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Suicides Among American Indian/Alaska Natives — National Violent Death Reporting System, 18 States, 2003–2014

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Suicide disproportionately affects American Indians/Alaska Natives (AI/AN). The suicide rate among AI/AN has been increasing since 2003 (*1*), and in 2015, AI/AN suicide rates in the 18 states participating in the National Violent Death Reporting System (NVDRS) were 21.5 per 100,000, more than 3.5 times higher than those among racial/ethnic groups with the lowest rates.* To study completed suicides across all ages of AI/AN, NVDRS data collected from 2003 to 2014 were analyzed by comparing differences in suicide characteristics and circumstances between AI/AN and white decedents. Group differences were assessed using chi-squared tests and logistic regression. Across multiple demographics, incident characteristics, and circumstances, AI/AN decedents were significantly different from white decedents. More than one third (35.7%) of AI/AN decedents were aged 10–24 years (versus 11.1% of whites). Compared with whites, AI/AN decedents had 6.6 times the odds of living in a nonmetropolitan area, 2.1 times the odds of a positive alcohol toxicology result, and 2.4 times the odds of a suicide of a friend or family member affecting their death. Suicide prevention efforts should incorporate evidence-based, culturally relevant strategies at individual, interpersonal, and community levels (*2*) and need to account for the heterogeneity among AI/AN communities (*3*,*4*).

CDC's NVDRS is an active state-based surveillance system that monitors the occurrence and characteristics of violent deaths, including suicides. NVDRS links three data sources (death certificates, coroner/medical examiner reports, and law enforcement reports) to create a comprehensive picture of who dies from violence, where and when victims are injured, and what factors contributed to the victim's death. This report includes all available 2003–2014 NVDRS data from the 18 participating states.† Analyses were limited to suicide decedents aged ≥10 years. Non-Hispanic AI/AN are defined in NVDRS as persons with ancestries of the original inhabitants of North America who maintain their cultural

* https://wonder.cdc.gov/ucd-icd10.html.

† In 2003, the National Violent Death Reporting System (NVDRS) began data collection with six states (Maryland, Massachusetts, New Jersey, Oregon, South Carolina, and Virginia) participating; seven states (Alaska, Colorado, Georgia, North Carolina, Oklahoma, Rhode Island, and Wisconsin) joined in 2004, three (Kentucky, New Mexico, and Utah) in 2005, and two (Michigan and Ohio) in 2010. Ohio collected statewide data starting in 2011 and Michigan starting in 2014. CDC provides funding for state participation, and the ultimate goal is for NVDRS to expand to include all 50 states, U.S. territories, and the District of Columbia.

INSIDE

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identification.[§,¶] Non-Hispanic whites (whites) were used as a comparison group because they have the second-highest suicide rate, but concentrated among different age groups than AI/AN, allowing for comparisons that might reveal unique contributors to suicide above general risk factors. Rural-Urban Commuting Area codes were used to classify geographic areas into metropolitan and nonmetropolitan categories.[**] Demographics, incident characteristics, and precipitating circumstances were examined by race/ethnicity using chi-squared tests. Significant chi-squared results ($p<0.05$) were further examined using logistic regression, controlling for age and sex.

From 2003 to 2014, a total of 1,531 suicides among AI/AN and 103,986 among whites were collected in NVDRS (Table 1). More than one third (35.7%) of AI/AN suicides occurred among youths aged 10–24 years (9.8% aged 10–17 years, 25.9% aged 18–24 years). In contrast, 11.1% of suicides among whites were in persons aged 10–24 years (2.5% aged 10–17 years, 8.6% aged 18–24 years). More than two thirds (69.4%) of AI/AN decedents resided in nonmetropolitan areas, whereas the majority of white decedents (72.7%) resided in metropolitan areas (adjusted odds ratio [aOR] = 6.6; 95% confidence interval [CI] = 5.9–7.3). The largest proportion of both AI/AN and white decedents died by firearm (42.1% and 52.9%, respectively), with hanging/strangulation/suffocation being the next largest proportion (39.7% and 22.5%, respectively).

Circumstance information, obtained primarily through information provided by persons who knew the decedent as indicated in coroner/medical examiner reports and law enforcement reports, was known for 87.5% of AI/AN and 89.8% of white suicides (Table 2). Although intimate partner problems were a common precipitating circumstance for both AI/AN (39.1%) and white decedents (29.4%), AI/AN had significantly higher odds of experiencing this circumstance (aOR = 1.2; 95% CI = 1.1–1.3). Approximately two in 10 AI/AN suicides were preceded by an argument, compared with one in 10 white suicides (aOR = 1.4; 95% CI = 1.2–1.7). Compared with white decedents, AI/AN decedents had 2.4 times the odds of the suicide of a friend or family member affecting their death (as ascertained through a note or interviews with persons who knew the decedent) (95% CI = 1.9–3.1) and 1.7 times the odds

§ https://www.cdc.gov/violenceprevention/pdf/nvdrs_web_codingmanual.pdf.

¶ Information on race and ethnicity are recorded as separate items in NVDRS consistent with U.S. Department of Health and Human Services (HHS) and Office of Management and Budget standards for race/ethnicity categorization. HHS guidance on race/ethnicity is available at https://aspe.hhs.gov/datacncl/standards/ACA/4302/index.shtml.

** ZIP Code Rural-Urban Commuting Area (RUCA) codes (2010) were used to determine whether decedents resided in nonmetropolitan versus metropolitan areas. RUCA codes measure daily commuting flows, population density, and urbanization levels to classify sub-county level geographic areas. Victim residential ZIP codes were dichotomized as "metro" (RUCA codes 1–3) and "nonmetro" (RUCA codes 4–10). Descriptions of the RUCA classification codes 1–10 are available at https://www.ers.usda.gov/data-products/rural-urban-commuting-area-codes/documentation/.

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TABLE 1. Selected demographic and incident characteristics of non-Hispanic American Indian/Alaska Natives and non-Hispanic white suicide decedents — National Violent Death Reporting System, 18 states,* 2003–2014

Characteristic	No. (%) AI/AN (N = 1,531)	No. (%) White (N = 103,986)	aOR (95% CI)†
Age group (yrs)			
10–17§	150 (9.8)	2,554 (2.5)	—
18–24§	396 (25.9)	8,958 (8.6)	—
25–44§	665 (43.4)	33,550 (32.3)	—
45–64§	279 (18.2)	41,428 (39.8)	—
≥65§	41 (2.7)	17,404 (16.8)	—
Sex			
Male	1,190 (77.7)	80,798 (77.7)	—
Female	341 (22.3)	23,184 (22.3)	—
Nonmetropolitan resident¶			
Nonmetropolitan§	1,063 (69.4)	27,665 (27.3)	6.6 (5.9–7.3)
Mechanism			
Firearm§	645 (42.1)	55,035 (52.9)	0.8 (0.7–0.9)
Hanging, strangulation, suffocation§	607 (39.7)	23,358 (22.5)	1.6 (1.4–1.7)
Poisoning§	175 (11.4)	18,508 (17.8)	0.7 (0.6–0.8)
Motor vehicle§	41 (2.7)	1,220 (1.2)	1.7 (1.2–2.3)
Sharp instrument	24 (1.6)	1,895 (1.8)	—**
Fall§	12 (0.8)	1,699 (1.6)	—††
Other (single method)	19 (1.2)	1,528 (1.5)	—**
Location			
House or apartment§	1,124 (73.4)	78,360 (75.4)	1.0 (0.9–1.1)
Transport related§§	112 (7.3)	8,529 (8.2)	—**
Natural area§,¶¶	98 (6.4)	4,670 (4.5)	1.3 (1.1–1.6)
Supervised facility§,***	45 (3.0)	1,567 (1.5)	1.6 (1.2–2.1)
Hotel/Motel	24 (1.6)	2,351 (2.3)	—**
Abandoned building or industrial setting§,†††	19 (1.2)	439 (0.4)	—††
School including college§	12 (0.8)	192 (0.2)	—††
Other	83 (5.4)	5,875 (5.6)	—**

Abbreviations: AI/AN = non-Hispanic American Indian/Alaska Native; aOR = adjusted odds ratio; CI = confidence interval; white = non-Hispanic white.

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

† Adjusted odds ratios measure the association between the decedent having the demographic or incident characteristic and the race of the decedent being AI/AN. Each adjusted odds ratio used white as the reference group and controlled for age group and sex. Therefore, odd ratios for age groups and sex are not presented.

§ Chi-squared test result for difference between AI/AN and white significant at p<0.05.

¶ ZIP Code Rural-Urban Commuting Area (RUCA) codes (2010) were used to determine whether a victim resided in a nonmetropolitan versus a metropolitan area. Victim residential ZIP codes were dichotomized as "metro" (RUCA codes 1–3) and "nonmetro" (RUCA codes 4–10). Descriptions of the RUCA classifications codes 1–10 are available at https://www.ers.usda.gov/data–products/rural–urban–commuting–area–codes/documentation/.

** No significant difference was found between AI/AN and white for this incident characteristic, therefore no measure of association was calculated.

†† Statistical reliability criteria for logistic regression not met because cell frequencies were less than the required minimum.

§§ Includes suicides that occurred in a motor vehicle, street, highway, parking lot/garage, public transport, railroad tracks, or bridge.

¶¶ Includes suicides that occurred in a beach, river, field, or woods.

*** Includes suicides that occurred in jail, prison, or supervised residential facility.

††† Includes suicides that occurred in industrial or construction sites or an abandoned house, building, or warehouse.

of the nonsuicide death of a friend or family member affecting their death (95% CI = 1.4–2.1).

Current diagnosed mental health problems (aOR = 0.4; 95% CI = 0.4–0.5), depressed mood (aOR = 0.9; 95% CI = 0.8–1.0), and current mental health treatment (aOR = 0.5; 95% CI = 0.4–0.5) were less likely to be reported among AI/AN decedents than among white decedents (Table 2). Substance abuse problems other than alcohol were not significantly different between AI/AN and white decedents; however, AI/AN decedents had 1.8 times the odds of a reported alcohol problem compared with white decedents (95% CI = 1.6–2.1). In addition, AI/AN decedents were more likely to have reportedly used alcohol in the hours before death (aOR = 2.7; 95% CI = 2.4-3.0) and had more than twice the odds of a positive alcohol toxicology result (aOR = 2.1; 95% CI = 1.9–2.5) (Table 3). Among those tested, AI/AN decedents were significantly more likely to test positive for marijuana (aOR = 1.5; 95% CI = 1.2–1.8) and amphetamines (aOR = 1.4; 95% CI = 1.1–1.9), and significantly less likely to test positive for antidepressants (aOR = 0.7; 95% CI = 0.5–0.9) and opioids (aOR = 0.5; 95% CI = 0.4–0.7) than were white decedents (Table 3).

Discussion

Suicide rates among AI/AN are historically higher than those of the total U.S. population (*1*). The results of this study are consistent with previous research on risk factors for AI/AN suicidal behaviors (*3*,*5*) and provide additional information on important circumstances and characteristics that precede suicide among AI/AN. Across many demographics, incident characteristics, and circumstances, AI/AN decedents were significantly different from whites.

Approximately 70% of AI/AN decedents resided in nonmetropolitan areas, including rural settings, underscoring the importance of implementing suicide prevention strategies in rural AI/AN communities. Residential status can affect the circumstances surrounding suicide. For example, in this study AI/AN decedents had lower odds than did white decedents of having received a mental health diagnosis or mental health treatment, even when controlling for age and sex. Rural areas often have lower availability and use of mental health services because of provider shortages†† and social barriers, including stigma and lack of culturally competent care (*6*). To address provider shortages, financial incentives, such as loan forgiveness for mental health practitioners, represent one strategy that could be helpful in recruiting providers for rural and nonmetropolitan areas (*2*). The high rate of suicides among AI/AN youths highlights the need for early prevention. School-based

†† https://datawarehouse.hrsa.gov/topics/shortageAreas.aspx.

TABLE 2. Circumstances precipitating suicide deaths of non-Hispanic American Indian/Alaska Natives compared with non-Hispanic whites — National Violent Death Reporting System, 18 states,* 2003–2014

Circumstance	No. (%)† AI/AN	No. (%)† White	aOR (95% CI)§
Total decedents	**1,531 (100)**	**103,986 (100)**	—
Cases with known circumstances¶,**	1,339 (87.5)	93,403 (89.8)	—
Suicide event			
History of suicidal thoughts or plan††	111 (33.4)	6,955 (32.7)	—§§
History of suicide attempts¶	308 (23.0)	18,935 (20.3)	1.0 (0.9–1.2)
Disclosed suicidal intent¶	457 (34.1)	26,377 (28.2)	1.3 (1.1–1.4)
Interpersonal			
Intimate partner problem¶	524 (39.1)	27,464 (29.4)	1.2 (1.1–1.3)
Family relationship problem¶¶	83 (10.6)	4,965 (8.8)	—§§
Victim of interpersonal violence within past month¶	21 (1.6)	444 (0.5)	—***
Perpetrator of interpersonal violence within past month¶	91 (6.8)	3,107 (3.3)	2.0 (1.6–2.4)
Argument preceded death¶,¶¶	154 (19.7)	6,102 (10.8)	1.4 (1.2–1.7)
Life stressor			
Victim in custody¶,**	76 (5.0)	2,458 (2.4)	1.7 (1.4–2.2)
Released from institution within previous month¶,†††	17 (4.6)	1,885 (8.2)	—***
Criminal legal problem¶	201 (15.0)	8,493 (9.1)	1.5 (1.3–1.7)
Civil legal problem¶	34 (2.5)	3,420 (3.7)	—***
Physical health problem¶	144 (10.6)	21,655 (23.2)	0.9 (0.7–1.0)
Job problem¶,§§§	92 (7.6)	12,038 (13.2)	0.5 (0.4–0.6)
Financial problem¶,§§§	76 (6.3)	11,211 (12.3)	0.5 (0.4–0.7)
School problem¶¶¶	36 (21.4)	688 (22.0)	—§§
Eviction/Loss of home	25 (1.9)	2,525 (2.7)	—§§
Suicide of friend or family member¶	79 (5.9)	1,797 (1.9)	2.4 (1.9–3.1)
Death of friend or family member¶	118 (8.8)	6,116 (6.6)	1.7 (1.4–2.1)
Any crisis within past 2 weeks	411 (30.7)	26,815 (28.7)	—§§
Mental health/Substance use			
Current mental health problem¶	371 (27.7)	43,614 (46.7)	0.4 (0.4–0.5)
Current depressed mood¶	489 (36.5)	38,940 (41.7)	0.9 (0.8–1.0)
Current mental health treatment¶	261 (19.5)	31,987 (34.2)	0.5 (0.4–0.5)
History of mental health treatment¶	311 (23.2)	37,499 (40.2)	0.4 (0.4–0.5)
Reported alcohol use in hours preceding death¶	651 (48.6)	23,370 (25.0)	2.7 (2.4–3.0)
Alcohol abuse problem¶	371 (27.7)	17,242 (18.5)	1.8 (1.6–2.1)
Substance abuse problem other than alcohol	202 (15.1)	14,365 (15.4)	—§§

Abbreviations: AI/AN = non-Hispanic American Indian/Alaska Native; aOR = adjusted odds ratio; CI = confidence interval; NVDRS = National Violent Death Reporting System; white = non-Hispanic white.

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

† Denominator includes only those suicides with ≥1 precipitating circumstances, unless otherwise noted. Sums of percentages in columns may exceed 100% because a suicide could have more than one precipitating circumstance.

§ Adjusted odds ratios measure the association between the decedent having the precipitating circumstance present and the race of the decedent being AI/AN. Each adjusted odds ratio used white as the reference group and controlled for age group and sex.

¶ Chi-squared test result for difference between AI/AN and white significant at p<0.05.

** Denominator includes all suicide decedents (1,531 AI/AN; 103,986 white).

†† Variable added to NVDRS in 2013; Denominator includes only decedents from 2013 and later with ≥1 known circumstances (332 AI/AN; 21,246 white).

§§ No significant difference was found between AI/AN and white for this incident characteristic, therefore no measure of association was calculated.

¶¶ Variable added to NVDRS in 2009; Denominator includes only decedents from 2009 and later with ≥1 known circumstances (780 AI/AN; 56,274 white).

*** Statistical reliability criteria for logistic regression not met because cell frequencies were less than the required minimum.

††† Variable added to NVDRS in 2013; Denominator includes all suicide decedents from 2013 and later (367 AI/AN; 22,959 white). Institution includes jail or other detention facility, hospital, psychiatric institution, supervised residential facility or nursing home.

§§§ Denominator includes only decedents ≥18 years with ≥1 known circumstance (1,213 AI/AN; 91,097 white).

¶¶¶ Denominator includes only decedents ≤18 years with ≥1 known circumstance (168 AI/AN; 3,125 white).

programs are able to reach a large number of AI/AN youths at high risk and could increase the availability of services for AI/AN in isolated nonmetropolitan areas (*4*). In addition, school-based programs that focus on individual life skills development and interpersonal social emotional learning programs to promote healthy relationships and conflict resolution might address the higher occurrence of intimate partner problems and arguments preceding AI/AN suicides (*2*,*4*).

AI/AN decedents were more likely to have a friend's or family member's suicide contribute to their death. A previous study in one AI/AN tribe found that suicidal behavior occurred close in time and within tight social networks, suggesting suicide

contagion (*5*). Given the observation that AI/AN had an elevated risk of their own suicide being linked to the suicide death of a loved one, community level prevention strategies, including programs that focus on postvention (e.g., survivor support groups) and safe reporting of suicides by the media (e.g., not using sensationalized headlines), should be considered (http://reportingonsuicide.org/wp-content/themes/ros2015/assets/images/Recommendations-eng.pdf) (*2*).

Substance use is a recognized risk factor for suicidal behavior (*4*). A larger proportion of AI/AN decedents used alcohol before their suicide and had reported alcohol abuse problems. Previous studies have found that AI/AN youths aged 12–17 years have the highest rates of alcohol use among all racial/ethnic groups (*4*). Community-based programs to reduce excessive alcohol use (e.g., enforcement of laws prohibiting sales to minors and increasing alcohol taxes) and individual-level programs for persons at various risk levels, such as improved access to substance abuse treatment and life skills development programs for youths are necessary (*1*,*4*,*7*). Differences in the prevalence of alcohol use, interpersonal problems, and access to mental health treatment among AI/AN might be symptoms of disproportionate exposure to poverty, historical trauma, and other contexts of inequity and should not be viewed as inherent to AI/AN culture (*4*,*8*).

The findings in this report are subject to at least five limitations. First, race of AI/AN decedents is often misclassified on death certificates resulting in underascertainment of AI/AN mortality, including suicide (*9*). Second, tribal affiliation is not collected in NVDRS. Thus, the heterogeneity of AI/AN tribes and the cultural differences between these communities could not be assessed, and results might not be generalizable across all AI/AN communities. Future studies are needed to identify risk and protective factors for suicide that might be unique to individual tribes or communities. Third, it was not possible to determine whether decedents resided on tribal reservations based on the available information. Fourth, mental health diagnoses and treatment status are based on informant reports and could be underreported for either or both groups. Finally, NVDRS data were available from 18 states as of the time of this report and are therefore not necessarily representative of suicides outside these areas.

Prior research suggests comprehensive suicide prevention strategies designed to address the specific needs of an AI/AN

Summary

What is already known about this topic?

American Indian/Alaska Natives (AI/AN) have the highest rates of suicide of any racial/ethnic group in the United States. The rates of suicide in this population have been increasing since 2003.

What is added by this report?

Analysis of National Violent Death Reporting System data from 18 states showed AI/AN suicide decedents were younger and had higher odds of living in a nonmetropolitan area than did non-Hispanic whites who died by suicide. Suicide and nonsuicide deaths of friends and family, as well as alcohol use preceding death were associated with AI/AN decedents more often than non-Hispanic white decedents.

What are the implications for public health practice?

The high prevalence of suicide among the AI/AN population and the comparative differences in suicide circumstances among AI/AN decedents illustrate some of the disparities this population faces. Focused, yet comprehensive, suicide prevention and intervention efforts are needed that incorporate culturally relevant, evidence-based strategies at the individual, interpersonal, and community levels.

TABLE 3. Toxicology* results of non-Hispanic American Indian/Alaska Native suicide decedents compared with non-Hispanic white suicide decedents — National Violent Death Reporting System, 18 states,† 2003–2014

	AI/AN		White		
Toxicology	No. (%) tested	No. (%) positive	No. (%) tested	No. (%) positive	aOR (95% CI)§
Alcohol	846 (55.3)	449 (53.5)	66,955 (64.4)	23,436 (35.0)	2.1 (1.9–2.5)
Amphetamine	593 (38.7)	47 (8.0)	42,762 (41.1)	1,966 (4.7)	1.4 (1.1–1.9)
Antidepressant	389 (25.4)	77 (20.2)	39,489 (38.0)	11,329 (28.7)	0.7 (0.5–0.9)
Benzodiazepine	148 (9.7)	23 (15.8)	11,142 (10.7)	4,003 (36.1)	—¶
Cocaine	607 (39.7)	24 (4.0)	45,757 (44.0)	2,786 (6.1)	—¶
Marijuana	481 (31.4)	98 (20.7)	35,374 (34.0)	3,802 (10.9)	1.5 (1.2–1.8)
Opioid	614 (40.1)	72 (11.7)	46,773 (45.0)	11,126 (24.1)	0.5 (0.4–0.7)

Abbreviations: AI/AN = non-Hispanic American Indian/Alaska Native; aOR = adjusted odds ratio; CI = confidence interval; white = non-Hispanic white.

* All substances included in the table had a chi-squared test results that was significant at p<0.05. Substances indicating no significant difference between AI/AN and white at p<0.05 were excluded from the table.

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

§ Adjusted odds ratios measure the association between the decedent having tested positive for the substance and the race of the decedent being AI/AN. The denominator was the number of decedents who were tested for each substance. Each adjusted odds ratio used white as the reference group and controlled for age group and sex.

¶ Statistical reliability criteria for logistic regression not met because cell frequencies were less than the required minimum.

community are associated with reductions in suicide (*10*). The high prevalence of suicide among AI/AN and the comparative differences in suicide circumstances among this group are illustrative of the inequities faced by this population. This study highlights the importance of focused suicide prevention and intervention efforts that incorporate culturally relevant, evidence-based strategies at the individual, interpersonal, and community levels (*2*).

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Conflict of Interest

No conflicts of interest were reported

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CDC Grand Rounds: Promoting Hearing Health Across the Lifespan

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Globally, one in three adults has some level of measurable hearing loss, and 1.1 billion young persons are at risk for hearing loss attributable to noise exposure. Although noisy occupations such as construction, mining, and manufacturing are primary causes of hearing loss in adults, nonoccupational noise also can damage hearing. Loud noises can cause permanent hearing loss through metabolic exhaustion or mechanical destruction of the sensory cells within the cochlea. Some of the sounds of daily life, including those made by lawn mowers, recreational vehicles, power tools, and music, might play a role in the decline in hearing health. Hearing loss as a disability largely depends on a person's communication needs and how hearing loss affects the ability to function in a job. The loss of critical middle and high frequencies can significantly impair communication in hearing-critical jobs (e.g., law enforcement and air traffic control).

Occupational Noise-Induced Hearing Loss

A recent analysis of 2011–2012 National Health and Nutrition Examination Survey (NHANES) data estimates that approximately 14% of U.S. adults aged 20–69 years (27.7 million persons) have hearing loss. After adjustments for age and sex, hearing impairment was nearly twice as prevalent in men as in women; age, sex, ethnicity, and firearm use were all important risk factors for hearing loss (*1*).

CDC's National Institute for Occupational Safety and Health (NIOSH) estimates that 22 million workers are exposed to hazardous levels of noise in their workplaces (*2*). The estimated prevalence of hearing loss among noise-exposed workers is 12%–25%, depending on type of industry. Reductions in workplace noise and increased use of hearing protection might have contributed to a decreased prevalence of hearing loss over time in some sectors, including agriculture, forestry, fishing, and hunting and transportation, warehousing, and utilities (*3*). The risk for incident hearing loss (i.e., the likelihood of observing a new case of hearing loss in a worker's longitudinal audiometric data) decreased by 46% from the periods 1986–1990 to 2006–2010 (*3*).

This is another in a series of occasional MMWR *reports titled CDC Grand Rounds. These reports are based on grand rounds presentations at CDC on high-profile issues in public health science, practice, and policy. Information about CDC Grand Rounds is available at https://www.cdc.gov/about/grand-rounds.*

For high exposure levels such as firearm or aircraft noise above 140 decibels sound pressure level (dB SPL), engineering and administrative controls might not reduce noise exposures adequately. Such situations require hearing protection devices (HPDs) providing upwards of 30–40 dB of noise reduction when worn properly. Despite the existence of occupational regulations for hearing protection, many workers fail to achieve adequate protection because their earplugs or earmuffs do not fit properly. Hearing protector fit testing provides an opportunity to train workers to properly fit hearing protectors and to encourage effective use. The NIOSH HPD Well-Fit hearing protector fit-test system is a simple, portable solution for testing in quiet office spaces. Other fit-testing systems are commercially available (*4*).

Nonoccupational Noise-Induced Hearing Loss

Primary sources of nonoccupational hearing loss in the United States include noise exposure from recreational hunting or shooting, use of personal music players, overexposure at concerts and clubs, and certain hobbies (e.g., motorsports and woodworking with power tools). In 2016, CDC began initiatives to raise awareness about the risk for permanent hearing damage attributable to nonoccupational noise exposures, including the development of new communication tools about noise-induced hearing loss. An analysis of 2011–2012 NHANES audiometric data from 3,583 adults aged 20–69 years identified persons with high-frequency audiometric notches suggestive of noise-induced hearing loss (*5*). Persons with normal hearing can detect sounds equally soft at all frequencies. When hearing is damaged by noise, the hearing test will show a loss of acuity in a narrow range of middle to high frequencies (3–6 kHz) with better hearing at both lower and higher frequencies. Often, the earliest sign is a notched configuration in the audiogram (Figure).

The weighted prevalence of an audiometric notch was 24%, extrapolated to represent nearly 40 million U.S. adults. Unilateral audiometric notches were three times more prevalent than were bilateral audiometric notches and were more prevalent in men than in women. Participants who reported having exposure to loud noise at work were twice as likely to have evidence of hearing damage as were those who did not. However, 20% of persons with no occupational exposure to loud noise had an audiometric notch, suggesting that 21 million U.S. adults likely have hearing damage from noise at home or in their communities

(*5*). The presence of an audiometric notch increased with age, ranging from 19% of participants aged 20–29 years to 29% of those aged 40–49 years. The prevalence of notches decreased among persons aged 50–59 years, as high-frequency hearing loss associated with aging increasingly masks the notch associated with noise-induced hearing loss (Figure).

Regardless of whether participants' exposure was to work or recreational noise, 24% of those with such damage reported that their hearing was excellent or good, suggesting that many persons might be either unaware of or ignoring noise-induced hearing damage. Although most noise-induced hearing loss is preventable, the NHANES analysis found that 70% of persons exposed to loud noise in the past 12 months had seldom or never worn hearing protection (*5*).

Noise-induced hearing loss in youths is not a new problem. An analysis of 1988–1994 NHANES data identified audiometric notches in 20% of males and 12% of females aged 12–19 years among a population of 5,249 U.S. children and young adults aged 6–19 years (*6*). An analysis of 2005 and 2006 NHANES data found that 17% of both males and females had notched audiograms (*7*).

Hearing Loss Worldwide

Hearing loss affects tens of millions of persons in the United States and hundreds of millions of persons worldwide, and during the past few decades, the estimated number of persons with hearing loss has steadily increased (*8*). The World Health Organization (WHO) estimates that approximately 360 million persons live with disabling hearing loss, including approximately 328 million (91%) adults (56% males and 44% females) and 32 million (9%) children. As the population ages, it is estimated that approximately 320 million persons aged >65 years will have hearing loss by 2030 and approximately 500 million by 2050 (*8*).

National Prevention Efforts

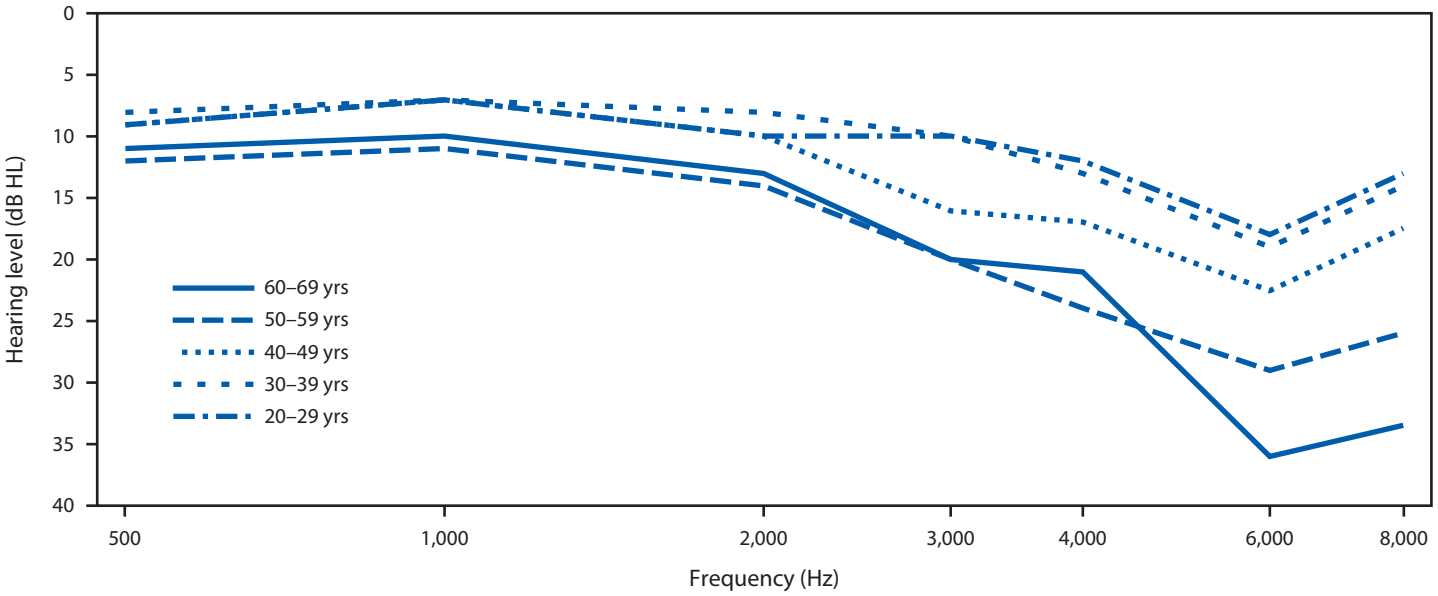
To ensure that all persons can benefit from efforts to prevent noise-induced hearing loss, a coordinated public health hearing loss reduction and mitigation approach should focus on effective population-based preventive interventions that go beyond clinical service and traditional areas of diagnosis, treatment, and research and focus on epidemiologic surveillance, health promotion, and disease prevention. Such an approach can help determine the needs of the population and the barriers to care, leading to policies for prevention and management of hearing loss. Health communication science provides a theoretical framework to study, develop, and evaluate interventions designed to change individual behavior. Some of these theories have been applied in the promotion of hearing health.

Dangerous Decibels (http://dangerousdecibels.org/) is an evidence-based intervention program that has changed knowledge, attitudes, beliefs, and behaviors of both youths and adults for the prevention of noise-induced hearing loss and tinnitus. The messaging incorporates three strategies for hearing loss prevention: 1) turn it down, 2) walk away, and 3) protect your ears. Originally developed for youths, Dangerous Decibels has been successfully adapted for civilian adults and the military, and its effectiveness was demonstrated in randomized trials among children in the United States and in studies in New Zealand and Brazil (*9*,*10*). Comparison of responses to predelivery and two postdelivery questionnaires found that participants in the Dangerous Decibels presentation exhibited substantial improvements in knowledge, attitudes, and intended behaviors related to hearing and hearing loss prevention that were partially maintained 3 months after the presentation. Most recently, Dangerous Decibels expanded into a community-based intervention and is self-sustaining in U.S. Native American communities (*9*). The materials are in use in all 50 states, four U.S. territories, and 41 countries. Online games and activities are available, including Jolene, a system that measures music-listening sound levels and aids in educational outreach for hearing health (*11*).

CDC has developed tools and communication products to promote best practices for hearing loss prevention. In addition to practical engineering controls, administrative controls, and using hearing protectors, NIOSH promotes the Buy Quiet and Quiet-by-Design programs, designed for employers to take an inventory of their potentially harmful loud tools and replace them with quieter ones. Approximately 20 companies and individuals have been recognized for successful efforts by the Safe-in-Sound Excellence in Hearing Loss Prevention and Innovation Award (http://www.safeinsound.us/) developed by NIOSH and the National Hearing Conservation Association (*12*). In 2015, United Technologies, a corporation that serves customers in the commercial aerospace, defense, and building industries, received the award for promoting a hearing-loss prevention culture throughout the corporation. United Technologies reduced the number of persons exposed to hazardous noise by approximately 80%, thereby eliminating the need for a hearing conservation program for approximately 10,000 workers.

Other efforts include the promotion of recommended noise exposure standards for the workplace. NIOSH recommends an 85-dB limit for an average daily 8-hour exposure and a 3-dB exchange rate, which means that each increase of 3 dB in exposure level reduces the recommended exposure time by half (*13*). Thus, an 88-dB exposure limit is recommended for up to 4 hours and a 91-dB exposure limit for 2 hours. The National Hearing Conservation Association 85-3 Coalition,

FIGURE. Mean audiometric thresholds for persons aged 20–69 years with identified unilateral (right ear only) notches — National Health and Nutrition Examination Survey, United States 2011–2012



an organization of worker, professional, and industrial hygiene associations, promotes the use of an 85-dB limit and 3-dB exchange rate to protect the hearing of workers (*14*).

WHO focuses on undertaking evidence-based advocacy to raise awareness of deafness, hearing loss, and hearing care within all levels of society. WHO develops policy that advocates for hearing care provisions in its 194 member countries and develops standardized technical tools, recommendations, guidelines, and training resources to support policy development and implementation. It also engages directly with national ministries of health and other stakeholders to develop, implement, and monitor strategies for ear and hearing care.

Two principal advocacy initiatives promoted by WHO include World Hearing Day (http://www.who.int/pbd/deafness/world-hearing-day/en/) and the Make Listening Safe initiative (http://www.who.int/pbd/deafness/activities/MLS/en/) (*15*). The Make Listening Safe initiative was launched in 2015 to reduce the growing risk for hearing loss posed by unsafe listening practices in recreational settings. As part of this initiative, WHO is working with partners to develop technical standards and applications for personal audio systems and to promote safe listening practices among application (app) users. World Hearing Day, observed each year on March 3, aims to increase hearing loss awareness among policymakers, professionals, and communities. The 2018 theme is "Hear the future," drawing attention to the globally increasing number of persons with hearing loss, focusing on preventive strategies, and outlining steps to ensure access to necessary rehabilitation services and communication tools and products.

Noise reduction and avoidance can prevent hearing loss or slow its progression. Persons can protect themselves by moving away or taking breaks from loud sounds, using quieter consumer products, lowering volumes on personal listening devices, reducing time listening to loud levels of music, and using hearing protectors. Hearing protectors need to fit well to reduce noise exposures effectively. Health care providers can inform patients about hearing loss symptoms, early diagnosis of hearing loss, and prevention strategies.

Policymakers, governments, and manufacturers of equipment can develop policies to reduce noise levels and limit noise exposures of the public. In parts of Europe, community noise and the effect of urban soundscapes on public health have received considerable attention. In the United States, national, state, and local community noise-control efforts are largely uncoordinated, potentially resulting in higher levels of community noise. Increasing awareness and reducing needless exposures to loud noise might help the public take appropriate steps to protect their hearing.

Conflict of Interest

No conflicts of interest were reported.

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Trichinellosis Outbreak Linked to Consumption of Privately Raised Raw Boar Meat — California, 2017

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On January 15, 2017, a hospital physician notified the Alameda County Public Health Department (ACPHD) in California of a patient with a suspected diagnosis of trichinellosis, a roundworm disease transmitted by the consumption of raw or undercooked meat containing *Trichinella spp.* larvae (*1*). A family member of the initial patient reported that at least three other friends and family members had been evaluated at area hospitals for fever, myalgia, abdominal pain, diarrhea, and vomiting. The patients had attended a celebration on December 28, 2016, at which several pork dishes were served, including larb, a traditional Laotian raw pork dish, leading the hospital physician to suspect a diagnosis of trichinellosis. Although the event hosts did not know the exact number of attendees, ACPHD identified 29 persons who attended the event and seven persons who did not attend the event, but consumed pork taken home from the event by attendees. The event hosts reported that the meat had come from a domesticated wild boar raised and slaughtered on their private family farm in northern California. ACPHD conducted a case investigation that included identification of additional cases, testing of leftover raw meat, and a retrospective cohort study to identify risk factors for infection.

Investigation and Findings

Contact information for additional attendees and exposed persons was obtained during interviews with confirmed attendees. Reports of suspected diagnoses of trichinellosis among event attendees were requested from hospital infection prevention specialists, outpatient clinic providers, and local health jurisdictions where event attendees lived.

Exposure to *Trichinella* was defined as consumption of pork in which *Trichinella spiralis* larvae were identified. Thirty-six potentially exposed persons were identified, including 29 who attended the event and seven who consumed food taken home from the event by attendees. Among the potentially exposed persons, 20 (56%) were interviewed, 16 for whom professional language interpreters were used. Fourteen potentially exposed persons were not interviewed because contact information was unavailable, and two persons could not be reached. Clinical and exposure information from all 20 persons who were interviewed was collected using a structured questionnaire administered by telephone 28–92 days after the December 28 event. Medical records for patients with a suspected diagnosis of trichinellosis were requested from hospitals and outpatient providers and abstracted. In consultation with the California Department of Public Health and CDC, ACPHD recommended serologic testing for *Trichinella* for all persons with a suspected diagnosis of trichinellosis using a commercial laboratory's enzyme-linked immunosorbent assay* to detect immunoglobulin G (IgG) directed against a *Trichinella* excretory-secretory antigen.

An illness that was clinically compatible with trichinellosis was defined as the occurrence of 1) myalgia and fever; or 2) periorbital edema; or 3) eosinophilia (≥6% eosinophils), with or without gastrointestinal symptoms (e.g., diarrhea, vomiting, or abdominal pain) in an attendee or someone who had consumed food brought home by an attendee. A probable case was defined as clinically compatible illness in a patient with exposure to *Trichinella*. Confirmed cases were defined as laboratory-confirmed *Trichinella* infection (i.e., a positive serologic test for *Trichinella* IgG antibodies) in a patient with history of exposure and clinically compatible illness.

Ten confirmed and two probable cases of trichinellosis were identified; 11 occurred in men. Eleven patients self-identified as Asian, and one identified as Asian and white. The median age was 58 years (range = 39–71 years). Onset dates ranged from December 28, 2016, to January 23, 2017. Nine patients were hospitalized, two of whom were admitted to the intensive care unit; nine had sepsis, seven had acute kidney injury, and two had gastrointestinal bleeding, one case of which was attributed to nonsteroidal antiinflammatory drug use. Eight patients had elevated peak creatine phosphokinase levels indicating skeletal muscle damage (median = 2,821 μg/L; range = 566–25,467 [normal <200 μg/L]), and seven had elevated peak lactic acid levels, which is an indicator of sepsis (median = 3.1 mmol/L; range = 2.3–5.3 [normal = 0.5–2.2 mmol/L]). Six had elevated peak troponin levels indicating damage to the myocardium (median = 0.76 μg/L; range = 0.23–2.02 [normal <0.10 μg/L]). Ten cases were confirmed by a positive *Trichinella* serological test; two patients were not tested (Table).

Several event attendees had also assisted with food preparation. The three pork-containing dishes reported to have been served at the event included pork stew, grilled pork, and raw larb. Attendees were interviewed about preparation

* Gold Standard Diagnostics, testing performed at Focus Diagnostics, Inc., San Juan Capistrano, California.

TABLE. Clinical characteristics of trichinellosis cases associated with consumption of raw boar meat (N = 12) — California, 2017

Characteristic	No. of patients (%)
Sign/Symptom	
Myalgia	12 (100)
Fever	11 (92)
Weakness	10 (83)
Chills	10 (83)
Diarrhea	9 (75)
Nausea/Vomiting	9 (75)
Abdominal pain	6 (50)
Cough	4 (33)
Shortness of breath	4 (33)
Periorbital edema	4 (33)
Laboratory result	
Reactive *Trichinella* immunoglobulin G	10 (83)
Elevated eosinophil percentage (≥6%)	10 (83)
Elevated creatine phosphokinase (>200 μg/L)	8 (67)*
Elevated lactic acid (>2.2 mmol/L)	7 (58)*
Elevated troponins (≥0.1 μg/L)	6 (50)*
Treatment	
Albendazole	11 (92)
Glucocorticoid	7 (58)
Complication	
Sepsis	9 (75)
Acute kidney injury	7 (58)
Gastrointestinal bleed	2 (17)
Death	0 (—)
Highest level of care	
Intensive care unit	2 (17)
Hospitalization	7 (58)
Emergency department	1 (8)
Outpatient	2 (17)

* Three patients had elevated creatine phosphokinase, lactic acid, and troponins.

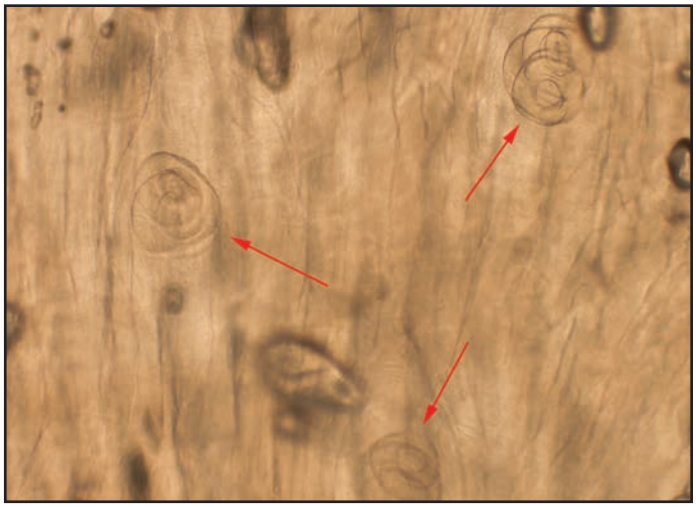
and consumption of the three pork dishes served at or taken home from the event, as well as consumption of any other pork-containing dishes served at the event and other sources of wild boar or bear meat. Attack rates and relative risks were calculated. Leftover raw pork from the implicated meal was obtained from the event hosts.

Larvae in an unstained touch preparation from the raw pork were verified as *Trichinella spp.* from a photomicroscopic image (Figure); samples were sent to CDC's Division of Parasitic Diseases and Malaria diagnostic laboratory and identified as *Trichinella spiralis* through sequencing of the polymerase chain reaction–amplified ITS1-ITS2 region. Consumption of larb was significantly associated with trichinellosis, with an attack rate of 100% and a relative risk of 3.33 (95% confidence interval = 1.29–8.59). No other meat dishes were associated with an increased relative risk.

Public Health Response

The caretaker of the source farm could not be reached, but the event host who owns the farm reported that the caretaker purchased the pig from a private farm at age 5 weeks, raised it in an outdoor, fenced pen, and slaughtered it with the farm

FIGURE. Microscopic image of *Trichinella spiralis* (arrows) encysted within implicated raw pork* — California, 2017



Photo/Valerie Ng, Department of Laboratory Medicine and Pathology, Highland Hospital, Alameda Health System
* Unstained touch preparation, 100x magnification.

owner at age 2.5 years. The farm owner stated there are several pigs being raised on the farm, and the swine are only given commercial feed and never cooked or uncooked meat, offal, or garbage. The farm owner denied any rodent infestation issues on the farm but did state that small animals such as chicks had occasionally gotten into the fenced pen and been eaten by the pigs, indicating that small mammals infected with *Trichinella* could have entered the pen and been consumed by the swine. The event host has slaughtered pigs and served the fresh raw pork dish at previous celebrations; no illnesses had been reported before this event. Health education regarding safe food handling practices and avoiding consumption of raw meat was provided during interviews with potentially exposed persons and patients. The host was educated about reducing the risk for trichinellosis when consuming pigs from his farm by freezing raw meat for 30 days and cooking meat to a minimum internal temperature of 160°F (71.1°C) to kill *Trichinella* larvae (*2*). Although the host did not indicate that he would employ these risk reduction techniques, he did state that he would not serve raw pork from pigs from his farm in the future. Some patients said they would no longer eat raw meat; one patient reported he would continue to eat raw meat from animals that he hunts, believing that raw meat confers strength.

Discussion

Historically, most cases of trichinellosis were associated with the consumption of raw or undercooked *Trichinella*-infected pork (median = 360 cases reported to CDC per year during 1947–1956); however, largely owing to improvements in agricultural and food processing standards (*3*), many fewer

Summary

What is already known about this topic?

Trichinellosis is a parasitic infection that can cause severe disease including sepsis. It is caused by the consumption of raw or undercooked meat containing *Trichinella spp.* larvae. Although strict agricultural and food processing standards have substantially reduced the prevalence of trichinellosis in the United States, persons who consume raw or undercooked wild game meat and pork from noncommercial sources remain at risk for the disease.

What is added by this report?

In January 2017, 12 cases of trichinellosis were reported among persons who attended an event on December 28, 2016, at which larb, a traditional Laotian raw pork dish, was served. The implicated pork came from a domesticated wild boar raised and slaughtered on a private farm in northern California; leftover samples were found to contain *Trichinella spiralis*. Nine infected persons were hospitalized with sepsis and seven had acute kidney injury.

What are the implications for public health practice?

Cultural practices that involve the consumption of raw meat might place certain groups at a higher risk for infection with *Trichinella* and other zoonotic parasites. Strengthening efforts by public health, agriculture, and wildlife authorities to provide culturally competent approaches to educating private farmers, hunters, and communities about trichinellosis prevention might reduce the risk for infection.

cases are currently reported (median = 14.5 cases reported per year during 2006–2015) (*4*). Whereas trichinellosis is rare in the United States, it remains a public health threat, especially among populations that consume raw or undercooked wild game meat or pork from noncommercial sources (*5*). Recent outbreaks of trichinellosis have been associated with wild boar, bear, walrus, and unspecified pork (*4*,*6*). The outbreak described in this report was linked to consumption of a privately raised boar, yet surveillance data during 2008–2012 identified just one case of trichinellosis linked to the consumption of home-raised swine (*4*), suggesting that this might be an underrecognized risk factor for trichinellosis. Home-raised and home-slaughtered swine produced for personal consumption typically are not subject to the same safety and inspection standards as are commercially produced swine and might be outside the purview of inspections by the state agriculture department or animal health board. Home-raised swine with access to the outdoors are also at risk for acquiring other zoonotic parasites, including toxoplasmosis and *Ascaris suum* (large roundworm of pigs). Educating persons who raise swine for personal consumption about these safety concerns by public health or agriculture authorities might mitigate the risks.

Clinical disease associated with trichinellosis can be severe and might include sepsis, which has rarely been reported in the English-language scientific literature. This outbreak investigation indicates that high-risk meat preparation and consumption practices might be part of valued cultural traditions. Public health, agriculture, and wildlife authorities should strengthen efforts to provide culturally competent education about trichinellosis prevention to private farmers, hunters, and communities whose cultural practices include raw meat consumption.

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Conflict of Interest

No conflicts of interest were reported.

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Rabies Vaccine Hesitancy and Deaths Among Pregnant and Breastfeeding Women — Vietnam, 2015–2016

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Human rabies deaths are preventable through prompt administration of postexposure prophylaxis (PEP) with rabies immune globulin and rabies vaccine after exposure to a rabid animal (*1*); there are no known contraindications to receiving PEP (*1*,*2*). Despite widespread availability of PEP in Vietnam, in 2015 the Ministry of Health (MoH) received reports of pregnant and breastfeeding women with clinically diagnosed rabies. MoH investigated factors associated with these rabies cases. MoH found that, during 2015–2016, among 169 cases reported in Vietnam, two probable cases of rabies were reported in breastfeeding mothers and four in pregnant women, all of whom had been bitten by dogs. All six patients died. Three of the four pregnant women had cesarean deliveries. One of the three newborns died from complications believed to be unrelated to rabies; the fourth pregnant woman contracted rabies too early in pregnancy for the fetus to be viable. Two of the patients sought care from a medical provider or traditional healer; however, none sought PEP after being bitten. In each case, families reported the patient's fear of risk to the fetus or breastfed child as the primary barrier to receiving PEP. These findings highlight the need for public health messaging about the safety and effectiveness of PEP in preventing rabies among all persons with exposures, including pregnant and breastfeeding women.

Investigation and Results

Human rabies cases are reportable to MoH in Vietnam within 48 hours after clinical diagnosis, based on the World Health Organization's probable case definition* (*1*). Probable cases of human rabies are investigated by MoH staff members from the National Rabies Control Program, using a standardized form to collect information on demographics, exposure, clinical symptoms, treatment, barriers to receipt of PEP, and outcomes. Although confirmatory laboratory testing is available, for various reasons including cultural barriers, hesitation by medical providers to collect specimens, and the cost of shipping specimens to the national laboratory, very few specimens are collected (*3*). Vietnam is committed to increasing accessibility of PEP throughout the country. Bite victims can receive care at any district or provincial medical center but are responsible for PEP-associated costs (approximately $153 USD for a full course, about equal to the average monthly salary in Vietnam) (*3*).

To assess risk factors for not receiving rabies PEP, investigation forms for probable rabies cases identified during 2015–2016 were reviewed. To evaluate the accessibility of PEP to the six pregnant or breastfeeding women with rabies, the distance and estimated travel time by automobile or motorized scooter (the primary mode of transportation) to district and provincial-level medical centers from the homes of the six patients were measured. The median age of the six pregnant or breastfeeding women with rabies was 27 years (range = 19–33 years), and all patients had attended at least junior high school (Table). The mean incubation period (from dog exposure to symptom onset) was 85 days (range = 49–126 days). The median interval from symptom onset to death was 2 days (range = 1–4 days).

The six patients resided in four of Vietnam's 63 provinces and major cities. The patients exhibited classic signs and symptoms of rabies, including aerophobia (sensitivity to air movement) (six patients), fever (four), and hydrophobia (four). Because of cultural practices, laboratory confirmation was not available for any of the patients.

Four patients were pregnant at the time of rabies exposure, including three whose pregnancies were at 32–37 weeks' gestation at the time of symptom onset, prompting emergency cesarean delivery. Two neonates survived, and the third died shortly after delivery from complications believed to be unrelated to rabies. The fourth pregnant patient developed rabies at approximately 18 weeks' gestation; therefore, her fetus could not be saved.

Two other patients were breastfeeding children aged <1 year at the time of rabies exposure. Family members reported that mothers expressed concern about the possibility of PEP being transferred to their children through breast milk, fearing that the antibodies could harm the children because of their young age. Ten household contacts, including husbands of the six patients, the two children of the breastfeeding mothers, and two surviving neonates received PEP. All patients were reported to have been aware of both rabies and PEP, but none sought PEP.

*A probable case of rabies is defined as the occurrence of an acute neurological syndrome dominated by forms of hyperactivity or paralytic syndromes progressing toward coma and death, usually by cardiac or respiratory failure, typically within 7–10 days after the first sign, in a patient with a history of animal contact.

TABLE. Selected characteristics, animal exposure, signs and symptoms, and treatment for six fatal rabies cases in pregnant and breastfeeding women — Vietnam 2015–2016

Characteristic	No.
Education	
Junior high school	5
Senior high school	1
Dog bite	6
Status of dog at time of patient exposure	
Normal*	2
Stray	3
Ill	1
Dog rabies vaccination status	
Yes	0
No	2
Unknown	4
Bite location	
Foot or leg	5
Hand or arm	1
Rabies signs and symptoms†	
Aerophobia (sensitivity to movement of air)	6
Anorexia	3
Anxiety	2
Fever	4
Headache	5
Hydrophobia	4
Insomnia	3
Malaise or fatigue	5
Muscle pain or spams	3
Paresthesia or localized pain	2
Wound treatment	
None	2
At home	2
Medical center	1
Traditional healer	1
Received any postexposure prophylaxis	0

* Family reported that the dog appeared normal at the time of exposure. No information was available regarding the status of the dog after 10 days.
† Patients could have multiple symptoms.

Family members reported that the pregnant women were concerned about potential risks to their fetus. Only one patient, a breastfeeding mother, sought medical care after an exposure (Table), but she declined PEP after receiving wound treatment for multiple severe bites to her hand and arm by a stray dog. One of the pregnant patients was reported to have sought care from a traditional healer after being bitten twice on the leg by a stray dog. Family members reported that she had believed that treatment from a traditional healer was safer than PEP. Among the four other bite victims, one treated her wound at home with water, one with water and soap, and two did not treat their bite wound.

None of the family members reported cost or transportation as a specific deterrent to receiving PEP. The average distance from the patients' homes to the provincial medical center where PEP was available was 32.6 miles (range = 9.7–76.4 miles) (52.4 km [range = 15.6–123.0 km]) and time to travel was 78.5 minutes (range = 23–173 minutes). The average distance to the district medical center where rabies vaccine (but not rabies immune globulin) was available was 9.8 miles (range = 3.2–18.7 miles) (15.8 km [range = 5.1–30.1 km]), with a travel time of 30.7 minutes (range = 11–65 minutes).

Discussion

Most of the world's estimated 60,000 annual rabies deaths occur in countries where canine rabies is endemic and where PEP is often inaccessible to bite victims (*4*). When PEP is available, documentation of vaccination hesitancy for prevention of rabies is rare. This investigation identified six rabies deaths among breastfeeding or pregnant women. Based on information provided by family members, these deaths might have been associated with unfounded concerns about vaccine-associated risks to the fetus or breastfed child. A previous U.S. report also documented refusal to receive PEP by a pregnant woman with a potential rabies exposure because of concerns about the effect of PEP in the fetus; that patient did not develop rabies (*5*). Studies have found no increased risk for spontaneous abortions, premature births, or fetal abnormalities among pregnant women after receiving PEP (*2*,*6*,*7*).

A growing body of literature documents peripartum rabies cases. Including the six cases reported here, case reports and a literature review found 20 documented probable or suspected peripartum rabies cases reported during the 114-year period, 1902–2016 (*8*,*9*). A total of 17 neonates survived, and were reported to be healthy, including eight who did not receive vaccine or immunoglobulin after caesarean or vaginal delivery (*8*). Among the three neonates who did not survive, one acquired rabies, and the other two died from complications unrelated to rabies (*8*,*10*).

Vietnam has made progress in reducing human rabies deaths. The number of human rabies cases declined 82%, from 505 cases in 1994 to 91 in 2016 (*3*). The expansion of PEP centers in the country has played a critical role in this reduction by increasing access to PEP. National PEP surveillance data indicate that an average of 400,000 vaccine doses are administered and 32,000 persons receive rabies immune globulin each year (*3*). However, work is needed to understand and address the barriers to rabies treatment among pregnant and breastfeeding women. In this investigation, only one of the six pregnant or breastfeeding bite victims sought medical care after an exposure.

One strategy aimed at improving health care–seeking behavior and PEP acceptance is training village health workers to educate community members, including pregnant and breastfeeding women, regarding treatment options for rabies and the safety of PEP. Village health workers are respected in the community and are often sought for health advice on matters including prenatal nutrition and childhood illness. These health workers could also alert health authorities about

Summary

What is already known about this topic?

Human rabies deaths are preventable through prompt administration of postexposure prophylaxis (PEP) with rabies immune globulin and rabies vaccine after exposure to rabid animals. Rabies PEP is safe for use among pregnant and breastfeeding women; studies have found no increased risk for spontaneous abortions, premature births, or fetal abnormalities among pregnant women after receiving PEP.

What is added by this report?

During 2015–2016, six probable cases of rabies were reported among pregnant and breastfeeding women in Vietnam. None of the six patients sought PEP after exposure. In each case, families reported the patients' fear of risk to the fetus or breastfed child as the primary barrier to the women receiving PEP.

What are the implications for public health practice?

One strategy aimed at improving health care–seeking behavior and PEP acceptance is training village health workers to educate community members, including pregnant and breastfeeding women, regarding treatment options for rabies and the safety of PEP. As more countries expand access to PEP, special attention should focus on addressing vaccine hesitancy, particularly among pregnant and breastfeeding women, and improving education of community health workers.

animal exposures, prompting a community investigation to identify additional exposures. Educating traditional healers about rabies, the importance of PEP, and legal ramifications of rabies treatment by traditional healers might prevent additional cases through proper medical treatment. All six dogs associated with these cases were unvaccinated or had an unknown vaccination history, suggesting a need for improvement in the canine rabies vaccination programs in Vietnam.

Although PEP is viewed favorably by the general population in Vietnam, these findings suggest that some community members lack knowledge about its safety and appropriateness for pregnant and breastfeeding women. Given that rabies is almost always fatal in unvaccinated persons, there is an urgent need for public health messaging about the safety and effectiveness of PEP, including for pregnant and breastfeeding women.

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Conflict of Interest

No conflicts of interest were reported.

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Progress Toward Poliomyelitis Eradication — Nigeria, January–December 2017

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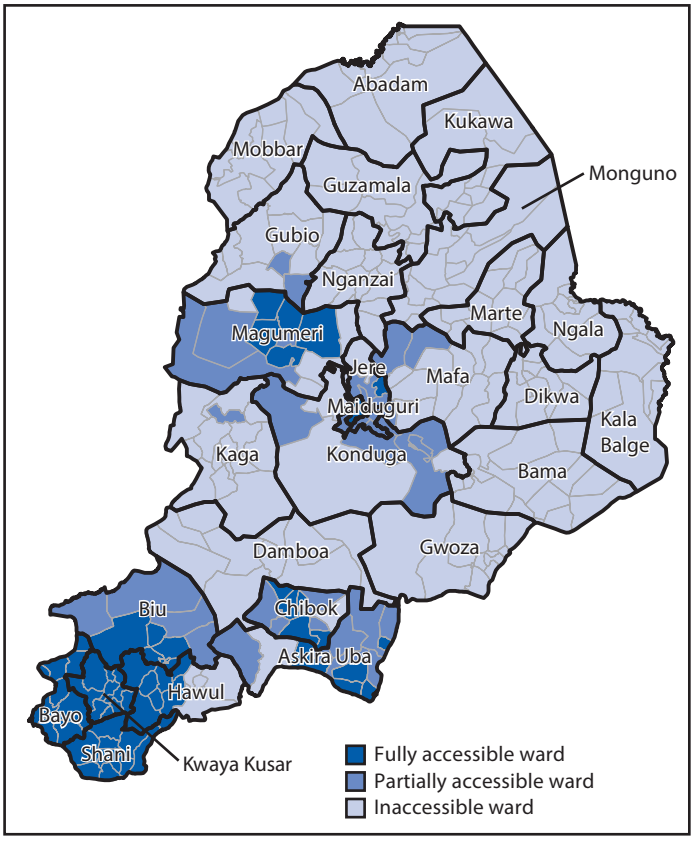
Nearly three decades after the World Health Assembly launched the Global Polio Eradication Initiative in 1988, four of the six World Health Organization (WHO) regions have been certified polio-free (*1*). Nigeria is one of three countries, including Pakistan and Afghanistan, where wild poliovirus (WPV) transmission has never been interrupted. In September 2015, after >1 year without any reported WPV cases, Nigeria was removed from WHO's list of countries with endemic WPV transmission (*2*); however, during August and September 2016, four type 1 WPV (WPV1) cases were reported from Borno State, a state in northeastern Nigeria experiencing a violent insurgency (*3*). The Nigerian government, in collaboration with partners, launched a large-scale coordinated response to the outbreak (*3*). This report describes progress in polio eradication activities in Nigeria during January–December 2017 and updates previous reports (*3–5*). No WPV cases have been reported in Nigeria since September 2016; the latest case had onset of paralysis on August 21, 2016 (*3*). However, polio surveillance has not been feasible in insurgent-controlled areas of Borno State. Implementation of new strategies has helped mitigate the challenges of reaching and vaccinating children living in security-compromised areas, and other strategies are planned. Despite these initiatives, however, approximately 130,000–210,000 (28%–45%) of the estimated 469,000 eligible children living in inaccessible areas in 2016 have not been vaccinated. Sustained efforts to optimize surveillance and improve immunization coverage, especially among children in inaccessible areas, are needed.

Security Situation

During the past 8 years, Borno State in northeastern Nigeria has been at the center of an insurgency that has affected other Nigerian states including Adamawa, Gombe, and Yobe and the neighboring Lake Chad Basin countries of Cameroon, Chad, and Niger. Insecurity in this region has led to a major humanitarian emergency, with forced displacement of an estimated 2.1 million persons within Nigeria and 200,000 refugees seeking shelter in other countries (*6*). At the height of the insurgency in 2015, 60% of settlements were inaccessible for implementation of vaccination and surveillance activities (Figure 1). Security assessments conducted during December 2017 in Borno State indicate that of the 27 districts (local government areas [LGAs]), eight (30%) are fully accessible to polio eradication program personnel, 17 (63%) are accessible only by polio eradication program personnel with military escorts, and two (7%) are accessible only by combat-ready military personnel. Overall, an estimated 30% of subdistrict level communities (settlements) in Borno State were fully inaccessible to personnel in the Nigeria polio eradication program. Analyses of satellite imagery conducted in October 2017 estimated that approximately 130,000–210,000 (28%–45%) of the estimated 469,000 children aged ≤5 years living in inaccessible areas in Borno State in 2016 had not been reached by polio vaccination or surveillance efforts.

FIGURE 1. Accessibility of local government areas to polio eradication program personnel, by ward — Borno State, Nigeria, September 2015



Poliovirus Surveillance

Acute Flaccid Paralysis Surveillance. During 2016 and 2017, Nigeria met major acute flaccid paralysis (AFP) performance indicators for all states, including the nonpolio AFP (NPAFP)

rate (which assesses surveillance system sensitivity) and stool adequacy (which assesses the timeliness and appropriateness of investigation of suspected cases) (*7*). In Borno State, NPAFP rates of 27.0 (2016) and 24.5 (2017) cases per 100,000 children aged <15 years were reported, exceeding the target of three per 100,000. Among all persons with reported AFP, 95% in 2016 and 90% in 2017 had two adequate stool specimens collected 24–48 hours apart and ≤14 days after paralysis onset (target = 80%). However, the population in the security-compromised areas have not been accessible for surveillance efforts. In addition, concerns about the quality of case detection and investigation in accessible areas of Borno State and Adamawa, Taraba, and Yobe states in the Northeast and Kaduna and Sokoto states in the Northwest were identified through surveillance assessments in 2017, and indicate the potential to miss detection of poliovirus transmission elsewhere in Nigeria.

Surveillance system strengthening measures were implemented in 2016 and 2017, including increased AFP case searches among camps for internally displaced persons in Borno State, engagement of community informants from inaccessible areas, and retrospective active case searches in newly accessible areas. To improve timeliness and accuracy of AFP case reporting in geographic hard-to-reach areas, a mobile phone application, Auto-Visual AFP Detection and Reporting (AVADAR), was implemented, starting in selected high priority LGAs in Borno State and Adamawa, Sokoto, and Yobe states (*8*). Despite these efforts, 25 of 27 LGAs in Borno State had settlements that were inaccessible for surveillance in 2016 and 2017, including all of Abadam and Marte LGAs (Figure 1).

Environmental Surveillance. Environmental surveillance, through testing wastewater sampled at selected sites, can be a sensitive supplement to AFP surveillance for detection of polioviruses. During 2017, the number of such sites increased 33%, from 56 in 30 LGAs to 70 in 35 LGAs. As of December 2017, 18 of the 37 state-level jurisdictions in Nigeria had at least one environmental surveillance site. In addition, the frequency of sample collection at most surveillance sites has increased from once to twice monthly in many states, and more frequently in Borno State and some other high-risk areas. Seven wastewater collection sites can be found in the metropolitan area of Maiduguri, the capital of Borno State. In 2017, no circulating vaccine derived poliovirus type 2 (cVDPV2) or WPV isolates were detected through environmental surveillance.

WPV and cVDPV Cases

After the switch from trivalent oral polio vaccine, which contains polio vaccine virus types 1, 2, and 3 to bivalent oral polio vaccine (bOPV) (types 1 and 3) in April 2016, enhanced laboratory testing using viral sequencing methods for type 2 poliovirus isolates was introduced to improve laboratory case detection. Since September 2016, no WPV cases have been reported in Nigeria. A cVDPV2 case was last identified in Sokoto in October 2016.

Vaccination Activities

During 2017, eight mass vaccination campaigns (supplementary immunization activities [SIAs]) were conducted in Nigeria (Table). The first SIA in January was part of a response to the detection of cVDPV2 isolates in Borno State in March and August 2016 and in Sokoto in October 2016 (*3*). Two national-level SIAs were conducted in March and April;

TABLE. Polio supplementary immunization activity dates, antigen types, coverage, and reported lot quality assurance sampling results — Nigeria, 2017

SIA date in 2017	Vaccine antigen type	Target area	No. children vaccinated	LGAs achieving ≥90% coverage on LQAS* (%)
Jan 28–31	mOPV2	18 northern states†	32,360,489	89
Feb 25–28	bOPV	14 states at the highest risk for polio§	25,350,055	87
Mar 25–28	bOPV	All 36 states + FCT	57,937,250	75
Apr 29–Aug 22¶	bOPV	All 36 states + FCT	57,928,320	77
May 20–30**	IPV + mOPV2	Sokoto	463,963 (IPV) 1,893,914 (mOPV2)	91
Jul 8–11	bOPV	18 northern states†	32,449,576	85
Oct 6–24††	bOPV	18 northern states†	31,242,217	78
Nov 4–14	bOPV	7 highest priority states§§	9,847,162	89

Abbreviations: bOPV = bivalent oral poliovirus types 1 and 3; FCT = federal capital territory; IPV = inactivated polio vaccine; LGAs = local government areas; LQAS = lot quality assurance sampling; mOPV2 = monovalent oral poliovirus type 2; SIA = supplemental immunization activity.

* ≥90% coverage achievement pass mark on LQAS set by Nigeria polio program.

† 18 states included Abuja and the Federal Capital Territory, Adamawa, Bauchi, Borno State, Gombe, Jigawa, Kaduna, Kano, Katsina, Kebbi, Kogi, Nasarawa, Niger, Plateau, Sokoto, Taraba, Yobe, and Zamfara.

§ 14 states included Abuja and the Federal Capital Territory, Adamawa, Bauchi, Borno State, Gombe, Jigawa, Kaduna, Kano, Katsina, Nasarawa, Sokoto, Taraba, Yobe, and Zamfara.

¶ Campaign staggered across states to improve effectiveness and quality.

** Response to vaccine-derived poliovirus isolation.

†† Campaign in Borno State coordinated with other Lake Chad Basin countries.

§§ Seven states included Adamawa, Bauchi, Borno, Gombe, Sokoto, Taraba, and Yobe.

approximately 58 million children were vaccinated during each round. SIA performance was evaluated using lot quality assurance sampling (LQAS) methodology, which provides a quick and reliable immunization campaign assessment; >90% of LGAs surveyed passed the 80% LQAS threshold.

In collaboration with the Nigerian military, two measures have been employed to increase poliovirus immunity among children in insecure areas of Borno and Yobe states. The Reaching Every Settlement initiative engages civilian vigilante and military support to reach children in settlements in which vaccinators require security escorts. During 2017, approximately 251,000 children in 2,921 settlements were vaccinated during 16 Reaching Every Settlement rounds. The Reaching Inaccessible Children initiative deploys military personnel with basic vaccination training to vaccinate children living in settlements that can only be accessed by combat-ready military personnel. During 2017, six Reaching Inaccessible Children rounds vaccinated 50,196 children in 1,412 inhabited settlements.

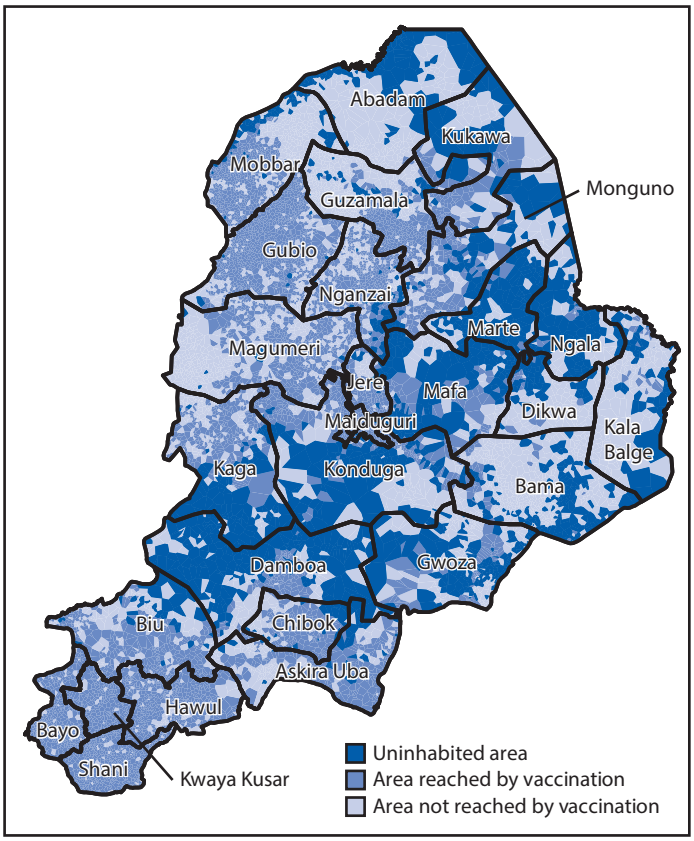
Assessment of vaccination status of children arriving in camps for internally displaced persons from insurgent-held areas is conducted to help monitor progress in vaccinating children living in inaccessible areas. Other efforts aimed at improving population immunity include vaccination at markets and international borders and outreach to nomadic and migrant populations. In-depth analysis of satellite imagery to identify inaccessible areas (*9*) has facilitated identification and characterization of settlements and populations in areas inaccessible to polio program personnel (Figure 2), helping guide the implementation of targeted approaches to reach and immunize eligible children in these areas.

The routine immunization schedule for Nigeria includes bOPV at birth, followed by 3 additional bOPV doses at ages 6, 10, and 14 weeks. In 2015, a single dose of inactivated poliovirus vaccine was also included in the routine immunization schedule at age 14 weeks. During 2016–2017, a national coverage survey estimated that overall, 33% of children aged 12–23 months were fully vaccinated against polio, although large variations were observed by state, ranging from 7% in Sokoto and Yobe to 75% in Lagos.

Discussion

Since the identification of four WPV cases in Borno State in 2016, the Nigerian polio program has intensified polio eradication activities, especially in areas experiencing insurgency. However, the ability of program personnel to implement eradication activities, including high quality surveillance and vaccination, has been limited because of ongoing insurgency-related inaccessibility to areas in Borno State and other states in the country's northeast and northwest areas.

FIGURE 2. Polio vaccination coverage, by area — Borno State, Nigeria, August 2016–October 2017



Because of military interventions against the insurgency, the percentage of settlements that are inaccessible to polio eradication personnel has been reduced from 60% in September 2015 to approximately 30% in December 2017. Implementation of the Reaching Every Settlement and Reaching Inaccessible Children strategies has helped reach some of the children living in areas inaccessible to house-to-house vaccination teams, and at least five contacts with children eligible for immunization in these areas are planned. Children reached by these initiatives need to be tracked to ensure receipt of the multiple OPV doses needed to complete the immunization series. Increased involvement of the military in implementing Reaching Every Settlement and Reaching Inaccessible Children strategies is planned in 2018 to reach as many children as possible in inaccessible areas.

The low OPV3 coverage among children aged 12–23 months in the 2016–2017 national vaccination survey reflects persistently poor delivery of routine immunization services, particularly in states in northeast and northwest Nigeria (*10*). A National Emergency Routine Immunization Coordinating Center has been commissioned to identify and implement strategies to increase vaccination coverage, starting in the poorest performing states. Understanding reasons for the persistently low coverage in the northeast and northwest

Summary

What is already known about this topic?

In August 2015, the World Health Organization removed Nigeria from the list of polio-endemic countries because of the high likelihood that endemic wild poliovirus (WPV) circulation had been interrupted in Nigeria. However, during August and September 2016, four WPV cases were reported in Borno State, a northeastern Nigerian state experiencing protracted insurgency.

What is added by this report?

No WPV cases have been reported since September 2016. New strategies implemented by the Nigeria polio program have helped improve polio eradication activities, including those in areas with security challenges. However, approximately 28%–45% of eligible children living in the inaccessible areas have not been vaccinated, and surveillance has not been feasible in insurgent-controlled areas of Borno State.

What are the implications for public health practice?

Although access to communities for polio eradication activities continues to improve, approximately 30% of subdistrict level communities in Borno State remain inaccessible because of insurgency-related insecurity. Sustained efforts are needed to optimize surveillance and improve immunization coverage, especially among children in inaccessible areas.

areas despite years of investment is a major focus in planning remedial activities.

Surveillance activities have been strengthened since the last reported WPV case in Nigeria in September 2016, including expanding the number of environmental surveillance sites and increasing the number of surveillance community informants who reside in areas with limited access for polio program personnel in the states of Borno and Yobe to alert the program of potential AFP cases. Although national surveillance performance indicators are high, there are concerns about ongoing undetected poliovirus circulation in inaccessible areas; ongoing undetected poliovirus circulation is also possible in some accessible areas of Borno and other states where concerns about case investigation quality were identified.

Efforts to address the impediments created by insecurity and geographic access limitations continue to be implemented and expanded. Searching for recent AFP cases in security-compromised areas is one objective of the Reaching Every Settlement and Reaching Inaccessible Children initiatives. A commitment to strengthening routine and supplementary immunization coverage in all areas of the country is needed, as are efforts to ensure high quality surveillance.

Conflict of Interest

No conflicts of interest were reported.

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Notes from the Field

HIV Infection Investigation in a Rural Area — West Virginia, 2017

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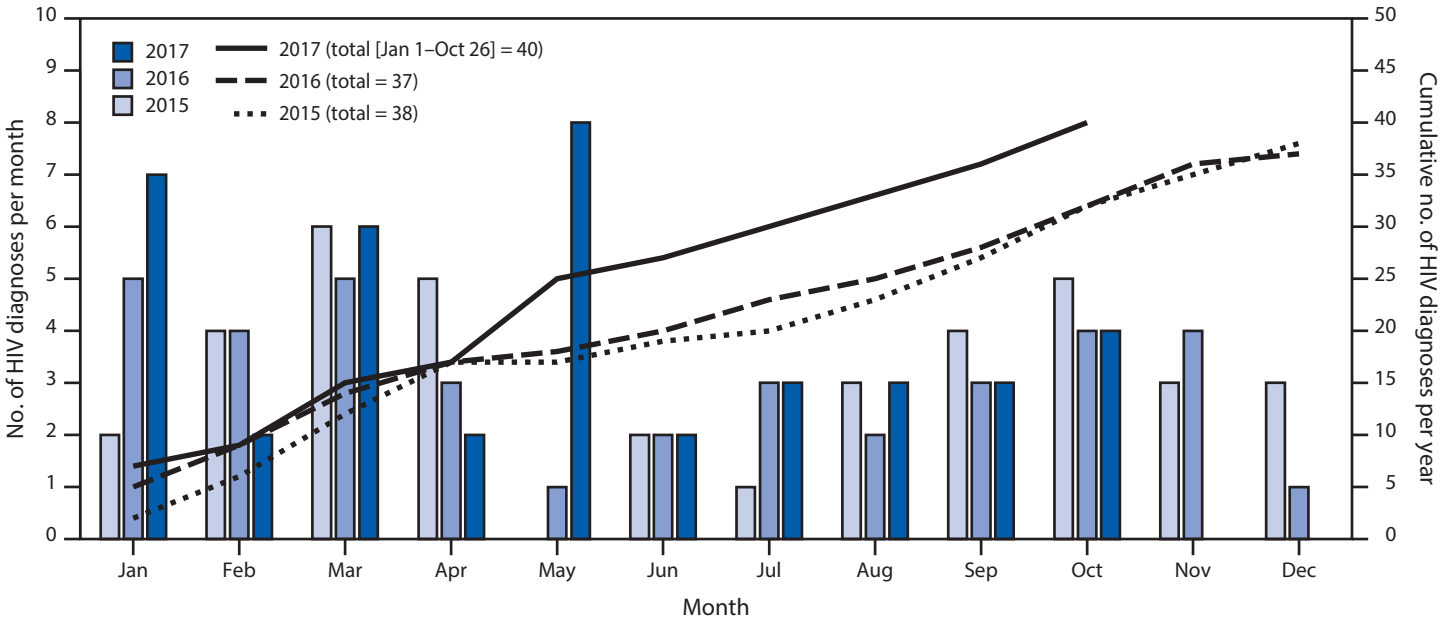
From January to July 2017, the West Virginia Department of Health and Human Resources (WV DHHR) identified 10 cases of human immunodeficiency virus (HIV) infection in three counties where HIV diagnoses typically range from six to 13 annually (*1*). In these counties, the spread of bloodborne pathogens via injection drug use (IDU) is a major public health concern, and risk reduction programs offering syringe services were not available, although they were available in other counties (*2*,*3*). As of July 2017, nine of the 10 persons identified were men who have sex with men (MSM), two of whom had reported a prior history of IDU. Coinfections with syphilis (five patients), hepatitis B virus (three), and hepatitis C virus (HCV) (two) were also documented. By September 2017, the sexual or injection contacts named by persons in the investigation expanded the original assessment area to encompass 15 counties, 14 of which were among the nation's top 220 counties thought to be particularly vulnerable to rapid spread of HIV and HCV infections via IDU (*4*). The investigated counties share some characteristics with rural Scott County, Indiana, where an HIV outbreak was linked to IDU in 2015 (*5*), including a high prevalence of drug overdose deaths, prescription opioid sales, and unemployment.

WV DHHR and CDC reviewed HIV surveillance and partner services data to identify persons with HIV infection diagnosed in 2017 who resided in one of the 15 counties at the time of diagnosis. These included HIV-infected persons who were epidemiologically linked (sex or IDU partner) or molecularly linked (by closely related HIV nucleotide sequences at a distance of ≤0.005 substitutions per site) to at least one case diagnosed in 2017 who resided in one of the 15 counties at the time of diagnosis. In addition, information on available health care services was obtained through individual interviews with 18 local providers and five persons from the investigation who had HIV infection.

As of October 26, 2017, the investigation had identified 57 persons with diagnosed HIV infection, including 40 cases (73%) diagnosed in 2017 (Figure) and 17 cases diagnosed before 2017 that were epidemiologically linked (11 cases) or molecularly linked (six). Males accounted for 51 (89%) persons with HIV infection; 43 (75%) were white, and 28 (49%) were

FIGURE. Number of HIV diagnoses per month and cumulative number of diagnoses per year — 15 West Virginia counties, 2015–2017



Abbreviation: HIV = human immunodeficiency virus.

aged <30 years. The mode of transmission was male-to-male sexual contact in 34 cases (60%), IDU in five (9%), both male-to-male sexual contact and IDU in three (5%), heterosexual contact in two (4%), and unknown in 13 (23%). Ten (18%) persons had HIV Stage 3 (acquired immunodeficiency syndrome [AIDS]) at the time of diagnosis. All 40 persons with HIV infection diagnosed in 2017 had been linked to HIV care; 13 (77%) of the 17 persons diagnosed before 2017 had an HIV medical care visit in the past 6 months.

Risk reduction programs that provide syringe services are available in three of the 15 counties (none of the original three counties in the investigation). HIV testing is available at all 15 county health department clinics. HIV medical care providers are available in three counties (including one of the original counties in the investigation). Ryan White HIV/AIDS Program case management services, which support organizations to deliver HIV care and treatment for low-income persons living with HIV infection, are available throughout the state. Providers who offer preexposure prophylaxis for prevention of HIV infection are available in clinic settings in four counties (including two of the original counties in the investigation). Local providers and persons with HIV infection who were interviewed described stigma, transportation from remote areas, and poor health literacy as challenges to HIV testing in rural areas.

WV DHHR implemented strategies to limit further transmission of HIV among the MSM population and among persons who inject drugs. WV DHHR is expanding access to HIV testing and plans to work with county health departments to implement additional preexposure prophylaxis clinics. For example, a geotargeted advertisement in the 15 counties on popular MSM-focused social media sites was purchased to encourage HIV testing. In addition, in November, WV DHHR selected 11 health care entities across West Virginia for funding, including entitites in five of the counties in this investigation, to support comprehensive community-level prevention programs that include syringe services programs where they are permitted and desired. Continued efforts are underway to further characterize the HIV transmission network and potential HIV transmission through IDU risk behavior among patients and their extended contact networks.

Conflict of Interest

Nivedha Panneer reports stock ownership in Gilead Sciences, outside the current work. No other conflicts of interest were reported.

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Notes from the Field

Occupational Hazards Associated with Harvesting and Processing Cannabis — Washington, 2015–2016

Kerton R. Victory, PhD[1]; James Couch, PhD[2]; Brian Lowe, PhD[3]; Brett J. Green, PhD[4]

Although the possession, use, and sale of all forms of cannabis are illegal under U.S. federal law, since 2012, multiple states have legalized the retail sale of cannabis for medical and recreational use (*1*). Previous research studies have indicated that Δ9-tetrahydrocannabinol (Δ9-THC), the principal psychoactive constituent of cannabis, can cause acute and chronic health effects (*2*). However, health effects from long-term occupational exposures to cannabis during harvesting and processing are unknown, in part because most studies have focused primarily on nonoccupational settings (*3*). In June 2015, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation (HHE) from a representative of the United Food and Commercial Workers International Union to evaluate potential health and safety hazards associated with harvesting and processing cannabis at an outdoor farm.

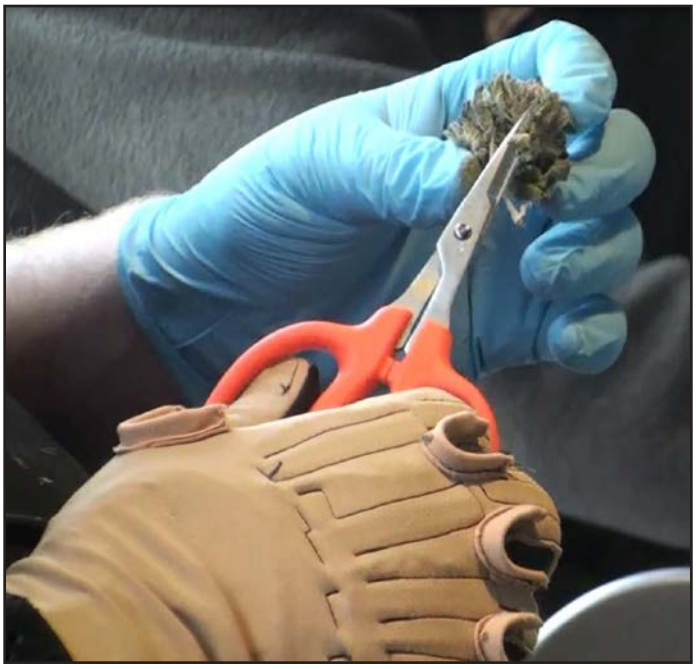
In response to the request, NIOSH visited the farm in August and October 2015. The farm was located in Washington; the state had legalized cannabis for medicinal use in 1998 and recreational use in 2012. At the time of the HHE, the farm was operated by the owner and three employees. The 5-acre farm did not use any pesticides and grew cannabis, vegetables, and fruits. During the visit, the owner and all three employees were interviewed about their work, safety, and health concerns. Work practices were observed, and musculoskeletal risk factors for the hands, wrists, and shoulders during harvesting and processing tasks were evaluated. Digital force gauges and pinch gauges were used to assess manual hand forces during destemming, and a CyberGlove electrogoniometer glove (http://www.cyberglovesystems.com/) was used to assess dynamics and repetitive motion of the hand and fingers in trimming. Area and personal air samples were collected to test for gram-negative bacterial lipopolysaccharide (commonly referred to as endotoxin) and to determine bacterial and fungal diversity using 16S ribosomal RNA (16S rRNA) and fungal internal transcribed spacer (ITS) region gene sequencing, respectively (4). Exposure to these biologic hazards can increase the risk for allergic and respiratory symptoms (2). Surface wipe samples were collected and analyzed for Δ9-THC using ultra high performance liquid chromatography tandem mass spectrometry (*5*).

The owner and all three employees reported performing several tasks at the farm, including harvesting, bud stripping, and trimming. No one reported hand, wrist, or shoulder symptoms or other musculoskeletal problems. However, employees did express concerns about whether they might develop long-term musculoskeletal problems because of manually hand trimming cannabis. Harvesting tasks were observed and recorded by photograph and video. Analysis indicated that hand trimming of cannabis (Figure) involved low hand forces but was highly repetitive work.

Personal, full-shift endotoxin air sample concentrations ranged from 2.8 to 37 endotoxin units per cubic meter, which was below the Dutch Expert Committee on Occupational Safety recommended occupational exposure limit of 90 endotoxin units per cubic meter. No U.S. occupational exposure limits for endotoxin are available. Analysis of bacterial diversity revealed outdoor area air samples composed of sequences derived from the phyla Proteobacteria (34%) and Actinobacteria (23%), whereas personal air samples were predominantly composed of sequences derived from the phylum Actinobacteria (47%). In contrast, sequencing of fungal ITS regions revealed a diversity composed of sequences predominantly assigned to the phylum Basidiomycota in outdoor (91%) and drying room samples (70%), whereas personal air samples had a lower fungal diversity predominantly composed of the Ascomycota fungal species, *Botrytis cinerea* (59%). This fungal species is a well-characterized aeroallergen and plant pathogen of cannabis. Δ9-THC was detected in all 27 surface sample wipes collected in cannabis production areas ranging from 0.17 to 210 μg per 100 cm^2.

The findings of this HHE indicated that the employees have exposures to highly repetitive work, most notably during hand trimming activities, which increase workers' risk for musculoskeletal disorders (*6*). Worker exposure to aerosolized Actinobacteria and fungi such as *B. cinerea*, might also result from processing and hand trimming activities, which can increase the risk for allergic and respiratory symptoms, as has previously been observed in the cannabis processing industry (*2*). Δ9-THC surface wipe concentrations indicated the potential for dermal and ingestion exposures. However, the health implications from long-term occupational exposure to Δ9-THC are unknown. Detailed information is available in the final HHE report (https://www.cdc.gov/niosh/hhe/reports/pdfs/2015-0111-3271.pdf). The NIOSH HHE program (https://www.cdc.gov/niosh/hhe/) continues to evaluate potential hazards associated with the harvesting and processing of cannabis and will provide updated

FIGURE. Hand trimming of cannabis flower using scissors while wearing a CyberGlove



Photo/National Institute for Occupational Safety and Health

recommendations to educate employers and employees on the occupational hazards associated with the harvesting and processing of cannabis plants.

Acknowledgments

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Conflict of Interest

No conflicts of interest were reported.

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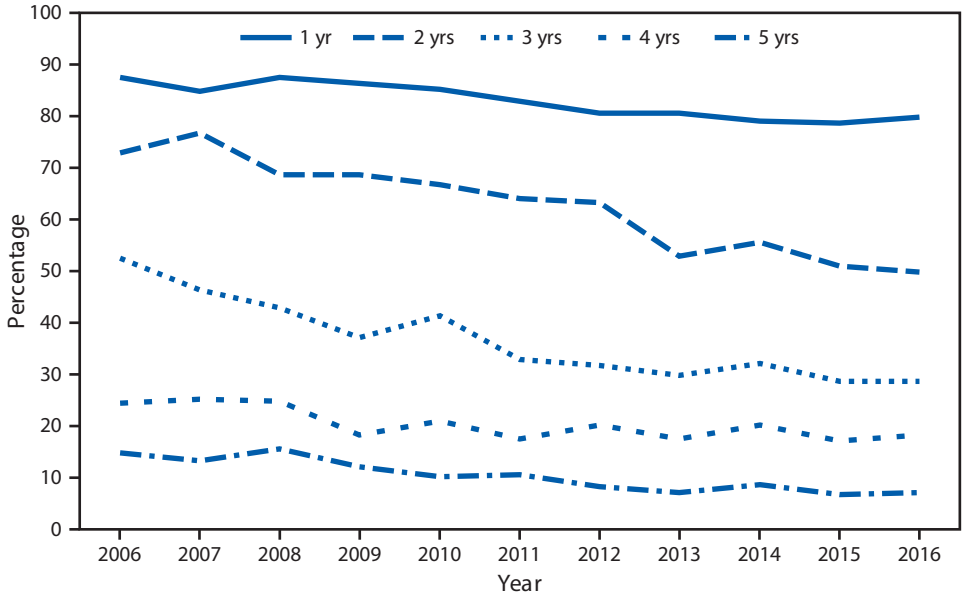
QuickStats

FROM THE NATIONAL CENTER FOR HEALTH STATISTICS

Percentage of Children Aged 1–5 Years Who Had Never Been to a Dentist,* by Age and Year — National Health Interview Survey,† United States, 2006–2016



* Based on a response of "never" to the question "About how long has it been since (sample child) last saw a dentist? Include all types of dentists, such as orthodontists, oral surgeons, and all other dental specialists, as well as dental hygienists."

† Estimates are based on household interviews of a sample of the civilian, noninstitutionalized U.S. population and are derived from the National Health Interview Survey Sample Child component.

During 2006–2016, the percentage of children aged 1–5 years who had never seen a dentist decreased as age increased. In 2016, 80.2% of children aged 1 year, 49.7% of children aged 2 years, 28.6% of children aged 3 years, 18.3% of children aged 4 years, and 6.8% of children aged 5 years had never seen a dentist. For all ages, the percentage of children who had never seen a dentist declined from 2006 to 2016.

Source: National Health Interview Survey, 2006–2016. https://www.cdc.gov/nchs/nhis/index.htm.

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