, a substantial amount of antigenic drift from the vaccine reference virus B/Brisbane/60/2008 was observed.

Interim estimates of the effectiveness of the 2017–18 inactivated influenza vaccines against medically attended respiratory illness published in February 2018 were 36% (95% confidence interval [CI] = 27%–44%) overall, 25% (CI = 13%–36%) against illness caused by influenza A(H3N2) viruses, 67% (CI = 54%–76%) against illness caused by influenza A(H1N1) pdm09, and 42% (CI = 25%–56%) against illness caused by influenza B viruses (*9*). Even during seasons when vaccine effectiveness is reduced, vaccination can offer substantial benefit and reduce the likelihood of severe outcomes, including hospitalization and death. This season's estimates will be published later this year; however, during the 2016–17 season, vaccination averted an estimated 5.29 million illnesses,[††††]

[††††] https://www.cdc.gov/flu/about/disease/2016-17.htm.

Summary

What is already known about this topic?

CDC collects, compiles, and analyzes data on influenza activity and viruses in the United States.

What is added by this report?

The 2017–18 influenza season was a high severity, A(H3N2)-predominant season. Influenza activity indicators were notable for the volume and intensity of influenza cases that occurred in most of the country at the same time. Record hospitalization rates and high numbers of influenza-associated pediatric deaths also were reported.

What are the implications for public health practice?

Receiving a seasonal flu vaccine each year remains the best way to protect against seasonal influenza and its potentially severe consequences. Testing for seasonal influenza viruses and monitoring for novel influenza A virus infections should continue year-round.

2.64 million medical visits, and 84,700 influenza-associated hospitalizations.

The timing of the peaks for certain influenza surveillance indicators this season was unusual. Influenza activity in children typically precedes that in adults, and peak ILI and laboratory positivity percentages precede the peak in hospitalizations, followed by the mortality peak. In this season, influenza-associated hospitalizations and mortality peaked earlier than the percentage of specimens testing positive for influenza in clinical laboratories and the percentage of outpatient visits for ILI. Influenza activity peaked among older adults earlier than among children and young adults; this also occurred, to a lesser extent, during the 2016–17 season (*5*).

Previous influenza A(H3N2)-predominant seasons have also been associated with increased hospitalizations and deaths; however, the 2017–18 season followed an A(H3N2)-predominant season, and all severity indicators were higher than during the 2016–17 season. The majority of A(H3N2) viruses were genetically characterized as 3C.2a clade, similar, but genetically distinct from the 3C.2a1 subclade that predominated during the 2016–17 season, and from the viruses that circulated during Australia's 2017 influenza season (*7*,*10*). Outside the United States and Canada, A(H3N2) viruses did not predominate in other Northern hemisphere temperate countries. Further studies are needed to understand the virologic, host, or environmental factors responsible for this high severity season.

The severity of this influenza season highlights the importance of public health measures to control and prevent influenza. Annual influenza vaccination remains the most effective way to prevent influenza illness. Although influenza activity in the United States is typically low during the summer, influenza cases and outbreaks can occur, and clinicians should consider influenza in the differential diagnosis of respiratory illnesses at any time of year. CDC recommends prompt treatment with influenza antiviral medications for persons with confirmed or suspected influenza who are severely ill or at high risk for serious influenza complications. Health care providers should consider novel influenza virus infections in persons with ILI and swine or poultry exposure, or with severe acute respiratory infection after travel to areas where avian influenza viruses have been detected. Providers should alert the local public health department if novel influenza virus infection is suspected. Clinical laboratories using a commercially available influenza diagnostic assay that includes influenza A virus subtype determination should contact their state public health laboratory to facilitate transport and additional testing of any unsubtypeable influenza A–positive specimen. Public health laboratories should immediately send unsubtypeable influenza A viruses to CDC, because early identification and investigation are critical to ensuring timely risk assessment and implementation of appropriate public health measures.

Influenza surveillance reports for the United States are posted online weekly (https://www.cdc.gov/flu/weekly). Additional information regarding influenza viruses, influenza surveillance, influenza vaccine, influenza antiviral medications, and novel influenza A infections in humans is available online (https://www.cdc.gov/flu).

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State, county, city, and territorial health departments and public health laboratories; U.S. World Health Organization collaborating laboratories; National Respiratory and Enteric Virus Surveillance System laboratories; U.S. Outpatient Influenza-Like Illness Surveillance Network sites; National Center for Health Statistics, CDC; World Health Organization, FluNet; Angie Foust, Elisabeth Blanchard, Priya Budhathoki, Thomas Rowe, Lizheng Guo, LaShondra Berman, Shannon Emery, Janná Murray, Ji Liu, Bo Shu, Brian Lynch, Ewelina Lyszkowicz, Shoshona Le, Malania Wilson, Juliana DaSilva, Alma Trujillo, Thomas Stark, Samuel Shepard, Sujatha Seenu, Ha Nguyen, Vasiliy Mishin, Juan De la Cruz, Catherine Smith, Roxana Cintron, Norman Hassell, Influenza Division, National Center for Immunization and Respiratory Diseases, CDC.

Conflict of Interest

No conflicts of interest were reported.

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Morbidity and Mortality Weekly Report

Update: ACIP Recommendations for the Use of Quadrivalent Live Attenuated Influenza Vaccine (LAIV4) — United States, 2018–19 Influenza Season

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Intranasally administered live attenuated influenza vaccine (LAIV) was initially licensed in the United States in 2003 as a trivalent formulation (LAIV3) (FluMist, MedImmune, LLC). Quadrivalent live attenuated influenza vaccine (LAIV4) (FluMist Quadrivalent, MedImmune) has been licensed in the United States since 2012 and was first available during the 2013–14 influenza season, replacing LAIV3. During the 2016–17 and 2017–18 influenza seasons, the Advisory Committee on Immunization Practices (ACIP) recommended that LAIV4 not be used because of concerns about low effectiveness against influenza A(H1N1)pdm09-like viruses circulating in the United States during the 2013–14 and 2015–16 seasons (*1*,*2*). On February 21, 2018, ACIP recommended that LAIV4 be an option for influenza vaccination of persons for whom it is appropriate for the 2018–19 season (*3*). This document provides an overview of the information discussed in the decision-making process leading to this recommendation. A description of methodology and data reviewed will be included in the background materials that will supplement the 2018–19 ACIP Influenza Recommendations, which will replace the 2017–18 ACIP influenza statement (*2*), and which will also contain guidance for the use of LAIV4.

Before the 2009 influenza A(H1N1) pandemic, three randomized trials noted superior relative efficacy of LAIV3 compared with trivalent inactivated influenza vaccine (IIV3) among children (*4*–*6*). However, LAIV4 demonstrated no statistically significant effectiveness against influenza A(H1N1)pdm09-like viruses among children aged 2 through 17 years in U.S. studies conducted during the 2013–14 and 2015–16 seasons (*7*–*12*), during which these viruses predominated. This lack of effectiveness was postulated as attributable to decreased replicative fitness of the influenza A(H1N1)pdm09-like viruses included in LAIV4 during those seasons (A/California/7/2009 for 2013–14 and A/Bolivia/559/2013 for 2015–16) (*13*). Investigations into the potential cause of this reduced effectiveness against influenza A(H1N1)pdm09 revealed that these LAIV viruses exhibited reduced replication in human nasal epithelial cells, compared with prepandemic influenza A(H1N1) LAIV viruses. For the 2017–18 season, a new influenza A(H1N1)pdm09-like virus (A/Slovenia/2903/2015) was included in LAIV4, replacing A/Bolivia/559/2013. However, LAIV4 was not recommended for use in the United States during 2017–18, and no U.S. effectiveness estimates were available.

Methods

Data from three sources were presented to ACIP for discussion. These included 1) an analysis of the effectiveness of LAIV4 and inactivated influenza vaccines for the 2013–14 through 2015–16 seasons among children aged 2 through 17 years, using pooled data from five U.S. observational studies (*3*); 2) a systematic review of published literature regarding the effectiveness of LAIV3 and LAIV4 among children during the 2010–11 through 2016–17 seasons (*3*); and 3) a study conducted by the manufacturer that evaluated viral shedding and immunogenicity associated with LAIV4 containing the new influenza A(H1N1)pdm09-like virus (A/Slovenia/2903/2015) among U.S. children aged 24 months through <4 years (*14*).

Summary of Data Reviewed

Review of LAIV effectiveness data for previous seasons in the United States confirms low to no significant effectiveness of LAIV against influenza A(H1N1)pdm09-like viruses. However, LAIV was generally effective against influenza B viruses and was of similar effectiveness to IIV against influenza A(H3N2) viruses. No effectiveness estimates were available for the current formulation of LAIV4 containing A/Slovenia/2903/2015 against influenza A(H1N1)pdm09-like viruses at the time of the review (*3*).

Data presented by the manufacturer indicated that the new LAIV4 influenza A(H1N1)pdm09-like virus, A/Slovenia/2903/2015, was shed by a higher proportion of children during days 4 through 7 following the first of 2 doses of vaccine. A/Slovenia/2903/2015 induced significantly higher antibody responses than its predecessor, A/Bolivia/559/2013. Seroconversion rates to A/Slovenia/2903/2015 were comparable to those obtained in response to prepandemic influenza A(H1N1) LAIV strains used during seasons in which the vaccine was observed to be effective against A(H1N1) influenza viruses (*14*).

The manufacturer also summarized information from previous presentations to ACIP concerning new candidate vaccine virus evaluation techniques that were employed in their investigation to identify the cause of low LAIV4 effectiveness, and how these techniques will be used going forward (*14*,*15*). Specifically, it was reported that two additional methods will be employed in the evaluation and selection of candidate vaccine viruses for inclusion in LAIV4, and these data will be shared each year with the Food and Drug Administration. Replicative fitness of candidate strains will be evaluated in human nasal epithelial cell culture. Previous methods using eggs and Madin-Darby canine kidney (MDCK) cell culture were found not to be predictive of replication of influenza A(H1N1)pdm09-like LAIV viruses in human cells. In addition, infectivity of vaccine viruses will be quantified using both 50% tissue culture infective dose ($TCID_{50}$) and fluorescent focus assay (FFA), instead of FFA only. Whereas FFA measures expression of viral antigens on the cell surface and does not require multiple rounds of viral replication, $TCID_{50}$ measures the spread of vaccine virus between cells through sustained replication cycles. Evaluation of influenza A(H1N1)pdm09-like viruses used in the 2013–14 (A/California/7/2009) and 2015–16 (A/Bolivia/559/2013) vaccines revealed that viral titers obtained via $TCID_{50}$ were substantially lower than those obtained via FFA, indicating that these viruses were less able to sustain multiple rounds of replication. For A/Slovenia/2903/2015, the titers obtained via these two methods are similar and were comparable to those associated with prepandemic influenza A(H1N1) viruses with known efficacy (*15*).

Discussion

Analyses of data from 2010–11 through 2016–17 indicate that LAIV was effective against influenza B viruses, and effectiveness against influenza A(H3N2) viruses was similar to that of inactivated influenza vaccines. During this period, LAIV was poorly effective among children aged 2 through 17 years against influenza A(H1N1)pdm09 viruses in the United States. Shedding and immunogenicity data provided by the manufacturer suggest that the new influenza A(H1N1)pdm09-like virus included in the current LAIV4, A/Slovenia/2903/2015, has improved replicative fitness over previous LAIV4 influenza A(H1N1)pdm09-like vaccine strains. However, no published effectiveness estimates for this formulation of the vaccine against influenza A(H1N1)pdm09 viruses were yet available because influenza A(H3N2) and influenza B viruses have predominated during the 2017–18 Northern Hemisphere season.

Effectiveness of influenza vaccines varies and is affected by many factors, including age and health status of the recipient, influenza type and subtype, prior influenza vaccination history, and degree of antigenic match between the vaccine and circulating viruses. It is possible that the vaccine effectiveness also differs among different individual vaccine products (for example, different IIVs); however, product-specific comparative effectiveness data are lacking for most vaccines. Although U.S. national influenza vaccination coverage among children did not decline substantially overall during the 2016–17 season (the first season in which it was recommended that LAIV not be used) (*3*), overall vaccination coverage remains suboptimal. Additional options for vaccination of children, including use of noninjectable vaccines such as LAIV4, might provide a means to improve coverage, particularly in school-based settings.

Recommendation of the ACIP

For the 2018–19 U.S. influenza season, providers may choose to administer any licensed, age-appropriate influenza vaccine (IIV, recombinant influenza vaccine [RIV], or LAIV4). LAIV4 is an option for those for whom it is otherwise appropriate. No preference is expressed for any influenza vaccine product. ACIP will continue to review data concerning the effectiveness of LAIV4 as they become available. Providers should be aware that the effectiveness of the updated LAIV4 containing A/Slovenia/2903/2015 against currently circulating influenza A(H1N1)pdm09-like viruses is not yet known.

Conflict of Interest

Emmanuel B. Walter reports grants from Novartis V&D, Novavax, and Merck & Co, outside the submitted work. No other conflicts of interest were reported.

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Notes from the Field

Crimean-Congo Hemorrhagic Fever Outbreak — Central Uganda, August–September 2017

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On August 20, 2017, physicians in two noncontiguous districts in central Uganda (Kyankwanzi and Nakaseke) reported two unrelated cases of Crimean-Congo hemorrhagic fever (CCHF). CCHF is the most widespread tickborne viral hemorrhagic fever in the world and represents a global health security threat (*1–3*); a single case of CCHF constitutes an outbreak. Humans are infected through tick bites or contact with the blood or body fluids of infected persons or animals. Treatment of infected patients is supportive, and the case-fatality rate ranges from 3%–40% (*2*,*3*). No licensed vaccine is available (*2*). Although CCHF cases were first reported in Uganda between 1958 and 1977, no subsequent cases were reported until 2013, when enhanced viral hemorrhagic fever surveillance capacity began to identify CCHF outbreaks (*3–5*).

The two cases were confirmed by serology and reverse-transcription–polymerase chain reaction (RT-PCR) testing at the Uganda Virus Research Institute (UVRI), a specimen referral system established in 2013 with assistance from CDC/Uganda in an effort to advance the global health security agenda (*5*). Upon confirmation of the two cases, the Uganda Ministry of Health deployed a team to investigate on August 22, 2017. A suspected case was defined as sudden onset of fever >100.4°F (38°C) for ≥3 days during July 1–September 30, 2017, plus either spontaneous bleeding or bruising, or laboratory evidence of unexplained leukopenia or thrombocytopenia in a resident of either of the two affected districts. A confirmed case was one that tested positive for CCHF by both RT-PCR and immunoglobulin M serology (*4*).

To identify cases, medical records of patients seen at area referral hospitals with fever and bleeding symptoms were reviewed. An active case search was also conducted in the affected communities. In addition to the two initial patients with confirmed cases, both of whom survived, among 23 medical records reviewed, five additional patients met the suspected case definition, two of whom died. Symptom onset occurred during July 9–September 17, 2017. Specimens were unavailable for confirmatory CCHF testing from the five patients with suspected cases. All cases occurred in men aged 19–87 years; no secondary cases were found.

A case-control study was conducted to compare potential exposures of case-patients and controls. Controls (four per case) were selected from among case-patients' asymptomatic neighbors, matched by sex and age. Data on potential exposures, including tick bites or barehanded crushing of ticks, milking or butchering livestock, butchering wildlife, and caring for sick persons, were collected using a standardized questionnaire. Because infected animals might develop high viral load titers yet remain asymptomatic (*6*), blood samples were collected from cattle and goats from two farms where patients with confirmed cases worked and were tested using an enzyme-linked immunosorbent serologic assay.

Tick exposure was reported by four of seven suspected and confirmed case-patients and three of 28 (11%) controls (Mantel-Haenszel odds ratio = 11.0; Fisher exact 95% confidence interval [CI] = 1.1–112.0). At farms where patients with confirmed cases worked, 37 (60%) of 62 cattle and 5 (24%) of 21 goats were found to be seropositive for CCHF. Animals from these farms were quarantined for 1 month, during which time farm owners and workers were advised to use adequate protection when handling them.

A district rapid response team in each of the two affected districts was activated on August 23, 2017, including establishment of an emergency hotline for case reporting. Area hospitals designated isolation units for screening and isolating patients with suspected cases and collecting blood samples for testing at UVRI. Health care workers were trained in patient management and infection control; and district veterinary officers reached out to farmers, especially those whose farms had seropositive animals, regarding tick control (e.g., dipping livestock in acaricide concentrates). Community outreach concerning the signs, symptoms, and complications of CCHF and preventive measures was conducted via radio during August 24–September 30, 2017. Area residents were advised to avoid handling ticks with bare hands and to wear protective gear such as gloves, boots, and clothes to minimize their exposure risk while grazing livestock. No subsequent cases were reported after these measures were implemented. The rapid and coordinated response to this outbreak demonstrated the significant progress made to enhance global health security in Uganda.

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Ministry of Health of Uganda; CDC; World Health Organization; Uganda Virus Research Institute; Ministry of Agriculture, Animal Industry and Fisheries of Uganda; District Local Governments of Kiboga, Kyankwanzi, and Nakaseke.

Conflict of Interest

No conflicts of interest were reported.

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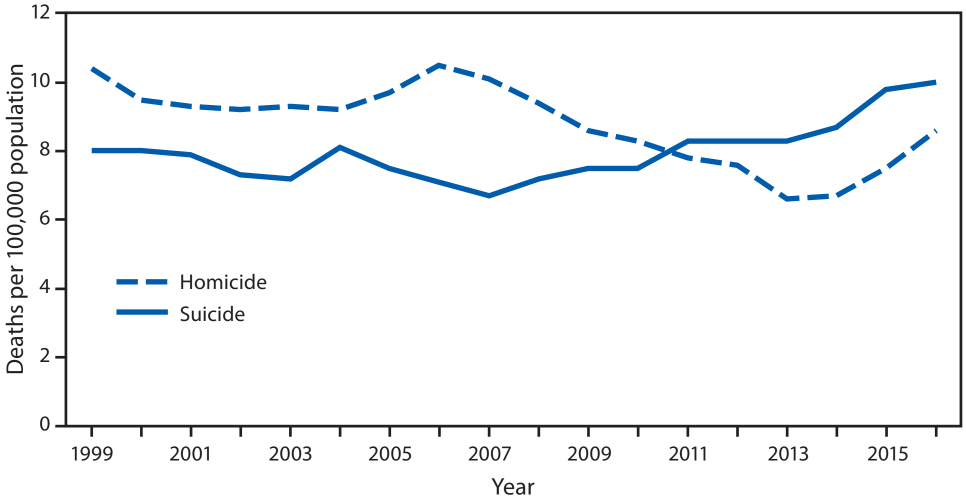
QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Homicide* and Suicide† Death Rates§ for Persons Aged 15–19 Years — National Vital Statistics System, United States, 1999–2016



* Homicides are identified with *International Classification of Diseases*, *Tenth Revision* codes X85–Y09, Y87.1, and U01–U02. In 2016, there were 1,816 homicides among persons aged 15–19 years.

† Suicides are identified with *International Classification of Diseases*, *Tenth Revision* codes X85–Y09, Y87.1, and U03. In 2016, there were 2,117 suicides among persons aged 15–19 years.

§ Rates are per 100,000 population aged 15–19 years.

In 1999, the homicide death rate for persons aged 15–19 years (10.4 per 100,000) was higher than the suicide rate (8.0). By 2010–2011, the homicide and suicide rates had converged. After 2011, the suicide rate increased to 10.0 in 2016; the homicide rate declined through 2013 but then increased to 8.6 in 2016.

Source: National Vital Statistics System. 1999–2016. https://www.cdc.gov/nchs/nvss/deaths.htm.

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

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