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# Suicide Rates by Major Occupational Group — 17 States, 2012 and 2015

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During 2000–2016, the suicide rate among the U.S. working age population (persons aged 16–64 years) increased 34%, from 12.9 per 100,000 population to 17.3 (https://www.cdc.gov/injury/wisqars). To better understand suicide among different occupational groups and inform suicide prevention efforts, CDC analyzed suicide deaths by Standard Occupational Classification (SOC) major groups for decedents aged 16–64 years from the 17 states participating in both the 2012 and 2015 National Violent Death Reporting System (NVDRS) (https://www.cdc.gov/violenceprevention/nvdrs). The occupational group with the highest male suicide rate in 2012 and 2015 was Construction and Extraction (43.6 and 53.2 per 100,000 civilian noninstitutionalized working persons, respectively), whereas the group with the highest female suicide rate was Arts, Design, Entertainment, Sports, and Media (11.7 [2012] and 15.6 [2015]). The largest suicide rate increase among males from 2012 to 2015 (47%) occurred in the Arts, Design, Entertainment, Sports, and Media occupational group (26.9 to 39.7) and among females, in the Food Preparation and Serving Related group, from 6.1 to 9.4 (54%). CDC's technical package of strategies to prevent suicide is a resource for communities, including workplace settings (*1*).

NVDRS combines data on all violent deaths (defined as those resulting from the intentional use of physical force or power, threatened or actual, against oneself, another person, or a group or community), including suicide, based on death certificates, coroner/medical examiner reports, and law enforcement reports. Data on usual lifetime occupation among 22,053 suicide decedents aged 16–64 years from the 17 states* that participated in NVDRS in 2012 and 2015 were analyzed. CDC's National Institute for Occupational Safety and Health Industry and Occupation Computerized Coding System (NIOCCS 3.0) (https://wwwn.cdc.gov/nioccs3) was used to assign 2010 U.S. Census civilian occupation and industry codes to NVDRS decedent records based on decedents' usual lifetime occupation and industry as reported on the death certificate. Results are reported by 2010 SOC major groups, converted from U.S. Census codes by NIOCCS. Records that could not be coded by NIOCCS were manually coded using the NIOCCS computer-assisted feature. All coding assignments were reviewed by industry and occupation coding experts for accuracy.

Suicide counts are presented by year, sex, and usual lifetime occupational group. Suicide rates were calculated using annual

* Alaska, Colorado, Georgia, Kentucky, Maryland, Massachusetts, New Jersey, New Mexico, North Carolina, Ohio, Oklahoma, Oregon, Rhode Island, South Carolina, Utah, Virginia, and Wisconsin.

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civilian noninstitutionalized working population counts by occupational group (based on longest job held during the previous calendar year) from the Current Population Survey Annual Social and Economic Supplement (*2*) as the denominator; 95% confidence intervals (CIs) were calculated using the National Center for Health Statistics method for death rates (*3*). The rate change from 2012 to 2015 is presented for each occupational group by sex, as is each group's rank for rate change (i.e., where rank position 1 signifies the greatest suicide rate increase). Decedents whose NVDRS data from coroner/medical examiner reports or law enforcement reports indicated that the decedent was not employed at the time of death (unemployed, disabled, incarcerated, homemaker, or student) were excluded from rate calculations, as were decedents with military or unpaid occupations, and those with insufficient information to classify occupation. Separate analyses of suicide deaths among males in agriculture-related SOC detailed groups were conducted; such rates were not calculated for female decedents because of small numbers.

NIOCCS classified 83% (8,858 in 2012 and 9,508 in 2015) of decedent records (Table 1); this count includes those that the NIOCCS program determined to have insufficient information to classify occupation. After expert review of NIOCCS automated code assignments, 231 (3%) of 2012 records and 290 (3%) of 2015 records were recoded. The remaining 1,799 (2012) and 1,888 (2015) (17% for both years) records were coded using the NIOCCS computer-assisted feature. For 2012 and 2015 combined, 5,089 (23%) decedents were not included in suicide rate calculations because they were in the military, had unpaid occupations (e.g., did not work, homemaker, or student), or had insufficient information to classify lifetime occupation. Another 2,236 (10%) were excluded because they were not employed at the time of death.

In both 2012 and 2015, the largest percentage of male suicides (19%–20% of decedents) occurred among those in the Construction and Extraction group (SOC 47) (Table 2); the largest percentage of female suicides in both years occurred among decedents with unpaid occupations (29%). The largest percentage of female suicides among classifiable occupations occurred in the Office and Administrative Support group (SOC 43) in both years (15%). In both years, the highest suicide rates among males were in the Construction and Extraction group (43.6 in 2012 and 53.2 in 2015 per 100,000 civilian noninstitutionalized working persons) (Table 3). Among females, the highest suicide rates in both years were in the Arts, Design, Entertainment, Sports, and Media group (SOC 27) (11.7 in 2012 and 15.6 in 2015). Among males, the largest suicide rate increase from 2012 to 2015 (47%) occurred in the Arts, Design, Entertainment, Sports, and Media group (from 26.9 to 39.7), and among females (54%) in the Food Preparation and Serving Related group (SOC 35) (from 6.1 to 9.4). Rate changes among females in six SOC major groups were not reported because of small numbers (≤20 decedents in one or both years).

The 2012 and 2015 male suicide rates among Farmers, Ranchers, and Other Agricultural Managers (SOC 11–9013,

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**TABLE 1. Procedure for Identification of analysis cohort of suicide decedents, by occupation — National Violent Death Reporting System (NVDRS) — 17 U.S. states* 2012 and 2015**

| Analytic procedure | 2012 no. | 2015 no. |
|---|---|---|
| Suicide decedents obtained from NVDRS data set† | 12,811 | 13,967 |
| **Excluded before assignment of occupation code** | | |
| Aged <16 years or >64 years or missing sex | 2,154 | 2,571 |
| **Assignment of occupation code** | | |
| Assigned based on decedent usual lifetime occupation | 10,657 | 11,396 |
| Autocoded by NIOCCS | 8,858 | 9,508 |
| Manually reassigned using the NIOCCS computer-assisted feature | 231 | 290 |
| Manually assigned using the NIOCCS computer-assisted feature | 1,799 | 1,888 |
| **Rate analysis** | | |
| Decedents presumed to be in the labor force at time of death§ | 6,881 | 7,847 |

**Abbreviation:** NIOCCS = National Institute for Occupational Safety and Health Industry and Occupation Computerized Coding System.

* Alaska, Colorado, Georgia, Kentucky, Maryland, Massachusetts, New Jersey, New Mexico, North Carolina, Ohio, Oklahoma, Oregon, Rhode Island, South Carolina, Utah, Virginia, and Wisconsin.

† The total number of deaths (including suicides) reported in the NVDRS data set (June 2018) for the 17 U.S. states analyzed included 19,885 decedents in 2012 and 21,884 decedents in 2015.

§ Because annual U.S. population count data by occupational group reflects the longest held job in the previous year among civilian, noninstitutionalized persons, suicide decedents whose NVDRS data from coroner/medical examiner or law enforcement reports indicated no employment (e.g., retired, unemployed, disabled, incarcerated, home maker, or student) at the time of death were excluded from rate analysis. Decedents were excluded if NVDRS current occupation information contained any of the following: "student, unemp*, not empl*, laid off, retir*, disab*, incarcer*, inmate, prisoner, homemaker, home maker, housewife, house wife, never worked, or not working." Manual review of records excluded based on these criteria resulted in five records being reinstated (e.g., "student teacher" and two occupations listed for a decedent with just one occupation explicitly identified as retired).

**TABLE 2. Number and percentage of suicide decedents* in Standard Occupational Classification (SOC) major group, by year and sex — National Violent Death Reporting System, 17 states,† 2012 and 2015**

| | | Male | | Female | |
|---|---|---|---|---|---|
| SOC code | Occupational group | 2012 no. (%) | 2015 no. (%) | 2012 no. (%) | 2015 no. (%) |
| 11 | Management | 534 (8) | 611 (9) | 117 (7) | 118 (7) |
| 13 | Business and Financial Operations | 155 (2) | 145 (2) | 81 (5) | 84 (5) |
| 15 | Computer and Mathematical | 208 (3) | 237 (3) | 22 (1) | 32 (2) |
| 17 | Architecture and Engineering | 172 (3) | 167 (2) | 10 (1) | 15 (1) |
| 19 | Life, Physical, and Social Science | 56 (1) | 52 (1) | 15 (1) | 21 (1) |
| 21 | Community and Social Service | 41 (1) | 48 (1) | 39 (2) | 40 (2) |
| 23 | Legal | 54 (1) | 49 (1) | 34 (2) | 29 (2) |
| 25 | Education, Training, and Library | 91 (1) | 87 (1) | 82 (5) | 84 (5) |
| 27 | Arts, Design, Entertainment, Sports, and Media | 140 (2) | 186 (3) | 54 (3) | 76 (4) |
| 29 | Health Care Practitioners and Technical occupations | 145 (2) | 169 (2) | 220 (14) | 225 (12) |
| 31 | Health Care Support | 35 (1) | 34 (<1) | 97 (6) | 124 (7) |
| 33 | Protective Service | 232 (4) | 226 (3) | 29 (2) | 32 (2) |
| 35 | Food Preparation and Serving Related | 214 (3) | 301 (4) | 112 (7) | 154 (9) |
| 37 | Building and Grounds Cleaning and Maintenance | 316 (5) | 315 (4) | 36 (2) | 46 (3) |
| 39 | Personal Care and Service | 81 (1) | 85 (1) | 98 (6) | 102 (6) |
| 41 | Sales and Related | 555 (9) | 553 (8) | 170 (11) | 212 (12) |
| 43 | Office and Administrative Support | 244 (4) | 260 (4) | 234 (15) | 268 (15) |
| 45 | Farming, Fishing, and Forestry | 68 (1) | 71 (1) | 7 (<1) | 5 (<1) |
| 47 | Construction and Extraction | 1,216 (19) | 1,404 (20) | 12 (1) | 17 (1) |
| 49 | Installation, Maintenance, and Repair | 549 (9) | 621 (9) | 8 (1) | NR |
| 51 | Production | 605 (9) | 679 (10) | 64 (4) | 81 (4) |
| 53 | Transportation and Material Moving | 736 (11) | 817 (11) | 52 (3) | 39 (2) |
| NA | Military | 228 (3) | 203 (2) | 15 (1) | 13 (<1) |
| NA | Unpaid | 822 (10) | 913 (11) | 724 (29) | 795 (29) |
| NA | Insufficient Information to Classify Occupation | 651 (8) | 425 (5) | 177 (9) | 123 (4) |

**Abbreviation:** NA = not assigned; NR = not reported due to cell size <5.

* Aged 16–64 years.

† Alaska, Colorado, Georgia, Kentucky, Maryland, Massachusetts, New Jersey, New Mexico, North Carolina, Ohio, Oklahoma, Oregon, Rhode Island, South Carolina, Utah, Virginia, and Wisconsin.

a subgroup of the SOC 11 Management major group) were 44.9 (CI = 34.2–57.9) and 32.2 (CI = 24.2–42.0) per 100,000, based on 59 and 54 suicides in 2012 and 2015, respectively. The 2012 and 2015 male suicide rates for Agricultural Workers (SOC 45–2000, a subgroup of the SOC 45 Farming, Fishing, and Forestry major group) were 20.4 (CI = 13.8–29.1) and 17.3 (CI = 12.1–23.9), based on 30 and 36 suicides in 2012 and 2015, respectively.

## Discussion

Suicide rates varied widely across occupational groups in both 2012 and 2015, and rates among males and females increased in many occupational groups. The etiology of suicide is multifactorial, and identifying the specific role that occupational factors might play in suicide risk is complicated; both work (e.g., little job control or job insecurity) and nonwork (e.g., relationship conflict) factors are associated with psychological distress and suicide (*4*). The relationship between occupation and suicide might be confounded by access to lethal means on the job and socioeconomic factors such as lower income and education (*5*,*6*). Previous studies have employed a range of methodologies to study the proposed association between suicide and occupation and, at times, have arrived at different conclusions. For example, although this analysis aligns with another that found high suicide rates among construction workers in Colorado (*7*), a meta-analysis using an international occupational classification system found persons in other less-skilled occupations, such as laborers and cleaners, to be at higher risk (*6*).

A better understanding of how suicides are distributed by occupational group might help inform prevention programs and policies. Because many adults spend a substantial amount of their time at work, the workplace is an important but underutilized location for suicide prevention (*8*). Workplaces could potentially benefit from suicide prevention activities.

**TABLE 3. Suicide rate per 100,000 civilian, noninstitutionalized working persons aged 16–64 years, by sex, based on suicide decedents (N = 14,728) presumed in the labor force at time of death using Standard Occupational Classification (SOC) major groups — National Violent Death Reporting System, 17 states,* 2012 and 2015**

| Males | | | | | | Females | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SOC code | Occupational group | 2012 | 2015 | Rate change % | Rank† | SOC code | Occupational group | 2012 | 2015 | Rate change % | Rank† |
| **47** | **Construction and Extraction** | | | | | **27** | **Arts, Design, Entertainment, Sports, and Media** | | | | |
| | Rate rank§ | 1 | 1 | +22% | 5 | | Rate rank§ | 1 | 1 | +34% | 2 |
| | Rate per 100,000 | 43.6 | 53.2 | | | | Rate per 100,000 | 11.7 | 15.6 | | |
| | 95% CI¶ | 40.9–46.3 | 50.2–56.1 | | | | 95% CI¶ | 8.6–15.5 | 12.1–19.8 | | |
| | Suicide decedents, no. | 1,009 | 1,248 | | | | Suicide decedents, no. | 47 | 67 | | |
| | Population, no. | 2,313,934 | 2,345,952 | | | | Population, no. | 403,305 | 429,424 | | |
| **27** | **Arts, Design, Entertainment, Sports, and Media** | | | | | **33** | **Protective Service** | | | | |
| | Rate rank | 7 | 2 | +47% | 1 | | Rate rank | 2 | 2 | +5% | 9 |
| | Rate per 100,000 | 26.9 | 39.7 | | | | Rate per 100,000 | 11.6 | 12.2 | | |
| | 95% CI | 22.1–31.8 | 33.6–45.8 | | | | 95% CI | 7.5–17.1 | 8.1–17.7 | | |
| | Suicide decedents, no. | 117 | 162 | | | | Suicide decedents, no. | 25 | 28 | | |
| | Population, no. | 434,177 | 408,113 | | | | Population, no. | 215,345 | 228,862 | | |
| **49** | **Installation, Maintenance, and Repair** | | | | | **31** | **Health Care Support** | | | | |
| | Rate rank | 2 | 3 | +24% | 3 | | Rate rank | 5 | 3 | +31% | 3 |
| | Rate per 100,000 | 31.6 | 39.1 | | | | Rate per 100,000 | 8.4 | 11.0 | | |
| | 95% CI | 28.7–34.4 | 35.8–42.3 | | | | 95% CI | 6.7–10.4 | 8.9–13.0 | | |
| | Suicide decedents, no. | 473 | 542 | | | | Suicide decedents, no. | 83 | 108 | | |
| | Population, no. | 1,498,263 | 1,387,681 | | | | Population, no. | 993,407 | 984,369 | | |
| **53** | **Transportation and Material Moving** | | | | | **35** | **Food Preparation and Serving Related** | | | | |
| | Rate rank | 4 | 4 | +9% | 8 | | Rate rank | 11 | 4 | +54% | 1 |
| | Rate per 100,000 | 28.4 | 30.9 | | | | Rate per 100,000 | 6.1 | 9.4 | | |
| | 95% CI | 26.2–30.7 | 28.6–33.1 | | | | 95% CI | 4.9–7.5 | 7.8–11.0 | | |
| | Suicide decedents, no. | 615 | 721 | | | | Suicide decedents, no. | 94 | 139 | | |
| | Population, no. | 2,164,530 | 2,336,133 | | | | Population, no. | 1,539,199 | 1,479,822 | | |
| **51** | **Production** | | | | | **23** | **Legal** | | | | |
| | Rate rank | 3 | 5 | +7% | 10 | | Rate rank | 3 | 5 | -17% | 15 |
| | Rate per 100,000 | 28.4 | 30.5 | | | | Rate per 100,000 | 11.1 | 9.2 | | |
| | 95% CI | 26.0–30.9 | 28.1–33.0 | | | | 95% CI | 7.5–15.9 | 5.8–13.9 | | |
| | Suicide decedents, no. | 524 | 607 | | | | Suicide decedents, no. | 30 | 22 | | |
| | Population, no. | 1,843,879 | 1,987,864 | | | | Population, no. | 269,243 | 238,870 | | |
| **33** | **Protective Service** | | | | | **29** | **Health Care Practitioners and Technical** | | | | |
| | Rate rank | 6 | 6 | +4% | 11 | | Rate rank | 4 | 6 | -13% | 13 |
| | Rate per 100,000 | 27.1 | 28.2 | | | | Rate per 100,000 | 10.3 | 9.0 | | |
| | 95% CI | 23.3–30.9 | 24.2–32.1 | | | | 95% CI | 8.9–11.8 | 7.7–10.3 | | |
| | Suicide decedents, no. | 198 | 194 | | | | Suicide decedents, no. | 195 | 193 | | |
| | Population, no. | 730,044 | 689,034 | | | | Population, no. | 1,890,885 | 2,140,217 | | |
| **37** | **Building and Grounds Cleaning and Maintenance** | | | | | **51** | **Production** | | | | |
| | Rate rank | 5 | 7 | -2% | 14 | | Rate rank | 7 | 7 | +18% | 6 |
| | Rate per 100,000 | 27.3 | 26.8 | | | | Rate per 100,000 | 7.6 | 9.0 | | |
| | 95% CI | 24.1–30.5 | 23.6–30.0 | | | | 95% CI | 5.8–10.0 | 7.0–11.3 | | |
| | Suicide decedents, no. | 281 | 276 | | | | Suicide decedents, no. | 55 | 72 | | |
| | Population, no. | 1,028,779 | 1,029,385 | | | | Population, no. | 719,183 | 800,640 | | |
| **29** | **Health Care Practitioners and Technical** | | | | | **39** | **Personal Care and Service** | | | | |
| | Rate rank | 14 | 8 | +23% | 4 | | Rate rank | 9 | 8 | +14% | 7 |
| | Rate per 100,000 | 20.8 | 25.6 | | | | Rate per 100,000 | 6.8 | 7.7 | | |
| | 95% CI | 17.1–24.6 | 21.5–29.8 | | | | 95% CI | 5.5–8.4 | 6.2–9.5 | | |
| | Suicide decedents, no. | 119 | 145 | | | | Suicide decedents, no. | 89 | 92 | | |
| | Population, no. | 571,387 | 565,768 | | | | Population, no. | 1,308,535 | 1,187,811 | | |

See table footnotes on page 1258.

**TABLE 3. (*Continued*) Suicide rate per 100,000 civilian, noninstitutionalized working persons aged 16–64 years, by sex, based on suicide decedents (N = 14,728) presumed in the labor force at time of death using Standard Occupational Classification (SOC) major groups — National Violent Death Reporting System, 17 states,* 2012 and 2015**

| Males | | | | | | Females | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SOC code | Occupational group | 2012 | 2015 | Rate change % | Rank† | SOC code | Occupational group | 2012 | 2015 | Rate change % | Rank† |
| **45** | **Farming, Fishing, and Forestry** | | | | | **41** | **Sales and Related** | | | | |
| | Rate rank | 8 | 9 | -13% | 21 | | Rate rank | 10 | 9 | +20% | 5 |
| | Rate per 100,000 | 26.3 | 22.8 | | | | Rate per 100,000 | 6.4 | 7.7 | | |
| | 95% CI | 20.0–34.0 | 17.7–29.0 | | | | 95% CI | 5.3–7.4 | 6.6–8.7 | | |
| | Suicide decedents, no. | 58 | 67 | | | | Suicide decedents, no. | 148 | 192 | | |
| | Population, no. | 220,364 | 293,746 | | | | Population, no. | 2,325,223 | 2,505,186 | | |
| **41** | **Sales and Related** | | | | | **15** | **Computer and Mathematical** | | | | |
| | Rate rank | 11 | 10 | +1% | 12 | | Rate rank | NR | 10 | NR | NR |
| | Rate per 100,000 | 21.3 | 21.5 | | | | Rate per 100,000 | NR | 7.3 | | |
| | 95% CI | 19.4–23.2 | 19.6–23.4 | | | | 95% CI | NR | 5.0–10.5 | | |
| | Suicide decedents, no. | 487 | 489 | | | | Suicide decedents, no. | 20 | 30 | | |
| | Population, no. | 2,282,361 | 2,276,666 | | | | Population, no. | 390,260 | 408,410 | | |
| **35** | **Food Preparation and Serving Related** | | | | | **53** | **Transportation and Material Moving** | | | | |
| | Rate rank | 19 | 11 | +43% | 2 | | Rate rank | 6 | 11 | -17% | 14 |
| | Rate per 100,000 | 14.6 | 20.9 | | | | Rate per 100,000 | 8.3 | 6.9 | | |
| | 95% CI | 12.5–16.7 | 18.4–23.3 | | | | 95% CI | 6.0–11.2 | 4.8–9.7 | | |
| | Suicide decedents, no. | 180 | 276 | | | | Suicide decedents, no. | 43 | 33 | | |
| | Population, no. | 1,234,381 | 1,321,800 | | | | Population, no. | 517,082 | 477,143 | | |
| **31** | **Health Care Support** | | | | | **21** | **Community and Social Service** | | | | |
| | Rate rank | 9 | 12 | -12% | 18 | | Rate rank | 8 | 12 | -17% | 16 |
| | Rate per 100,000 | 22.1 | 19.5 | | | | Rate per 100,000 | 7.3 | 6.0 | | |
| | 95% CI | 14.8–31.7 | 12.5–29.0 | | | | 95% CI | 5.1–10.2 | 4.2–8.4 | | |
| | Suicide decedents, no. | 29 | 24 | | | | Suicide decedents, no. | 34 | 36 | | |
| | Population, no. | 131,497 | 123,003 | | | | Population, no. | 464,942 | 595,582 | | |
| **17** | **Architecture and Engineering** | | | | | **43** | **Office and Administrative Support** | | | | |
| | Rate rank | 10 | 13 | -10% | 15 | | Rate rank | 14 | 13 | +27% | 4 |
| | Rate per 100,000 | 21.6 | 19.4 | | | | Rate per 100,000 | 4.7 | 6.0 | | |
| | 95% CI | 18.1–25.1 | 16.3–22.6 | | | | 95% CI | 4.1–5.4 | 5.2–6.8 | | |
| | Suicide decedents, no. | 145 | 147 | | | | Suicide decedents, no. | 201 | 239 | | |
| | Population, no. | 670,938 | 756,515 | | | | Population, no. | 4,267,892 | 3,985,105 | | |
| **23** | **Legal** | | | | | **13** | **Business and Financial Operations** | | | | |
| | Rate rank | 12 | 14 | -12% | 19 | | Rate rank | 12 | 14 | -5% | 11 |
| | Rate per 100,000 | 21.3 | 18.7 | | | | Rate per 100,000 | 5.7 | 5.4 | | |
| | 95% CI | 15.7–28.2 | 13.4–25.4 | | | | 95% CI | 4.4–7.2 | 4.2–6.8 | | |
| | Suicide decedents, no. | 48 | 41 | | | | Suicide decedents, no. | 70 | 71 | | |
| | Population, no. | 225,681 | 219,171 | | | | Population, no. | 1,235,880 | 1,321,724 | | |
| **11** | **Management** | | | | | **37** | **Building and Grounds Cleaning and Maintenance** | | | | |
| | Rate rank | 17 | 15 | +8% | 9 | | Rate rank | 15 | 15 | +14% | 8 |
| | Rate per 100,000 | 16.4 | 17.8 | | | | Rate per 100,000 | 4.6 | 5.2 | | |
| | 95% CI | 14.9–17.9 | 16.3–19.3 | | | | 95% CI | 3.1–6.5 | 3.7–7.2 | | |
| | Suicide decedents, no. | 477 | 530 | | | | Suicide decedents, no. | 31 | 36 | | |
| | Population, no. | 2,906,468 | 2,981,498 | | | | Population, no. | 673,483 | 688,809 | | |
| **39** | **Personal Care and Service** | | | | | **11** | **Management** | | | | |
| | Rate rank | 13 | 16 | -21% | 22 | | Rate rank | 13 | 16 | -12% | 12 |
| | Rate per 100,000 | 20.9 | 16.5 | | | | Rate per 100,000 | 5.6 | 4.9 | | |
| | 95% CI | 16.2–26.4 | 12.9–20.7 | | | | 95% CI | 4.5–6.7 | 4.0–5.9 | | |
| | Suicide decedents, no. | 68 | 73 | | | | Suicide decedents, no. | 104 | 103 | | |
| | Population, no. | 326,037 | 443,543 | | | | Population, no. | 1,855,055 | 2,083,968 | | |

See table footnotes on page 1258.

**TABLE 3. (*Continued*) Suicide rate per 100,000 civilian, noninstitutionalized working persons aged 16–64 years, by sex, based on suicide decedents (N = 14,728) presumed in the labor force at time of death using Standard Occupational Classification (SOC) major groups — National Violent Death Reporting System, 17 states,* 2012 and 2015**

| Males | | | | | | Females | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rate change | | | | | | Rate change | |
| SOC code | Occupational group | 2012 | 2015 | % | Rank† | SOC code | Occupational group | 2012 | 2015 | % | Rank† |
| **15** | **Computer and Mathematical** | | | | | **25** | **Education, Training, and Library** | | | | |
| | Rate rank | 15 | 17 | -11% | 16 | | Rate rank | 16 | 17 | +3% | 10 |
| | Rate per 100,000 | 18.1 | 16.1 | | | | Rate per 100,000 | 3.3 | 3.4 | | |
| | 95% CI | 15.5–20.8 | 13.9–18.4 | | | | 95% CI | 2.6–4.2 | 2.7–4.2 | | |
| | Suicide decedents, no. | 179 | 202 | | | | Suicide decedents, no. | 69 | 74 | | |
| | Population, no. | 986,994 | 1,252,275 | | | | Population, no. | 2,091,706 | 2,186,483 | | |
| **43** | **Office and Administrative Support** | | | | | **17** | **Architecture and Engineering** | | | | |
| | Rate rank | 20 | 18 | +12% | 7 | | Rate rank | NR | NR | NR | NR |
| | Rate per 100,000 | 14.1 | 15.8 | | | | Rate per 100,000 | NR | NR | | |
| | 95% CI | 12.2–16.1 | 13.7–17.9 | | | | 95% CI | NR | NR | | |
| | Suicide decedents, no. | 206 | 223 | | | | Suicide decedents, no. | 10 | 12 | | |
| | Population, no. | 1,456,242 | 1,411,453 | | | | Population, no. | 135,632 | 144,852 | | |
| **19** | **Life, Physical, and Social Science** | | | | | **19** | **Life, Physical, and Social Science** | | | | |
| | Rate rank | 16 | 19 | -13% | 20 | | Rate rank | NR | NR | NR | NR |
| | Rate per 100,000 | 17.3 | 15.0 | | | | Rate per 100,000 | NR | NR | | |
| | 95% CI | 12.7–23.0 | 11.0–20.0 | | | | 95% CI | NR | NR | | |
| | Suicide decedents, no. | 47 | 47 | | | | Suicide decedents, no. | 13 | 19 | | |
| | Population, no. | 271,690 | 312,925 | | | | Population, no. | 225,992 | 204,566 | | |
| **21** | **Community and Social Service** | | | | | **45** | **Farming, Fishing, and Forestry** | | | | |
| | Rate rank | 21 | 20 | +15% | 6 | | Rate rank | NR | NR | NR | NR |
| | Rate per 100,000 | 12.8 | 14.6 | | | | Rate per 100,000 | NR | NR | | |
| | 95% CI | 8.8–17.9 | 10.7–19.6 | | | | 95% CI | NR | NR | | |
| | Suicide decedents, no. | 33 | 45 | | | | Suicide decedents, no. | 7 | 5 | | |
| | Population, no. | 258,744 | 307,829 | | | | Population, no. | 54,068 | 91,967 | | |
| **13** | **Business and Financial Operations** | | | | | **47** | **Construction and Extraction** | | | | |
| | Rate rank | 18 | 21 | -11% | 17 | | Rate rank | NR | NR | NR | NR |
| | Rate per 100,000 | 14.6 | 13.0 | | | | Rate per 100,000 | NR | NR | | |
| | 95% CI | 12.1–17.2 | 10.7–15.3 | | | | 95% CI | NR | NR | | |
| | Suicide decedents, no. | 125 | 122 | | | | Suicide decedents, no. | 9 | 14 | | |
| | Population, no. | 855,329 | 941,806 | | | | Population, no. | 55,164 | 76,173 | | |
| **25** | **Education, Training, and Library** | | | | | **49** | **Installation, Maintenance, and Repair** | | | | |
| | Rate rank | 22 | 22 | -1% | 13 | | Rate rank | NR | NR | NR | NR |
| | Rate per 100,000 | 10.9 | 10.9 | | | | Rate per 100,000 | NR | NR | | |
| | 95% CI | 8.6–13.6 | 8.6–13.5 | | | | 95% CI | NR | NR | | |
| | Suicide decedents, no. | 78 | 79 | | | | Suicide decedents, no. | 8 | NR | | |
| | Population, no. | 713,321 | 727,167 | | | | Population, no. | 73,231 | 46,136 | | |

**Abbreviations:** CI = confidence interval; NR = not reported; number of decedents not reported <5, and rates were not calculated for occupational groups with ≤20 decedents; SOC = Standard Occupational Classification.

† Rate change rank refers to each occupational group's rank order for rate change from 2012 to 2015, where rank position 1 signifies the greatest suicide rate increase.

§ Occupational groups were ranked by 2015 suicide rate, separately for males and females. Because of rounding, some rate and rate change results are not precisely calculable from the data presented.

¶ 95% CIs were calculated using CDC's National Center for Health Statistics methods, including confidence limit factors for mortality rates based on <100 decedents.

Additional and tailored prevention approaches might be necessary to support workers at higher risk. Workplace suicide prevention efforts to date have focused primarily on early detection and tertiary intervention through the training of persons (i.e. gatekeepers) to identify those at risk for suicide and refer them to supporting services. However, more research on the role of the workplace in primary suicide prevention is needed, including improving working conditions and reducing stress (*8*).

The findings in this report are subject to at least four limitations. First, because of the nature of the data that were available, and consistent with previous research methods, this report compared decedents' usual lifetime occupation as recorded on the death certificate with occupations of the employed population to calculate suicide rates. Additional

**Summary**

What is already known about this topic?

From 2000 to 2016, the U.S. suicide rate among working aged (16–64 years) adults increased 34% from 12.9 per 100,000 population to 17.3.

What is added by this report?

2012 and 2015 National Violent Death Reporting System data from 17 states indicated the major occupational group with the highest male suicide rate was Construction and Extraction (43.6 [2012] and 53.2 [2015]). The Arts, Design, Entertainment, Sports, and Media major occupation group had the highest female suicide rate in 2012 (11.7) and 2015 (15.6).

What are the implications for public health practice?

A comprehensive approach to suicide prevention, including workplace-based approaches, is needed. CDC's technical package of strategies to prevent suicide is a resource for communities and workplaces to identify prevention strategies with the best available evidence.

data from coroner/medical examiner and law enforcement reports were used to exclude decedents identified as not in the labor force at time of death. Separate analyses indicated that if no such exclusion were applied, suicide rates would have been higher for all groups, although the top and bottom eight ranked occupational groups in 2015 by male suicide rate would maintain the same rank position, as would the top three and bottom four occupational groups by female suicide rate. Second, this report did not address confounding factors that might account for higher or lower rates of suicide between and within occupational groups, including education and income (*9*,*10*). Within SOC major occupational groups, employee education and income might vary widely. For example, the Management SOC major group includes farmers, ranchers, and chief executives of large companies, and the Construction and Extraction group includes both employees who might be salaried (e.g., supervisors) and those who might be paid hourly wages (e.g., roofer helpers). Future research might benefit from using more narrowly defined occupational groups and controlling for education and income to refine understanding of the relationship between occupation and suicide. Third, industry and occupation data obtained from death certificates rely on the accuracy and completeness of employment information provided by decedents' family members. It is also possible that completeness and accuracy of that information might be associated with decedents' job history. For example, categorization based on single lifetime industry and occupation might not accurately reflect employment for those persons with multiple lifetime occupations and those who worked across industries. Finally, this report is based on data from 17 U.S. states that participated in NVDRS in 2012 and 2015, and the data are not nationally representative.

To address the multifactorial etiology of suicide, CDC recommends a comprehensive approach to prevention (*1*). Strategies might include enhancing social connectedness and expanding access to relevant resources, strengthening state or local economic supports, implementing practices that encourage help-seeking and decrease stigma, and providing referrals to mental health and other services (*1*). Strategies can be implemented to assure support and reduce access to lethal means among persons at risk. Decision makers, including employers, can create a response plan, should a suicide affect their organization. Surviving family and friends can be supported to reduce their own suicide risk. The media can follow reporting recommendations to avoid sensationalized reporting and can refrain from providing details on suicide methods (*1*). Further workplace prevention resources are available at https://theactionalliance.org/, and help is available at 1-800-273-TALK.

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# Global Routine Vaccination Coverage — 2017

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Endorsed by the World Health Assembly in 2012, the *Global Vaccine Action Plan 2011–2020* (GVAP) (*1*) calls on all countries to reach ≥90% national coverage with all vaccines in the country's national immunization schedule by 2020. This report updates previous reports (*2*,*3*) and presents global, regional, and national vaccination coverage estimates and trends as of 2017. It also describes the number of infants surviving to age 1 year (surviving infants) who did not receive the third dose of diphtheria and tetanus toxoids and pertussis–containing vaccine (DTP3), a key indicator of immunization program performance (*4*,*5*), with a focus on the countries with the highest number of children who did not receive DTP3 in 2017. Based on the World Health Organization (WHO) and United Nations Children's Fund (UNICEF) estimates, global DTP3 coverage increased from 79% in 2007 to 84% in 2010, and has remained stable from 2010 to 2017 (84% to 85%). In 2017, among the 19.9 million children who did not receive DTP3 in the first year of life, 62% (12.4 million) lived in 10 countries. From 2007 to 2017, the number of children who had not received DTP3 decreased in five of these 10 countries and remained stable or increased in the other five. Similar to DTP3 coverage, global coverage with the first measles-containing vaccine dose (MCV1) increased from 80% in 2007 to 84% in 2010, and has remained stable from 2010 to 2017 (84% to 85%). Coverage with the third dose of polio vaccine (Pol3) has remained stable at 84%–85% since 2010. From 2007 to 2017, estimated global coverage with the second MCV dose (MCV2) increased from 33% to 67%, as did coverage with the completed series of rotavirus (2% to 28%), pneumococcal conjugate (PCV) (4% to 44%), rubella (26% to 52%), *Haemophilus influenzae* type b (Hib) (25% to 72%) and hepatitis B (HepB) (birth dose: 24% to 43%; 3-dose series: 63% to 84%) vaccines. Targeted, context-specific strategies are needed to reach and sustain high vaccination coverage, particularly in countries with the highest number of unvaccinated children.

In 1974, WHO established the Expanded Program on Immunization (EPI) to ensure that all children have access to four routinely recommended vaccines that protect against tuberculosis, diphtheria, tetanus, pertussis, polio, and measles (*4*): bacillus Calmette-Guérin vaccine (BCG), DTP, polio vaccine (Pol), and MCV. WHO and UNICEF derive national coverage estimates through an annual country-by-country review of all available data, including administrative and survey-based coverage (*5*,*6*); in general, only doses administered through routine immunization visits are counted.* DTP3 coverage by age 12 months is a key indicator of immunization program performance.

Despite increases in global DTP3 coverage from 79% in 2007 to 84% in 2010, DTP3 coverage has remained stable since 2010, estimated at 85% in 2017. In 2017, DTP3 coverage ranged from 72% in the WHO African Region to 97% in the Western Pacific Region (Table 1). National DTP3 coverage estimates ranged from 25% to 99%. Overall, 123 (63%) of 194 countries achieved ≥90% national DTP3 coverage in 2017, an increase from 117 countries (60%) in 2016. Among the 19.9 million children worldwide who did not receive 3 DTP doses during the first year of life, 12.4 million (62%) lived in 10 countries (Table 2). Among all children who did not complete the 3-dose DTP series in 2017, 13.7 million (69%) did not receive any DTP dose ("left out") and 6.2 million (31%) started, but did not complete the DTP series ("dropped out").

Globally, the annual number of surviving infants increased by 4% (5.7 million) from 130.5 million in 2007 to 136.2 million in 2017.† During this same period, global DTP3 coverage increased by 6% (from 79% to 85%), and the number of children who did not receive DTP3 decreased by 7.6 million (28%), from 27.5 to 19.9 million. Among the 10 countries with the highest number of children who had not received DTP3 in 2017, these trends varied. For example, during this period, the annual number of surviving infants decreased by 1.6 million (6%) in India, but remained stable or increased in nine of the other 10 countries (Table 2). DTP3 coverage increased in seven of these 10 countries and decreased in two. In Nigeria, the country with the largest number of children who had not received DTP3 in 2017, DTP3 coverage did not change during this period (Table 2). Among these countries, the number of children who had not received DTP3 decreased in the Democratic Republic of the Congo, Ethiopia, India, Indonesia and Pakistan, while

* For a given vaccine, the administrative coverage is calculated by dividing the number of vaccine doses administered to those in a specified target group by the estimated target population. Doses administered through routine immunization visits are counted, but doses administered through supplementary immunization activities (mass immunization campaigns) generally are not. During vaccination coverage surveys, a representative sample of households are visited and caregivers of children in a specified target group (e.g., aged 12–23 months) are interviewed. Dates of vaccination are transcribed from the child's home-based record, recorded based on caregiver recall, or transcribed from health facility records. Survey-based vaccination coverage is calculated as the proportion of persons in a target age group who received a vaccine dose.

† Source for the number of surviving infants is the United Nations population projections database. https://population.un.org/wpp/.

**TABLE 1. Vaccination coverage, by vaccine and World Health Organization region — worldwide, 2017**

| Vaccine | No. (%) countries with vaccine in schedule | Coverage* (%) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Global | African | Americas | Eastern Mediterranean | European | South-East Asia | Western Pacific |
| BCG | 158 (81) | 88 | 80 | 92 | 86 | 92 | 91 | 97 |
| HepB BD | 105 (54) | 43 | 10 | 69 | 34 | 41 | 44 | 85 |
| HepB3 | 188 (97) | 84 | 72 | 90 | 81 | 82 | 88 | 93 |
| DTP3 | 194 (100) | 85 | 72 | 91 | 81 | 94 | 88 | 97 |
| Hib3 | 191 (98) | 72 | 72 | 91 | 81 | 76 | 86 | 28 |
| Pol3 | 194 (100) | 85 | 71 | 90 | 81 | 93 | 88 | 97 |
| Rota_last | 96 (49) | 28 | 46 | 68 | 30 | 24 | 9 | 1 |
| PCV3 | 139 (72) | 44 | 68 | 82 | 52 | 70 | 12 | 16 |
| MCV1 | 194 (100) | 85 | 70 | 92 | 81 | 95 | 87 | 97 |
| RCV1 | 162 (84) | 52 | 26 | 92 | 46 | 95 | 21 | 97 |
| MCV2 | 167 (86) | 67 | 25 | 74 | 67 | 90 | 77 | 94 |

**Abbreviations:** BCG = Bacille Calmette-Guérin vaccine; DTP3 = third dose of diphtheria and tetanus toxoids and pertussis-containing vaccine; HepB BD = birth dose of hepatitis B vaccine; HepB3 = third dose of hepatitis B vaccine; Hib3 = third dose of *Haemophilus influenzae* type b vaccine; MCV1 = first dose of measles-containing vaccine; MCV2 = second dose of MCV; PCV3 = third dose of pneumococcal conjugate vaccine; Pol3 = third dose of polio vaccine; RCV1 = first dose of rubella-containing vaccine; Rota_last = final dose of rotavirus vaccine series (number of doses to complete the series varies among vaccine products).

* BCG coverage based on 158 countries with BCG in the national schedule, whereas coverage for all other vaccines based on 194 countries (global) or all countries in the specified region. Administrative coverage is the number of vaccine doses administered to those in a specified target group divided by the estimated target population. During vaccination coverage surveys, a representative sample of households are visited and caregivers of children in a specified target group (e.g., aged 12–23 months) are interviewed. Dates of vaccination are transcribed from the child's home-based record, recorded based on caregiver recall, or transcribed from health facility records. Survey-based vaccination coverage is calculated as the proportion of persons in a target age group who received a vaccine dose.

in Afghanistan, Angola, Iraq, Nigeria, and South Africa, the number remained stable or increased.

In 2007, 9.3 million children in India and 3.3 million children in Nigeria did not complete the 3-dose DTP series (Figure). Although the population eligible for DTP3 declined by 6% in India and increased by 23% in Nigeria during 2007–2017, DTP3 coverage increased by 24% in India, but did not change in Nigeria. In 2014, Nigeria surpassed India as the country with the highest number of children who had not received DTP3 (3.72 million in Nigeria, 3.65 million in India).

Similar to DTP3, global MCV1 coverage increased from 80% in 2007 to 84% in 2010 and remained stable from 2010 to 2017 (85%). In 2017, MCV1 coverage ranged from 70% in the African Region to 97% in the Western Pacific Region (Table 1) and from 20% to 99% by country. Globally, 118 (61%) countries achieved the GVAP 2020 target of ≥90% national MCV1 coverage (*1*,*7*). Similar to DTP3 and MCV1, global Pol3 coverage increased from 81% in 2007 to 84% in 2010 and remained stable from 2010 to 2017 (85%). Global MCV2 coverage by the end of the second year of life increased from 16% in 2007 to 52% in 2017 and from 33% to 67% when older age groups (3–14 years) were included. MCV2 coverage by WHO region varied from 25% in the African region to 94% in the Western Pacific region, including in countries that have not yet introduced MCV2[§] (Table 1).

[§] Whereas BCG coverage is based on 158 countries with BCG in the national schedule, coverage for all other vaccines, including MCV2, is based on 194 countries for global estimates or on all countries in the specified region for regional estimates. In 2017, 86% of countries had MCV2 in their schedule.

Among new and underused vaccines, global coverage with the completed rotavirus series increased from 2% to 28% during 2007–2017. Coverage also increased for PCV[¶] (4% to 44%), rubella (26% to 52%), Hib (25% to 72%), and HepB (birth dose: 24% to 43%; 3-dose series: 63% to 84%) vaccines (Table 1), as a result of both improvements in national coverages and new country introductions.

## Discussion

Substantial progress has been made in global vaccination coverage since the establishment of the EPI in 1974. Global coverage with DTP3 and MCV1 reached 85% in 2017, and global MCV2 coverage has doubled in the past decade. Challenges to achieving high routine immunization coverage remain, however, with only 63% and 61% of countries reaching the GVAP 2020 target of ≥90% national coverage for DTP3 and MCV1, respectively. Although global DTP3 coverage has remained stable for much of the past decade, this finding is not uniform across the 10 countries that are home to the highest number of children who have not received DTP3 in 2017, with increases in DTP3 coverage in seven countries, but decreased or unchanged coverage rates in three. Trends in MCV1 coverage from 2007 to 2017 are similar to those for DTP3, both globally and for the ten countries highlighted in this report (*7*).

Challenges to increasing and maintaining vaccination coverage need to be addressed in a country- and context-specific

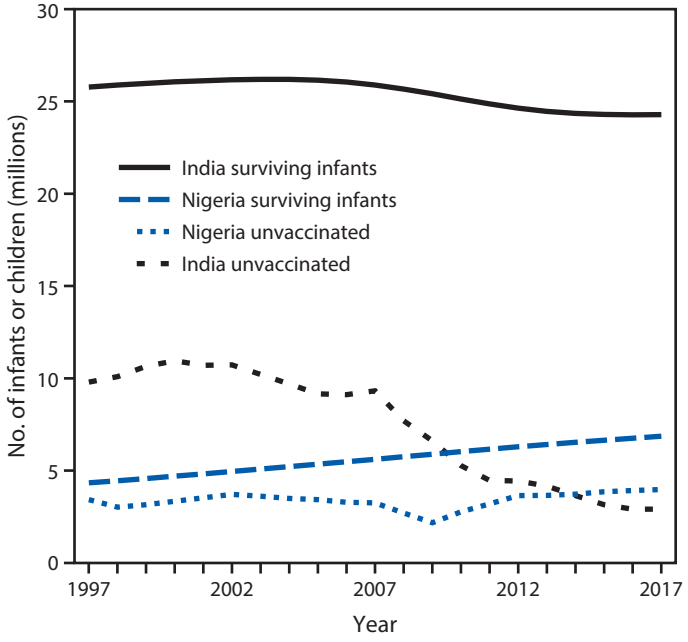
[¶] Global estimates for 3 doses of PCV available beginning in 2008; estimates shown are from 2008 to 2017.

**TABLE 2. Number of surviving infants,* DTP3 coverage, and number of children not receiving DTP3 — worldwide and in countries with the highest number of children not receiving DTP3, 2007–2017**

| | No. of surviving infants (millions) | | | | DTP3 coverage (%) | | | | No. not receiving DTP3 (millions) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Area/Country | 2007 | 2012 | 2017 | Change 2007 to 2017 | 2007 | 2012 | 2017 | Change 2007 to 2017 | 2007 | 2012 | 2017 | Change 2007 to 2017 |
| Global | 130.5 | 134.7 | 136.2 | 5.7 | 79 | 84 | 85 | 6 | 27.5 | 20.9 | 19.9 | -7.6 |
| Nigeria | 5.6 | 6.3 | 6.9 | 1.3 | 42 | 42 | 42 | 0 | 3.3 | 3.6 | 4.0 | 0.7 |
| India | 25.9 | 24.6 | 24.3 | -1.6 | 64 | 82 | 88 | 24 | 9.3 | 4.4 | 2.9 | -6.4 |
| Pakistan | 4.5 | 4.9 | 5.1 | 0.6 | 54 | 64 | 75 | 21 | 2.1 | 1.8 | 1.3 | -0.8 |
| Indonesia | 4.8 | 4.9 | 4.8 | 0.0 | 73 | 83 | 79 | 6 | 1.3 | 0.8 | 1.0 | -0.3 |
| Ethiopia | 2.8 | 3.0 | 3.2 | 0.4 | 50 | 62 | 73 | 23 | 1.4 | 1.1 | 0.9 | -0.5 |
| DRC | 2.4 | 2.8 | 3.2 | 0.8 | 70 | 75 | 81 | 11 | 0.7 | 0.7 | 0.6 | -0.1 |
| Angola | 0.9 | 1.0 | 1.2 | 0.3 | 58 | 54 | 52 | -6 | 0.4 | 0.5 | 0.6 | 0.2 |
| Iraq | 1.0 | 1.1 | 1.2 | 0.2 | 57 | 69 | 63 | 6 | 0.4 | 0.3 | 0.5 | 0.1 |
| South Africa | 1.1 | 1.1 | 1.1 | 0.0 | 82 | 65 | 66 | -16 | 0.2 | 0.4 | 0.4 | 0.2 |
| Afghanistan | 1.0 | 1.1 | 1.1 | 0.1 | 63 | 67 | 65 | 2 | 0.4 | 0.3 | 0.4 | 0.0 |

**Abbreviations:** DRC = Democratic Republic of the Congo; DTP3 = third dose of diphtheria and tetanus toxoids and pertussis-containing vaccine.
* Number of children surviving to age 1 year.

**FIGURE. Number of surviving infants* and children who did not receive DTP3† (unvaccinated) by age 1 year — India and Nigeria, 1997–2017**




**Abbreviation:** DTP3 = third dose of diphtheria and tetanus toxoids and pertussis-containing vaccine.
* Number of children surviving to age 1 year.
† The number of children not receiving DTP3 is calculated based on yearly estimates of the number of surviving infants and DTP3 coverage rates.

manner. In countries where coverage is increasing, continued investment in immunization programs will be critical for ensuring that gains are maintained. Historically, as DTP3 coverage has increased, the average annual rate of change in coverage has decreased, demonstrating the difficulty in maintaining positive annual growth, particularly at coverage levels above 90% (*8*). Specific strategies might be required to achieve coverage ≥90%. Among the 12.4 million children who have not received DTP3 living in the 10 countries with the most unvaccinated children, 73% (9.2 million) had not received any DTP doses, suggesting that many of the challenges lie with reaching the "left out," those children who have not been reached by immunization programs. Rapid population growth might contribute to the challenges in maintaining or increasing coverage in countries where DTP3 coverage has declined or stagnated. Exploration of these population patterns and barriers to immunization at the subnational level might help to inform targeted interventions.

The findings in this report are subject to at least two limitations. Inaccuracies in vaccination coverage reporting at lower administrative levels and outdated national census data might result in over- or underestimation of administrative vaccination coverage. Second, parental recall errors could affect survey-based estimates of coverage (*5*,*7*).

Improvements in national immunization program performance are necessary to reach and sustain high vaccination coverage to increase protection from vaccine-preventable diseases for all children. Prioritizing countries with the highest number of unvaccinated children to implement targeted, context-specific strategies has the potential for a substantial impact on vaccination coverage globally.

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**Summary**

What is already known about this topic?

Since 1974, global coverage with vaccines to prevent diphtheria, tetanus, pertussis, polio, and measles has increased from <5% to 85%.

What is added by this report?

Global coverage with the third dose of diphtheria and tetanus toxoids and pertussis-containing vaccine (DTP3), third dose of polio vaccine, and first dose of measles-containing vaccine has remained at 84%–85% since 2010. In 2017, 62% of children who did not receive DTP3 lived in 10 countries; positive trends in vaccination coverage (2007–2017) were observed in seven of these countries.

What are the implications for public health practice?

Prioritizing countries with the highest number of unvaccinated children to implement context-specific strategies has the potential to increase immunization coverage globally.

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# Progress Toward Global Eradication of Dracunculiasis — January 2017–June 2018

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Dracunculiasis (Guinea worm disease), caused by the parasite *Dracunculus medinensis*, is acquired by drinking water containing copepods (water fleas) infected with its larvae. The worm typically emerges through the skin on a lower limb approximately 1 year after infection, causing pain and disability (*1*). The worldwide eradication campaign began at CDC in 1980. In 1986, the World Health Assembly called for dracunculiasis elimination, and the global Guinea Worm Eradication Program (GWEP), led by the Carter Center in partnership with the World Health Organization (WHO), United Nations Children's Fund (UNICEF), CDC, and others, began assisting ministries of health in countries with dracunculiasis. There is no vaccine or medicine to treat the disease; the GWEP relies on case containment* to prevent water contamination and other interventions to prevent infection, including health education, water filtration, chemical treatment of water, and provision of safe drinking water (*1*,*2*). In 1986, an estimated 3.5 million cases† occurred each year in 20§ African and Asian countries (*3*,*4*). This report, based on updated health ministry data (*3*), describes progress during January 2017–June 2018 and updates previous reports (*1*,*4*). In 2017, 30 cases were reported from Chad and Ethiopia, and 855 infected animals (mostly dogs) were reported from Chad, Ethiopia, and Mali, compared with 25 cases and 1,049 animal infections reported in 2016. During January–June 2018, the number of cases declined to three cases each in Chad and South Sudan and one in Angola, with 709 infected animals reported, compared with eight cases and 547 animal infections during the same period of 2017. With only five affected countries, the eradication goal is near, but is challenged by civil unrest, insecurity, and lingering epidemiologic and zoologic questions.

Comparisons of the numbers of reported *D. medinensis* cases between years and countries have been made (Table 1). There was a 20% increase in cases in 2017 (30), compared with 2016 (25); cases were reported from two countries in 2017 (Chad and Ethiopia) compared with three countries in 2016 (Chad, Ethiopia, and South Sudan). During the first 6 months of 2018, seven cases in humans were reported from three countries, compared with eight cases during the same period of 2017, all from Chad. Similar comparisons for animal infections have been made (Table 2). During 2017, 855 animal infections were reported, an 18% decline, compared with the 1,049 infections reported in 2016; in both years, animal infections occurred only in Chad, Ethiopia, and Mali. During January–June 2018, 709 animal infections (mostly in dogs) were reported, compared with 547 during January–June 2017 (Table 2). *D. medinensis* worms removed from animals are genetically indistinguishable from those removed from humans (*5*).

In affected countries, the national GWEP receives monthly case reports from each village under active surveillance¶ and calculates the proportion of villages reporting monthly (Table 3). Countries enter the WHO precertification stage of eradication after 1 full year with no reported indigenous cases. Villages where endemic transmission of dracunculiasis is interrupted (i.e., zero cases reported for ≥12 consecutive months) are kept under active surveillance for 2 additional consecutive years. WHO certifies a country free of dracunculiasis after maintenance of adequate nationwide surveillance for ≥3 consecutive years with no indigenous cases.** WHO has certified 199 countries, areas, and territories as free from dracunculiasis (*3*), with only seven countries still lacking certification: four where dracunculiasis remains endemic (Chad, Ethiopia, Mali, and

* Transmission from a patient with dracunculiasis is contained only if all of the following conditions are met for each emerged worm: 1) the infected patient is identified ≤24 hours after worm emergence; 2) the patient has not entered any water source since the worm emerged; 3) a village volunteer or other health care provider has managed the patient properly, by cleaning and bandaging the lesion until the worm has been fully removed manually and by providing health education to discourage the patient from contaminating any water source (if two or more emerging worms are present, transmission is not contained until the last worm is removed); 4) the containment process, including verification of dracunculiasis, is validated by a Guinea Worm Eradication Program supervisor within 7 days of emergence of the worm; and 5) the approved chemical temephos (Abate) is used to treat potentially contaminated surface water if any uncertainty about contamination of the source of drinking water exists, or if such a source of drinking water is known to have been contaminated.

† A dracunculiasis case is defined as an infection occurring in a person exhibiting a skin lesion or lesions with emergence of one or more worms laboratory-confirmed at CDC as *D. medinensis*. Because *D. medinensis* has a 10–14 month incubation period, each infected person is counted as a case only once during a calendar year.

§ Originally 20 countries, but the former country of Sudan officially separated into two countries (South Sudan and Sudan) on July 9, 2011.

¶ Villages under active surveillance are those that have endemic dracunculiasis or are at high risk for importation. Active surveillance involves daily searches of households for persons or animals with signs of dracunculiasis. An imported case is an infection resulting from ingestion of contaminated water in a place other than the community where the case is detected and reported. Since 2012, no internationally imported cases have been reported.

** An indigenous case of dracunculiasis is defined as an infection consisting of a skin lesion or lesions with emergence of one or more Guinea worms in a person who had no history of travel outside their residential locality during the preceding year.

**TABLE 1. Number of reported indigenous dracunculiasis cases in humans,* by country — worldwide, January 2016–June 2018**

| Country | No. of cases (% Contained) | | % Change | No. of cases (% Contained) | | % Change |
|---|---|---|---|---|---|---|
| | Jan–Dec 2016 | Jan–Dec 2017 | Jan–Dec 2016 to Jan–Dec 2017 | Jan–Jun 2017 | Jan–Jun 2018 | Jan–Jun 2016 to Jan–Jun 2017 |
| Chad | 16 (56) | 15 (60) | -6 | 8 (75) | 3 (100) | -63 |
| Ethiopia | 3 (67) | 15 (20) | 400 | 0 | 0 | 0 |
| Mali† | 0 | 0 | 0 | 0 | 0 | 0 |
| South Sudan | 6 (50) | 0 | -100 | 0 | 3 (0) | ∞ |
| Angola§ | 0 | 0 | 0 | 0 | 1 (0) | ∞ |
| **Total** | **25 (56)** | **30 (43)** | **20** | **8 (75)** | **7 (43)** | **-13** |

* No international importations were reported during the 18-month period January 2017–June 2018.
† Civil unrest and insecurity since a coup d'état in April 2012 continued to constrain program operations in regions with endemic dracunculiasis (Gao, Kidal, Mopti, and Timbuktu) during 2017–2018.
§ Final classification of case origin pending further investigation.

**TABLE 2. Number of reported indigenous dracunculiasis infections in animals,* by country — worldwide, January 2016–June 2018**

| Country | No. of Cases (% Contained) | | % Change | No. of Cases (% Contained) | | % Change |
|---|---|---|---|---|---|---|
| | Jan–Dec 2016 | Jan–Dec 2017 | Jan–Dec 2016 to Jan–Dec 2017 | Jan–Jun 2017 | Jan–Jun 2018 | Jan–Jun 2016 to Jan–Jun 2017 |
| Chad | 1,022 (65) | 830 (75) | -19 | 535 (75) | 696 (78) | 30 |
| Ethiopia | 16 (63) | 15 (40) | -6 | 10 (30) | 10 (40) | 0 |
| Mali† | 11 (73) | 10 (80) | -9 | 2 (50) | 3 (67) | 50 |
| **Total** | **1,049 (65)** | **855 (65)** | **-18** | **547 (73)** | **709 (78)** | **30** |

* No international importations were reported during the 18-month period January 2017–June 2018.
† Civil unrest and insecurity since a coup d'état in April 2012 continued to constrain program operations in regions with endemic dracunculiasis (Gao, Kidal, Mopti, and Timbuktu) during 2017–2018.

South Sudan), one in the precertification stage (Sudan), and two that were never known to have had endemic dracunculiasis (Angola and the Democratic Republic of the Congo). In April 2018, while preparing for certification, Angola discovered an unexplained case that is still under investigation.

During January 2017–June 2018, CDC evaluated 120 worm specimens that emerged from humans, including 114 (95%) in countries with endemic dracunculiasis (47 from Chad, 17 from Ethiopia, and 50 from South Sudan), and six (5%) in countries not known to have currently endemic dracunculiasis (one from Angola, one from Cameroon, and four from the Democratic Republic of the Congo). Among the 120 specimens, 76 (63%) were from 2017 (27 [36%] identified as *D. medinensis* from Chad and Ethiopia) and 44 (37%) were from January–June 2018 (22 [50%] identified as *D. medinensis* from Angola, Chad, Ethiopia, and South Sudan). During 2017, 35 specimens from animals were submitted, 27 (77%) of which were identified as *D. medinensis*. The 27 confirmed worms came from Ethiopia (four baboons and 12 dogs), Mali (one cat and nine dogs), and Chad (one dog). During January–June 2018, 18 specimens from animals were submitted, and 17 (94%) were identified as *D. medinensis*, from Ethiopia (nine dogs), Mali (five dogs), and Chad (one cat, two dogs).

## Country Reports

**Chad**. After a decade with no reported cases, Chad reported 10 indigenous cases in humans in 2010. Dracunculiasis was declared to be endemic again in 2012 (*1*,*6*). Chad reported 15 cases in humans (10 contained) in 2017 and 16 cases (nine contained) in 2016. During the first half of 2018, Chad reported three cases in humans (all contained), compared with eight cases (six contained) during the same period in 2017 (Table 1). One of 14 villages reporting a case in a human in 2017 and none of three reporting a case during January–June 2018 had reported a case in a human previously.

In 2012, Chad reported Guinea worm infections in domestic dogs for the first time (*6*), primarily from communities along the Chari River. The Carter Center is assisting the Ministry of Health in implementing active village-based surveillance for human and animal infections in almost 1,900 at-risk villages. Because of previous investigations, a working hypothesis is that transmission in humans and dogs might occur without drinking contaminated water, perhaps through ingestion of fish or other aquatic animals that serve as transport or paratenic hosts (intermediate hosts in which the *D. medinensis* larvae live but do not develop). New infections can occur when humans consume inadequately cooked transport or paratenic hosts and when dogs eat such hosts raw (*6*). During 2017, a

**TABLE 3. Reported dracunculiasis cases in humans and animals, surveillance, and status of local interventions in villages with endemic disease, by country — worldwide, 2017**

| Cases in humans/Surveillance/Intervention status | Country | | | | Total |
|---|---|---|---|---|---|
| | Chad* | Ethiopia | Mali† | South Sudan | |
| **Reported cases in human** | | | | | |
| No. of indigenous cases, 2017 | 15 | 15 | 0 | 0 | 30 |
| No. of imported cases,§ 2017 | 0 | 0 | 0 | 0 | 0 |
| % Contained¶ in 2017 | 60 | 20 | 0 | 0 | 40 |
| % Change in indigenous cases in humans in villages or localities under surveillance, same period 2016 and 2017 | -6 | 400 | 0 | 0 | 20 |
| **Reported cases in animals** | | | | | |
| No. of indigenous cases, 2017 | 830 | 15 | 10 | 0 | 855 |
| No. of imported cases,** 2017 | 0 | 0 | 5 | 0 | 5 |
| % Contained¶ in 2017 | 75 | 40 | 80 | 0 | 75 |
| % Change in indigenous cases in animals in villages or localities under surveillance, same period 2016 and 2017 | -19 | -6 | -9 | 0 | -18 |
| **Villages under active surveillance, 2017** | | | | | |
| No. of villages | 1,860 | 167 | 455 | 4,046 | 6,528 |
| % Reporting monthly | 99 | 98 | 99 | 99 | 99 |
| No. of villages reporting ≥1 cases in humans | 13 | 6 | 0 | 0 | 19 |
| No. of villages reporting only imported** cases in humans | 0 | 6 | 0 | 0 | 6 |
| No. of villages reporting indigenous cases in humans | 13 | 0 | 0 | 0 | 13 |
| No. of villages reporting ≥1 cases in animals | 271 | 6 | 10 | 0 | 287 |
| No. of villages reporting only imported** cases in animals | 0 | 0 | 5 | 0 | 5 |
| No. of villages reporting indigenous cases in animals | 271 | 6 | 5 | 0 | 282 |
| **Status of interventions in villages with endemic human dracunculiasis, 2017** | | | | | |
| No. of villages with endemic human dracunculiasis, 2016–2017 | 20 | 9 | 0 | 4 | 33 |
| % Reporting monthly†† | 100 | 100 | —§§ | 100 | 100 |
| % Filters in all households†† | 100 | 100 | —§§ | 100 | 100 |
| % Using temephos†† | 20 | 100 | —§§ | 100 | 52 |
| % ≥1 source of safe water†† | 80 | 89 | —§§ | 50 | 79 |
| % Provided health education†† | 100 | 100 | —§§ | 100 | 100 |
| **Status of interventions in villages with endemic animal dracunculiasis, 2017** | | | | | |
| No. of villages with endemic animal dracunculiasis, 2016–2017 | 378 | 9 | 15 | 0 | 402 |
| % Reporting monthly†† | 100 | 100 | 100 | 0 | 100 |
| % Using temephos†† | 18 | 100 | 100 | 0 | 23 |
| % Provided health education†† | 100 | 100 | 100 | 0 | 100 |

* Participants at the annual Chad Guinea Worm Eradication Program review meeting in November 2014 adopted "1+ case village" as a new description for villages in Chad affected by cases of Guinea worm disease in humans or dogs infected with Guinea worms and defined it as "a village with one or more indigenous and/or imported cases of Guinea worm infections in humans, dogs, and/or cats in the current calendar year and/or previous year."

† Civil unrest and insecurity since a coup d'état in April 2012 continued to constrain program operations in regions with endemic dracunculiasis (Gao, Kidal, Mopti, and Timbuktu) during 2017–2018.

§ Imported from another country.

¶ Transmission from a patient with dracunculiasis is contained only if all of the following conditions are met for each emerged worm: 1) the infected patient is identified ≤24 hours after worm emergence; 2) the patient has not entered any water source since the worm emerged; 3) a village volunteer or other healthcare provider has managed the patient properly, by cleaning and bandaging the lesion until the worm has been fully removed manually and by providing health education to discourage the patient from contaminating any water source (if two or more emerging worms are present, transmission is not contained until the last worm is removed); 4) the containment process, including verification of dracunculiasis, is validated by a Guinea Worm Eradication Program supervisor within 7 days of emergence of the worm; and 5) temephos is used to treat potentially contaminated surface water if any uncertainty about contamination of these sources of drinking water exists, or if a such a source of drinking water is known to have been contaminated.

** Imported from another in-country village with endemic disease.

†† The denominator is the number of villages or localities with endemic disease where the program applied interventions during 2016–2017.

§§ Data are not available.

total of 817 domestic dog and 13 domestic cat infections were reported, 19% fewer than the 1,011 dog and 18% more than the 11 cat infections reported in 2016 (Table 2). This was the first observed reduction in infected dogs since 2012. However, during January–June 2018, there were 685 infected dogs and 11 infected cats reported, compared with 534 dogs and one cat during January–June 2017, representing a 30% increase.

Since October 2013, Chad's GWEP urged villagers to cook their fish well, bury fish entrails, and prevent dogs from eating fish entrails. Since June 2017, approximately 81% of households sampled monthly in at-risk communities were burying fish entrails. In February 2014, health educators began persuading villagers to tether (contain) infected dogs until the worms emerged to prevent water contamination. In February 2015, the program introduced a reward equivalent to US$20 for

reporting and tethering an infected dog. Whereas 40%, 68%, and 68% of infected dogs were tethered in 2014, 2015, and 2016, respectively, 76% of infected dogs were tethered in 2017, and 77% in January–June 2018.

Before 2010, Chad began offering a cash reward equivalent to US$100 for reporting a human dracunculiasis case. In areas under active surveillance, 80% of 885 residents surveyed during January–June 2018 knew of this reward, and 67% of 852 persons knew of the reward for reporting and tethering an infected dog. In July 2017, Chad launched a nationwide communication campaign to increase awareness of the cash rewards and knowledge about how to prevent dracunculiasis.

As of June 2018, 77% of villages reporting cases in humans had at least one source of drinking water free of copepods. Given limited use of temephos (an organophosphate larvicide used to treat unsafe water) in large lagoons used for fishing and for drinking water, a novel technique for applying temephos to cordoned sections of lagoons has been used to protect 19, 29, 61, and 57 villages in 2014, 2015, 2016, and 2017, respectively. Beginning October 2017, temephos also was applied monthly in small ponds in the villages with the most infected dogs, reaching 18 villages by December 2017 and 67 villages by June 2018.

The Carter Center and CDC are supporting research to better understand the unusual current epidemiology of dracunculiasis in Chad, assess antihelminthic treatment of dogs to prevent maturation of worms, and study food sources and movements of dogs in an area of Chad with endemic disease. The International Task Force for Disease Eradication reviewed much of this work in October 2017 (*7*). In collaboration with researchers from the University of Georgia, this initiative has demonstrated that fish can serve as transport hosts for *Dracunculus* spp. in the laboratory (*8*) and that *D. medinensis* can use frogs as paratenic hosts (*9*,*10*). As further proof of the latter, a *Dracunculus* larva has been recovered from a wild frog in Chad (*10*). Anthelminthic treatments of dogs with avermectins[††] have not been effective.

**Ethiopia**. During January–December 2017, Ethiopia reported 15 cases of dracunculiasis in humans (three contained), among residents from six villages in Gambella and Oromia Regions, all among migrant laborers from Oromia who drank water from a contaminated pond at a commercial farm in Abobo district of Gambella (Table 1). January 2017–June 2018 represented the first time in several years that no case in humans was reported from Gambella's Gog district. Ethiopia reported 11 infected dogs (six contained) and four infected baboons in 2017, compared with 14 dogs and two baboons in 2016, all in Gog district. During January–June 2018, Ethiopia reported no cases in humans, eight infected dogs (four contained), no infected baboons, and two uncontained infected domestic cats, all in Gog district, compared with six infected dogs (three contained) and four infected baboons (none contained) during January–June 2017. Since 2017, The Carter Center has provided support to Ethiopian public health and wildlife authorities on a baboon-dog epidemiology and ecology project.

The Ethiopian Dracunculiasis Eradication Program has 167 villages under active surveillance and is applying temephos monthly to most water sources used by humans or animals in the at-risk area of Gog district. In 2018, Ethiopia increased its cash rewards for reporting a human dracunculiasis case to US$360 (up from US$100 in 2014) and for tethering an infected animal to US$40 (up from US$20 in 2016). In 2017, approximately 83% of persons surveyed in active surveillance areas (Gambella Region and formerly endemic Southern Nations, Nationalities and Peoples' Region) but only 22% of persons in Oromia knew of the rewards. Ethiopia launched a nationwide communication campaign to increase knowledge of rewards and dracunculiasis prevention in 2017.

**Mali.** In 2017, Mali reported no human dracunculiasis cases for the second successive year and reported no cases during January–June 2018 (Table 1). Mali reported 11 infected dogs (eight contained) in 2016 and nine infected dogs (six contained) and one infected domestic cat (uncontained) in 2017. During January–June 2018, Mali reported three infected dogs (two contained), all detected in Segou Region, and no infected cats. Parts of Mali's area of endemicity are inaccessible because of insecurity. Mali has 455 villages under active surveillance and offers a US$100 reward for reporting a case in a human and US$20 for reporting and tethering an infected animal. During 2017, Malian health staff members questioned 33,000

**Summary**

What is already known about this topic?

The number of cases of dracunculiasis (Guinea worm disease) has decreased from an estimated 3.5 million in 1986 to 30 in 2017. Emergence of Guinea worm infections in dogs has complicated eradication efforts.

What is added by this report?

The number of human dracunculiasis cases reported declined to seven cases in three countries (Angola, Chad, and South Sudan) during January–June 2018, while the number of infected animals reported stood at 709 during the same period.

What are the implications for public health practice?

Existence of infected dogs, especially in Chad, and impeded access because of civil unrest and insecurity in Mali and South Sudan are now the greatest challenges to interrupting transmission.

[††] Avermectins are a group of related macrocyclic lactone derivative drugs with potent anthelminthic activity.

persons about dracunculiasis during immunization campaigns; 86% of persons living in areas of active surveillance were aware of the cash reward for reporting an infected person. During April–June 2018, 83% of 190 persons surveyed were aware of the reward for reporting cases in humans, and 71% knew of the reward for reporting infected animals. Mali has launched a nationwide communication campaign to increase awareness of the rewards and improve knowledge of preventive measures.

**South Sudan.** During 2017, South Sudan reported no cases of dracunculiasis in humans for the first time (Table 1); only one infected animal has been reported (a dog in the same household as an infected person reported in 2015). After 19 consecutive months with no reported cases, the program discovered three cases in May and June 2018. All three patients were cattle herders from migratory communities in a recently pacified area of Western Lakes State that has suffered communal violence and displacements in recent years. In 2017, the program had 4,046 villages under active surveillance and increased the reward for reporting a dracunculiasis case to approximately US$139 and again to approximately US$400 in 2018. A 2017 survey of 50,612 residents in two counties of Warrap and Western Bahr Al Ghazal found that 72% of persons knew of the reward. In October 2017, South Sudan launched a nationwide campaign to increase knowledge of dracunculiasis prevention and awareness of the reward and in April 2018 established a National Committee for Documentation of Dracunculiasis Elimination.

## Discussion

In 2017, two countries (Chad and Ethiopia) continued to report cases of dracunculiasis in humans and animals. One additional country (Mali), with no cases in humans detected for 2 years, reported infected dogs and cats. In 2018, cases in humans were again detected in South Sudan, where fighting and civil unrest had limited adequate access. South Sudan has had traditional waterborne transmission of dracunculiasis, only one animal infection, strong programmatic leadership, and strong political support by the government, all suggesting that endemic transmission can be halted if adequate security can be maintained.

The discovery in April 2018 of a single dracunculiasis case in southern Angola was unexpected, and its etiology is unclear. No previous dracunculiasis case had been reported or alleged to have been imported from Angola. The worm (confirmed as *D. medinensis* by CDC) occurred in a child who had never traveled outside her home area and was discovered during a nationwide search for dracunculiasis as Angola prepared for WHO certification that it had no endemic disease. Initial investigations found no other confirmed infection in a human or dog in the child's home village and neighboring villages.

Continued transmission of Guinea worm infections to a small number of dogs and cats in Ethiopia and Mali and baboons in Ethiopia appears to be geographically limited in each country (i.e., to a section of Ethiopia's Gog district and adjacent districts of Mali's Mopti and Segou regions). Transmission in both countries now appears to be driven by infected dogs; infections in other species (e.g., humans, cats, and baboons) might be incidental. In 2017, human transmission remained interrupted in Mali for the second consecutive year and was absent in Ethiopia's Gog district for the first time. In 2017, the aberrant outbreak among 15 humans in Ethiopia in Abobo district was traced to a single shared source of contaminated drinking water, underscoring the importance of the parasite's reproductive potential in favorable settings. The ecologic study of dogs and baboons now underway in Ethiopia might help to explain the unusual epidemiologic pattern of residual Guinea worm infections in both countries. DNA studies show promise in tracing genetic lineages of the worms.

Transmission of Guinea worm infections to many dogs and few humans in Chad continues a peculiar pattern that remains consistent after more than 8 years, manifested as single cases in humans in new villages each year, with infections rarely occurring in the same village in successive years. Laboratory tests indicate no distinction between Guinea worms removed from humans and dogs. Research studies increasingly favor the hypothesis that the parasite's life cycle in Chad involves a transport or paratenic host. As research continues, the program has intensified active surveillance, education of villagers, containment of infected dogs, burial of fish entrails, and application of temephos, giving priority to villages with the most infected dogs.

The final four countries with endemic *D. medinensis* infections are distinguished from the other 17 countries that had endemic disease in the past: South Sudan because of its long civil war, Mali because of insecurity limiting access in some areas with endemic disease, and Chad, Ethiopia, and Mali because of the infection's unusual epidemiologic patterns there.

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# Updated Framework for Development of Evidence-Based Recommendations by the Advisory Committee on Immunization Practices

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The Advisory Committee on Immunization Practices (ACIP)* is a federal advisory committee that provides expert advice to the Director of CDC and the Secretary of the U.S. Department of Health and Human Services in the form of recommendations on the use of vaccines and related agents for control of vaccine-preventable diseases in the U.S. civilian population (*1*,*2*). Work groups that gather, analyze, and prepare scientific information assist in the recommendation formulation process and present options for recommendations based on the scientific evidence they have assessed. Recommendations that are approved by a majority of ACIP's voting members are then reviewed by the Director of CDC and published in *MMWR* if approved by the director. This report briefly summarizes an update to the ACIP process for developing evidence-based recommendations that ACIP adopted at its February 2018 meeting.

In 2010, ACIP formally adopted the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach for developing evidence-based recommendations (*3*–*6*). Since then, the preparation and presentation of GRADE evidence profiles, which communicate an assessment of the quality of the evidence for outcomes related to benefits and harms (*7*), has been an integral part of ACIP recommendation development (https://www.cdc.gov/vaccines/acip/recs/grade/table-refs.html). However, during the process of recommendation formulation, in addition to the certainty in the evidence as presented in such evidence profiles, panels consider myriad factors such as the values held by the target population regarding the outcomes, health economic data, and implementation issues. Significant additions in this area have been incorporated into GRADE methodology in the past 8 years, particularly the use of Evidence to Decision or Evidence to Recommendation (EtR) frameworks to support the process of moving from evidence to decision and to provide transparency regarding the impact of additional factors on deliberations when considering a recommendation (*8*). Elucidation of these factors and the judgments behind them facilitate transparency, consistency, and communication of recommendations to health care providers, partner organizations, and the public.

ACIP has continued to follow the methodological advances in the GRADE approach, and, as a result, has developed a modified EtR framework tailored to the needs of ACIP (https://www.cdc.gov/vaccines/acip/recs/grade/downloads/ACIP-evidence-rec-frame-508.pdf), which was formally adopted by a unanimous vote at the February 2018 ACIP meeting. Other guideline development panels, including National Immunization Technical Advisory Groups and the World Health Organization's Strategic Advisory Group of Experts on Immunization, have adopted the new GRADE approach and developed EtR frameworks for use in formulating recommendations (*9*). The ACIP Evidence-Based Recommendations Work Group, which includes internal stakeholders, current and former ACIP members, external methodologists, and representatives from the GRADE Working Group,† is actively engaged in the development and review of the ACIP EtR framework and supporting materials.

New or substantially revised ACIP recommendations for vaccination will use the EtR framework to communicate the deliberations and judgments made by ACIP during formulation of its recommendations. Recommendations will be communicated in the framework in one of three categories: 1) ACIP recommends vaccination for all persons in an age group or a group at increased risk for vaccine-preventable disease; 2) ACIP does not recommend the use of a vaccine; or 3) the ACIP recommendation relies upon guidance of the clinician in the context of individual clinician-patient interactions to determine whether or not vaccination is appropriate for a specific patient. In some instances (e.g., when additional information is needed), ACIP might not make a recommendation, and this option is also reflected in the EtR framework separately (https://www.cdc.gov/vaccines/acip/recs/grade/downloads/ACIP-evidence-rec-frame-508.pdf).

* Recommendations for routine use of vaccines in children, adolescents, and adults are developed by the Advisory Committee on Immunization Practices (ACIP). ACIP is chartered as a federal advisory committee to provide expert external advice and guidance to the Director of CDC on use of vaccines and related agents for the control of vaccine-preventable diseases in the civilian population of the United States. Recommendations for routine use of vaccines in children and adolescents are harmonized to the greatest extent possible with recommendations made by the American Academy of Pediatrics (AAP), the American Academy of Family Physicians (AAFP), and the American College of Obstetricians and Gynecologists (ACOG). Recommendations for routine use of vaccines in adults are harmonized with recommendations of AAFP, ACOG, the American College of Physicians (ACP), and the American College of Nurse-Midwives. ACIP recommendations adopted by the CDC Director become agency guidelines on the date published in the *Morbidity and Mortality Weekly Report* (*MMWR*). Additional information regarding ACIP is available at https://www.cdc.gov/vaccines/acip.

† http://www.gradeworkinggroup.org/.

**Summary**

What is already known about this topic?

In 2010, the Advisory Committee on Immunization Practices (ACIP) implemented the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach for developing evidence-based recommendations.

What is added by this report?

Since the original adoption of the GRADE evidence-based recommendation process by ACIP, the use of Evidence to Decision or Evidence to Recommendation (EtR) frameworks have been incorporated into GRADE methodology. ACIP adopted the use of an EtR framework at its February 2018 meeting.

What are the implications for public health practice?

The EtR framework elucidates the additional factors considered in vaccine recommendation deliberations and facilitates transparency, consistency, and communication of recommendations to health care providers, partner organizations, and the public.

This standardized and more explicit process for developing ACIP recommendations is expected to enhance transparency, consistency, and communication. Additional information about GRADE is available at https://www.cdc.gov/vaccines/acip/recs/grade/about-grade.html.

## Acknowledgments

Members of the Advisory Committee on Immunization Practices (ACIP) (ACIP member roster for 2017–2018 available at https://www.cdc.gov/vaccines/acip/committee/members.html); ACIP Evidence Based Recommendations Work Group; Art Reingold, former Evidence Based Recommendations Work Group Chair; Amanda Cohn, Jessica MacNeil, National Center for Immunization and Respiratory Diseases, CDC.

## ACIP Evidence Based Recommendations Work Group

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All authors have completed and submitted the ICMJE form for disclosure of potential conflicts of interest. No potential conflicts of interest were disclosed.

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# Increase in Acute Flaccid Myelitis — United States, 2018

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*On November 13, 2018, this report was posted as an* MMWR *Early Release on the* MMWR *website (https://www.cdc.gov/mmwr).*

In August 2018, CDC noted an increased number of reports of patients having symptoms clinically compatible with acute flaccid myelitis (AFM), a rare condition characterized by rapid onset of flaccid weakness in one or more limbs and spinal cord gray matter lesions, compared with August 2017. Since 2014, CDC has conducted surveillance for AFM using a standardized case definition (*1*,*2*). An Epi-X* notice was issued on August 23, 2018, to increase clinician awareness and provide guidance for case reporting.

Patients who meet the clinical case criteria for AFM, defined as acute flaccid limb weakness, are classified using the Council of State and Territorial Epidemiologists case definitions of "confirmed" (magnetic resonance imaging [MRI] with spinal cord lesion largely restricted to gray matter and spanning ≥1 spinal segments), "probable" (cerebrospinal fluid [CSF] pleocytosis [>5 white blood cells per $mm^3$]), or "not a case."

Among 106 patients with acute flaccid limb weakness classified during January 1–November 2, 2018, 80 cases of AFM were classified as confirmed (from 25 states) (Figure), 6 as probable, and 20 as noncases. This represents a threefold increase in confirmed cases compared with the same period in 2017. Among confirmed cases, the median patient age was 4 years (range = 7 months–32 years; interquartile range [IQR] = 2.4–7.6 years), 47 (59%) were male, and, among 65 patients with information on race available, 56 (86%) were white. During the 4 weeks preceding the onset of limb weakness, signs and symptoms consistent with a viral illness were reported for 79 (99%), including fever for 65 (81%), respiratory symptoms (e.g., cough, rhinorrhea, and congestion) for 62 (78%), and gastrointestinal symptoms (e.g., vomiting and diarrhea) for 30 (38%) patients with confirmed AFM. Upper limb only involvement was reported by 38 (47.5%) patients, lower limb only by 7 (8.8%), two to three upper and lower limbs by 12 (15.0%), and all four limbs by 23 (28.8%). All patients with confirmed AFM were hospitalized, and 47 (59%) were admitted to intensive care units; no deaths have been reported.

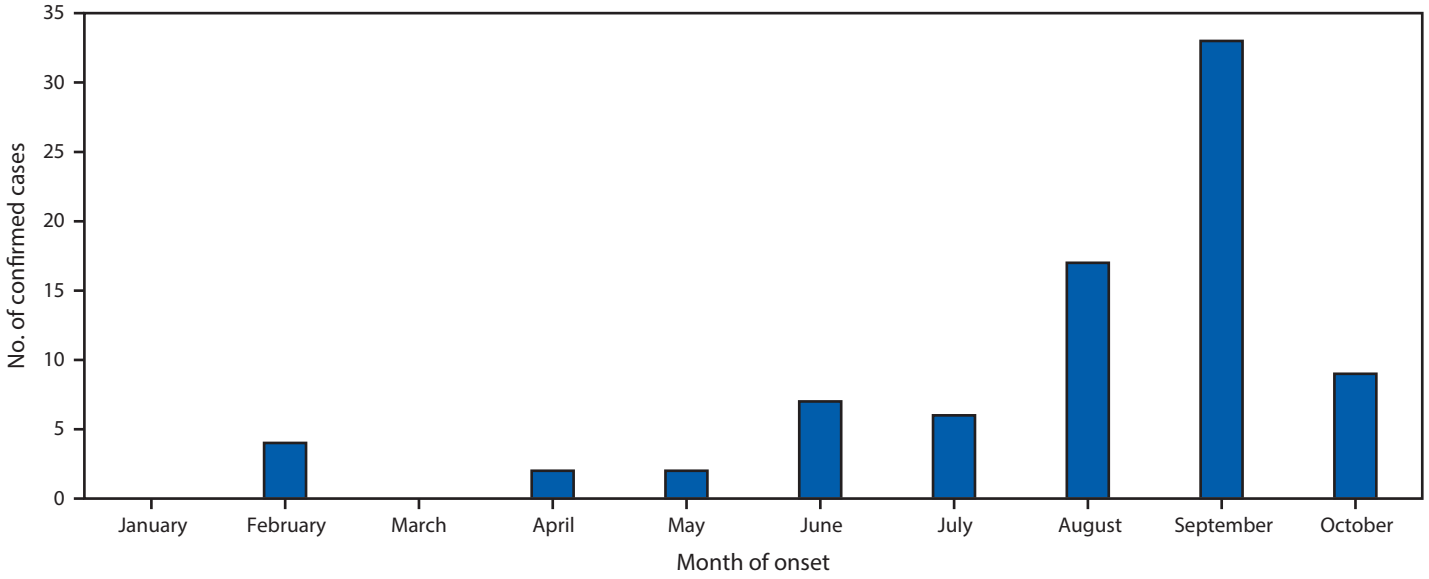
Among 78 (98%) confirmed cases with available CSF results, 65 (83%) had pleocytosis, with a median cell count of 103 cells per $mm^3$ (range = 6–814; IQR = 56–194); most had a lymphocyte predominance. Median CSF protein and glucose were 47 mg per dL (range = 8–289; IQR = 37–62; normal <45) and 59 mg per dL (range = 40–138; IQR = 52–65; normal ≥40), respectively. The median interval from limb weakness to CSF collection was 1 day (range = 0–16; IQR = 1–3). The median interval from sign or symptom onset to CSF collection was 7 days (range = 0–23; IQR = 5–8) for respiratory illness, 4 days (range = 0–22; IQR = 3–7) for gastrointestinal symptoms, and 3 days (range = 0–17; IQR = 2–6) for fever.

CDC conducts enterovirus/rhinovirus (EV/RV) testing for all patients meeting the clinical criteria for AFM, when specimens are available. Of the 80 confirmed cases in 2018, testing was performed on a total of 125 clinical specimens from 71 (89%) patients, including 21 CSF, 59 upper respiratory, and 45 stool/rectal swab specimens (Table). Among these, specimens from 38 (54%) patients were positive by EV/RV real-time reverse transcription–polymerase chain reaction testing, including 11 (29%) for EV-A71, 14 (37%) for EV-D68, and 13 (34%) for other viruses, primarily from nonsterile sites. CSF specimens from two patients were positive. One CSF specimen was positive for EV-A71; this patient also had a stool specimen positive for EV-A71. The second patient had a CSF specimen positive for EV-D68; this patient also had EV-D68 and parechovirus-A6 identified in a respiratory specimen. Two additional patients had more than one virus detected in a single respiratory specimen, including one with EV-D68 and echovirus 6 and one with RV-A24 and parechovirus-A6. All stool specimens tested negative for poliovirus. Among the 20 patients who did not meet the AFM case definition and were classified as noncases, 1 (5%) had a positive CSF specimen (echovirus 25), 7 (35%) had positive respiratory specimens (EV-A71, RV-A24, RV-A56, RV-A90, EV/RV not typed), and 6 (30%) had positive stool or rectal swab specimens (EV-D68, EV-A71, RV-A90, echovirus 9, echovirus 11, echovirus 25).

Because some enteroviruses can cause acute flaccid limb weakness, and there was a temporal association with AFM and a nationwide severe respiratory outbreak of EV-D68 in 2014 (*2*), CDC performs EV/RV testing in an effort to identify etiologies for AFM cases. Despite a subsequent peak of AFM in 2016 (https://www.cdc.gov/acute-flaccid-myelitis/afm-surveillance.html), CDC did not receive reports of large outbreaks of severe respiratory illness in 2016. Further, there has been limited detection of pathogens in CSF in these cases; virus identified in CSF would be considered etiologic. Almost all patients with AFM

* https://www.cdc.gov/mmwr/epix/epix.html.

**FIGURE. Number of confirmed cases of acute flaccid myelitis (AFM) reported to CDC, by month of onset — United States, January–October, 2018***




* Confirmed AFM cases that CDC was made aware of as of November 2, 2018. Patients under investigation are still being classified, and the case counts are subject to change.

**TABLE. Enterovirus/rhinovirus (EV/RV) type testing results* of specimens from patients with confirmed acute flaccid myelitis and specimens positive for EV/RV, by specimen type — United States, January–October 2018**

| Enterovirus and rhinovirus testing, by type | CDC laboratory results | | | |
|---|---|---|---|---|
| | CSF specimens (n = 21) | Respiratory specimens (n = 59) | Stool/Rectal swab specimens (n = 45) | Total (N = 125) |
| **EV- or RV-positive no. (%)** | **2 (10)** | **31 (53)** | **17 (38)** | **50** |
| **Subtype, no. (%) positive†** | | | | |
| EV-A71 | 1 (50) | 10 (32) | 10 (59) | 21 (42) |
| EV-D68 | 1 (50) | 13 (42) | 1 (6) | 15 (30) |
| EV-D68/PeV-A6 | 0 — | 1 (3) | 0 — | 1 (2) |
| RV-A38 | 0 — | 1 (3) | 0 — | 1 (2) |
| RV-A101 | 0 — | 1 (3) | 0 — | 1 (2) |
| RV-A24/PeV-A6 | 0 — | 1 (3) | 0 — | 1 (2) |
| RV-A81 | 0 — | 1 (3) | 0 — | 1 (2) |
| RV-A54 | 0 — | 1 (3) | 0 — | 1 (2) |
| CVA2 | 0 — | 0 — | 1 (6) | 1 (2) |
| CVA4 | 0 — | 0 — | 1 (6) | 1 (2) |
| CVA9 | 0 — | 0 — | 1 (6) | 1 (2) |
| CVA16 | 0 — | 0 — | 1 (6) | 1 (2) |
| PeV-A1 | 0 — | 0 — | 1 (6) | 1 (2) |
| Nontyped EV/RV | 0 — | 2 (6) | 1 (6) | 3 (6) |

**Abbreviations:** CSF = cerebrospinal fluid; CVA = Coxsackie A virus; PeV-A6 = parechovirus A6.
* Specimens tested at CDC laboratory.
† Among EV- or RV-positive specimens.

have reported signs and symptoms consistent with viral illness in the weeks preceding limb weakness. Clinical, laboratory, and epidemiologic evidence to date suggest a viral association. CDC and collaborators continue to investigate risk factors for AFM and to study the causes and mechanisms of AFM.

Parents and caregivers are urged to seek immediate medical care for a child who develops sudden weakness of the arms or legs. In the evaluation of a child with acute flaccid limb weakness, clinicians are advised to inquire about recent fever with or without antecedent respiratory or gastrointestinal symptoms and to collect timely specimens for viral testing, including CSF, serum, respiratory, and stool specimens. Additional information for clinicians is available at https://www.cdc.gov/acute-flaccid-myelitis/hcp/index.html. Patients with acute flaccid limb weakness should be reported to their health departments as soon as possible regardless of laboratory or MRI findings.

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All authors have completed and submitted the ICMJE form for disclosure of potential conflicts of interest. W. Allan Nix reports U.S. Patent Numbers 7,714,122 and 8,048,630, and U.S. Provisional Patent Application Serial Number 62/171,657. No other potential conflicts of interest were disclosed.

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# Notes from the Field

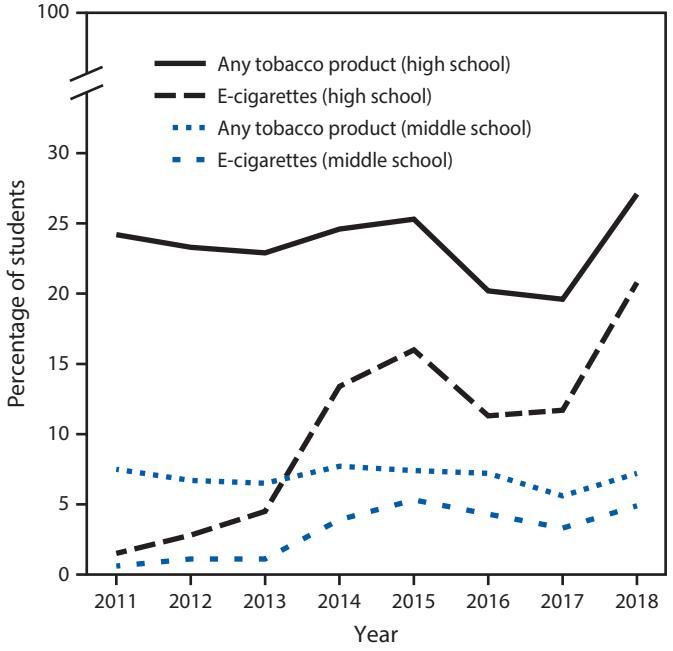
## Use of Electronic Cigarettes and Any Tobacco Product Among Middle and High School Students — United States, 2011–2018

Karen A. Cullen, PhD[1]; Bridget K. Ambrose, PhD[1]; Andrea S. Gentzke, PhD[2]; Benjamin J. Apelberg, PhD[1]; Ahmed Jamal, MBBS[2]; Brian A. King, PhD[2]

Electronic cigarettes (e-cigarettes) are battery-powered devices that provide nicotine and other additives to the user in the form of an aerosol (*1*). E-cigarettes entered the U.S. marketplace in 2007 (*1*), and by 2014, e-cigarettes were the most commonly used tobacco product among U.S. youths (*2*). Data from the 2011–2018 National Youth Tobacco Survey (NYTS), a cross-sectional, voluntary, school-based, self-administered, pencil-and-paper survey of U.S. middle and high school students, were analyzed to determine the prevalence of current use (≥1 day in past 30 days) of e-cigarettes,* current use of any tobacco product,† frequency of (number of days during the preceding 30 days) e-cigarette use, and current use (any time during preceding 30 days) of any flavored e-cigarettes among U.S. middle school (grades 6–8) and high school (grades 9–12) students. Logistic regression (2011–2018) and t-tests (2017–2018) were performed to determine statistically significant differences ($p<0.05$).

Among high school students, current e-cigarette use increased from 1.5% (220,000 students) in 2011 to 20.8% (3.05 million students) in 2018 ($p<0.001$) (Figure). During 2017–2018, current e-cigarette use increased by 78% (from 11.7% to 20.8%, $p<0.001$). The proportion of current e-cigarette users who reported use on ≥20 of the past 30 days increased from 20.0% in 2017 to 27.7% in 2018 ($p = 0.008$). Among high school students, during 2017–2018, current use of any flavored e-cigarettes increased among current e-cigarette users (from 60.9% to 67.8%, $p = 0.02$); current use of menthol- or mint-flavored e-cigarettes increased among all current e-cigarette users (from 42.3% to 51.2%, $p = 0.04$) and current exclusive e-cigarette users (from 21.4% to 38.1%, $p = 0.002$).

**FIGURE. Percentage of middle and high school students who currently use e-cigarettes* and any tobacco product† — National Youth Tobacco Survey, United States, 2011–2018**




* Current e-cigarette use was assessed by responses to these questions during the indicated survey years: "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" (2011–2013); "During the past 30 days, on how many days did you use e-cigarettes such as Blu, 21st Century Smoke, or NJOY?" (2014); "During the past 30 days, on how many days did you use electronic cigarettes or e-cigarettes?" (2015); and "During the past 30 days, on how many days did you use e-cigarettes?" (2016–2018). During 2015–2018, e-cigarette questions were preceded by an introductory paragraph defining the product.

† Any tobacco product was defined as use of one or more of the following tobacco products on ≥1 day in the past 30 days: cigarettes, cigars (defined as cigars, cigarillos, or little cigars), smokeless tobacco (defined as chewing tobacco, snuff, or dip), e-cigarettes, hookahs, tobacco pipes, snus, dissolvable tobacco, and bidis.

Among middle school students, current e-cigarette use increased from 0.6% in 2011 (60,000 students) to 4.9% (570,000 students) in 2018 ($p<0.001$) (Figure). During 2017–2018, current e-cigarette use increased by 48% (from 3.3% to 4.9%, $p = 0.001$); the proportion of current e-cigarette users who reported use on ≥20 days of the past 30 days did not significantly change (from 12.9% to 16.2%, $p = 0.26$).

Current use of any tobacco product among high school students was 24.2% (3.69 million students) in 2011 and 27.1% (4.04 million students) in 2018 ($p>0.05$) (Figure). Current use of any tobacco product among middle school students was 7.5% (870,000 students) in 2011 and 7.2% (840,000 students) in 2018 ($p>0.05$). During 2017–2018, overall tobacco

* Current e-cigarette use was defined as a response greater than "0 days" to the question, "During the past 30 days, on how many days did you use e-cigarettes?" The e-cigarette questions were preceded by the following information: "The next 11 questions are about electronic cigarettes or e-cigarettes. E-cigarettes are battery powered devices that usually contain a nicotine-based liquid that is vaporized and inhaled. You may know them as e-cigs, vape-pens, hookah-pens, e-hookahs, e-cigars, e-pipes, personal vaporizers, or mods. Some brand examples include NJOY, blu, Vuse, MarkTen, Logic, Vapin Plus, eGo, and Halo."

† Any tobacco product use was defined as use of one or more of the following tobacco products on ≥1 day in the past 30 days: cigarettes, cigars (defined as cigars, cigarillos, or little cigars), smokeless tobacco (defined as chewing tobacco, snuff, or dip), e-cigarettes, hookahs, tobacco pipes, snus, dissolvable tobacco, and bidis.

product use increased by 38% among high school students (from 19.6% to 27.1%, p<0.001) and by 29% among middle school students (from 5.6% to 7.2%, p = 0.008).

Current e-cigarette use increased considerably among U.S. middle and high school students during 2017–2018, reversing a decline observed in recent years and increasing overall tobacco product use (*3*). Moreover, during 2017–2018, frequent e-cigarette use increased among high school students. Although e-cigarettes have the potential to benefit adult smokers if used as a complete substitute for combustible tobacco smoking, the use of any form of tobacco product among youths, including e-cigarettes, is unsafe (*1*). The Surgeon General has concluded that e-cigarette use among youths and young adults is of public health concern; exposure to nicotine during adolescence can cause addiction and can harm the developing adolescent brain (*1*).

The rise in e-cigarette use during 2017–2018 is likely because of the recent popularity of e-cigarettes shaped like a USB flash drive, such as JUUL; these products can be used discreetly, have a high nicotine content, and come in flavors that appeal to youths (*4*). In September 2018, the Food and Drug Administration (FDA) issued more than 1,300 warning letters and civil money penalty fines to retailers who illegally sold e-cigarette products to minors, the majority of which were blu, JUUL, Logic, MarkTen XL, and Vuse; this was the largest coordinated enforcement effort in FDA's history (*5*). Sustained implementation of proven population-based strategies, in coordination with the regulation of tobacco products by FDA, is key to reducing all forms of tobacco product use and initiation, including e-cigarettes, among U.S. youths (*1*).

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All authors have completed and submitted the ICMJE form for disclosure of potential conflicts of interest. No potential conflicts of interest were disclosed.

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## Retraction Notice: Suicide Rates by Occupational Group — 17 States, 2012

On July 1, 2016, *MMWR* published "Suicide Rates by Occupational Group — 17 States, 2012" (*1*). On June 14, 2018, the authors informed *MMWR* about their concerns regarding the validity of some of the findings in the report, and on June 29, 2018, *MMWR* published "*Notice to Readers:* Ongoing Analysis of Suicide Rates Data by Occupational Group from Results Reported in *MMWR*" (*2*). The analysis is complete, and because the corrections change the conclusions, the original report is retracted.

A new *MMWR* report, "Suicide Rates by Major Occupational Group — 17 States, 2012 and 2015," is published today (*3*). This report corrects inadvertent errors in the retracted report, uses updated methodology, includes authors from the National Institute for Occupational Safety and Health and additional authors from the National Center for Injury Prevention and Control, and provides analysis of both 2012 and 2015 National Violent Death Reporting System data. Corrected errors include the manual misclassification of some occupation codes in the earlier report (e.g., erroneous coding of farmers to the Farming, Fishing, and Forestry major occupational group instead of to the correct Management major occupational group), which led to errors in reporting of suicide numbers and rates in some groups.

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2. CDC. Notice to readers: ongoing analysis of suicide rates data by occupational group from results reported in MMWR. MMWR Morb Mortal Wkly Rep 2018;67:729. https://doi.org/10.15585/mmwr.mm6725a7
3. Peterson C, Stone DM, Marsh SM, et al. Suicide rates by major occupational group—17 states, 2012 and 2015. MMWR Morb Mortal Wkly Rep 2018;67:1253–60.

## Correction and Republication: Prevalence and Characteristics of Autism Spectrum Disorder Among Children Aged 8 Years — Autism and Developmental Disabilities Monitoring Network, 11 Sites, United States, 2012

On April 1, 2016, *MMWR* Surveillance Summaries published "Prevalence and Characteristics of Autism Spectrum Disorder Among Children Aged 8 Years—Autism and Developmental Disabilities Monitoring Network, 11 Sites, United States, 2012" (*1*). On June 5, 2018, the authors informed *MMWR* about a number of inadvertent errors throughout the report that resulted from reporting of autism spectrum disorder cases among persons who did not live in the geographic surveillance area. Corrections of these errors do not change the interpretation or the conclusions of the original report. In accordance with December 2017 guidance from the International Committee of Medical Journal Editors (*2*), *MMWR* has corrected and republished the report (*3*). The republished report includes the original report with clearly marked corrections in supplementary materials.

### References

1. Christensen DL, Baio J, Van Naarden Braun K, et al. Prevalence and characteristics of autism spectrum disorder among children aged 8 years—Autism and Developmental Disabilities Monitoring Network, 11 sites, United States, 2012. MMWR Surveill Summ 2016;65(No. SS-3). https://doi.org/10.15585/mmwr.ss6503a1
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# Erratum

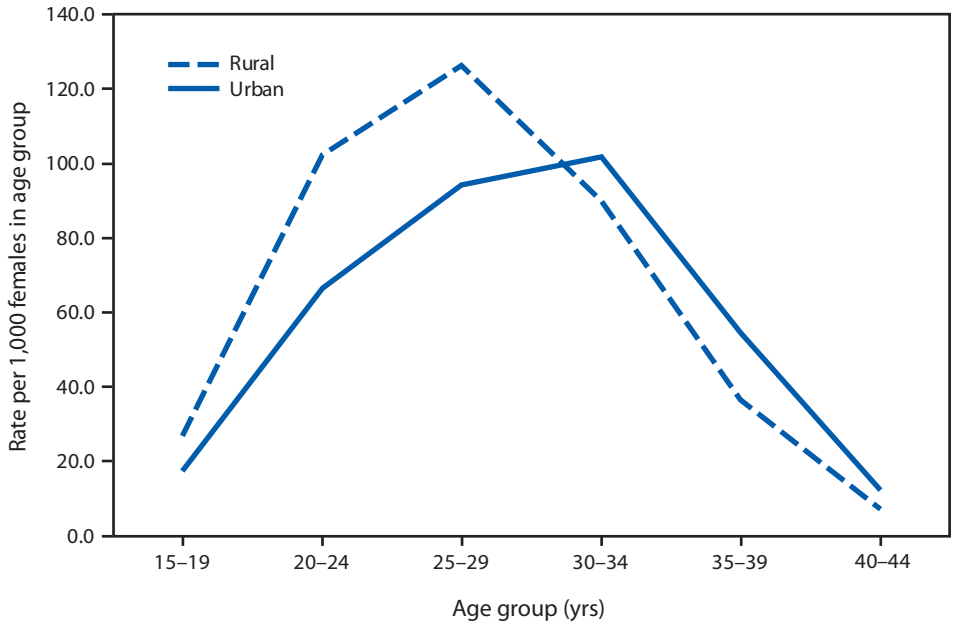
## Vol. 67, No. SS-6

In the Surveillance Summary "Prevalence of Autism Spectrum Disorder Among Children Aged 8 Years — Autism Developmental Disabilities Monitoring Network, 11 Sites, United States, 2014," on page 3, the first sentence of the first full paragraph should have read "ADDM estimates of ASD prevalence among children aged 8 years in multiple U.S. communities have increased from approximately one in 150 children during 2000–2002 to **approximately** one in 68 during 2010–2012, more than doubling during this period (*6–11*)."

# QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

## Birth Rates* by Urbanization Level† and Age Group of Mother — National Vital Statistics System, United States, 2017




* Birth rates are births per 1,000 females in the specified age group.
† Urbanization level is based on maternal county of residence. Counties were classified according to their metropolitan status using the National Center for Health Statistics Urban–Rural Classification Scheme (https://www.cdc.gov/nchs/data_access/urban_rural.htm).

In 2017, women aged <30 years in rural counties had higher birth rates than in urban counties. For women aged ≥30 years, birth rates were higher in urban counties than in rural counties. In 2017, the highest birth rates in rural counties were to women aged 25–29 years (126.4 births per 1,000 women); in urban counties the highest birth rates were to women aged 30–34 years (101.7 births per 1,000 women).

**Source:** NCHS Data Brief no. 323. Trends in fertility and mother's age at first birth among rural and metropolitan counties: United States, 2007–2017. https://www.cdc.gov/nchs/data/databriefs/db323-h.pdf.

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